Leidraad Duurzaamheid in richtlijnen

Toevoegen van duurzaamheidsaspecten in richtlijnontwikkeling

Deel A: Methodologische handreiking

INITIATIEF
Nederlandse Vereniging voor Heelkunde

IN SAMENWERKING MET
Nederlandse Vereniging voor Obstetrie en Gynaecologie
Nederlands Oogheelkundig Gezelschap
Nederlandse Orthopaedische Vereniging
Nederlandse Vereniging van Anesthesiemedewerkers
Nederlandse Vereniging voor Anesthesiologie
Nederlandse Vereniging voor KNO-Heelkunde en Heelkunde van het Hoofd-Halsgebied
Nederlandse Vereniging voor Plastische Chirurgie
Nederlandse Vereniging voor Urologie
Vereniging voor Hygiëne & Infectiepreventie in de Gezondheidszorg
Zorginstituut Nederland
Nederlandse Vereniging voor Dermatologie en Venereologie

MET ONDERSTEUNING VAN
Kennisinstituut van de Federatie Medisch Specialisten

FINANCIERING
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Colofon
CONCEPT LEIDRAAD DUURZAAMHEID
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Inhoudsopgave Leidraad

1. Samenstelling van de werkgroep

Werkgroep

- Dhr. dr. F.W. Jansen (voorzitter), gynaecoloog, NVOG
- Mevr. dr. N.D. de Bouvy, chirurg, NVVH
- Mevr. drs. I.R. van den Berg, uroloog, NVU
- Dhr. drs. P.W. van Egmond, orthopedisch chirurg, NOV
- Dhr. dr. R.J.H. Ensink, KNO arts, NVKNO
- Mevr. drs. N. de Haas, plastische (hand-)chirurg, NVPC (vanaf januari 2022)
- Mevr. dr. A. Kwee, gynaecoloog, NVOG
- Mevr. dr. N.C. Naus-Postema, oogarts, NOG
- Mevr. drs. K.E. van Nieuwenhuizen, arts-onderzoeker, Leids Universitair Medisch Centrum
- Mevr. drs. C.S. Sie, anesthesioloog, NVA
- Dhr. drs. N.A. Noordzij, plastisch chirurg, NVPC (tot december 2021)
- Dhr. dr. E.S. Smits, plastisch chirurg, NVPC
- Mevr. dr. K.E. Veldkamp, arts-microbioloog, NVMM
- Mevr. drs. F.J.M. Westerlaken, deskundige Infectiepreventie, VHIG

Meelezers in klankbordgroep

- Dhr. dr. ir. J.B. Guinée, persoonlijke titel (hoogleraar Life Cycle Assessment, Universiteit Leiden)
- Mevr. ir. P. de Heer, adviseur; Zorginstituut Nederland
- Dhr. drs. Y. Lam, dermatoloog i.o., NVDV
- Mevr. dr. M.W. Langendam, persoonlijke titel (epidemioloog, AmsterdamUMC)
- Mevr. dr. J.H. van der Lee, senior adviseur, Kennisinstituut van de Federatie Medisch Specialisten
- Mevr. D. Malenica-Nusse, anesthesie medewerker, NVAM

Met ondersteuning van:

- Dhr. ir. T.A. van Barneveld, directeur, Kennisinstituut van de Federatie Medisch Specialisten
- Dhr. drs. A.A. Lamberts, senior adviseur, Kennisinstituut van de Federatie Medisch Specialisten
- Mevr. dr. C.T.J. Michels, adviseur, Kennisinstituut van de Federatie Medisch Specialisten

2. Schematisch overzicht

Fase 1. Inventariseren en prioriteren van te ontwikkelen richtlijnmodules

Stappen	Aanbevelingen
1. Samenstellen werkgroep/cluster en startgesprek voorzitter 2. Patiëntenparticipatie 3. Knelpunteninventarisatie en need-for-update 4. Vaststellen en verspreiden raamwerk	*Voor werkgroepleden* Denk aan duurzaamheid bij het opstellen van het raamwerk en samenstellen van de werkgroep. *Voor richtlijnadviseurs* Maak het onderwerp duurzaamheid onderdeel van het startgesprek met de voorzitter. Indien de richtlijn een onderwerp bevat waar duurzaamheid een potentieel knelpunt is: • Neem duurzaamheid expliciet mee in de knelpunteninventarisatie • Besteed specifiek aandacht aan duurzaamheid bij het vaststellen van het raamwerk. • Overweeg het consulteren van een deskundige met expertise op facetten van duurzaamheid. Denk hierbij bijvoorbeeld aan een deskundige in het kader van afval, inkoop of Life Cycle Assessments (LCA's).

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Fase 2. Ontwikkeling van modules

Stappen	Aanbevelingen

5. Opstellen van uitgangsvragen en zoekvragen
6. Vaststellen, definiëren en prioriteren van uitkomstmaten
7. Literatuur zoeken en selecteren
8. Literatuur beoordelen en samenvatten
9. Overwegingen formuleren
10. Aanbevelingen formuleren
11. Ontwikkeling aanverwante producten
	Voor werkgroepleden
	Indien een module specifiek op duurzaamheid wordt gericht:
	• Laat duurzaamheid zo concreet mogelijk aan bod komen in de 'overwegingen' en gebruik hierbij de 'R-ladder (strategieën van circulariteit)'.
	• Beveel het meest duurzame alternatief aan bij gelijke effectiviteit en veiligheid.
	
	Voor richtlijnadviseurs
	Indien een onderwerp binnen het kader duurzaamheid valt:
	• Neem (een) duurzaamheidsuitkomst(en) op in de zoekvraag en pas het duurzaamheids-zoekblok toe.
	• Indien een Life Cycle Assessment (LCA) wordt uitgewerkt in de literatuursamenvatting van de module:
	  • pas de GRADE-methodiek toe en wees transparant in de beschrijving van de beoordeling volgens GRADE;
	  • gebruik de LCA 'evidence tabel' om het wetenschappelijk bewijs te presenteren; en
	  • raadpleeg de LCA 'critical appraisal' om de kwaliteit te beoordelen.

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Fase 3. Afronding en publicatie

Stappen	Aanbevelingen
12. Commentaarfase 13. Autorisatiefase 14. Thuisarts informatie ontwikkelen 15. Publicatie op Richtlijnendatabase	*Voor werkgroepleden* • Indien duurzaamheid een rol speelt, zorg dat voor patiënten informatie beschikbaar is over de duurzaamheidsaspecten van de behandeling/ingreep. • Wees bewust van duurzaamheid bij de ontwikkeling van de Thuisarts-teksten. Hierbij kan Thuisarts.nl een actieve rol spelen. *Voor richtlijnadviseurs* Geef extra aandacht aan duurzaamheid bij het nieuwsbericht dat gepubliceerd wordt over de richtlijn op de Richtlijnendatabase, indien duurzaamheid een rol speelt. Informeer ook het Landelijk netwerk Groene OK hierover.

3. Aanleiding en doel

Aanleiding

De gezondheidszorg wordt geconfronteerd met de effecten van klimaatverandering op de gezondheid van mensen. De zorgsector heeft zelf ook invloed op het milieu en het klimaat. Uit eerdere studies is gebleken dat de CO_2-uitstoot door de gezondheidszorg 6-8% bedraagt van de totale jaarlijkse CO_2-uitstoot van Nederland (Pichler, 2019; de Bruin, 2019; Karliner, 2019; Steenmeijer, 2022). De zorgsector is daarnaast verantwoordelijk voor 4% van het afval in Nederland en voor 13% van het grondstoffengebruik (e.g. metalen, mineralen) (Steenmeijer, 2022). Ook belanden er medicijnresten in het oppervlakte- en grondwater door het gebruik van medicatie en het onjuist weggooien.

Operatiekamers zijn wat betreft vierkante meters meestal klein in relatie tot de oppervlakte van een heel ziekenhuis. En hoewel operatiekamers slechts 6-10% innemen van de totale fysieke ziekenhuisruimtes, zijn operatiekamers verantwoordelijk voor 30% van het totale ziekenhuisafval (Groene OK, 2021). Hiermee behoren operatiekamers tot de grootste 'interne vervuilers' van een ziekenhuis. Geschat wordt dat 20-30% van het totale ziekenhuisafval afkomstig is van de operatiekamer (Axelrod, 2014). Ook worden 30-40% van alle materialen die dagelijks een ziekenhuis binnenkomen verbruikt op de OK (Radboudumc, 2023). Daarnaast hebben operatiekamers een relatief hoge energieconsumptie door de luchtbehandeling en een relatief grote uitstoot van inhalatieanesthetica (MacNeill, 2017; Eckelman, 2018). Kortom, chirurgische activiteiten genereren een aanzienlijke ecologische voetafdruk. Naar verwachting kunnen op operatiekamers CO_2-uitstootreducerende maatregelen en behandelkeuzes een belangrijke bijdrage leveren aan het terugdringen van de CO_2-uitstoot van het ziekenhuis als geheel.

Het huidige Nederlandse klimaatbeleid is erop gericht om de landelijke CO_2-uitstoot met 55% te reduceren ten opzichte van 1990 (Rijksoverheid, 2019). Voor de Nederlandse zorgsector is deze ambitie vastgelegd in de Green Deal Zorg 3.0 'Samen werken aan duurzame zorg', waarin partijen gezamenlijke doelen stellen zoals in 2030 55% minder CO_2-uitstoot genereren dan in 2018, in 2030 50% minder primair grondstoffenverbruik dan in 2019, klimaatneutraal zijn in 2050, het realiseren van maximaal circulaire zorg in 2050 en het verminderen van de milieubelasting door medicatie (Green Deal, 2022).

Om deze klimaatdoelen te behalen en om in 2050 tot een CO_2-neutrale gezondheidszorg te komen is het van belang dat in de gehele zorgsector naar effectieve maatregelen wordt gezocht. Duurzaamheid met betrekking tot het milieu speelt tot op heden geen rol in de landelijke medisch specialistische richtlijnen voor de diagnostiek en behandeling van aandoeningen in de tweede en derde lijn. Als we duurzaamheidsaspecten standaard meenemen in de medisch specialistische richtlijnen, zal dit naar verwachting leiden tot efficiënter gebruik van beperkte middelen, zal duurzaamheid een vast onderdeel gaan uitmaken van het dagelijkse handelen van medisch specialisten en kunnen zorgverleners op een actieve manier een bijdrage leveren aan de klimaatdoelstellingen.

Doelstelling

Het doel van dit project is om algemene handvatten te ontwikkelen voor het opnemen van duurzaamheidsaspecten met betrekking tot het milieu bij revisie van bestaande of ontwikkeling van nieuwe landelijke richtlijnen in de snijdende disciplines. Met deze methodologische handreiking wil deze werkgroep toekomstige richtlijncommissies van professionele standaarden (e.g. leidraden, richtlijnen, modules) kaders bieden om op zoek te gaan naar duurzamere zorg op operatiekamers.

Duurzaamheid is een breed begrip, en de verschillende betekenissen kunnen een ander doel hebben. Zo is duurzame ontwikkeling een ontwikkeling die tegemoetkomt aan de levensbehoeften van de huidige generatie, zonder die van toekomstige generaties tekort te doen. Daaronder worden zowel economische, sociale als leefomgevingsbehoeften geschaard (CBS, 2023). De werkgroep focust zich in deze leidraad voornamelijk op duurzaamheid met betrekking tot het milieu, waarin de nadruk ligt op gezond milieu en leefomgeving. Dat wil zeggen, zo min mogelijk uitstoot van broeikasgassen, geen uitputting van grondstoffen, geen vervuiling en het in stand houden van ecosystemen. Aanbevelingen die zijn geformuleerd om duurzaamheid mee te nemen in richtlijnontwikkeling, richten zich specifiek op het verbeteren van de milieu-impact, de (negatieve) invloed die het menselijk handelen heeft op de natuurlijke omgeving en op de ecosystemen van de aarde.

Aanpak en werkwijze

Deze leidraad biedt een methodologische handreiking, welke stapsgewijs beschrijft hoe gedurende de richtlijnontwikkeling duurzaamheid meegenomen kan worden. In deze leidraad worden alleen duurzaamheidsuitkomsten meegenomen. Andere factoren met betrekking tot bijvoorbeeld klinische effectiviteit of kosten worden niet behandeld. Het is aan de richtlijncommissies zelf om te bepalen welke andere (effectiviteits-)uitkomsten van belang zijn bij hun richtlijn.

De ontwikkeling en het onderhoud van richtlijn(modules) kan worden onderscheiden in verschillende fases (Federatie Medisch Specialisten, 2022).

1. <u>Inventariseren en prioriteren van te ontwikkelen richtlijnmodules</u>
   Met het inventariseren van de actualiteit van richtlijnmodules wordt in kaart gebracht wat de te ontwikkelen en onderhouden richtlijnmodules zijn. Prioriteren is nodig omdat het vanwege beperkte capaciteit en middelen niet mogelijk is om alles (tegelijk) te ontwikkelen.
2. <u>Ontwikkeling van modules</u>
   De ontwikkeling van richtlijnmodules gebeurt via het principe van evidence-based richtlijnontwikkeling.
3. <u>Afronding en publicatie</u>
   Deze fase bestaat uit de commentaarfase, autorisatiefase en disseminatie en implementatie. De commentaarfase is belangrijk om de medische inhoud en toepasbaarheid te toetsen. Daarnaast is de commentaarfase ook een belangrijke stap om voor draagvlak voor de richtlijnmodules te zorgen bij de relevante partijen. Al vanaf het begin van de ontwikkeling van een richtlijnmodule moet worden nagedacht over welke professionele en organisatorische aanpassingen en systeemaanpassingen nodig zijn. Er kan over nagedacht worden of er meer producten of activiteiten nodig zijn om de implementatie te vergroten. Alles wat nodig is om de richtlijnmodules te implementeren wordt opgenomen in een implementatieplan.

Hieronder wordt per fase inzichtelijk gemaakt welke acties ondernomen kunnen worden door richtlijncommissies en richtlijnontwikkelaars. In *Tabel 1* staan de verschillende fases die tijdens de richtlijnontwikkeling doorlopen worden. Bij elke fase kan duurzaamheid een rol spelen.

Tabel 1 Fases richtlijnontwikkeling en mogelijke duurzaamheidsvragen

Fase van richtlijnontwikkeling	Stappen	Vragen gerelateerd aan duurzaamheid
Fase 1. Inventariseren en prioriteren van te ontwikkelen richtlijnmodules	1. Samenstellen werkgroep/cluster en startgesprek voorzitter 2. Patiëntenparticipatie 3. Knelpunteninventarisatie en need-for-update 4. Vaststellen en verspreiden raamwerk	• Wanneer moet een deskundige op het gebied van duurzaamheid deelnemen aan de werkgroep/het cluster? Aan wat voor soort deskundige moet dan worden gedacht? • Welke rol heeft duurzaamheid bij het opstellen van het raamwerk? • Hoe kan duurzaamheid worden meegenomen in de knelpuntenanalyse?

		• Wanneer moet een werkgroep een richtlijnmodule specifiek richten op duurzaamheid?
Fase 2. Ontwikkeling van modules	5. Opstellen van uitgangsvragen en zoekvragen 6. Vaststellen, definiëren en prioriteren van uitkomstmaten 7. Literatuur zoeken en selecteren 8. Literatuur beoordelen en samenvatten 9. Overwegingen formuleren 10. Aanbevelingen formuleren 11. Ontwikkeling aanverwante producten	• Wanneer en hoe moet een werkgroep de zoekstrategie aanpassen/ richten op duurzaamheid? • Moet er een gehele module gericht worden op duurzaamheid of kan er een extra uitkomstmaat worden meegenomen? Aan wat voor uitkomstmaten moet dan worden gedacht? • Hoe kan duurzaamheid (standaard) worden meegenomen in het 'Evidence to decision framework'? • Hoe neem je duurzaamheid in je overwegingen mee? • Welke rol kan duurzaamheid hebben in het formuleren van de aanbevelingen?
Fase 3. Afronding en publicatie	12. Commentaarfase 13. Autorisatiefase 14. Thuisarts informatie ontwikkelen 15. Publicatie op Richtlijnendatabase	• Hoe speelt duurzaamheid een rol in de commentaarfase? • Welke rol kan duurzaamheid hebben bij het informeren van patiënten?

In de '**Verantwoording**' staan de algemene gegevens, werkwijze en methode in detail toegelicht. Deze leidraad biedt een methodologische handreiking die zich specifiek richt op richtlijnontwikkeling binnen snijdende specialismen (op operatiekamers). Echter kan de methodologische handreiking ook worden toegepast bij andere disciplines. Naast de leidraad zijn er vijf inhoudelijke duurzaamheidsmodules ontwikkeld, welke separaat van deze methodologische handreiking worden opgeleverd. Deze inhoudelijke duurzaamheidsmodules dienen als pilot om het veld te verkennen en kennislacunes te inventariseren.

Deze methodologische handreiking is opgesteld met behulp van expertise van de werkgroep en klankbordgroep die uit verschillende disciplines bestaat (zie 'Samenstelling van de werkgroep').
De knelpunteninventarisatie bestond uit verschillende bijeenkomsten met verschillende partijen:

- Adviseurs van het Kennisinstituut van de Federatie Medisch Specialisten hebben vanuit het perspectief van richtlijnontwikkelaars knelpunten aangeleverd tijdens een bijeenkomst op 24 februari 2022 (zie Bijlage 4: Verslag Bijeenkomst adviseurs).
- Daarnaast zijn knelpunten aangedragen tijdens de kick-off bijeenkomst 'Toevoegen van duurzaamheidsaspecten in richtlijnontwikkeling' die op 28 maart 2022 heeft plaatsgevonden in het kader van de ontwikkeling van de Leidraad Duurzaamheid. Aan deze bijeenkomst hebben 17 organisaties en individuele experts deelgenomen (NVOG, NVA, NVDV, SRI, NVMDL, VHIG, NVvH, NVU, NVMM, RIVM, NVKNO, NOV, NVvN, ZIN, NOG, NVKNO, ZonMw; zie Bijlage 5: Verslag Kick-off bijeenkomst).

De verkregen input is meegenomen bij het opstellen van de methodologische handreiking en de uitwerking van de inhoudelijke duurzaamheidsmodules .

De methodologische handreiking en bijbehorende inhoudelijke duurzaamheidsmodules zijn ter commentaar voorgelegd aan de betrokken (wetenschappelijke) verenigingen en de leden van de Adviescommissie Richtlijnen van de Federatie van Medisch Specialisten. [partijen] hebben gereageerd op ons verzoek. De aangeleverde commentaren zijn bekeken, verwerkt en besproken met de werkgroep. Naar aanleiding van de commentaren werd de Leidraad Duurzaamheid aangepast en definitief vastgesteld door de werkgroep.

4. Fase 1: Inventariseren en prioriteren van richtlijnmodules

Aanbevelingen

Voor werkgroepleden
- Denk aan duurzaamheid bij het opstellen van het raamwerk en samenstellen van de werkgroep.

Voor richtlijnadviseurs
- Maak het onderwerp duurzaamheid onderdeel van het startgesprek met de voorzitter.
- Indien de richtlijn een onderwerp bevat waar duurzaamheid een potentieel knelpunt is:
  - Neem duurzaamheid expliciet mee in de knelpunteninventarisatie
  - Besteed specifiek aandacht aan duurzaamheid bij het vaststellen van het raamwerk.
  - Overweeg het consulteren van een deskundige met expertise op facetten van duurzaamheid. Denk hierbij bijvoorbeeld aan een deskundige in het kader van afval, inkoop of Life Cycle Assessments (LCA’s).

Stap 1. Samenstellen werkgroep en startgesprek voorzitter: bespreek duurzaamheid

De werkgroep adviseert dat richtlijnadviseurs duurzaamheid bij aanvang van richtlijnontwikkeling (i.e. in een vroeg stadium) aan bod laten komen, zodat er (meer) bewustwording gecreëerd wordt bij betrokken partijen en stakeholders. Richtlijnadviseurs kunnen tijdens het startgesprek met de voorzitter, tijdens de eerste werkgroepvergadering, en tijdens het opstellen van het raamwerk duurzaamheid onder de aandacht brengen. Laat richtlijncommissies actief denken aan duurzaamheid, door bijvoorbeeld vragen te stellen als:
- Welke onderdelen in behandelingen of producten hebben een negatieve invloed op het milieu? Kunnen hier andere keuzes worden gemaakt?
- Hoe zien de reisbewegingen van patiënten eruit? Zijn alle reisbewegingen voor behandelingen daadwerkelijk nodig?
- Is het mogelijk om medicatiegebruik te reduceren?

Benoem hierbij enkele voorbeelden, zoals: afval, vorm van anesthesie, operatietechnieken, het (her-) gebruik van materialen of medicijnen, luchtbehandeling, reisbewegingen van personeel en/of patiënten, of transport van goederen. Indien nodig kunnen richtlijncommissies vervolgens duurzaamheidsaspecten op maat verwerken in de richtlijn. Het wordt geadviseerd om hierbij gebruik te maken van de ‘R-ladder (strategieën van circulariteit)’, zie voor meer toelichting hierover Fase 2 ‘Ontwikkeling van modules’.

Samenstelling werkgroep: betrek expertise op facetten van duurzaamheid

Stel als richtlijnadviseur concrete vragen gericht op duurzaamheid om bewustwording te creëren bij werkgroepleden en in te schatten waar de invloed op het milieu zich bevindt. Overweeg het consulteren van experts op facetten van duurzaamheid als het raamwerk een onderwerp bevat dat een grote impact heeft op het milieu, bijvoorbeeld een deskundige op het gebied van afvalverwerking, die kan meedenken over methoden om ziekenhuisafval te reduceren.
Er zijn verschillende soorten deskundigen binnen het circulair werken (werken zonder afval en met hergebruik van grondstoffen) en duurzaam werken, bijvoorbeeld medisch specialisten die affiniteit hebben met duurzaamheid of die betrokken zijn (geweest) bij de Green Deal of duurzaamheidsinitiatieven in het ziekenhuis. Naast medisch-inhoudelijke perspectieven kan ook een deskundige in de werkgroep betrokken worden die bekend is met ‘duurzaam denken’. Denk bijvoorbeeld aan deskundigen of onderzoekers die een achtergrond hebben in Health Technology Assessment (HTA), Life Cycle Assessment (LCA), Milieuwetenschappen, en/of werkzaam zijn bij

universiteiten, Medical Delta of het RIVM. Welke expertise het meest aangewezen is, is afhankelijk van de knelpunten.

Stap 2. Patiëntenparticipatie: bespreek duurzaamheid

Patiënten en zorgverleners zoeken samen naar de behandeling of zorg die het beste bij de patiënt past. Wat het beste past, hangt af van wat iemand belangrijk vindt en welke afwegingen iemand maakt. Naast klinische overwegingen kunnen kosten (e.g. dure interventies, dure geneesmiddelen), beschikbaarheid, haalbaarheid of duurzaamheid meegenomen worden in *samen beslissen*. Zorgverleners kunnen bijvoorbeeld duurzaamheid actiever benoemen tijdens besprekingen met de patiënt of duurzaamheid kan een grotere rol krijgen in keuzehulpen. Hier kunnen patiëntenverenigingen ook een rol in nemen.

Stap 3. Knelpunteninventarisatie en Need-for-update: duurzaamheid opnemen

Knelpunteninventarisatie

Met een knelpunteninventarisatie wordt beoogd een richtlijn zo goed mogelijk te laten aansluiten bij de behoeften van de dagelijkse praktijk. Op basis van de geïnventariseerde knelpunten wordt het raamwerk opgesteld. Als blijkt dat bepaalde onderwerpen de impact op duurzaamheid aanzienlijk beïnvloeden, dan is het waardevol om hiervoor specifiek aandacht te hebben bij het opstellen van het raamwerk. De werkgroep wordt geadviseerd om zo concreet mogelijk naar duurzaamheid te vragen. Stel bijvoorbeeld tijdens de invitational conference de vraag: Bij welke knelpunten zijn verbeteringen op het gebied van duurzaamheid mogelijk? Dit bevordert bewustwording van duurzaamheid.

Bij een schriftelijke knelpunteninventarisatie worden standaard drie vragen voorgelegd aan betrokken en andere partijen. Voeg hieraan een vierde vraag toe:

1. Zijn er knelpunten die nog niet geadresseerd zijn in het raamwerk?
2. Zijn er uitgangsvragen opgenomen in het raamwerk waar u zich niet in kunt vinden?
3. Welke uitgangsvragen hebben voor u de hoogste prioriteit?
4. ***Welke uitgangsvragen hebben invloed op duurzaamheid? Welke rol speelt duurzaamheid in de modules?***

Need for update

Om patiënten de beste zorg te kunnen geven, is het van belang dat richtlijnen gebaseerd zijn op de meest recente wetenschappelijke inzichten en inzichten uit de praktijk. Richtlijnen worden steeds vaker modulair onderhouden, waarbij alleen die onderdelen van de richtlijn ('modules') worden herzien waarvoor dat nodig is. Door een nieuwe werkwijze in te richten waarin jaarlijks modulair onderhoud plaatsvindt, kan nieuwe kennis sneller verwerkt worden in richtlijnen en geïmplementeerd worden in de praktijk. Dit doet het Kennisinstituut door te werken in clusters. In de 'Need for Update' fase worden alle betrokken wetenschappelijke verenigingen, patiëntenorganisaties en overige stakeholders benaderd om een compleet overzicht te krijgen van de geldigheid van de modules behorend tot de richtlijnen binnen dit cluster. Er vindt een schriftelijke inventarisatie plaats van de geldigheid van de modules behorend tot het cluster. Hierbij dient ook specifiek gevraagd te worden naar duurzaamheid. De werkgroep stelt voor om in de schriftelijke 'Need for Update' specifiek te vragen naar: Welke rol moet duurzaamheid spelen in de modules? En een afweging te maken of er extra aandacht aan gegeven moet worden.

Stap 4. Raamwerk en prioritering: het betrekken van duurzaamheid

Bij het opstellen van het raamwerk kan per knelpunt gekeken worden naar duurzaamheid. Hierbij kan gebruik worden gemaakt van het Green House Gas protocol (WRI/WBCSD, 2004), de ambities van de Green Deal (Green Deal, 2022) of de principes van het British Centre for Sustainable Healthcare (Mortimer, 2010). Denk bijvoorbeeld aan:

- Preventie van ziekte: Hoe kan zorggebruik worden voorkomen en verminderd? Hoe creëren we een leefomgeving in en buiten zorginstellingen die de gezondheid van iedereen (zorgpersoneel en patiënten) bevordert?
- Zelfmanagement: hoe bevorderen we zelfmanagement van patiënten? Hoe optimaliseren we scholing/instructie voor patiënten? Hoe zetten we digitale zorgoplossingen (e.g. digitale consulten, e-learning voor patiënten, telemonitoring) het beste in?
- Circulariteit: hoe bevorderen we meer circulaire bedrijfsvoering? Hoe voorkomen we verspilling van geld, tijd en grondstoffen? Hoe kunnen we overbehandeling, heroperaties of onnodige zorg verminderen?
- Vermindering van uitstoot van broeikasgassen en milieuvervuiling: Is behandeling noodzakelijk? Hoe dringen we de hoeveelheid medicijnresten in oppervlaktewater en grondwater terug? Hoe kunnen we het (her)gebruik van duurzame medicijnen, hulpmiddelen en instrumenten stimuleren? Hoe kunnen we reisbewegingen beperken? Hoe kunnen we energiegebruik van apparatuur beperken?

De gesignaleerde knelpunten uit het raamwerk worden vertaald naar uitgangsvragen. Bij veel richtlijnen kunnen niet alle gesignaleerde knelpunten meegenomen worden. Dit is de reden waarom geprioriteerd moet worden. Bij prioritering dienen aspecten zoals duurzaamheid en doelmatigheid een rol te spelen; deze aspecten zitten immers verweven in het hele zorgproces en bepalen grotendeels de houdbaarheid van de zorg. Indien duurzaamheid als knelpunt wordt geprioriteerd, dan zou een richtlijncommissie duurzaamheid op verschillende manieren kunnen meenemen in richtlijnontwikkeling, door:

- Een of meerdere uitkomstmaten gericht op duurzaamheid mee te nemen in de zoekvraag;
- In de overwegingen van een module duurzaamheid te beschrijven als onderdeel van het Evidence to decision framework; en/of
- Een (sub)module specifiek op duurzaamheid te richten, indien aspecten van duurzaamheid meer uitwerking behoeven en er knelpunten worden ervaren.

5. Fase 2: Ontwikkeling van modules

Aanbevelingen

Voor werkgroepleden

Indien een module specifiek op duurzaamheid wordt gericht:

- Laat duurzaamheid zo concreet mogelijk aan bod komen in de 'overwegingen' en gebruik hierbij de 'R-ladder (strategieën van circulariteit)'.
- Beveel het meest duurzame alternatief aan bij gelijke effectiviteit en veiligheid.

Voor richtlijnadviseurs

Indien een onderwerp binnen het kader duurzaamheid valt:

- Neem (een) duurzaamheidsuitkomst(en) op in de zoekvraag en pas het duurzaamheids-zoekblok toe.
- Indien een Life Cycle Assessment (LCA) wordt uitgewerkt in de literatuursamenvatting van de module:
    - pas de GRADE-methodiek toe en wees transparant in de beschrijving van de beoordeling volgens GRADE;
    - gebruik de LCA 'evidence tabel' om het wetenschappelijk bewijs te presenteren; en
    - raadpleeg de LCA 'critical appraisal' om de kwaliteit te beoordelen.

Stap 5. Opstellen van uitgangsvragen en zoekvragen

Het knelpunt wordt vertaald naar een uitgangsvraag met daaraan gekoppeld een zoekvraag conform de PICO-methode. Bij het opstellen van de zoekvraag kan er specifiek aandacht geschonken worden aan de duurzaamheidscomponent, bijvoorbeeld door duurzaamheidsuitkomsten op te nemen in de PICO en indien mogelijk de zoekstrategie aan te passen. Zo is het bijvoorbeeld mogelijk om te bepalen in welke mate een product over zijn gehele levenscyclus het milieu belast middels een Life Cycle Assessment (LCA; Guinee, 2002). LCA is een stapsgewijze methode om de milieu-impact van twee of meer producten of diensten te vergelijken gedurende de totale levenscyclus, van grondstofwinning tot afvalverwerkingsfase, eventueel met recycling ervan. Hierbij kunnen diverse soorten milieuschade beschouwd worden, zoals klimaatverandering, verzuring en waterschaarste. Het complete LCA-proces bevat de volgende fasen: definitie van doel en reikwijdte bepaling (goal and scope definition), dataverzameling (inventory analysis), effectanalyse (impact assessment) en de interpretatie (interpretation) van de resultaten (Guinée, 2002).

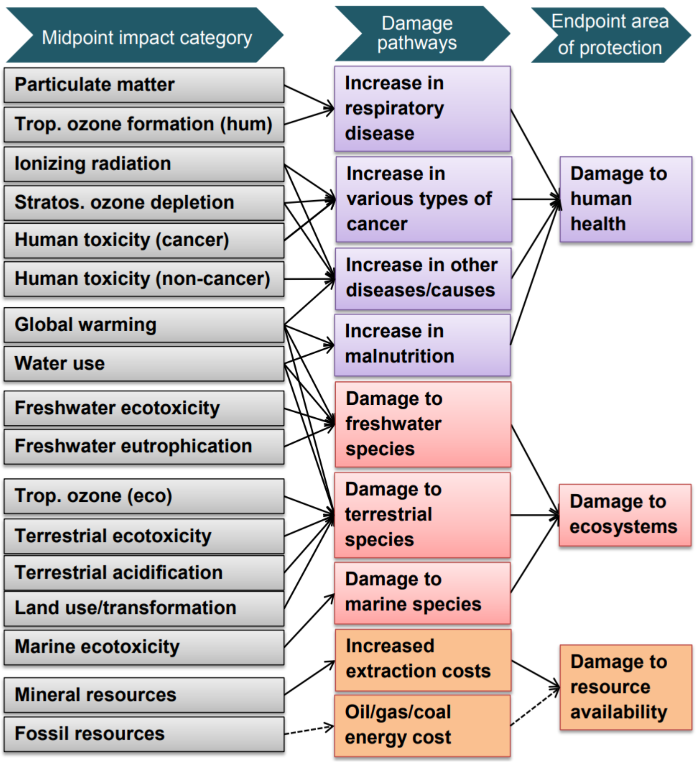
Stap 6. Vaststellen, definiëren en prioriteren van uitkomstmaten

Voor de richtlijn worden enkel de belangrijkste uitkomstmaten gekozen die van betekenis zijn om de klinische praktijkvoering op te baseren. Het is belangrijk om standaard een brede set uitkomstmaten mee te nemen, zodat op basis van gecombineerde facetten een afweging kan worden gemaakt. Denk bijvoorbeeld aan kwaliteit van leven, complicaties, opnameduur, het aantal heroperaties of afval. Als duurzaamheid bij een module een rol speelt, neem dan duurzaamheidsuitkomsten mee in de zoekvraag. Naast medisch-inhoudelijke uitkomsten kan gedacht worden aan duurzaamheidsuitkomsten, zoals:

- CO_2-uitstoot
- Afval
- Energiegebruik
- Therapietrouw, gebruiksgemak
- Watergebruik, watervervuiling
- Reisafstand, reistijd

- Uitkomsten van het ReCiPe model (zie *Figuur 1*, Huijbregts, 2017). Denk aan uitkomsten zoals verzuring, eutrofiëring (vermesting), humane toxiciteit, eco-toxiciteit of ozonafbraak.

Het ReCiPe model heeft binnen LCA's een plaats als methodiek voor de effectanalyse (impact assessments). Het ReCiPe model is een methode om milieueffecten en -problemen te kwantificeren. Per uitkomst kan een uitkomst worden geschat (bijvoorbeeld per metaal). Dit levert een soort milieuprofiel op: een 'scorelijst' met milieu-effecten, zoals klimaatverandering, waterverbruik, waterschaarste, landgebruik en bodemverzuring. Aan het milieuprofiel is te zien welke milieuaspecten slecht scoren in de levenscyclus van een product of dienst en welke onderdelen in de levenscyclus de grootste bijdrage leveren aan de verschillende milieueffecten.
Het acroniem "ReCiPe" staat voor de methode die kan dienen als recept om impact te berekenen (Goedkoop, 2009). Daarnaast staat het acroniem ook voor de initialen van de instituten die in 2008 ReCiPe hebben ontwikkeld (RIVM, Radboud Universiteit, CML, PRé).



***Figuur 1** Overzicht structuur ReCiPe (Huijbregts, 2017)*

Het gebruik van soortgelijke duurzaamheidsuitkomsten in richtlijnontwikkeling is in 2023 nieuw in de gezondheidszorg. De afkapwaarden van milieu-relevantie blijken lastig vast te stellen bij duurzaamheidsuitkomsten (zoals van het ReCiPe model). Wanneer is een vermindering van afval minimaal (klinisch) relevant? Het is veelal een politieke afweging welk effect de maatschappij belangrijk acht. Vanwege een gebrek aan kennis en standaarden in klinische verschillen voor deze uitkomsten, heeft de werkgroep besloten de GRADE methodiek zoveel als mogelijk te volgen conform de huidige werkwijze van richtlijnontwikkeling (Federatie Medisch Specialisten, 2022). De werkgroep heeft deze methode toegepast bij de vijf inhoudelijke duurzaamheidsmodules (Richtlijnendatabase.nl) en in deze modules transparant beschreven hoe de beoordeling van de literatuur heeft plaatsgevonden.

Indien duurzaamheidsuitkomsten een rol spelen in een richtlijnmodule, adviseert de werkgroep om het ReCiPe model te bekijken voor inspiratie m.b.t. uitkomstmaten, zodat erkende en relevante uitkomsten gedefinieerd worden.

Stap 7. Literatuur: zoeken en selecteren

Op basis van de opgestelde PICO's zet de richtlijnadviseur samen met de literatuurspecialist de zoekstrategieën op. Daar waar grote invloed op duurzaamheid verwacht wordt, is het raadzaam om de zoekstrategie aan te passen op duurzaamheidsuitkomsten. Hiervoor is een duurzaamheidszoekfilter ontwikkeld door de literatuurspecialist van het Kennisinstituut (zie *Bijlage 1*). Het zoekfilter houdt rekening met studiedesigns specifiek gericht op duurzaamheid. Op deze manier wordt zo breed mogelijk gezocht. Daarnaast wordt geadviseerd om naast standaard studiedesigns (zoals systematic reviews, RCT's) ook LCA's mee te nemen en te selecteren.

Stap 8. Literatuur: beoordelen en samenvatten

Evidence tabel

Momenteel zijn er nog weinig erkende kaders, eisen en standaarden bekend voor het bepalen en vergelijken van de kwaliteit van LCA's. Door LCA's en soortgelijke studiedesigns te zoeken en te selecteren, nemen richtlijncommissies zoveel mogelijk input op het gebied van duurzaamheid mee in richtlijnontwikkeling. Hier is transparantie noodzakelijk, gezien het ontbreken van vergelijkende LCA-kwaliteitsstandaarden.
Het Kennisinstituut heeft een nieuw format gemaakt voor een 'evidence tabel' om studiekarakteristieken van LCA's weer te kunnen geven en data-extractie uit te kunnen voeren (zie *Bijlage 2*). Deze evidence tabel is gemaakt op basis van de vijf inhoudelijke duurzaamheidsmodules en expert opinion vanuit de werkgroep.

Kwaliteit van LCA's

De werkgroep acht het uiterst relevant om de kwaliteit van LCA's kritisch te beoordelen. Hier ligt echter een kennislacune, aangezien een breed geaccepteerde kwaliteitsstandaard voor LCA's ontbreekt. In deze leidraad is daarom in de vijf inhoudelijke duurzaamheidsmodules gebruik gemaakt van de 'critical appraisal' van Drew (2021), zie *Bijlage 3*. Drew (2021) ontwikkelde een beoordeling gebaseerd op Weidema's richtlijnen voor kritische beoordeling van een LCA (Weidema, 1997). Dit scoresysteem bestaat uit 16 beoordelingscriteria, die zijn verdeeld over de verschillende fasen van een LCA. Criteria bestaan uit een reeks indicatoren voor studiekwaliteit, zoals interne validiteit, externe validiteit, consistentie, transparantie en bias. De procentuele score geeft een indicatie van de algehele studiekwaliteit. Een hogere score duidt op een hogere algehele studiekwaliteit.

GRADE beoordeling

In de GRADE-methodiek is de kwaliteit van bewijs gedefinieerd als de mate van zekerheid dat de schattingen van de richting en grootte van een effect correct zijn. Hierbij wordt de zekerheid van het bewijsmateriaal beoordeeld aan de hand van vijf factoren (risk of bias, inconsistentie, indirectheid, imprecisie en publicatiebias), zie *Figuur 2*. De kwaliteit van het bewijs weerspiegelt de mate van zekerheid dat het geschatte effect een bepaalde aanbeveling voldoende kan ondersteunen. De GRADE-methode wordt op een stapsgewijze en transparante manier toegepast, zodat aanbevelingen op een gestructureerde manier tot stand komen.

Het gebruik van GRADE in milieustudies en LCA's is relatief nieuw maar zal de komende jaren waarschijnlijk toenemen (Aiassa, 2015; EFSA, 2010; Mandrioli, 2015; Woodruff, 2014). Om LCA's goed te kunnen beoordelen op bewijskracht, behoeft de GRADE-methodiek uitbreiding (Morgan, 2019). Hier ligt een kennislacune. De werkgroep adviseert voorlopig om de standaard GRADE-methodiek zo veel mogelijk te volgen. Het is hierbij essentieel om transparant te zijn over beslissingen waarin de methode (nog) niet voorziet.

Hoewel de ervaring met het toepassen van de GRADE-methodiek op LCA's (nog) beperkt is, stelt de werkgroep voor dat de initiële kwaliteit van bewijs van LCA's op 'hoog' start. Een LCA is immers als methodiek het hoogst haalbare als het gaat om het in kaart brengen van de milieu-impact. De bewijskracht kan vervolgens eventueel afgewaardeerd worden op basis van de vijf GRADE-factoren:

- Risk of bias
- Inconsistentie
- Indirectheid
- Imprecisie
- Publicatiebias

Indien milieu-impact op een andere manier is onderzocht dan via een LCA (bijvoorbeeld een bepaling van hoeveelheid afval of een aparte berekening van CO_2-uitstoot), adviseert de werkgroep om te starten met initiële kwaliteit 'laag'. De kwaliteit van bewijs kan vervolgens eventueel opgewaardeerd worden wanneer er een groot verschil is aangetoond tussen twee opties. Daarnaast is het van belang bewust te zijn van het doel van LCA's. Dit is niet om een exacte effectmaat aan tonen, maar om de invloed op het milieu van verschillende opties met elkaar te vergelijken, om te kunnen achterhalen waar naar verwachting de meeste milieu-impact zit. Daarnaast is het bedoeld om milieu 'hotspots' aan te tonen, onderdelen van de levenscyclus met de grootste invloed op het milieu, en waar dus de grootste winst te behalen is indien mogelijkheden voor verbetering worden gezocht.

Op basis van de eerste verkenning in de vijf inhoudelijke duurzaamheidsmodules, welke evalueren welke interventies de grootste milieubelasting geven, is GRADE toegepast bij LCA's. Hierbij ligt de focus niet op de *exacte* effectgrootte, maar op de vraag bij welke interventie de impact op milieu en klimaat *relatief* het grootst is. De werkgroep acht het cruciaal dat de redenen voor afwaarderen transparant en zo concreet mogelijk geformuleerd worden in de richtlijnteksten.
De werkgroep is zich ervan bewust dat de (nog) onvoldoende kennis over LCA's in richtlijnontwikkeling mogelijk zal leiden tot een *lage* tot *zeer lage* bewijskracht. Mochten richtlijncommissies toch sterke aanbevelingen willen formuleren, dan wordt geadviseerd dit duidelijk en adequaat te beargumenteren in de overwegingen.
De werkgroep acht het wenselijk dat er onderzoek plaatsvindt naar een GRADE-methodiek specifiek voor LCA's, analoog aan de ontwikkeling van het CEA-framework gericht op de GRADE-beoordeling bij kosten-effectiviteitsstudies (Guyatt, 2012; Brunetti , 2012).

1. Initial level of certainty	
Study design	Initial certainty
RCTs	High
Observational studies	Low

→

2. Factors that can influence the quality of the evidence	
Lower if	Higher if
Limitations in study design or execution (risk of bias) ↓ 1 or 2 levels Inconsistency of results ↓ 1 or 2 levels Indirectness of evidence ↓ 1 or 2 levels Imprecision ↓ 1 or 2 levels Publication bias ↓ 1 or 2 levels	Large magnitude of effect ↑ 1 or 2 levels All plausible confounding would reduce the demonstrated effect or increase the effect if no effect was observed ↑ 1 level Dose-response gradient ↑ 1 level

→

3. Final level of certainty in an estimate of effect
High
Moderate
Low
Very low

Figuur 2 *Schematisch overzicht van de standaard GRADE beoordeling bij interventiestudies (gebaseerd op Guyatt, 2011; Schünemann, 2022)*

Stap 9. Overwegingen formuleren

Voor het formuleren van aanbevelingen in de praktijk is niet alleen de bewijskracht van de conclusies uit de literatuur belangrijk, maar zijn ook de overwegingen belangrijk (zoals waarden en voorkeuren van patiënten, kosten (middelenbeslag), en aanvaardbaarheid, haalbaarheid en implementatie). Het is belangrijk dat duurzaamheid meegewogen wordt in de overwegingen.

Evidence to decision framework

De werkgroep is van mening dat duurzaamheid het beste past onder het domein 'Aanvaardbaarheid, haalbaarheid en implementatie' van het Evidence to Decision framework. Het is belangrijk dat richtlijncommissies en richtlijnadviseurs zich bewust zijn van duurzaamheidsaspecten bij het formuleren van overwegingen. Door gebruik van de 'R-ladder (strategieën van circulariteit)' (zie *Figuur 3*) kan bij een aanbeveling concreet gekeken worden welke duurzaamheidsstappen passend zijn en op welke R ingespeeld kan worden (zie ter illustratie de vijf inhoudelijke duurzaamheidsmodules). Het wordt geadviseerd om middels de 'R-ladder (strategieën van circulariteit)' duurzaamheid zo concreet mogelijk aan bod te laten komen in de overwegingen. Daarnaast kan gedacht worden aan vragen als:

- Hoe verhoudt de potentiële duurzaamheidswinst zich tot effectiviteit, gezondheidswinst en kosten?
- Wat is de milieu-impact van interventies? Waar zitten de hotspots (domeinen met grootste verbeterruimte)? Hoe kunnen die gereduceerd worden?

Hierbij kunnen ook andere aspecten genoemd worden, zoals:

- Logistiek: transport afstand, type transport, inleverpunten voor medicijnen;
- Zorgproces: digitale consulten, thuismonitoring;
- Inkoop: optimale betrokkenheid industrie, duurzaam inkopen;
- Ontwerp: duurzaam ontwerpen van medische hulpmiddelen, betrokkenheid industrie en fabrikanten.

De werkgroep adviseert om duurzaamheid standaard als factor mee te nemen in de 'weging' om tot aanbevelingen te komen. Het is vaak lastig te beoordelen hoeveel gewicht aan verschillende uitkomsten moet worden toegekend bij het afwegen hiervan. Bij vergelijkbare veiligheid en effectiviteit, dient duurzaamheid de doorslaggevende factor te zijn.

Naast het domein 'Aanvaardbaarheid, haalbaarheid en implementatie', kan duurzaamheid ook een rol spelen bij andere domeinen, bijvoorbeeld:

- Domein 'Waarden en voorkeuren van patiënten (en evt. hun verzorgers)': de impact van digitale zorg (reisbewegingen, dataverbruik)
- Domein 'Kosten (middelenbeslag)': de impact van duurzame zorg op kosten, de trade-off tussen duurzaamheid en kosten-effectiviteit, bij het beperken van onnodige zorg (overbehandeling, onnodige diagnostiek).

Gebruik de R-ladder (strategieën van circulariteit)

De 'R-ladder (strategieën van circulariteit)' (zie *Figuur 3*, gebaseerd op Cramer, 2014; Hanemaaijer; 2018; Potting, 2016; Reike, 2018) kan richtlijncommissies en richtlijnadviseurs houvast geven om de milieu-impact te beperken en hierin concrete keuzes te maken. Bovenaan de ladder (R1-Refuse, R2-Reduce) staat het verminderen van consumptie en productie en het slimmer maken en gebruiken van producten. Het midden van de ladder (R3-Redesign, R4-Re-use, R5-Repair, R6-Refurbish, R7-Remanufacture, R8-Repurpose) is gericht op het verlengen van de levensduur van producten en onderdelen. Onderaan de ladder (R9-Recycling, R10-Recover) staat het nuttig verwerken van materialen die anders verbrand zouden worden. De R-ladder laat zien dat de hoogste prioriteit om duurzaam te werken ‘R1-Refuse’ is, oftewel, niet gebruiken. Kortom, hoe lager het grondstofgebruik, des te hoger op de R-ladder.

Figuur 3 *Prioriteitsvolgorde circulariteit strategieën conform de ‘R-ladder (strategieën van circulariteit)’ (gebaseerd op Cramer, 2014; Hanemaaijer; 2018; Potting, 2016; Reike, 2018)*

Er zijn verschillende duurzaamheidsvragen per laddertrede mogelijk, denk bijvoorbeeld aan:

- *R1-Refuse, R2-Reduce*
  - Kan de indicatiestelling voor operaties aangescherpt worden?
  - Kunnen geneesmiddelen doelmatiger ingezet worden?
  - Kan de luchtbehandeling in een lagere stand gezet worden als er geen operatie plaatsvindt? Kan de luchtbehandeling uit worden gezet? Kan er in een lagere klasse worden geopereerd die energiezuiniger is?
  - Kan het aantal steriele doeken verminderd worden? Is het noodzakelijk om de patiënt helemaal af te dekken?
  - Kan inhalatieanesthetica op een lagere flow worden toegediend? Kan inhalatieanesthetica worden vervangen door intraveneuze anesthetica?
- *Redesign (R3), Re-use (R4)*
  - Kan een instrument/implantaat zodanig ontworpen worden dat de levensduur verlengd wordt?
  - Kunnen reusables gebruikt worden in plaats van disposables? Zouden hybride instrumenten (instrumenten die zowel componenten voor eenmalig gebruik als herbruikbare componenten bevatten) een optie kunnen zijn?
  - Kan de wisselduur van beademingsslangen op de anesthesietoestellen verlengd worden?
  - Kan het reinigings-, desinfectie- en sterilisatieproces worden verbeterd?
  - Kunnen oude apparatuur of instrumenten opnieuw gebruikt worden?
- *Repair (R5), Refurbish (R6), Remanufacture (R7)*
  - Kan een kapot product nog gerepareerd worden?

- *Repurpose (R8), Recycling (R9), Recover (R10)*
    - Kunnen oude producten (bijvoorbeeld een echoapparaat) voor een nieuw doeleinde ingezet worden?
    - Kan inhalatieanesthetica afgevangen worden met een filter?

Deze R-ladder geeft inzicht in welk onderdeel duurzaamheidskeuzes ingrijpen in het zorgproces. Het is aan richtlijncommissies en richtlijnadviseurs om te bepalen op welke R'en er wordt ingespeeld.

Stap 10. Aanbevelingen formuleren

Aanbevelingen geven, op grond van een zorgvuldige weging van de overwegingen en conclusies verkregen uit het systematische literatuuronderzoek, een concrete en eenduidige beschrijving van de beste zorgoptie. De sterkte van de aanbeveling wordt altijd bepaald door weging van alle relevante argumenten samen. Hierbij moet duurzaamheid meegenomen worden. Bij gelijke effectiviteit en veiligheid wordt een keuze gemaakt voor de meest duurzame optie.

De discussie en afwegingen die gemaakt worden bij duurzaamheid kan vergeleken worden met kosten-effectiviteit (Federatie Medisch Specialisten, 2022). Bij gelijke effectiviteit wordt een keuze gemaakt voor de goedkopere optie (Federatie Medisch Specialisten, 2022). In de toekomst zouden kosten en duurzaamheid tegenover elkaar kunnen staan. Ook hierin zit een trade-off. Voor de werkgroep is het niet mogelijk om deze maatschappelijke keuze te maken. Toekomstig onderzoek en maatschappelijk debat zijn hiervoor noodzakelijk.

Stap 11. Ontwikkeling aanverwante producten

Een richtlijn is een instrument dat niet los kan worden gezien van andere, op kwaliteitsverbetering gerichte, producten. Deze producten zijn bijvoorbeeld gericht op verspreiding en implementatie. Bij een richtlijnmodule wordt altijd een implementatieplan en een lijst met kennislacunes gemaakt.

Implementatieplan

Alles wat nodig is om de richtlijnmodules te implementeren wordt genoemd in het implementatieplan. Het implementatieplan bevat aspecten zoals het tijdspad voor implementatie, het verwachte effect op de kosten, en ook worden de randvoorwaarden per aanbeveling in kaart gebracht. Dit resulteert in een aantal factoren die de implementatie van de richtlijn mogelijk kunnen belemmeren. Hierbij dient duurzaamheid goed overwogen te worden. In een module over medicatie kunnen vragen spelen als hoe gaan we om met restafval? Hoe kunnen we medicijngebruik reduceren of medicijnen hergebruiken? Denk hierbij aan oplossingen, zoals: bewustzijn creëren door voorlichting, het afval verminderen, beter recyclen, slimmer inkopen, meer samenwerking tussen disciplines.

Kennislacunes

Tijdens de richtlijnontwikkeling kunnen vragen onbeantwoord blijven omdat er nog geen (kwalitatief goede) studies naar zijn gedaan. Deze kennislacunes worden verzameld gedurende het ontwikkeltraject. Op het gebied van duurzaamheid liggen veel kennislacunes, waarvan er enkele zijn geïdentificeerd tijdens de ontwikkeling van deze Leidraad (zie *Hoofdstuk 8 Kennislacunes*). Mochten adviseurs of richtlijncommissies tijdens richtlijnontwikkeling kennislacunes identificeren, dan kunnen deze vermeld worden bij desbetreffende richtlijn, maar ook kunnen kennislacunes worden aangedragen bij bestaande landelijke initiatieven, zoals bijvoorbeeld het Landelijk Netwerk de Groene OK (www.degroeneok.nl) of het projectteam van het Ministerie van VWS (duurzamezorg@minvws.nl).

Aanverwante producten

Daarnaast kan ook gedacht worden aan andere aanverwante producten, die implementatie kunnen bevorderen. Dit kunnen producten zijn gericht op nascholing, wetenschappelijke publicaties, kostenevaluaties of afgeleide producten voor ziekenhuisorganisaties. Het Landelijk netwerk Groene OK kan hierbij een rol spelen. Dit netwerk organiseert bijvoorbeeld bijeenkomsten en congressen gericht op duurzaamheid en werkt samen met verschillende partijen (www.degroeneok.nl). Richtlijncommissies kunnen contact opnemen met dit netwerk, om ervaringen, ideeën en producten uit te wisselen en aansluiting te vinden bij andere initiatieven.

Medisch specialisten dienen zich bewust te zijn van de gevolgen van hun keuzes op duurzaamheid; hierin kan nascholing een grote rol spelen. Vanuit wetenschappelijke verenigingen dient meer aandacht gegeven te worden aan duurzaamheid.

6. Fase 3: Afronding en publicatie

Aanbevelingen

Voor werkgroepleden
- Indien duurzaamheid een rol speelt, zorg dat patiënten informatie beschikbaar is over de duurzaamheidsaspecten van de behandeling/ingreep.
- Wees bewust van duurzaamheid bij de ontwikkeling van de Thuisarts-teksten. Hierbij kan Thuisarts.nl een actieve rol spelen.

Voor richtlijnadviseurs
- Geef extra aandacht aan duurzaamheid bij het nieuwsbericht dat gepubliceerd wordt ten aanzien van de richtlijn op de Richtlijnendatabase, indien duurzaamheid een rol speelt. Informeer ook het Landelijk netwerk Groene OK hierover.

Stap 12 en 13. Commentaarfase en autorisatiefase

Naar verwachting zullen de commentaar- en autorisatiefase zullen niet anders verlopen wanneer duurzaamheid wordt meegenomen in een richtlijn.

Stap 14. Thuisarts informatie

Het is belangrijk dat patiënten goed geïnformeerd worden over de impact op duurzaamheid van de behandelingen. Zie ook de toelichting onder *'Stap 2. Patiëntenparticipatie'*. Op deze manier kan bewustwording van de gevolgen van keuzes gecreëerd worden.

- Patiënten kunnen hier zelf een rol in nemen, zij kunnen bij medisch specialisten duurzaamheid ter sprake brengen.
- Medisch specialisten kunnen patiënten erop wijzen wat de gevolgen van hun behandelopties zijn. Recent is duurzaamheid ook opgenomen in de KNMG gedragsregels. Als medisch specialist is het van belang om je in te zetten voor een duurzame zorgsector en gezonde leefwereld (KNMG, 2022). Bij gelijke klinische uitkomsten en veiligheid, kan het belang op het gebied van duurzaamheid benadrukt worden. Bijvoorbeeld indien digitale consulten of het hergebruiken van medicatie een optie zijn, dan adviseert de werkgroep om de potentiële winst in duurzaamheid actief kenbaar te maken aan patiënten.
- Richtlijnadviseurs kunnen gedurende het richtlijnontwikkelproces de betrokken patiëntenorganisaties wijzen op duurzaamheid. Maar het creëren van bewustzijn over duurzaamheid bij patiënten kan naar verwachting beter bereikt worden middels het publiceren van informatie op Thuisarts.nl. Momenteel is er op Thuisarts.nl nog geen informatie te vinden over de gevolgen van behandelingen op het milieu. De werkgroep acht het waardevol dat bij inhoudelijke Thuisarts-pagina's ook duurzaamheid opgenomen wordt. Thuisarts-redacteuren en richtlijnadviseurs van het Kennisinstituut dienen hier een actieve rol in te nemen.

Stap 15. Publicatie op Richtlijnendatabase

Vaak gaat publicatie van een richtlijn op de Richtlijnendatabase gepaard met een nieuwsbericht. Bij het nieuwsbericht zou extra aandacht gegeven kunnen worden aan duurzaamheid. Bij de publicatie van nieuwe richtlijnen waar specifiek aandacht voor duurzaamheid is, adviseert de werkgroep om het bijbehorende nieuwsbericht ook te communiceren aan het Landelijk netwerk Groene OK. Het Landelijk netwerk Groene OK is belangrijk voor de zichtbaarheid en bundeling van kennis en kunde over duurzaamheid.

Daarnaast is het wenselijk om op de website van de Federatie Medisch Specialisten apart aandacht te vragen voor duurzaamheid in de zorg. Dit kan door een duurzaamheids-pagina te ontwikkelen, waarop toegelicht wordt hoe medisch specialisten en de Federatie Medisch Specialisten omgaan met duurzaamheid. Hierbij kan verwezen worden naar het belang van duurzaamheid, deze methodologische handreiking, ontwikkelde duurzaamheidsmodules en bestaande duurzaamheids-initiatieven.

7. Toekomstperspectief

Met deze methodologische handreiking wil de werkgroep aan richtlijncommissies van kwaliteitsstandaarden (bijvoorbeeld zorgstandaarden, richtlijnen, modules) handvatten bieden om in het zorgproces op zoek te gaan naar verbeteringen om duurzaamheid van de zorg te vergroten. Momenteel richt deze methodologische handreiking zich op snijdende specialismen, maar de werkgroep ondersteunt nadrukkelijk dat ook andere specialismen hiermee aan de slag gaan. De aanbevelingen gelden immers ook voor algemene richtlijnen en andere disciplines.
Het wordt aangeraden om de klinische dagelijkse praktijk te evalueren op het gebied van duurzaamheid en onder andere de ‘R-ladder (strategieën van circulariteit)’ mee te nemen in richtlijnontwikkeling. Als meer richtlijncommissies duurzaamheid in het vizier hebben, kunnen wellicht in de toekomst grote “hoog-over” onderwerpen geïdentificeerd worden waarbij duurzaamheid generiek (multidisciplinair) opgepakt wordt.

8. Verantwoording

Vaststelling en geldigheid

Autorisatie/ vaststellingsdatum:	[nader te bepalen]
Eerstvolgende beoordeling actualiteit	[nader te bepalen]
Geautoriseerd / vastgesteld door:	Nederlandse Vereniging voor Heelkunde (initiatiefnemer), Adviescommissie Richtlijnen (adviescommissie van de Raad Kwaliteit van de Federatie van Medisch Specialisten)
Herbevestiging:	[datum]
Regiehouder(s):	Nederlandse Vereniging voor Heelkunde

Algemene gegevens

De ontwikkeling van deze methodologische handreiking en bijbehorende richtlijnmodules werd ondersteund door het Kennisinstituut van de Federatie Medisch Specialisten (www.demedischspecialist.nl/kennisinstituut) en werd gefinancierd uit de Kwaliteitsgelden Medisch Specialisten (SKMS). De financier heeft geen enkele invloed gehad op de inhoud van de richtlijnmodule.

Samenstelling werkgroep

Voor het ontwikkelen van de methodologische handreiking en bijbehorende richtlijnmodules is in 2021 een multidisciplinaire werkgroep ingesteld, bestaande uit vertegenwoordigers van alle relevante specialismen (zie hiervoor de Samenstelling van de werkgroep) die betrokken zijn bij de zorg voor patiënten op operatiekamers.

Belangenverklaringen

De Code ter voorkoming van oneigenlijke beïnvloeding door belangenverstrengeling is gevolgd. Alle werkgroepleden hebben schriftelijk verklaard of zij in de laatste drie jaar directe financiële belangen (betrekking bij een commercieel bedrijf, persoonlijke financiële belangen, onderzoeksfinanciering) of indirecte belangen (persoonlijke relaties, reputatiemanagement) hebben gehad. Gedurende de ontwikkeling of herziening van een module worden wijzigingen in belangen aan de voorzitter doorgegeven. De belangenverklaring wordt opnieuw bevestigd tijdens de commentaarfase.
Een overzicht van de belangen van werkgroepleden en het oordeel over het omgaan met eventuele belangen vindt u in onderstaande tabel. De ondertekende belangenverklaringen zijn op te vragen bij het secretariaat van het Kennisinstituut van de Federatie Medisch Specialisten.

Inbreng patiëntenperspectief

Er werd aandacht besteed aan het patiëntenperspectief door de leidraad voor commentaar voor te leggen aan de Patiëntenfederatie Nederland en de aangeleverde commentaren zijn bekeken en verwerkt.

Werkgroep				
Achternaam	***Hoofdfunctie***	***Nevenwerkzaamheden***	***Gemelde belangen***	***Ondernomen actie***
Jansen (voorzitter)	Hoogleraar Gynaecoloog LUMC en TU Delft	*Voorzitter Medical Delta (betaald) *Voorzitter landelijk netwerk "de Groene OK' (onbetaald) *Beeldhouwer	Onderzoekslijn ten aanzien van duurzaamheid: momenteel zijn 3 promovendi, onder mijn leiding onderzoek aan het doen op dit onderwerp. Hieruit verwacht ik geen vermarketing belangen.	*Geen restrictie*
Berg, van den	Uroloog, Franciscus Gasthuis & Vlietland	Geen	Geen	*Geen restrictie*
Bouvy	Chirurg, Maastricht UMC+	*Advisory Board Activ Surgical (betaald +/- 8 uur per jaar) *Secretaris Nederlandse Vereniging van Heelkunde	*KWF 2018-2022 Ontwikkeling van een intra peritoneale chemotherapie gel *KWF 2021-2024 Detectie(?) van schildklier kanker(?) in uitademingslucht	*Geen restrictie*
Egmond, van	Orthopedisch chirurg, ETZ Tilburg, vrijgevestigd	*DNFA wetenschappelijke commissie (onbetaald) *NVVT bestuur (onbetaald) *Congrescommissie traumalogen (onbetaald) *Landelijk Netwerk groene OK (onbetaald)	Geen	*Geen restrictie*
Ensink	KNO-arts, Gelre ziekenhuizen	*lid Advies commissie richtlijnen (vacatiegelden)	Geen	*Geen restrictie*
Haas, de	* Plastisch reconstructief en Handchirurg * Eigenaar en medeoprichter Kliniek Voor de Hand, Woerden	*Docent bij Health Investment (betaald) *Verrichten van Medische expertises (NVMSR lid; betaald)	Geen	*Geen restrictie*
Kwee	Gynaecoloog , UMCU, Utrecht (0.8fte UMCU waarvan 0.4fte gedetacheerd naar het programma Zorgevaluatie en Gepast Gebruik) (vanaf september 2023: volledig ZEGG)	Lid diverse (onbetaalde) commissies, o.a. *Voorzitter commissie Gynae Goes Green, NVOG *Lid landelijk netwerk groene OK *Lid adviescommissie Zorgevaluatie FMS *Lid werkgroep Leading the Change	Geen	*Geen restrictie*
Naus	Oogarts, Erasmus MC, Rotterdam	Geen	Geen	*Geen restrictie*
Nieuwenhuizen, van	Arts-onderzoeker afdeling gynaecologie (PhD kandidaat), LUMC	Arts-onderzoeker (PhD kandidaat, betaald). Hierbij o.a. actief als: * Voorzitter Young Medical Delta * Voorzitter Green Team LUMC * Lid Green Team OK LUMC en Green Team VK LUMC * Projectgroep de Groene Barometer (LNDGOK)	Geen	*Geen restrictie*
Noordzij (tot december 2021)	Plastisch chirurg, Rode Kruis Ziekenhuis Beverwijk per 1 oktober Spaarne Gasthuis Haarlem	Namens de NVPC in landelijk netwerk de Groene OK (onbetaald)	Geen	*Geen restrictie*
Sie	Anesthesioloog, Ikazia Ziekenhuis, Rotterdam	Lid commissie Kwaliteitsdocumenten NVA (onbetaald) Lid NVA werkgroep duurzaamheid (onbetaald)	Geen	*Geen restrictie*

Smits	*Plastisch chirurg, Erasmus MC * Maatschapslid AZRSFG (Plast.Chirurgie, Franciscus Gasthuis)	Allen onbetaald	*Mogelijk als ik later zelf een kliniek wil starten dat het goedkoper is als er minder luchtbehandeling nodig is. Echter die wens leeft niet bij mij. *Boegbeeldfunctie?	*Geen restrictie*
Veldkamp	*Arts-microblogloog, LUMC Hoofd Infectiepreventie *Voorzitter Infectiecommissie LUMC	*Voorzitter werkgroep Hygiëne en Infectiepreventie (HIP) van de NVMM (onbetaald) *Lid landelijk OMT-COVID-19 RIVM (vacatiegelden) *Lid expertiseteam Infectiepreventie FMS (onbetaald) Lid Cluster Advies Groep Samenwerkingsverband Richtlijnen Infectiepreventie (SRI) (onbetaald) *Werkgroeplld SRI Richtlijn Persoonlijke Beschermingsmiddelen (vacatiegelden) *Lid Algemene Visitatie Commissie NVMM, (vacatiegelden voor visitaties) *Adviseur opleidingscommissie deskundige Infectiepreventie CZO (onbetaald) *Voorzitter WG curatieve zorg Platform preparatie groep A ziekten, LCI, RIVM, (onbetaald)	Geen	*Geen restrictie*
Westerlaken	Deskundige Infectiepreventie, Erasmus MC	Lid en secretaris Green Team infectiepreventie VHIG (onbetaald)	Geen	*Geen restrictie*
Klankbordgroep				
Achternaam	***Hoofdfunctie***	***Nevenwerkzaamheden***	***Gemelde belangen***	
Guinée	Universitair Hoofddocent, Universiteit Leiden, Faculteit W&N, Instituut voor milieuwetenschappen (CML), afdeling Industrial Ecology	*Member of the ecoinvent editorial board (onbetaald) *Member of the Editorial Board of the International Journal of Life Cycle Assessment (onbetaald) *Member of the International Advisory Board of the Journal of Material Cycles and Waste Management (onbetaald)	*Carbon4PUR involving Covestro and Arcelor Mittal: https://www.carbon4pur.eu/ *SUPRIM on resources with mining companies such as Boliden; all not relevant for this topic: https://eitrawmaterials.eu/project/suprim/ *Safe by Design projecten: https://www.rijksoverheid.nl/documenten/rapporten/2021/11/30/implementing-safe-by-design-in-product-development-through-combining-risk-assessment-and-life-cycle-assessment-literature-review-and-guidelines en https://www.rijksoverheid.nl/documenten/rapporten/2021/11/30/selection-of-product-chemical-substance-combinations-for-illustrating-a-variety-of-safe-by-design-approaches	*Geen restrictie*
Heer, de	Adviseur Zorginstituut Nederland (1.0fte)	*Eigenaar eenmanszaak Mevrouw de Heer (kleine losse opdrachten, auteur) *Lid Planetary Health Hub NL (onbetaald) *Lid Planetary Health Alliance – Europe Hub (onbetaald)	Geen. Als voorstander van meer duurzaam denken in de zorg heb ik er belang bij dát er een leidraad komt, niet wat er in staat.	*Geen restrictie*
Langendam	Universitair docent en Principal Investigator, Amsterdam UMC,	Geen	*ZonMw Taalbarrières in de zorg en sociaal domein: generieke richtlijn module (geen rol als projectleider)	*Geen restrictie*

	afdeling Epidemiologie en Data Science		*ZonMw Monitor Innovatie van richtlijnen projecten (rol als projectleider) *ZonMw Modulair onderhoud richtlijnen jeugdgezondheidszorg (rol als projectleider) *Canadian Institutes of Health Research COVID-19 living recommendations map	
Lam	Vijfde jaars dermatoloog i.o, Erasmus MC	*Plaatsvervangend voorzitter vereniging arts assistenten dermatologie en venereologie (onbetaald) *Bestuurslid Nederlandse vereniging cosmetische dermatologie (onbetaald) * Dutch Representative for Youth Committee International Union of Angiology (onbetaald) *Associate editor Vascular Specialist international. (www.vsijournal.org) (onbetaald) *AIOS Ambassador of The Netherlands to the American Venous Forum (onbetaald)	Geen	*Geen restrictie*
Lee, van der	Senior adviseur, Kennisinstituut van Medisch Specialisten	*Onderzoeker, Amsterdam UMC (0.05fte) *Lid DSMB NVOG-consortium	Geen	*Geen restrictie*
Malenica	Anesthesie medewerker, Noordwest Ziekenhuisgroep, Alkmaar	Bestuurslid NVAM (onbetaald)	Geen	*Geen restrictie*

Kwalitatieve raming van mogelijke financiële gevolgen in het kader van de Wkkgz

Bij de richtlijn is conform de Wet kwaliteit, klachten en geschillen zorg (Wkkgz) een kwalitatieve raming uitgevoerd of de aanbevelingen mogelijk leiden tot substantiële financiële gevolgen. Bij het uitvoeren van deze beoordeling zijn richtlijnmodules op verschillende domeinen getoetst (zie het stroomschema op de Richtlijnendatabase).

Uit de kwalitatieve raming blijkt dat er waarschijnlijk geen substantiële financiële gevolgen zijn, zie onderstaande tabel.

Module	**Uitkomst raming**	**Toelichting**
Module 1 Operatietechnieken	Geen financiële gevolgen	Hoewel uit de toetsing volgt dat de aanbevelingen breed toepasbaar zijn (>40.000 patiënten), volgt uit de toetsing dat het overgrote deel (±90%) van de zorgaanbieders en zorgverleners al aan de norm voldoet, het geen andere organisatie van zorgverlening betreft, het geen toename in het aantal in te zetten zorgverleners betreft en het geen wijziging in het opleidingsniveau van zorgpersoneel betreft. Er worden daarom geen financiële gevolgen verwacht.
Module 2 Disposables vs reusables	Geen financiële gevolgen	Hoewel uit de toetsing volgt dat de aanbevelingen breed toepasbaar zijn (>40.000 patiënten), volgt uit de toetsing dat het overgrote deel (±90%) van de zorgaanbieders en zorgverleners al aan de norm voldoet, het geen andere organisatie van zorgverlening betreft, het geen toename in het aantal in te zetten zorgverleners betreft en het geen wijziging in het opleidingsniveau van zorgpersoneel betreft. Er worden daarom geen financiële gevolgen verwacht.
Module 3 Afdekmaterialen	Geen financiële gevolgen	Hoewel uit de toetsing volgt dat de aanbevelingen breed toepasbaar zijn (>40.000 patiënten), volgt uit de toetsing dat het overgrote deel (±90%) van de zorgaanbieders en zorgverleners al aan de norm voldoet, het geen andere organisatie van zorgverlening betreft, het geen toename in het aantal in te zetten zorgverleners betreft en het geen wijziging in het opleidingsniveau van zorgpersoneel betreft. Er worden daarom geen financiële gevolgen verwacht.
Module 4 Anesthesie	Geen financiële gevolgen	Hoewel uit de toetsing volgt dat de aanbevelingen breed toepasbaar zijn (>40.000 patiënten), volgt uit de toetsing dat het overgrote deel (±90%) van de zorgaanbieders en zorgverleners al aan de norm voldoet, het geen andere organisatie van zorgverlening betreft, het geen toename in het aantal in te zetten zorgverleners betreft en het geen wijziging in het opleidingsniveau van zorgpersoneel betreft. Er worden daarom geen financiële gevolgen verwacht.
Module 5 Luchtbehandeling	Geen financiële gevolgen	Hoewel uit de toetsing volgt dat de aanbevelingen breed toepasbaar zijn (>40.000 patiënten), volgt uit de toetsing dat het overgrote deel (±90%) van de zorgaanbieders en zorgverleners al aan de norm voldoet, het geen andere organisatie van zorgverlening betreft, het geen toename in het aantal in te zetten zorgverleners betreft en het geen wijziging in het opleidingsniveau van zorgpersoneel betreft. Er worden daarom geen financiële gevolgen verwacht.

Werkwijze

AGREE

Bijbehorende richtlijnmodules zijn opgesteld conform de eisen vermeld in het rapport Medisch Specialistische Richtlijnen 2.0 van de adviescommissie Richtlijnen van de Raad Kwaliteit. Dit rapport is gebaseerd op het AGREE II instrument (Appraisal of Guidelines for Research & Evaluation II; Brouwers, 2010).

Knelpuntenanalyse en uitgangsvragen

Deze leidraad is opgesteld met expertise van de werkgroep en klankbordgroep die uit verschillende disciplines bestaat. Adviseurs van het Kennisinstituut van de Federatie Medisch Specialisten hebben vanuit het perspectief van richtlijnontwikkelaars knelpunten aangeleverd tijdens een bijeenkomst op 24 februari 2022 (zie Bijlage 4: Verslag Bijeenkomst Adviseurs).
Daarnaast zijn knelpunten aangedragen tijdens de kick-off bijeenkomst die 28 maart 2022 heeft plaatsgevonden in het kader van de ontwikkeling van de Leidraad Duurzaamheid 'Toevoegen duurzaamheidsparagraaf aan landelijke richtlijnen'. Aan deze bijeenkomst hebben 18 organisaties deelgenomen (zie Bijlage 5: Verslag Kick-off bijeenkomst). De verkregen input is meegenomen bij het opstellen van de methodologische handreiking en bijbehorende modules.

Uitkomstmaten

Na het opstellen van de zoekvraag behorende bij de uitgangsvraag inventariseerde de werkgroep welke uitkomstmaten met betrekking tot de milieubelasting belangrijk zijn. Hierbij heeft de werkgroep gebruik gemaakt van het ReCiPe-model van het Rijksinstituut voor Volksgezondheid en Milieu (RIVM) (Huijbregts, 2016, Huijbregts, 2017). De werkgroep waardeerde uitkomstmaten volgens hun relatieve belang bij de besluitvorming rondom aanbevelingen, als cruciaal (kritiek voor de besluitvorming), belangrijk (maar niet cruciaal) en onbelangrijk. Tevens definieerde de werkgroep tenminste voor de cruciale uitkomstmaten welke verschillen zij klinisch (patiënt) relevant vonden.

Methode literatuursamenvatting

Een uitgebreide beschrijving van de strategie voor zoeken en selecteren van literatuur is te vinden onder 'Zoeken en selecteren' onder Onderbouwing. De beoordeling van de kracht van het wetenschappelijke bewijs wordt hieronder toegelicht.

Beoordelen van de kracht van het wetenschappelijke bewijs

De kracht van het wetenschappelijke bewijs werd bepaald volgens de GRADE-methode. GRADE staat voor 'Grading Recommendations Assessment, Development and Evaluation' (zie http://www.gradeworkinggroup.org/). De basisprincipes van de GRADE-methodiek zijn: het benoemen en prioriteren van de klinisch (patiënt) relevante uitkomstmaten, een systematische review per uitkomstmaat, en een beoordeling van de bewijskracht per uitkomstmaat op basis van de acht GRADE-domeinen (domeinen voor downgraden: risk of bias, inconsistentie, indirectheid, imprecisie, en publicatiebias; domeinen voor upgraden: dosis-effect relatie, groot effect, en residuele plausibele confounding).
GRADE onderscheidt vier gradaties voor de kwaliteit van het wetenschappelijk bewijs: hoog, redelijk, laag en zeer laag. Deze gradaties verwijzen naar de mate van zekerheid die er bestaat over de literatuurconclusie, in het bijzonder de mate van zekerheid dat de literatuurconclusie de aanbeveling adequaat ondersteunt (Schünemann, 2013; Hultcrantz, 2017).

GRADE	Definitie
Hoog	– er is hoge zekerheid dat het ware effect van behandeling dichtbij het geschatte effect van behandeling ligt; – het is zeer onwaarschijnlijk dat de literatuurconclusie klinisch relevant verandert wanneer er resultaten van nieuw grootschalig onderzoek aan de literatuuranalyse worden toegevoegd.
Redelijk	– er is redelijke zekerheid dat het ware effect van behandeling dichtbij het geschatte effect van behandeling ligt; – het is mogelijk dat de conclusie klinisch relevant verandert wanneer er resultaten van nieuw grootschalig onderzoek aan de literatuuranalyse worden toegevoegd.
Laag	– er is lage zekerheid dat het ware effect van behandeling dichtbij het geschatte effect van behandeling ligt; – er is een reële kans dat de conclusie klinisch relevant verandert wanneer er resultaten van nieuw grootschalig onderzoek aan de literatuuranalyse worden toegevoegd.

Zeer laag	– er is zeer lage zekerheid dat het ware effect van behandeling dichtbij het geschatte effect van behandeling ligt; – de literatuurconclusie is zeer onzeker.

Overwegingen (van bewijs naar aanbeveling)

Om te komen tot een aanbeveling zijn naast (de kwaliteit van) het wetenschappelijke bewijs ook andere aspecten belangrijk en worden meegewogen, zoals aanvullende argumenten uit bijvoorbeeld de biomechanica of fysiologie, waarden en voorkeuren van patiënten, kosten (middelenbeslag), aanvaardbaarheid, haalbaarheid en implementatie. Deze aspecten zijn systematisch vermeld en beoordeeld (gewogen) onder het kopje 'Overwegingen' en kunnen (mede) gebaseerd zijn op expert opinion. Hierbij is gebruik gemaakt van een gestructureerd format gebaseerd op het evidence-to-decision framework van de internationale GRADE Working Group (Alonso-Coello, 2016a; Alonso-Coello 2016b). Dit evidence-to-decision framework is een integraal onderdeel van de GRADE methodiek. Aanvullend hierop, heeft de werkgroep gebruik gemaakt van de 'R-ladder (strategieëen van circulariteit)' (gebaseerd op Cramer, 2014; Hanemaaijer; 2018; Potting, 2016; Reike, 2018), om de hotspots te evalueren.

Formuleren van aanbevelingen

De aanbevelingen geven antwoord op de uitgangsvraag en zijn gebaseerd op het beschikbare wetenschappelijke bewijs en de belangrijkste overwegingen, en een weging van de gunstige en ongunstige effecten van de relevante interventies. De kracht van het wetenschappelijk bewijs en het gewicht dat door de werkgroep wordt toegekend aan de overwegingen, bepalen samen de sterkte van de aanbeveling. Conform de GRADE-methodiek sluit een lage bewijskracht van conclusies in de systematische literatuuranalyse een sterke aanbeveling niet a priori uit, en zijn bij een hoge bewijskracht ook zwakke aanbevelingen mogelijk (Agoritsas, 2017; Neumann, 2016). De sterkte van de aanbeveling wordt altijd bepaald door weging van alle relevante argumenten tezamen. De werkgroep heeft bij elke aanbeveling opgenomen hoe zij tot de richting en sterkte van de aanbeveling zijn gekomen.
In de GRADE-methodiek wordt onderscheid gemaakt tussen sterke en zwakke (of conditionele) aanbevelingen. De sterkte van een aanbeveling verwijst naar de mate van zekerheid dat de voordelen van de interventie opwegen tegen de nadelen (of vice versa), gezien over het hele spectrum van patiënten waarvoor de aanbeveling is bedoeld. De sterkte van een aanbeveling heeft duidelijke implicaties voor patiënten, behandelaars en beleidsmakers (zie onderstaande tabel). Een aanbeveling is geen dictaat, zelfs een sterke aanbeveling gebaseerd op bewijs van hoge kwaliteit (GRADE gradering HOOG) zal niet altijd van toepassing zijn, onder alle mogelijke omstandigheden en voor elke individuele patiënt.

Implicaties van sterke en zwakke aanbevelingen voor verschillende richtlijngebruikers		
	Sterke aanbeveling	*Zwakke (conditionele) aanbeveling*
Voor patiënten	De meeste patiënten zouden de aanbevolen interventie of aanpak kiezen en slechts een klein aantal niet.	Een aanzienlijk deel van de patiënten zouden de aanbevolen interventie of aanpak kiezen, maar veel patiënten ook niet.
Voor behandelaars	De meeste patiënten zouden de aanbevolen interventie of aanpak moeten ontvangen.	Er zijn meerdere geschikte interventies of aanpakken. De patiënt moet worden ondersteund bij de keuze voor de interventie of aanpak die het beste aansluit bij zijn of haar waarden en voorkeuren.
Voor beleidsmakers	De aanbevolen interventie of aanpak kan worden gezien als standaardbeleid.	Beleidsbepaling vereist uitvoerige discussie met betrokkenheid van veel stakeholders. Er is een grotere kans op lokale beleidsverschillen.

Organisatie van zorg

In de knelpuntenanalyse en bij de ontwikkeling van de richtlijnmodule is expliciet aandacht geweest voor de organisatie van zorg: alle aspecten die randvoorwaardelijk zijn voor het verlenen van zorg (zoals coördinatie, communicatie, (financiële) middelen, mankracht en infrastructuur). Randvoorwaarden die relevant zijn voor het beantwoorden van deze specifieke uitgangsvraag zijn genoemd bij de overwegingen.

Commentaar- en autorisatiefase

De methodologische handreiking en bijbehorende inhoudelijke duurzaamheidsmodules zijn ter commentaar voorgelegd aan de betrokken (wetenschappelijke) verenigingen, (patiënt) organisaties en de leden van de Adviescommissie Richtlijnen van de Federatie van Medisch Specialisten. [partijen] hebben gereageerd op ons verzoek. De aangeleverde commentaren zijn bekeken, verwerkt en besproken met de werkgroep. Naar aanleiding van de commentaren werd de Leidraad Duurzaamheid aangepast en definitief vastgesteld door de werkgroep.

9. Implementatieplan methodologische handreiking

Aanbevelingen	Tijdspad voor implementatie: < 1 jaar, 1 tot 3 jaar of > 3 jaar	Verwacht effect op kosten	Randvoorwaarden voor implementatie (binnen aangegeven tijdspad)	Mogelijke barrières voor implementatie[1]	Te ondernemen acties voor implementatie[2]	Verantwoordelijken voor acties[3]	Overige opmerkingen
Alle aanbevelingen	< 1 jaar	Beperkt	Werkgroepleden en richtlijnadviseurs moeten bewust zijn van duurzaamheid tijdens de richtlijnontwikkeling.	Geen. Kennisverspreiding is van groot belang m.b.t. bewustwording.	• Voldoende kennis over LCA's en de 'R-ladder (strategieën van circulariteit)' bij zorgverleners. Dit zou middels een scholing of e-learning. • Verder onderzoek naar de impact van duurzaamheid. • Verspreiden van de leidraad. Hierbij kunnen congressen, het Landelijk Netwerk de Groene OK en informatiefilmpjes/kennisclips bij helpen.	• Nederlandse Vereniging voor Heelkunde (NVvH) en wetenschappelijke verenigingen. • Kennisinstituut van Medisch Specialisten. • Landelijk Netwerk de Groene OK. • Wetenschappers op het gebied van duurzaamheid.	Geen.

[1] Barrières kunnen zich bevinden op het niveau van de professional, op het niveau van de organisatie (het ziekenhuis) of op het niveau van het systeem (buiten het ziekenhuis). Denk bijvoorbeeld aan onenigheid in het land met betrekking tot de aanbeveling, onvoldoende motivatie of kennis bij de specialist, onvoldoende faciliteiten of personeel, nodige concentratie van zorg, kosten, slechte samenwerking tussen disciplines, nodige taakherschikking, etc.
[2] Denk aan acties die noodzakelijk zijn voor implementatie, maar ook acties die mogelijk zijn om de implementatie te bevorderen. Denk bijvoorbeeld aan controleren aanbeveling tijdens kwaliteitsvisitatie, publicatie van de richtlijn, ontwikkelen van implementatietools, informeren van ziekenhuisbestuurders, regelen van goede vergoeding voor een bepaald type behandeling, maken van samenwerkingsafspraken.
[3] Wie de verantwoordelijkheden draagt voor implementatie van de aanbevelingen, zal tevens afhankelijk zijn van het niveau waarop zich barrières bevinden. Barrières op het niveau van de professional zullen vaak opgelost moeten worden door de beroepsvereniging. Barrières op het niveau van de organisatie zullen vaak onder verantwoordelijkheid van de ziekenhuisbestuurders vallen. Bij het oplossen van barrières op het niveau van het systeem zijn ook andere partijen, zoals de NZA en zorgverzekeraars, van belang.

10. Kennislacunes

Tijdens de ontwikkeling van deze Leidraad Duurzaamheid heeft de werkgroep zich voornamelijk gebaseerd op basis van expert opinion en ervaring van de werkgroep, klankbordgroep en richtlijnadviseurs. Uit de vijf inhoudelijke duurzaamheidsmodules blijkt dat het wetenschappelijk bewijs over duurzaamheidsaspecten zeer beperkt is. Door gebruik te maken van de evidence-based methodiek (EBRO) is duidelijk geworden dat er kennislacunes bestaan. De werkgroep is van mening dat (vervolg)onderzoek wenselijk is om in de toekomst de impact op duurzaamheid beter vast te kunnen stellen en om meer handvatten te kunnen bieden voor het opnemen van duurzaamheidsaspecten bij richtlijnontwikkeling. De werkgroep een aantal kennislacunes geïdentificeerd:

- <u>Bewustwording van duurzaamheid in de zorgsector</u>
  In Nederland is de zorgsector verantwoordelijk voor een aanzienlijk deel van de CO_2-uitstoot. Hierin moeten zorgverleners meer verantwoordelijkheid in nemen. Om aan de klimaatdoelen te kunnen voldoen, is het essentieel dat alle professionals in de zorg (van bestuurder tot facilitair ondersteuner) geïnformeerd zijn over de relatie tussen menselijk handelen, klimaatverandering, milieuvervuiling en gezondheid. Hier ziet de werkgroep nog veel mogelijkheden tot verbetering. Momenteel ligt er nog te weinig focus op duurzaamheid in het veld.
  Vraag: *Hoe kan bewustwording van duurzaam handelen het best gecreëerd worden in de zorgsector?*
- <u>Bewijsvoering – kwaliteitsbeoordeling van LCA's</u>:
  Het vaststellen van impact op duurzaamheid wordt over het algemeen als complex beschouwd omdat een groot aantal processen, factoren en interacties meespelen. Uit de systematische zoekstrategieën van de vijf inhoudelijke duurzaamheidsmodules zijn voornamelijk LCA's geïdentificeerd. Echter, LCA's gaan gepaard met enkele methodologische uitdagingen, keuzes en aannames. Denk bijvoorbeeld aan het type en de definitie van de functionele eenheid, de beschikbaarheid van gegevens, de kwaliteit van de gebruikte gegevens, het gehanteerde referentiesysteem, het toegepaste scoresysteem of de gehanteerde wegingscriteria. Zo kunnen LCA's uitgaan van industriegemiddelden (secundaire gegevens) vanwege een gebrek aan ruwe gegevens (primaire gegevens), wat een mogelijke over- of onderschatting kan geven van de daadwerkelijke impact op duurzaamheid.
  Vragen: *Hoe hard zijn de uitkomsten van een LCA? Hoe bepaal je of een LCA bruikbaar en van goede kwaliteit is voor de gestelde uitgangsvraag?*
- <u>GRADE-framework voor LCA's</u>:
  De ervaring met GRADE op het gebied van milieu en gezondheid is relatief nieuw en nog volop in ontwikkeling (Morgan, 2016). Met betrekking tot LCA's en de toepassing van GRADE-methodiek, ontbreken er momenteel erkende en uniforme standaarden. De werkgroep heeft er nu voor gekozen om GRADE zoveel als mogelijk toe te passen, maar hier ligt een duidelijke kennislacune. Dit lijkt overeen te komen met de reeds gevoerde discussie over kosten-effectiviteitsstudies, zie bijvoorbeeld de ontwikkeling van het CEA-framework gericht de GRADE-beoordeling bij kosten-effectiviteitsstudies (Guyatt, 2012; Brunetti , 2012).
  Vragen: *Hoe kunnen we de GRADE-methodiek het beste toepassen op LCA's? Welke uniforme standaarden gelden hierbij?*

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Bijlage 1. Duurzaamheid zoekfilter

Embase
'biodegradable plastic'/exp OR 'biodiversity'/de OR 'climate change'/exp OR 'climate resilience'/exp OR 'disposable equipment'/exp OR 'ecological diversity'/exp OR 'energy conservation'/exp OR 'environmental aspects and related phenomena'/exp OR 'environmental footprint'/exp OR 'environmental protection'/exp OR 'eutrophication'/exp OR 'life cycle assessment'/exp OR 'pollution and pollution related phenomena'/exp OR 'species diversity'/exp OR 'waste and waste related phenomena'/exp OR 'wastewater'/exp OR 'water management'/exp OR 'water pollution'/exp OR acidification:ti,ab,kw OR (((air OR organic OR soil OR water OR plastic* OR liquid*) NEAR/4 (pollut* OR contamina* OR wast*)):ti,ab,kw) OR biodivers*:ti,ab,kw OR 'biological divers*':ti,ab,kw OR (((co2 OR 'co 2' OR carbon OR 'nitrous oxide') NEAR/3 (emission* OR footprint OR equival* OR reduct*)):ti,ab,kw) OR (((nature OR environment* OR climat*) NEAR/3 (impact* OR pollut* OR conservat* OR protect* OR preserv* OR effect* OR benefit* OR chang* OR exposure* OR resilien*)):ti,ab,kw) OR disposable*:ti,ab,kw OR ((eco* NEAR/3 (toxic* OR efficien* OR damage)):ti,ab,kw) OR ecotoxic*:ti,ab,kw OR ecoefficien*:ti,ab,kw OR (((emission OR waste) NEAR/3 reduc*):ti,ab,kw) OR environmental*:ti OR (((equipment* OR product* OR waste*) NEAR/3 reus*):ti,ab,kw) OR recycl*:ti,ab,kw OR 'resource recover*':ti,ab,kw OR eutrophicat*:ti,ab,kw OR (((global OR climate) NEAR/2 warming):ti,ab,kw) OR ((green* NEAR/2 (deal OR surger* OR effect* OR gas* OR resource*)):ti,ab,kw) OR (((hospital OR medical OR zero OR product* OR byproduct* OR 'by product*' OR avoid* OR energy OR management OR nuclear OR biomass) NEAR/3 waste*):ti,ab,kw) OR 'human toxicity potential*':ti,ab,kw OR (((ep OR h+ OR gwp OR faetp OR fatp OR ap OR cfc OR 'kg n' OR 'nox' OR '2.4' OR '2,4' OR pocp OR so2 OR dichlorobenzen* OR ethan* OR po4 OR dcb) NEAR/3 equival*):ti,ab,kw) OR ((ozone NEAR/3 (deplet* OR hole*)):ti,ab,kw) OR (((plastic* OR microplastic* OR 'micro plastic*') NEAR/3 (overuse OR soup OR pollut* OR contaminat*)):ti,ab,kw) OR recycle*:ti,ab,kw OR recycling:ti,ab,kw OR (((refuse OR waste) NEAR/3 disposal):ti,ab,kw) OR reusable*:ti,ab,kw OR reuse*:ti,kw OR reusing:ti,kw OR 'rising sea level*':ti,ab,kw OR 'sea level ris*':ti,ab,kw OR smog:ti,ab,kw OR sustainab*:ti,kw OR ((sustainab* NEAR/3 (development* OR cycle* OR management OR effect* OR environment*)):ti,ab,kw) OR ((water NEAR/3 (purificat* OR sanitat* OR treatment)):ti,ab,kw) OR wastewater:ti,ab,kw OR ((hydrogen NEAR/3 moles NEAR/3 equival*):ti,ab,kw) OR 'circular econom*':ti,ab,kw OR biodegradab*:ti,ab,kw OR (((ecological OR environmental OR water OR energy OR climate OR global) NEAR/2 footprint*):ti,ab,kw) OR waste:ti,ab,kw OR wastes:ti,ab,kw OR reuse:ti,ab,kw OR reusab*:ti,ab,kw OR reprocess*:ti,ab,kw OR pollut*:ti,ab,kw OR greening:ti,ab,kw OR spillage:ti,ab,kw OR spilling:ti,ab,kw OR spoilage:ti,ab,kw OR salinization:ti,ab,kw OR 'cradle to cradle':ti,ab,kw OR 'carbon neutral*':ti,ab,kw

Studiedesign LCA
'life cycle assessment'/exp OR ('life cycle’ OR lifecycle) NEAR/2 (assess* OR inventor* OR analys*):ti,ab,kw OR lca;ti,ab,kw

Ovid/Medline
Biodegradable Plastics/ or exp Biodiversity/ or exp Carbon Footprint/ or exp Environmental Pollution/ or exp Climate Change/ or Disposable Equipment/ or Environment/ or Equipment Reuse/ or exp Eutrophication/ or Greenhouse Gases/ or Greenhouse Effect/ or exp Hazardous Waste/ or exp Medical Waste/ or Ozone Depletion/ or Recycling/ or exp Refuse Disposal/ or Smog/ or Waste Products/ or exp Waste Water/ or acidification.ti,ab,kf. or ((air or organic or soil or water or plastic* or liquid*) adj4 (pollut* or contamina* or wast*)).ti,ab,kf. or (biodivers* or "biological divers*").ti,ab,kf. or ((co2 or "co 2" or carbon) adj3 (emission* or footprint or equival* or reduct*)).ti,ab,kf. or ((nature or environment* or climat*) adj3 (impact* or pollut* or conservat* or protect* or preserv* or effect* or benefit* or chang* or exposure* or resilien*)).ti,ab,kf. or disposable*.ti,ab,kf. or (eco* adj3 (toxic* or efficien* or damage)).ti,ab,kf. or ecotoxic*.ti,ab,kf. or ecoefficien*.ti,ab,kf. or ((waste or emission*) adj3 reduc*).ti,ab,kf. or environmental*.ti. or ((equipment* or product* or waste*) adj3 reus*).ti,ab,kf. or recycl*.ti,ab,kf. or resource recover*.ti,ab,kf. or eutrophicat*.ti,ab,kf. or ((global or climate) adj2 warming).ti,ab,kf. or (("life cycle" or lifecycle) adj2 (assess* or inventor*)).ti,ab,kf. or LCA.ti,ab,kf. or (green* adj2 (deal or surger* or effect* or gas* or resource*)).ti,ab,kf. or greening.ti,ab,kf. or ((hospital or medical or zero or product* or byproduct* or "by product*" or avoid* or energy or management or nuclear or biomass) adj3 waste*).ti,ab,kf. or "human toxicity potential*".ti,ab,kf. or ((EP or H+ or GWP or FAETP or FATP or AP or CFC

or "kg N" or "NOx" or "2.4" or "2,4" or POCP or SO2 or dichlorobenzen* or ethan* or PO4 or DCB) adj3 equival*).ti,ab,kf. or (ozone adj3 (deplet* or hole*)).ti,ab,kf. or ((plastic* or microplastic* or "micro plastic*") adj3 (overuse or soup or pollut* or contaminat*)).ti,ab,kf. or recycle*.ti,ab,kf. or recycling.ti,ab,kf. or ((refuse or waste) adj3 disposal).ti,ab,kf. or reusable*.ti,ab,kf. or reuse*.ti,kf. or reusing.ti,kf. or "rising sea level*".ti,ab,kf. or "sea level ris*".ti,ab,kf. or smog.ti,ab,kf. or sustainab*.ti,kf. or (sustainab* adj3 (development* or cycle* or management or effect* or environment*)).ti,ab,kf. or (water adj3 (purificat* or sanitat* or treatment)).ti,ab,kf. or wastewater.ti,ab,kf. or (hydrogen adj3 moles adj3 equival*).ti,ab,kf. or "circular econom*".ti,ab,kf. or biodegradab*.ti,ab,kf. or ((ecological or environmental or water or energy or global or climat*) adj2 footprint*).ti,ab,kf. or (waste adj3 by product*).ti,ab,kf. or waste.ti,ab,kf. or wastes.ti,ab,kf. or reuse.ti,ab,kf. or reusab*.ti,ab,kf. or reprocess*.ti,ab,kf. or pollut*.ti,ab,kf. or (microplastic* and pollut*).ti,ab,kf. or greening.ti,ab,kf. or spillage.ti,ab,kf. or spoilage.ti,ab,kf. or salinization.ti,ab,kf. or "cradle to cradle".ti,ab,kf.

Studiedesign LCA
(("life cycle” or lifecycle) adj2 (assess* or inventor* OR analys*)).ti,ab,kf. or LCA.ti,ab,kf.

Bijlage 2. Evidence tabel voor Life Cycle Assessment (LCA)

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes[1]	Interpretation	Comments
Author, year	Name journal: Journal information[2]: Peer reviewed by LCA expert?: [yes/no]	Type of study: LCA Objective of LCA: LCA-method[3]: Setting and country: Period/Year of data collection: Funding and conflict of interest:	Goal and scope of LCA[4]: Functional unit(s)[5]: System boundaries: Included stages: Stated excluded components: Inventory database: - Allocation: [yes/no] Normalization & Weighting: [yes/no] Impacts reported: [yes/no] Contribution analysis: [yes/no] Scenario analysis: [yes/no] Comparative analysis: [yes/no] Sensitivity analysis: [yes/no] Uncertainty analysis: [yes/no] Variance analysis: [yes/no]				Authors conclusion: Limitations:

[1] Report the outcome measures and effect size (include 95%CI and p-value if available)
[2] Journal information: specific LCA joural? report journal characteristics, such as: peer-reviewed? aim/scope? Impact factor?
[3] LCA-method: report the type of LCA method which is assessed, such as: Economic Input-Output LCA, Attributional LCA, Hybrid LCA
[4] Goals and scope: 'Phase of life cycle assessment in which the aim of the study, and in relation to that, the breadth and depth of the study is established'.
[5] Functional unit: Quantified description of the function of a product or process that serves as the reference basis for all calculations regarding impact assessment.

Bijlage 3. Critical appraisal of LCA's (Drew, 2021)

Drew (2021) developed a critical appraisal *pro forma*, based on Weidema's guidelines for critical review of LCA (Weidema, 1997). This scoring system consists of 16 appraisal criteria, which are divided between the different phases of an LCA. It addresses a range of study quality indicators, such as internal validity, external validity, consistency, transparency, and bias. The percentage score provides an indication of the overall study quality. A higher score indicates a higher overall study quality.

Appraisal criteria	**Indicator(s)** [range]	**Key effect modifiers**	Author, year
Phase 1: Goal & Scope (13 points)			
Study goal is clearly stated, including the study's rationale (1), intended application (1), and intended audience (1)	Transparency [0-3]		
Lifecycle assessment method is clearly stated (1)	Transparency [0-1]		
Functional unit is clearly defined and measurable (1), justified (1), and consistent with the study's intended application (1)	Consistency [0-3]		
The system to be studied is adequately described with clearly stated system boundaries (1), lifecycle stages (1), and appropriate justification of any omitted stages (1)	Transparency; Bias [0-3]		
The system covers production (1), use/reuse (1) and disposal (1) of materials and energy (half mark if only for energy and vice versa)	Internal Validity, Completeness [0-3]		
Phase 2: Inventory analysis (7 points)			
The data collection process is clearly explained, including the source(s) of foreground material weights and energy values (1); the source(s) of reference data (e.g. inventory database; 1); and what data are included (e.g. production and disposal of unit processes; 1)	Transparency, Internal Validity [0-3]		
Representativeness of the data is discussed (1), differences in electricity generating mix are accounted for (1), and the potential significance of exclusions or assumptions is addressed (1)	Internal validity; External validity [0-3]		
Allocation procedures, where necessary, are described and appropriately justified (1; mark given if no allocation used)	Transparency; Bias [0-1]		
Phase 3: Impact assessment (6 points)			
Impact categories (1), characterization method (1), and software used (1) are documented transparently	Transparency [0-3]		
Results are clearly reported in the context of the functional unit (1) (0.5 if graphically, 0 if only normalized results reported)	Consistency; Transparency [0-1]		
A contribution analysis is performed and clearly reported (1), and hotspots are identified (1)	[0-2]		

Phase 4: Interpretation (9 points)			
Conclusions are consistent with the goal and scope (1) and supported by the impact assessment results (1)	Internal validity; Consistency [0-2]		
Results are contextualized through the use of sensitivity analysis (1) and uncertainty analysis (1)	Internal validity [0-2]		
Limitations are adequately discussed (1), and the potential impact of omissions or assumptions on the study's outcomes are described (1)	Bias [0-2]		
The assessment has been critically appraised (i.e. peer review if journal article or independent, external critical review if report/thesis; 1)	Bias [0-1]		
Source(s) of funding and any potential conflict(s) of interest are disclosed (1), and are unlikely to be a source of bias (1)	Bias [0-2]		
		Total (/35)	
		Percentage score	

Bijlage 4. Verslag bijeenkomst adviseurs Kennisinstituut (24 februari 2022)

Inhoudelijk overleg

Datum:	Maandag 24 februari 2022
Tijd:	14.00u-15.30u
Locatie:	Digitaal, ZOOM
Aanwezigen:	Richtlijnadviseurs van het Kennisinstituut

1. Opening

Toon Lamberts (senior adviseur Kennisinstituut) opent het inhoudelijk overleg. Kim van Nieuwenhuizen (arts-onderzoeker, LUMC) wordt voorgesteld aan alle collega's, zij is van het de NVvH betrokken bij de werkgroep. Ook wordt kort benoemd dat Teus van Barneveld (directeur Kennisinstituut) aanwezig is vandaag, hij is naast Charlotte Michels en Toon betrokken als projectleider. Toon legt het doel van het inhoudelijk overleg uit en licht de agenda toe.

Het doel van dit inhoudelijk overleg is het verzamelen van aandachtspunten en ervaren knelpunten in de praktijk vanuit richtlijnadviseurs, zodat we deze input mee kunnen nemen in de uiteindelijke methodologische handreiking.

2. Aanleiding, opbouw en doelstelling Leidraad

Kim van Nieuwenhuizen (arts-onderzoeker, LUMC) licht kort de aanleiding van de Leidraad toe. De CO_2-uitstoot door de gezondheidszorg bedraagt 7% van de totale CO2-voetafdruk van Nederland (De Bruin, 2019; Eckelman, 2018) en geschat wordt dat 20-30% van het totale ziekenhuisafval afkomstig is van de OK (Friedericy, 2019). Om de gezondheid van toekomstige generaties te garanderen, moeten niet alleen de kosten van de zorg beteugeld worden, maar ook de belasting van het milieu door de zorg. Duurzaamheid is onlosmakelijk onderdeel geworden van medisch handelen sinds de ondertekening van de Green Deal en de convenanten aan de klimaattafels (e.g. Green Deal). Hier moeten we ook wat mee in de richtlijnontwikkeling. Echte is tot nu is er weinig tot geen aandacht voor de milieu effecten van een behandeling bij richtlijnen.

Charlotte Michels (adviseur Kennisinstituut) krijgt het woord van Kim. Doelstelling van deze Leidraad is om te komen tot algemene handvatten voor het opnemen van een duurzaamheidsparagraaf bij revisie van bestaande of ontwikkeling van nieuwe landelijke richtlijnen in de snijdende disciplines.

3. Opbouw Leidraad

Charlotte licht toe dat de Leidraad in twee delen wordt uitgewerkt:

- <u>Deel A: Methodologische handreiking</u>. We ontwikkelen een duurzaamheidskader voor richtlijnen, hierbij wordt een breed scala aan vragen opgepakt. Bijvoorbeeld:
  - Set van criteria om vast te stellen wanneer expliciet aandacht nodig is voor duurzaamheid bij richtlijnontwikkeling.
  - Criteria om te bepalen bij welke onderwerpen een "expert" op het gebied van duurzaamheid in de werkgroep op te nemen.
  - Standaard literatuursearches op duurzaamheidsaspecten.
  - Handreikingen hoe duurzaamheid kan worden meegenomen in: de knelpuntenanalyse, het 'evidence to decision framework' (overwegingen) en aanbevelingen.
- <u>Deel B: Vijf inhoudelijke modules gericht op duurzaamheid</u>. Er worden vijf inhoudelijke modules uitgewerkt, specifiek gericht op duurzaamheidaspecten (i.e. type operatietechnieken, reusables vs. disposables, afdekmaterialen, anesthesie en luchtbehandeling).

Charlotte vertelt dat we ons tijdens dit inhoudelijk overleg voornamelijk richten op ‘Deel A: Methodologische handreiking’. Tijdens dit project leggen we duurzaamheidsaspecten langs de Evidence Based Richtlijnontwikkeling. Per fase kan duurzaamheid een rol spelen. De stuurgroep heeft gezamenlijk een aantal duurzaamheidsvraagstukken vastgesteld waar we tijdens deze bijeenkomst over willen sparren. Een aantal voorbeelden worden toegelicht door Charlotte.

4. Break-out sessies

Voor het bespreken van mogelijke knelpunten en duurzaamheidsvraagstukken worden de aanwezigen opgedeeld in subgroepen. In 25 minuten worden de belangrijkste knelpunten die de adviseurs ervaren geïnventariseerd.

Voorbeeld verkregen input van een subgroepje tijdens de break-out sessie

<u>Voorbereidingsfase</u>

- Bij modulair onderhoud past het binnen de vraag bij nieuwe onderwerpen, en met suggesties kan bij de Need for update aandacht gegeven worden aan duurzaamheid.
- Belangrijk van tevoren met de voorzitter/ werkgroep bespreken of duurzaamheid belangrijk is om mee te nemen.
- Als het als een knelpunt wordt aangedragen, dan zal een expert moeten worden betrokken. Wij hebben binnen het Kennisinstituut geen expertise hiervoor.

<u>Ontwikkelingsfase</u>

- Het past het beste in de overwegingen, in onze versie onder kosten en in de Engelse versie onder resource use.
- Methodologisch gezien lijkt het geen optie bij verschil in effectiviteit. Effectiviteit zal dan de doorslaggevende factor zijn.
- Mogelijk heeft duurzaamheid meer bij organisatie van zorg een plaats: zoals beperking van reisbewegingen
- Voorkeur voor een algemene richtlijn/module om naar te verwijzen (maar er is wel een risico dat het verzandt bij adviseurs)
- Mogelijk bij een evidence (zie voorbeeld klompvoetjes)

<u>Algemene opmerkingen</u>

- Binnen het Kennisinstituut hebben we geen expertise. Dus bij een module zal een expert betrokken moeten worden als duurzaamheid in de overwegingen worden opgenomen.
- Idee: huidige modules doorlopen waar duurzaamheid mogelijk een rol speelt, samen met een expert.
- Mogelijk heeft duurzaamheid meer een plaats bij een leidraad vanwege het organisatie-van-zorgkarakter.
- Relevante documenten om naar te kijken: ethiek in richtlijnen

5. Sluiting

Charlotte heet iedereen weer welkom in de plenaire zoom-omgeving. In haar groepje was er veel discussie en kwam vooral naar voren dat er nog veel vragen op en liggen.
De planning en het verdere plan van aanpak wordt toegelicht. Zo zal er eind maart 2022 een kick-off bijeenkomst plaatsvinden voor medisch specialisten die ervaring hebben met richtlijnontwikkeling.

Bijlage 5. Verslag kick-off bijeenkomst (28 maart 2022)

Datum, tijd: Maandag 28 maart 2022, 17.00u-18.30u
Locatie: Digitaal via ZOOM
Aanwezigen: Anneke Kwee (NVOG), Cathy van Beek (individueel expert), Corina Sie (NVA), Edwin van Leent (NVDV), Femke Aanhane (SRI), Femme Dirksmeier-Harinck (NVMDL), Fleur Westerlaken (VHIG), Haitske Graveland (SRI), Hillie Beumer (NVVH), Jeroen van Moorselaar (NVU), Karin Ellen Veldkamp (NVMM), Kirsten Molendijk (RIVM), Klaartje Weidema (SRI), Leontien Geven (NVKNO), Margo Kusters (NVMM), Marjolijn Duijvestein (NVMDL), Melinda Witbreuk (NOV), Mieke Waltmans (VHIG), Miriam Slot (NVVN), Nicole Bouvy (NVVH), Nicole Hunfeld (The Green IC), Pauline de Heer (ZIN), Peter Go (NVVH), Pim van Egmond (NOV), Redmer van Leeuwen (NOG), Remco de Bree (NVKNO), Renata Klop (ZonMw), Selma Bons (NVA), Sjoerd Elferink (NOG), Tammo Brouwer (NVA), Yee Lai Lam (NVDV), Frank Willem Jansen (NVOG, voorzitter), Kim van Nieuwenhuizen (arts-onderzoeker, LUMC), Toon Lamberts (Kennisinstituut) en Charlotte Michels (Kennisinstituut)

1. Opening

Frank Willem Jansen (NVOG, voorzitter werkgroep) opent de kick-off meeting en heet iedereen van harte welkom. Voor deze bijeenkomst zijn voorzitters van lopende richtlijnen gericht op snijdende specialismen, bureaumedewerkers en inhoudsdeskundigen van partijen die in de werkgroep zitten, leden van de klankbordgroep en derde partijen uitgenodigd. Er zijn vandaag ongeveer 37 deelnemers namens 18 partijen aanwezig. Frank Willem ligt kort het doel van de Leidraad en deze bijeenkomst toe.

2. Aanleiding en doelstelling Leidraad

Kim van Nieuwenhuizen (arts-onderzoeker, LUMC) licht kort de aanleiding van de Leidraad toe. De CO_2-uitstoot door de gezondheidszorg bedraagt 7% van de totale CO2-voetafdruk van Nederland (De Bruin, 2019; Eckelman, 2018) en geschat wordt dat 20-30% van het totale ziekenhuisafval afkomstig is van de OK (Friedericy, 2019). Om de gezondheid van toekomstige generaties te garanderen, moeten niet alleen de kosten van de zorg beteugeld worden, maar ook de belasting van het milieu door de zorg. Tot nu is er weinig tot geen aandacht voor de milieu effecten van een behandeling bij richtlijnen.
Doelstelling van deze Leidraad is om te komen tot algemene handvatten voor het opnemen van een duurzaamheidsparagraaf bij revisie van bestaande of ontwikkeling van nieuwe landelijke richtlijnen in de snijdende disciplines.

Het doel van deze kick-off bijeenkomst is het verzamelen van aandachtspunten en ervaren knelpunten in de praktijk om uiteindelijk de methodologische handreiking op te kunnen stellen die inhoudelijk aansluit bij de behoefte van het veld.

3. Werkwijze richtlijnontwikkeling

De Leidraad wordt in twee delen uitgewerkt:

- <u>Deel A: Methodologische handreiking</u>. We ontwikkelen een duurzaamheidskader voor richtlijnen, hierbij wordt een breed scala aan vragen opgepakt. Bijvoorbeeld:
    - Set van criteria om vast te stellen wanneer expliciet aandacht nodig is voor duurzaamheid bij richtlijnontwikkeling.
    - Criteria om te bepalen bij welke onderwerpen een “expert” op het gebied van duurzaamheid in de werkgroep op te nemen.
    - Standaard literatuursearches op duurzaamheidsaspecten.
    - Handreikingen hoe duurzaamheid kan worden meegenomen in: de knelpuntenanalyse, het ‘evidence to decision framework’ (overwegingen) en aanbevelingen.

- Deel B: Vijf inhoudelijke modules gericht op duurzaamheid. Er worden vijf inhoudelijke modules uitgewerkt, specifiek gericht op duurzaamheidaspecten (i.e. type operatietechnieken, reusables vs. disposables, afdekmaterialen, anesthesie en luchtbehandeling).

4. Openstaande vraagstukken methodologische handreiking

Charlotte Michels (Kennisinstituut) vertelt dat we ons tijdens deze kick-off bijeenkomst voornamelijk richten op 'Deel A: Methodologische handreiking'. Kortom, hoe kunnen we werkgroepleden, bureaumedewerkers, adviseurs van het Kennisinstituut het beste ondersteunen om duurzaamheid te verwerken in richtlijnontwikkeling? Tijdens dit project leggen we duurzaamheidsaspecten langs de Evidence Based Richtlijnontwikkeling. Per fase kan duurzaamheid een rol spelen. De stuurgroep heeft gezamenlijk een aantal duurzaamheidsvraagstukken vastgesteld waar we tijdens deze bijeenkomst over willen sparren.

- Module (Frank Willem, room 1): Moet duurzaamheid aan bod komen per module of aan het einde van een conceptrichtlijn?
  Knelpunten (Charlotte, room 2): Moeten we duurzaamheid standaard meenemen als knelpunt?
- Uitkomsten (Kim, room 3): Moeten we duurzaamheid standaard meenemen bij het opstellen van de PICO?
  Overwegingen (Toon, room 4):
  - Hoe verhoudt duurzaamheid zich tot andere uitkomsten (bij. QALYs, kosten-effectiviteit)?
  - Wanneer speelt duurzaamheid een rol in de keuze van een behandeling? Zou dit een doorslaggevende factor moeten zijn?
  - Hoe kan duurzaamheid adequaat worden meegenomen in de overwegingen (i.e. evidence to decision framework)? Welke informatie heeft een werkgroep nodig?
- Werkgroep samenstelling (generiek): Wanneer moet er een duurzaamheidsexpert geraadpleegd worden? Wat verstaat u hieronder?
- Leidraad algemeen (generiek): Wat verwacht u van de leidraad? Hoe ondersteunt de leidraad bij het opstellen van een richtlijn?

5. Break-out sessies

Voor het bespreken van mogelijke knelpunten worden de aanwezigen opgedeeld in vier subgroepen. Elke subgroep heeft een onderwerp toegewezen gekregen, maar aanwezigen kunnen ook punten benoemen die buiten het onderwerp vallen. In 25 minuten worden de belangrijkste knelpunten die de aanwezigen ervaren geïnventariseerd.

Plenaire nabespreking

De uitkomsten van de subgroepen worden samengevat en plenair teruggekoppeld. In het kort de genoemde punten per onderwerp:

Room 1 (Frank Willem Jansen) *Afgevaardigden: Corina Sie (NVA), Haitske Graveland (SRI), Kirsten Molendijk (RIVM), Margo Kusters (NVMM), Marjolijn Duijvestein (NVMDL), Melinda Witbreuk (NOV), Pim van Egmond (NOV), Renata Klop (ZonMw), Selma Bons (NVA), Sjoerd Elferink (NOG)*

- De voorkeur ligt bij een tussenvorm om per modules de duurzaamheidsaspecten te behandelen.
- De herziening van richtlijnen wordt per module opgepakt en veel medisch specialisten lezen richtlijnen per module, daarom zou het mooi zijn om duurzaamheid per module te verwerken.
- Er heerst erkenning dat bepaalde modules moeilijk te vatten zullen zijn op duurzaamheidsaspecten.
- Algemeenheden (reusable vs. disposable, medicatie toediening, patiënten controles op afstand) graag generiek/ algemeen oppakken.

Room 2 (Charlotte Michels) *Afgevaardigden: Tammo Brouwer (NVA), Peter Go (NVVH), Pauline de Heer (ZiN), Yee Lai Lam (NVDV), Nicole Hunfeld (The Green IC), Hillie Beumer (NVVH)*

- Duurzaamheid zo vroeg mogelijk in de richtlijnontwikkeling bespreken (ofwel, duurzaamheid standaard tijdens eerste bijeenkomst benoemen). Indien nodig kunnen werkgroepleden vervolgens duurzaamheidsaspecten op maat verwerken.

- Door duurzaamheid bij aanvang van de richtlijnontwikkeling mee te nemen, kunnen ook kennislacunes het best geïdentificeerd worden (zodat ook doelmatig vervolgonderzoek geïnitieerd wordt).
- Nu moet de focus liggen op 'hotspots'/ laaghangend fruit, waarbij een generieke aanpak wenselijk is. Op organisatie niveau zijn algemene richtlijnen gericht op duurzaamheid nodig, op deze manier kunnen ziekenhuizen zelf/op maat optimalisaties doorvoeren.
- Bij gelijke (kosten-)effectiviteit speelt duurzaamheid een doorslaggevende rol. De gevolgen van duurzame oplossingen moeten we doorrekenen.
- Genoemde voorbeelden van onderwerpen die aandacht behoeven: stoffen jassen, laminaire flow, robotchirurgie, anesthesiegassen vs. spuiten.
- Leidraad algemeen (generiek):
    - Adviezen geven zodat per ziekenhuis oplossingen op maat gegeven kunnen worden.
    - Handvatten om kennislacunes aan te stippen (dit mag door het hele proces lopen).
    - Afwegingen schetsen zodat werkgroepleden geholpen worden in de discussie. Veel zal gebaseerd worden op 'boeren verstand', er zijn immers geen RCT's bekend.

Room 3 (Kim van Nieuwenhuizen) *Afgevaardigden: Cathy van Beek (voorzitter Klimaattafel Gezondheidszorg Rotterdam), Anneke Kwee (NVOG), Leontien Geven (KNOV), Fleur Westerlaken (VHIG), Remco de Bree (KNOV), Redmer van Leeuwen (NOG), Femke Aanhane (SKILZ)*
- Om awareness te vergroten moet duurzaamheid zo snel mogelijk in de richtlijnontwikkeling naar voren komen. Omdat richtlijnen nu per module worden gereviseerd is individuele aanpak per module meer wenselijk.
- Er is veel discussie geweest in de subgroep m.b.t. PICO's. Naar verwachting is er relatief weinig literatuur gericht op duurzaamheid beschikbaar, dus duurzaamheid moeten we standaard meenemen in de 'overwegingen'.
- Kennishiaten moeten geadresseerd worden in richtlijnen, maar hierbij moeten wel handvatten geboden worden waar werkgroepleden aan moeten denken. Voorstel wordt gedaan om een lijst duurzaamheid-uitkomsten (voor PICO's) op te nemen in de Leidraad (e.g. DALYs, QALYs, CO_2-uitstoot, afval, energie). Het liefst zou je per CO_2-uitstoot willen weten wat de impact is op kwaliteit van leven en kosten.

Room 4 (Toon Lamberts) *Afgevaardigden: Edwin van Leent (NVDV), Femme Dirksmeier-Harinck (NVMDL), Jeroen van Moorselaar (NVU), Karin Ellen Veldkamp (NVMM), Klaartje Weidema (SRI), Mieke Waltmans (VHIG), Nicole Bouvy (NVVH), Miriam Slot (NVVN)*
- Zo breed mogelijk 'overwegingen' omschrijven (e.g. tandaard aandacht geven aan duurzaamheid, infectiepreventie, microbiologie, kwaliteit van leven). Bij gelijke effectiviteit en kwaliteit, dan spelen kosten en LCA's een grote rol in de 'overwegingen'.
- Hierbij moet ook de industrie meegenomen worden, omdat er perverse prikkels in de praktijk worden gezien (ter illustratie, soms worden apparaten met korting aangeboden en vervolgens dienen er prijzige disposables voor het gebruik gekocht worden).
- Hoe hard is de bewijsvoering m.b.t. duurzaamheid? Elke vorm van hoog kwalitatieve evidence ontbreekt, het is moeilijk om hiermee om te gaan. De uiteindelijke afweging zal afhankelijk zijn van de context en ingreep. Bijvoorbeeld vanuit infectiepreventie: hoe schoon moet schoon zijn?
- Vanuit de deskundigen infectiepreventie wordt er gewerkt aan een *Toolbox* om duurzaamheid op het gebied van infectiepreventie mee te kunnen nemen, dit zesdelige stappenplan zou mogelijk een mooie plek in de overwegingen bij richtlijnen kunnen krijgen.

6. Aanvullingen vanuit de ZOOM-chat en plenaire discussie

Tijdens de kick-off meeting hebben enkele deelnemers gebruik gemaakt van de chatfunctie van Zoom. Daarnaast worden nog enkele generieke vragen voorgelegd aan de aanwezigen door Frank Willem. De volgende onderwerpen/aandachtspunten zijn genoemd:

- Wanneer moet er een duurzaamheidsexpert geraadpleegd worden?
    - We moeten handelen naar bevind van zaken (e.g. RIVM, ZonMw, ingenieurs kunnen geraadpleegd worden), maar dit zal afhankelijk van de context zijn.
    - Er wordt voorgesteld om bestaande duurzaamheidsplatforms te clusteren, zodat experts elkaar weten te vinden.
- In april 2022 wordt een SRI handreiking gepubliceerd met stappenplan (zes stappen) hoe om te gaan met duurzaamheid.
- Vier pijlers van duurzame zorg worden herhaaldelijk genoemd: Klimaatcrisis (49% CO_2-reductie in 2030), Circulaire bedrijfsvoering, Medicijnresten uit afvalwater en Gezond makende leefomgeving en milieu. Naar verwachting worden hier steeds meer verplichtingen aan verbonden.

7. Vervolgafspraken en sluiting

Het verslag van deze avond wordt verspreid en er is gelegenheid tot commentaar of aanvullingen hierop. De werkgroepleden zullen de resultaten van deze kick-off bijeenkomst verwerken in de methodologische handreiking. Als de concept Leidraad gereed is zal deze ter commentaar aan genodigden worden verstuurd, er is dan gelegenheid commentaar/suggesties te leveren. Frank Willem Jansen en Charlotte Michels bedanken iedereen voor zijn/haar komst en actieve participatie.

Leidraad Duurzaamheid in richtlijnen

Toevoegen van duurzaamheidsaspecten in richtlijnontwikkeling

Deel B: Vijf inhoudelijke duurzaamheidsmodules

INITIATIEF
Nederlandse Vereniging voor Heelkunde

IN SAMENWERKING MET
Nederlandse Vereniging voor Obstetrie en Gynaecologie
Nederlands Oogheelkundig Gezelschap
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De bijbehorende Verantwoording is vermeld in *Deel A: Methodologische handreiking*.

Inhoudsopgave Leidraad Duurzaamheid: Deel B

Module 1: Operatietechnieken

Samenvatting

Uitgangsvraag

Wat is het effect op duurzaamheidsuitkomsten van robot-geassisteerde laparoscopische chirurgie in vergelijking met conventionele laparoscopische chirurgie of open chirurgie bij patiënten met een indicatie voor een operatie?

GRADE

Zeer laag tot Laag

Overwegingen: focus op Refuse (R1), Reduce (R2), Redesign (R3)

Aanbevelingen

Wees bewust dat robot-geassisteerde chirurgie een grotere (negatieve) impact heeft op het milieu dan andere operatietechnieken. Dit wordt met name veroorzaakt door het grote energieverbruik en de inzet van disposables bij robot-geassisteerde chirurgie.

Indien de klinische effectiviteit van de toe te passen operatietechnieken gelijk wordt ingeschat, zet dan de meest duurzame operatietechniek in.

Indien chirurgie wordt toegepast:

- Bij de indicatiestelling, laat duurzaamheid meewegen in de te kiezen operatietechniek. (R1-Refuse).
- Besteed aandacht aan het reduceren van het gebruik van disposables (R2-Reduce).
- Optimaliseer de inzet van duurzame energie en energiezuinige apparatuur (R2-Reduce).
- Zet in op Redesign (R3). Duurzaamheid moet worden meegenomen in het ontwerp van nieuwe en huidige technologieën. Realiseer een samenwerking met de industrie om dit te bewerkstelligen.

Uitgangsvraag module 1 'operatietechnieken'
Wat is het effect op duurzaamheidsuitkomsten van robot-geassisteerde laparoscopische chirurgie in vergelijking met conventionele laparoscopische chirurgie of open chirurgie bij patiënten met een indicatie voor een operatie?

Inleiding
Met het ondertekenen van de 'Green Deal Duurzame Zorg' dient de gezondheidszorg rekening te houden met de invloed van behandelingen op het milieu (Green Deal, 2022). Opereren gaat gepaard met een relatief grote hoeveelheid afval en mogelijk varieert de milieu-impact tussen verschillende operatietechnieken. In het algemeen zijn er drie operatietechnieken beschikbaar (robot-geassisteerde-, laparoscopische- en open chirurgie) voor dezelfde indicatie. De robot-geassisteerde operatietechniek wordt steeds vaker uitgevoerd in de Nederlandse praktijk (Tummers, 2021). De meest recente studies tonen geen grote verschillen in effectiviteit aan tussen robot-geassisteerde en laparoscopische chirurgie (Aiolfi, 2021; Muaddi, 2021). Wanneer de uitkomsten van operatietechnieken voor de patiënt vergelijkbaar zijn, kan er overwogen worden om te kiezen voor de meest duurzame operatietechniek. Het is momenteel nog onduidelijk welke invloed de betreffende operatietechniek heeft op duurzaamheid. In deze module worden de duurzaamheidsuitkomsten van de drie verschillende operatietechnieken met elkaar vergeleken.

Search and select
A systematic review of the literature was performed to answer the following question: *What is the effect on environmental sustainability of robot-assisted laparoscopic surgery compared with conventional laparoscopic surgery or open surgery?*

P: patients who underwent surgery
I: robot-assisted surgery
C: conventional laparoscopic surgery or open surgery
O: climate change (CO_2 footprint/Global Warming Potential (GWP)), waste, acidification, eutrophication, human toxicity, ecotoxicity, ozone depletion

<u>Relevant outcome measures</u>
Life cycle assessment (LCA) is a methodological tool used to quantitatively analyse the life cycle of products/activities within the context of environmental impact. The assessment comprises all stages needed to produce and use a product, from the initial development to the treatment of waste (the total life cycle). An LCA is mainly based on four phases: 1) goal and scope definition, 2) inventory analysis, 3) impact assessment, and 4) interpretation. The third phase is the life cycle impact assessment (LCIA), in which emissions and resource extractions are translated into a limited number of environmental impact scores by means of so-called characterisation factors. The ReCiPe model is a method for the impact assessment in an LCA (Huijbregts, 2016, Huijbregts, 2017). To determine the outcome measures regarding environmental impact, the ReCiPe model of the National Institute for Public Health and the Environment (in Dutch: Rijksinstituut voor Volksgezondheid en Milieu, RIVM) was used.

The outcomes determined by the working group are based on the ReCiPe model. The working group considered climate change (CO_2 footprint/Global Warming Potential) and waste as *critical* outcome measures for decision making; and acidification, eutrophication, human toxicity, ecotoxicity and ozone depletion as *important* outcome measures for decision making.

A priori, the working group did not define the outcome measures listed above but used the definitions used in the studies.
Outcomes focused on environmental life cycle assessment (LCA) impact categories are relatively new in healthcare. Given the variety in scopes and methods of performing and reporting LCAs, the working group did not a priori define the minimal important difference. Differences between the techniques were evaluated by the working group after data extraction.

Glossary

- <u>Acidification</u>: Reduction of the pH due to acidifying effects of emissions. Acid deposition of acidifying contaminants on soil, groundwater, surface waters, biological organisms, ecosystems, and substances. Expressed in SO_2 (sulfur dioxide) equivalents (Acero, 2015).
- <u>Climate change</u>: In the outcome category "climate change" we include two types of outcome measures:
  - <u>CO_2 footprint</u>: The total greenhouse gas (GHG) emissions caused by an individual, organization, event, or product. Expressed in CO_2 equivalents adopting the GWP (The Carbon Trust, 2018).
  - <u>Global Warming Potential (GWP)</u>: A measure of how much energy 1 kg of a specific GHG will absorb over a given period of time, relative to the emission of 1 kg of carbon dioxide (CO_2). The GWP is 1 for CO_2. GWP was developed to allow comparisons of the global warming impacts of different gases (EPA, 2021). The larger the GWP, the more that a given gas contributes to climate change (the greater the global warming effect of the gas).
- Economic input-output life cycle assessment (EIO-LCA): EIO-LCA uses annual input–output economy models and links monetary values of the industry sector (such as building sector) to their environmental inputs/outputs.
- <u>Ecotoxicity</u>: Toxic effects of chemicals on ecosystems. Environmental toxicity is measured as three separate impact categories which examine freshwater (e.g. lakes and rivers), marine (e.g. estuaries and the ocean) and land. Ecotoxicity describes exposure and the effects of toxic substances on the environment (Acero, 2015). Common environmental toxicants are diethyl phthalate (enters environment through industries manufacturing cosmetics, plastic and many other commercial products), bisphenol A (found in many mass-produced products such as, medical devices, food packaging, cosmetics, computers), pesticides, and oil. It is expressed in 1,4-dichlorobenzene (DB) equivalents.
- <u>Energy mix</u>: All sources of energy used from which energy is produced that can be directly used, e.g. in the form of electricity. Sources can be coal, oil, natural gas, hydro, nuclear and other renewables (e.g. wind, solar, thermal).
- <u>Eutrophication</u>: Accumulation of nutrients in water. Eutrophication includes the effects on ecosystems found in land or water due to over-fertilization or excess supply of nutrients (e.g. algal bloom), which can lead to changes in ecosystems and diversity of species. Expressed in PO_4 (phosphate) equivalents (Acero, 2015). This leads to ecosystem damage and has a negative effect on the climate.
- <u>Human toxicity</u>: Toxic effect of chemicals on humans. Human toxicity reflects the potential harm of a unit of chemical released into the environment, and it is based on the inherent toxicity of a compound and its potential dose (Acero, 2015). It is differentiated as non-cancer and cancer toxicity and affects human health. It is expressed in 1,4-dichlorobenzene (DB) equivalents.
- <u>Hybrid instruments</u>: Instruments which are partly disposable and partly reusable.
- <u>Life Cycle Assessment (LCA)</u>: This is a methodology for assessing environmental impacts associated with all the stages of the life cycle of a commercial product, process, or

service. An LCA mainly contsists of four steps: 1) goal and scope, 2) inventory analysis, 3) impact assessment, and 4) interpretation.

- Life Cycle Impact Assessment (LCIA): This is the third phase of an LCA, which aims to evaluate the potential environmental and human health impacts resulting from the elementary flows determined in the LCI.
- Ozone depletion: Reduction of the stratospheric ozone layer due to emissions of ozone depleting substances. Damage to the ozone layer reduces its ability to prevent ultraviolet (UV) light entering the earth's atmosphere, increasing the amount of carcinogenic UV light reaching the earth's surface. Expressed in kg CFC-11 equivalents (Acero, 2015).
- Waste: Total amount of waste expressed in kilograms, such as for example plastics or (disposable) instruments.

Search and select (Methods)

The databases Pubmed (via NCBI), Embase (via OVID), Web of Science (via Webofscience), Cochrane (via Cochrane library) and Emcare (via OVID) were searched with relevant search terms from 2000 until 7 December 2021. The detailed search strategy is depicted under the tab Methods. The systematic literature search resulted in 202 hits. Studies for this module were selected based on the following criteria:

- Systematic reviews in which searches were performed in at least two databases, with a detailed search strategy, risk of bias assessment and results of individual studies available, randomized controlled trials, (observational) comparative studies, Life Cycle Assessments;
- Full-text English or Dutch language publication; and
- Studies according to the PICO. This included studies that compared robot-assisted surgery with conventional laparoscopic or open surgery and included at least one of the outcomes conform the PICO.

Three studies were included for full text analysis. After reading the full text, all three studies were included in the literature summary of this module.

Results

Three studies were included in the analysis of the literature, which were all Life Cycle Assessments (LCAs). Important study characteristics and results are summarized in Appendix 1 'Evidence table of LCAs'. The quality assessment of the studies is summarized in Appendix 2 'Critical appraisal of LCAs'.

Summary of literature

Description of studies

Power (2012) describes an LCA to quantify the CO_2 footprint of minimally invasive surgery (MIS) compared to open surgery in the United States. MIS included robot-assisted laparoscopic surgery and laparoscopic surgery. A total of 2,520,223 MIS procedures from the year 2009 were included. The analysis compared MIS procedures to traditional open surgery, using an Economic Input-Output-LCA (EIO-LCA). Therefore, prior to the analysis, varying aspects between MIS and open surgery were determined and only these factors were included in the analysis to quantify the CO_2 footprint. Other fixed components of the overall CO_2 footprint common to surgery in general (e.g. operating theater, electricity use, patient travel, paper products used) were considered equivalent and were not taken into account. Different scopes of emissions were identified:

- Scope 1 CO_2 emissions: The CO_2 emission was defined as the amount of gas that was used for insufflation during MIS.

- Scope 2 and 3 CO_2 emissions: The CO_2 emissions were defined as all other processes before and after the MIS procedure. Furthermore, manufacturing and transportation of CO_2 cylinders, used to transport the CO_2 for insufflation, were taken into account.

Emissions related to the manufacturing process of the disposable instruments and to the postoperative stay were not included in the analysis. Thereby, not all disposable instruments were taken into account. Next to that, electricity use was considered equivalent, although it is expected to differ between the operating techniques, in particular between MIS and open surgery. MIS uses electricity driven instruments and cameras and in addition the robot uses robotic arms which require electricity. The relevant outcome measure was climate change (defined as CO_2 footprint).

Woods (2015) retrospectively reviewed 150 procedures of the consecutive and most recent patients to have undergone a staging procedure for endometrial cancer for three surgical modalities (50 per arm): robot-assisted laparoscopy (RA-LSC), conventional laparoscopy (LSC) and laparotomy. The functional unit was one endometrial staging procedure. Collected clinical data from the Albert Einstein College of Medicine, NY, USA, spanning the years 2008-2011, consisted of: age, body mass index (BMI), procedure type, operating time, history of prior abdominal surgery, length of stay, uterine weight, and surgical instruments used. The relevant outcome measures included climate change (defined as CO_2 footprint) and waste. CO_2 footprint was calculated by using an attributional LCA method (PAS 2050, GHG Protocol). Only energy and waste were included in this analysis. Data on energy and waste were obtained from previous studies, the National Energy Foundation and the US Energy Information Administration. Waste production (in kg) was determined based on operating room instrument data, specific to each modality. Disposal of 1 kg waste in a municipal landfill was considered equivalent to 1 kg CO_2 equivalents. Energy expenditure (in kWh) was calculated based on independent source data. Energy consumption was categorized in environmental, instrumental, robotic system and equipment. The total energy consumed per category was multiplied by the operative time, to establish a unique energy consumption value for each surgery. Emissions for transport and manufacturing of instruments and goods and for postoperative stay were not considered.

Thiel (2015) used a hybrid LCA framework (ISO 14040-44) to quantify the environmental emissions of four types of hysterectomy (vaginal, abdominal, laparoscopic, robotic). The functional unit of the study was one hysterectomy. This research used a hybrid LCA framework, by incorporating process LCA data and Economic Input Output LCA (EIO-LCA) data. Monte Carlo simulations were used to quantify the variability and uncertainty in emissions for each component of a hysterectomy. Waste (in kg) was deduced from the surgeries of patients that underwent an abdominal, a laparoscopic, or a robotic hysterectomy for noncancer related reasons. For one year, waste from 62 cases of each type of hysterectomy were quantified and characterized (17 laparoscopic and 15 abdominal, vaginal, and robotic). A life cycle inventory was conducted of the data collected through waste audits and site assessments, followed by the life cycle impact assessment, where environmental impacts for the inputs and outputs of the four types of hysterectomy were calculated for both process LCA and EIO-LCA. Relevant outcome measures included climate change (defined as CO_2 footprint), waste, acidification, eutrophication, human toxicity, ecotoxicity, and ozone depletion. The environmental impact of postoperative stay was not considered.

Results

1. Climate Change

All three studies (Power, 2012; Woods, 2015; Thiel, 2015) reported on CO_2 footprint.

Power (2012) reported that MIS had more CO_2 emissions (355,924 tonnes/year) in comparison to open surgery. Scope 1, gas that was used during MIS for insufflation, resulted in 303 tonnes of CO_2-emissions. Scope 2-3, CO_2 emissions (CO_2 capture/compression, transportation of CO_2 cylinders and incineration of disposable instruments) resulted in 355,621 tonnes of CO_2-emissions. This LCA of MIS, showed that the biggest contributor in CO_2 emissions is the capture/compression of CO_2 for insufflation. This is mainly caused by industrial gas manufacturing, followed by the actual use of the CO_2 for insufflation, the transportation of the gas, and the incineration of the disposable instruments.

Woods (2015) reported that the CO_2 footprint (based on waste and consumed energy) was 4,498 CO_2 equivalents for all 150 endometrial staging procedures. This corresponds with 30 kg CO_2 equivalents/patient. A robotic-assisted laparoscopy (RA-LSC) procedure resulted in a CO_2 footprint of 40.3 kg CO_2 equivalents/patient, a laparoscopy (LSC) procedure in 29.2 kg CO_2 equivalents/patient, and a laparotomy (LAP) in 22.7 kg CO_2 equivalents/patient. The CO_2 footprint of the RA-LSC represents a 38% and 77% increase over LSC and LAP, respectively. The emission of 40.3 kg CO_2 equivalents is comparable to a car ride from Amsterdam to Antwerp (±160 km, petrol car, 1:14). Comparing the three techniques, the RA-LSC has the biggest CO_2 footprint. Both energy use and waste contribute most to this CO_2 footprint. Due to the Da Vinci robot, the energy consumption of RA-LSC is the highest. The energy use for equipment is highest in the LSC group. Energy use adds more to the CO_2 footprint than waste.

Thiel (2015) reported a difference in CO_2 footprint between four types of hysterectomy. For all outcomes in this LCA, the surgical modality with the highest impact is defined as 100% and the other modalities are relatively compared to the modality with the highest impact. Robotic hysterectomies have the highest impact (100%), followed by the laparoscopic (65-70%), abdominal (35-40%) and vaginal modality (30-35%). In other words, the laparoscopic modality resulted in 30-35% less contribution to CO_2 footprint than a robotic modality. This LCA showed the biggest environmental impact is attributable to the robotic and laparoscopic surgical approaches for a hysterectomy. Within these modalities, the use of single-use instruments, single-use materials (e.g. gowns, gloves), and anesthetic gases are the biggest contributors.

2. Waste

All three studies (Power, 2012; Woods, 2015; Thiel, 2015) reported on waste. Power (2012) only reported a total of 208,441 kg/year from disposable trocar and laparoscopic instrument use for MIS. No other data regarding waste was provided in this study.

Woods (2015) reported that the LAP group produced 8.3 kg CO_2 equivalents of solid waste, the LSC group 11.2 kg CO_2 equivalents, and the RA-LSC group 11.2 kg CO_2 equivalents, respectively. Thus, RA-LSC represented a 74% and 36% increase over LAP and LSC, respectively. The solid waste consisted of four categories: infection control waste, single-use devices, consumable waste, and sterile wraps (see *Table 1*). The consumable waste was the largest contributor to solid waste for all surgical techniques. The largest amount of single-use device waste was generated by the LSC, followed by RA-LSC and LAP. The largest amount of waste for infection control was generated by the RA-LSC, followed by LAP and LSC. Sterile wraps contributed the least on waste for all surgical techniques.

Table 1. Types of waste described in Woods (2015)

Types of waste	Description	RA-LSC	LSC	LAP
Infection control	Drapes, Gowns, gloves	4.035 kg CO_2 eq. per patient (28% of total solid waste)	1.60 kg CO_2 eq. per patient (14% of total solid waste)	1.60 kg CO_2 eq. per patient (19% of total solid waste)
Consumable	Blue pack items (e.g. basins, suction tubing, towels, sponges)	6.90 kg CO_2 eq. per patient (48% of total solid waste)	6.03 kg CO_2 eq. per patient (54% of total solid waste)	5.86 kg CO_2 eq. per patient (71% of total solid waste)
Sterile wrap	Disposable blue wrap to maintain instrument sterility	0.88 kg CO_2 eq. per patient (6% of total solid waste)	0.99 kg CO_2 eq. per patient (9% of total solid waste)	0.44 kg CO_2 eq. per patient (5% of total solid waste).
Single-use device	Single-use devices (e.g. disposable energy-based surgical instruments, skin stapler)	2.47 kg CO_2 eq. per patient (17% of total solid waste)	3.35 kg CO_2 eq. per patient (30% of total solid waste)	0.82 kg CO_2 eq. per patient (10% of total solid waste)

Thiel (2015) reported that the robotic approach for a hysterectomy produced the highest amount of waste, following the laparoscopic, abdominal, and vaginal approaches. Robotic hysterectomies produced 13.7 kg municipal solid waste (MSW) per patient, which resulted in a total of 30% more waste compared to the other approaches.
This consisted of 50% gloves and other plastics, 22% by weight by gowns, drapes and bluewraps, 18% paper, and 5% cotton.
Abdominal hysterectomies had an average of 9.2 kg of MSW production and produced the largest amount of cotton waste per surgery. Across all four surgeries, the gowns, drapes and bluewraps were the majority of the MSW (robotic: 22%, laparoscopic: 35%). Other types of plastics, from thin film packaging wrappers to hard plastic trays, ranged from 36% MSW for vaginal hysterectomies to 46% for robotic hysterectomies.

3. Acidification

Only Thiel (2015) reported on acidification for the four surgical hysterectomies. The robotic approach had the highest impact on acidification (100%), followed by laparoscopic (70-75%), abdominal (25%), and vaginal approach (20%).

4. Eutrophication

Only Thiel (2015) reported a difference in eutrophication for the four surgical hysterectomies. The robotic approach had the highest impact on eutrophication (100%), followed by the laparoscopic (70-75%), abdominal (60-65%), and vaginal approach (55%).

5. Human toxicity

Only Thiel (2015) reported a difference in human toxicity for the four surgical hysterectomies. Human toxicity was divided into two subcategories: carcinogenic and non-carcinogenic potential. The robotic approach had the highest impact in both carcinogenic and non-carcinogenic potential categories (100%). Regarding the carcinogenic impact, the robotic approach was followed by the abdominal (90-100%), laparoscopic (80%), and vaginal approach (80%). Regarding the non-carcinogenic impact, the robotic approach was followed by the laparoscopic (85-90%), abdominal (80-90%), and vaginal approach (70-75%).

6. Ecotoxicity

Only Thiel (2015) reported a difference in ecotoxicity for the four surgical hysterectomies. The robotic approach had the highest impact on ecotoxicity (100%), followed by the laparoscopic (90-95%), abdominal (90%), and vaginal approach (75%).

7. Ozone depletion

Only Thiel (2015) reported a difference in ozone depletion for the four surgical hysterectomies. The robotic approach had the highest impact on ozone depletion (100%), followed by the laparoscopic (60-65%), abdominal, and vaginal approach (0-5%).

Level of evidence of the literature

There are currently no widely recognized guidelines for designing, conducting, or reporting systematic reviews in LCA (Zumsteg, 2012). The Standardized Technique for Assessing and Reporting Reviews of LCA (STARR-LCA) checklist was developed based on the PRISMA statement (which was designed to help systematic reviewers transparently report why the review was done, what the authors did, and what they found) (Page, 2021; Zumsteg, 2012; Costa, 2019; Drew, 2021). The STARR-LCA proposed a critical appraisal tool to assess the level of evidence of LCAs (Drew, 2021) which is used in this module to provide an indication of the study quality (see Appendix 2 'Critical appraisal of LCAs'). This tool consists of 16 assessment criteria for the different phases of an LCA, covering a set of quality indicators (such as internal validity, external validity, consistency, transparency, bias). The score gives an indication of the current study quality (a higher score indicates a higher study quality).
The use of the GRADE approach in environmental and occupational health is relatively new, and likely to grow in coming years, as systematic reviews become more common in the field of LCAs and the limitations of expert-based narrative review methods are increasingly recognized (Aiassa, 2015; EFSA, 2010; Mandrioli, 2015; Morgan, 2016; Woodruff, 2014). Further research is warranted in this field (Morgan, 2019), which is acknowledged by the working group. Although standards for using GRADE for LCAs are lacking, the working group decided that the level of evidence starts for LCAs starts at grade *high*. After all, the working group is mainly interested in which interventions have the greatest impact on environmental sustainability and LCAs are the best method to assess this (see also the report: 'Leidraad Duurzaamheid in richtlijnen' (NVvH, 2023). Furthermore, the GRADE standards are followed as much as possible.
As the three included studies contained LCAs (Power, 2012; Woods, 2015; Thiel, 2015), the level of evidence started at grade *high*.

1. Climate Change

Three studies (Power, 2012; Woods, 2015; Thiel, 2015) reported on 'climate change'. The level of evidence of this outcome measure was downgraded with 2 levels to *low* due to risk of bias (-1; functional unit was not clearly defined, assumptions are not clearly described) and imprecision (-1; limited internal validity of data, only the intraoperative period was included, and the post-operative period was excluded)

2. Waste

Three studies (Power, 2012; Woods, 2015; Thiel, 2015) reported on 'waste'. The level of evidence of this outcome measure was downgraded with 2 levels to *low* due to risk of bias (-1; functional unit was not clearly defined, assumptions are not clearly described) and imprecision (-1; limited internal validity of data, only the intraoperative period was included, and the post-operative period was excluded)

3. Acidification

Only Thiel (2015) reported on 'acidification'. The level of evidence regarding this outcome measure was downgraded with 3 levels to *very low* due to lack of risk of bias (-1; assumptions are not clearly described) and imprecision (-2; results are not reported in the context of the functional unit, only the intraoperative period was included and the postoperative period was excluded, evidence base lacks geographic and institutional diversity, data were only collected from one study including 62 hysterectomy cases).

4. Eutrophication

Only Thiel (2015) reported on 'eutrophication'. The level of evidence regarding this outcome measure was downgraded with 3 levels to *very low* due to lack of risk of bias (-1; assumptions are not clearly described) and imprecision (-2; results are not reported in the context of the functional unit, only the intraoperative period was included and the post-operative period was excluded, evidence base lacks geographic and institutional diversity, data were only collected from one study including 62 hysterectomy cases).

5. Human toxicity

Only Thiel (2015) reported on 'human toxicity'. The level of evidence regarding this outcome measure was downgraded with 3 levels to *very low* due to lack of risk of bias (-1; assumptions are not clearly described) and imprecision (-2; results are not reported in the context of the functional unit, only the intraoperative period was included and the post-operative period was excluded, evidence base lacks geographic and institutional diversity, data were only collected from one study including 62 hysterectomy cases).

6. Ecotoxicity

Only Thiel (2015) reported on 'ecotoxicity'. The level of evidence regarding this outcome measure was downgraded with 3 levels to *very low* due to lack of risk of bias (-1; assumptions are not clearly described) and imprecision (-2; results are not reported in the context of the functional unit, only the intraoperative period was included and the post-operative period was excluded, evidence base lacks geographic and institutional diversity, data were only collected from one study including 62 hysterectomy cases).

7. Ozone depletion

Only Thiel (2015) reported on 'ozone depletion'. The level of evidence regarding this outcome measure was downgraded with 3 levels to *very low* due to lack of risk of bias (-1; assumptions are not clearly described) and imprecision (-2; results are not reported in the context of the functional unit, only the intraoperative period was included and the post-operative period was excluded, evidence base lacks geographic and institutional diversity, data were only collected from one study including 62 hysterectomy cases).

Conclusions

1. Climate change (critical)

Low GRADE	The evidence suggests robot-assisted laparoscopic surgery increases climate change (CO_2 footprint/Global Warming Potential) when compared to conventional laparoscopic surgery or open surgery. *Sources: Power, 2012; Woods, 2015; Thiel, 2015*

2. Waste (critical)

Low GRADE	The evidence suggests robot-assisted laparoscopic surgery increases waste when compared to conventional laparoscopic surgery or open surgery. *Sources: Power, 2012; Woods, 2015; Thiel, 2015*

3. Acidification (important)

Very low GRADE	The evidence is very uncertain about the effect on acidification when robot-assisted laparoscopic surgery is compared to conventional laparoscopic surgery or open surgery. *Source: Thiel, 2015*

4. Eutrophication (important)

Very low GRADE	The evidence is very uncertain about the effect on eutrophication when robot-assisted laparoscopic surgery is compared to conventional laparoscopic surgery or open surgery. *Source: Thiel, 2015*

5. Human toxicity (important)

Very low GRADE	The evidence is very uncertain about the effect on human toxicity when robot-assisted laparoscopic surgery is compared to conventional laparoscopic surgery or open surgery. *Source: Thiel, 2015*

6. Ecotoxicity (important)

Very low GRADE	The evidence is very uncertain about the effect on ecotoxicity when robot-assisted laparoscopic surgery is compared to conventional laparoscopic surgery or open surgery. *Source: Thiel, 2015*

7. Ozone depletion (important)

Very low GRADE	The evidence is very uncertain about the effect on ozone depletion when robot-assisted laparoscopic surgery is compared to conventional laparoscopic surgery or open surgery. *Source: Thiel, 2015*

Overwegingen – van bewijs naar aanbeveling

Voor- en nadelen van de interventie en de kwaliteit van het bewijs

Op basis van de beschikbare literatuur is gekeken naar de milieu-impact van verschillende operatietechnieken. Er zijn drie Life Cycle Assessments (LCA's) geïncludeerd in de literatuursamenvatting. Deze LCA's verschillen onder andere in methodiek (EIO-LCA, Attributional LCA, Hybrid LCA-ISO 14040-44), databases en aannames. Daarnaast zijn er enkele methodologische beperkingen (*risk of bias, imprecisie*). De bewijskracht van de literatuur is daardoor *laag* voor de cruciale uitkomstmaten 'climate change' en 'waste'. Derhalve kunnen er op basis van de literatuur geen sterke conclusies worden getrokken over de mate van milieu-impact van de operatietechnieken.

De geïncludeerde LCA's zijn kritisch beoordeeld volgens Drew (2021), zie de bijlage 2 'Critical appraisal of LCAs'. De kwaliteit van de studies wordt hiermee beoordeeld op basis van de methodologie van een LCA. Dit scoresysteem bestaat uit 16 beoordelingscriteria, die zijn verdeeld over de verschillende fasen van een LCA. Het behandelt een reeks indicatoren voor studiekwaliteit, zoals *interne validiteit*, *externe validiteit*, *consistentie*, *transparantie* en *bias*. De procentuele score geeft een indicatie van de algehele studiekwaliteit. Een hogere score duidt op een hogere algehele studiekwaliteit. Thiel (2015) scoort met 80% het hoogst in vergelijking met Power (2012) en Woods (2015), die respectievelijk 54% en 57% scoren. In de drie studies (Power, 2012; Thiel, 2015; Woods, 2015) worden verschillende operatietechnieken met elkaar vergeleken op duurzaamheidsuitkomsten. De werkgroep heeft klinische uitkomsten (bijv. complicaties, overleving, opnameduur) in deze module niet meegenomen. De werkgroep wil er echter wel op wijzen dat klinische uitkomsten van belang zijn in duurzaamheidsvraagstukken. Deze uitkomsten (bijv. postoperatieve opnameduur) kunnen immers van invloed zijn op de milieu-impact.

Hoewel de bewijskracht van de cruciale uitkomstmaten uit komt op *laag,* wijzen de resultaten er consistent op dat robot-geassisteerde laparoscopische chirurgie de grootste milieu-impact heeft, in vergelijking met conventionele laparoscopische chirurgie of open chirurgie (Power, 2012; Thiel, 2015; Woods, 2015). Hierbij is het belangrijk te benadrukken dat in de LCA's de postoperatieve periode niet is meegenomen en in de analyses alleen specifiek is gekeken naar de operatie zelf. De werkgroep is zich ervan bewust dat postoperatieve factoren (zoals complicaties, heropnames, opnameduur) de milieu-impact kunnen veranderen.

Het is van belang om te evalueren waar in deze operatietechnieken de 'hotspots' met de hoogste milieu-impact zitten. In de 'hotspots' zit immers de grootste verbeterruimte. De drie LCA's identificeren verschillende 'hotspots': energieverbruik (o.a. voor chirurgische machines, verlichting, verwarming/ventilatie/air-conditioning), gebruik van gassen (o.a. verschillende anesthesiegassen en CO_2 voor abdominale insufflatie) en het gebruik van disposables en reusables (o.a. productie, reiniging en sterilisatie, afvalverwerking). In module 2 'disposables versus reusables' en module 4 'anesthesie' wordt de milieu-impact hiervan geëvalueerd.
De hotspots worden geëvalueerd middels de 'R-ladder (strategieën van circulariteit)' (zie figuur 1, gebaseerd op Cramer, 2014; Hanemaaijer; 2018; Potting, 2016; Reike, 2018). De R-ladder laat zien dat de hoogste prioriteit om duurzaam te werken 'refuse' is, oftewel, niet gebruiken. Hoe lager het grondstofgebruik, des te hoger op de R-ladder en hoe dichter je bij circulair werken bent.

Figuur 1. *Prioriteitsvolgorde circulariteit strategieën*

Refuse (R1) en Reduce (R2)

De drie LCA's impliceren dat robot-geassisteerde laparoscopie de grootste negatieve milieu-impact heeft. Tevens laat een LCA zien waar de grootste milieu-impact ('hotspots') in het proces zit. Soms is het mogelijk eenzelfde operatie met verschillende operatietechnieken uit te voeren. De werkgroep stelt dat, indien andere factoren die de keuze voor het type operatietechniek bepalen (bijv. effectiviteit, veiligheid) gelijk zijn voor een bepaalde indicatie, duurzaamheid een doorslaggevende rol zou moeten spelen in de keuze voor het type operatietechniek. De werkgroep adviseert om dan voor de techniek met de laagste milieu-impact te kiezen. Bepaalde operatietechnieken kunnen op deze manier 'geweigerd' (R1-Refuse) worden. Indien de operatietechniek 'best practice' is, kan er worden gekeken of de hotspots kunnen worden aangepakt om toch de milieu-impact van de desbetreffende operatietechniek te verlagen.

Twee LCAs (Woods, 2015; Thiel, 2015) laten zien dat de robot-geassisteerde laparoscopie de meeste energie verbruikt, waarbij inzet van het robotsysteem dit verschil bewerkstelligt. De hotspot 'energie' kan worden onderverdeeld in energie voor chirurgische machines en instrumentaria, energie voor verlichting, verwarming, ventilatie en airconditioning en er wordt energie verbruikt voor het verkrijgen van CO_2 voor insufflatie bij minimaal invasieve chirurgie (MIC). Thiel (2015) laat zien dat verwarming, ventilatie en luchtbehandeling op operatiekamers de grootste bijdrage leveren aan het totale energieverbruik. Daarnaast is de productie van disposables een belangrijke milieu 'hotspot' en draagt dit voor het grootste deel bij aan de totale milieu-impact (Thiel, 2015). Ten aanzien van R1-Refuse, zou het niet verbruiken van energie de beste keuze zijn. Indien een operatiekamer niet in gebruik is, wordt geadviseerd om eventuele machines, luchtbehandeling of verlichting uit te zetten. Wanneer het niet mogelijk is om dit uit te schakelen, is het verminderen van het verbruik van energie (R2-Reduce) een optie. Bijvoorbeeld middels het efficiënter inzetten van luchtbehandeling (zie module 5 'luchtbehandeling'), het regelmatig onderhouden van mechanische apparatuur/ instrumentaria, het vernieuwen van mechanische instrumentaria en filters, het beperken van energielekken, of door intensievere toepassing van meer duurzame energiebronnen.

Redesign (R3)

Operatietechnieken hebben zich over de afgelopen decennia in rap tempo doorontwikkeld. Nieuwe robotsystemen doen hun intrede en steeds complexere instrumentaria worden voor MIC ontwikkeld. In het design van apparatuur en instrumenten zal, in het kader van de negatieve milieu impact, duurzaamheid moeten worden meegenomen.
Het robotsysteem gebruikt relatief veel energie en produceert veel afval (Woods, 2015; Thiel, 2015). Dit biedt kansen voor verbeteringen in het design. De drie LCAs identificeren het gebruik van disposables als één van de 'hotspots', mede vanwege de hoeveelheid afval. Echter de productie van disposables blijkt voornamelijk van grote invloed te zijn op de uitkomstmaten 'CO_2 footprint', 'ozone depletion' en 'acidification' (Thiel, 2015). Binnen de robotchirurgie worden instrumenten wel al hergebruikt, maar hier zit vaak een maximum aan. De uitdaging ligt bij de industrie om instrumenten zodanig te ontwerpen dat deze zoveel mogelijk hergebruikt kunnen worden (verlengen van de levensduur), zonder het risico op patiëntveiligheid (zoals infecties) aan te tasten (zie module 2 'disposables versus reusables'). De industrie zal moeten worden uitgedaagd om hieraan mee te werken in de context van een circulaire economie.
Daarnaast draagt ook de hotspot 'insufflatie van de buik' bij laparoscopische operaties in grote mate bij aan de 'CO_2 footprint' en 'ozone depletion' (Thiel 2015; Power, 2012). Door een duurzamere manier te ontwikkelen (R3-Redesign) voor CO_2 winning, valt milieuwinst te behalen. Denk bijvoorbeeld aan een duurzamere productiemethode of duurzaam transport. Het verkrijgen van CO_2 voor MIC (productie, opwekken/leveren, gasextractie, transport) leidt gemiddeld tot 141 kg aan CO_2 emissies per MIC operatie (Power, 2012). Dit is vergelijkbaar met een enkele autorit (benzineauto, verbruik 1:14) van Amsterdam naar Stuttgart (±620km). De werkgroep stelt dat er meer aandacht moet komen voor een duurzame CO_2 winning om op dit gebied milieuwinst te behalen.
Daarnaast is het mogelijk om met minder CO_2 voor insufflatie te werken, dus door een lagere druk te gebruiken. Met deze lagere druk wordt minder CO_2 verbruikt, wat positief bijdraagt aan de impact op het milieu (R2-Reduce). Dit kan bijvoorbeeld worden uitgevoerd met het AirSeal® systeem, dat naast het behoud van een pneumoperitoneum met lagere drukken ook het gas CO_2 recirculeert en onnodig verlies voorkomt (Sroussi, 2017; Herati, 2009; Luketina, 2014; Bucur, 2016; George, 2015).

Re-use (R4)

Binnen de verschillende apparaten en disposables, kan hergebruik een grote rol spelen. Het is van belang om goed te kijken hoe 'oude' apparatuur opnieuw ingezet kan worden. Daarnaast tonen de drie LCAs aan dat de productie van disposables de grootste impact op het milieu heeft. Indien de patiëntveiligheid het toelaat, is hergebruik van materialen en apparatuur dan ook een uiterst relevante optie. De industrie moet ertoe worden aangezet om hergebruik mogelijk te maken en de milieu-impact te verlagen. Daarnaast speelt regelgeving een belangrijke rol. Optimalisatie van de wetgeving (Medical Device Regulation – MDR) met als doel de regels rondom hergebruik te verruimen zal positief kunnen bijdragen.

Repair (R5), Refurbish (R6), Remanufacture (R7)

De factoren R5-Repair, R6-Refurbish en R7-Remanufacture gaan binnen de operatietechnieken nauw met elkaar samen. Voordat een product of apparaat wordt afgedankt, is het van belang om opnieuw te kijken of de levensduur nog verlengd kan worden. Indien een product modulair is opgebouwd, geeft dat de mogelijkheid om bepaalde delen te vervangen en andere delen langer mee te laten gaan. De werkgroep adviseert om het repareren of opknappen van producten standaard te overwegen.

Repurpose (R8), Recycling (R9), Recover (R10)

Indien medische apparatuur of producten die gebruikt worden bij de verschillende operatietechnieken niet meer gebruikt kunnen worden waarvoor zij zijn bedoeld, kan er gekeken worden naar een nieuw doeleinde (R8-Repurpose) of het hergebruiken (R9-Recycling) van de grondstoffen van het product. Kijk of het mogelijk is om samen te werken met de afvalverwerker van het ziekenhuis voor de mogelijkheden. Een deel van het afval van een operatie zal moeten worden verbrand als het Specifiek Ziekenhuis Afval (SZA) betreft. In *Tabel 1-3* zijn de criteria en het proces weergeven waarop in ziekenhuizen het onderscheid tussen restafval (afval zonder risico) en SZA (afval met risico) gemaakt kan worden en waar recycling mogelijk wordt geacht (Green Team Infectiepreventie VHIG, 2023) (R9-Recycling). Indien afval moet worden verbrand, moet er naar worden gestreefd om dit met zoveel mogelijk energieterugwinning te laten plaatsvinden (R10-Recover).

Tabel 1. Afval met risico: Recycling niet toegestaan (bron: Green Team Infectiepreventie VHIG, 2023)

	Eural	Toelichting	Voorbeelden
Afval met risico (RMA) = Infectieuze afvalstoffen, niet-infectieuze lichaamsdelen en organen, cytotoxische/cytostatische geneesmiddelen	180103 *opslag veelal in SZA vaten (blauw of grijs)*	- Alle scherpe voorwerpen/naalden ongeacht herkomst of soort besmetting - Afval met <u>niet opgedroogd</u> bloed en alle niet opgedroogde excreta (bijv. sputum) ongeacht herkomst of soort besmetting - Afval dat in direct contact is geweest met patiënten met een infectieziekte welke voorkomt op de geldende cat. A ADR lijst *zonder* de toevoeging cultures only - Afval van patiënten met een infectieziekte dat niet voldoet aan bovengenoemde criteria maar waarvan op basis van een professionele inschatting bepaald kan worden dat het aannemelijk is dat het afval in de verwijderingsketen een risico vormt. - Afval dat mogelijkerwijs is besmet met micro-organismen en vrijkomt bij de bewuste vermeerdering van micro organismen in onder meer laboratoria, ongeacht herkomst of soort besmetting	Naalden en naalden-containers Afval met druipend bloed/lichaamsvloeistoffen Afval met opgesloten hoeveelheid bloed/lichaamsvloeistoffen (zoals bloedbuizen) Afval van kamers waar patiënten worden verpleegd/behandeld met: - Apenpokken - Pokken - VHK (zoals ebola, lassakoorts) - bijzonder besmettelijke aandoening, op indicatie van arts-microbioloog Afval van microbiologisch laboratorium
	180102	- niet-infectieuze lichaamsdelen en organen	Anatomische resten en orgaandelen die vrijkomen bij operatieve en obstetrische ingrepen, bij obductie en bij wetenschappelijk onderzoek/onderwijs
	180108	- cytotoxische en cytostatische geneesmiddelen	Medicatie, bereidingsmaterialen en materialen die in contact zijn geweest met patiënten die zijn behandeld met cytostatica (inco-materiaal, scherpe voorwerpen, verbanden, pleisters, etc.)

Tabel 2. Afval zonder infectierisico: Recycling wel toegestaan en technisch mogelijk (bron: Green Team Infectiepreventie VHIG, 2023)

	Toelichting	Voorbeelden
Afval zonder infectierisico (NRMA, Eural 180104) = Overig afval uit de gezondheidszorg van mens	- Afval van kamers waar patiënten worden verpleegd/behandeld waarbij inzameling en verwijdering niet zijn onderworpen aan speciale richtlijnen teneinde infectie te voorkomen - Afval met opgedroogde excreta. *N.B.: de eventuele esthetische aspecten (bijvoorbeeld materiaal met opgedroogd bloed) die samen kunnen hangen met dit afval spelen beleidsmatig geen rol.* - Afval van patiënten met categorie A ADR-infectieziekte, met toevoeging cultures only - Afval wat aanvankelijk risico houdend (RMA) was, maar waarbij het risico door decontaminatie is weggenomen	- tissues - disposable handschoenen - mondmaskers - gebruikte medische disposables, zonder druipend bloed (pincetten, scharen, onderleggers, bekkentjes, laryngoscopen, staplers etc. - linnengoed (disposable dekens, washandjes, afdekmaterialen) - verpakkingsmaterialen SMH - Rvs-materialen - papier/ glas

Tabel 3. Afval zonder infectierisico: Recycling wel toegestaan, niet altijd technisch (bron: Green Team Infectiepreventie VHIG, 2023)

	Overleg over recycle mogelijkheden met afvalverwerker	
Afval zonder infectierisico (NRMA, Eural 180104) = Overig afval uit de gezondheidszorg van mens	Verband	Situatie afhankelijk
	Gipsverband	Situatie afhankelijk
	Katheters	Situatie afhankelijk, eventueel uitwendige delen in PMD
	Infuuszakken	Niet-PVC kan bij PMD PVC mogelijk in de toekomst recyclebaar, nu nog restafval
	Infuussystemen	Situatie afhankelijk Tubing is moeilijk; mogelijk in de toekomst recyclebaar
	Spuiten (zonder naald)	Situatie afhankelijk. Moet gedemonteerd, dat is nog lastig. Ook afhankelijk van de inhoud van de spuit en mogelijk rubber deel.
	Disposable handschoenen	Afhankelijk van contaminatie. Er zijn initiatieven bekend (Groot-Brittanie) voor inzamelen als monostroom
	Wegwerpkleding (o.a. van isolatie of operatie)	Kan in principe, is afhankelijk van materiaal
	Luiers	Er zijn beperkt initiatieven, mogelijk in de toekomst op grotere schaal
	Gedecontamineerd risico-houdend medisch afval	Situatie afhankelijk

Waarden en voorkeuren van patiënten (en evt. hun verzorgers)

Om meer duurzame zorg te realiseren en duurzaamheidsinitiatieven te initiëren, is het cruciaal om voldoende maatschappelijk draagvlak te hebben bij patiënten en zorgverleners. Meer duurzame keuzes in de zorg vraagt gedragsverandering van zowel de patiënt als zorgverlener. Goede voorlichting en bewustwording is hierbij van groot belang. Duurzamere alternatieven in gebruik rondom een operatie zullen ook voor patiënten een positief effect hebben. Open chirurgie komt uit de LCA's als operatietechniek met de laagste negatieve milieu-impact, echter is hierin de postoperatieve periode niet meegenomen. Op basis van klinische uitkomsten van de verschillende operatietechnieken (bijv. bloedverlies, postoperatieve opnameduur, complicaties) en de daarbij gepaarde extra milieu-impact van het postoperatieve traject zal minimaal invasieve chirurgie (laparoscopie, robot) op duurzaamheidsuitkomsten de voorkeur behoeven. Zo wordt er voor een extra ligdag 45 kg CO_2 equivalenten gerekend (Elferink, 2023). Voor de patiënt en zorgverlener heeft een veilige en effectieve behandeling de voorkeur, waarbij duurzaamheid in het gehele traject wordt meegenomen.

Kosten (middelenbeslag)

De werkgroep verwacht dat in veel gevallen de behandelopties met de laagste milieu-impact zullen resulteren in kostenbesparing. Indien wordt gekozen voor het hoogst haalbare op de ladder van circulariteit (R1-Refuse, R2-Reduce), zullen bijvoorbeeld bepaalde producten niet of minder gebruikt worden. De werkgroep adviseert dan ook bij de keuze voor een bepaalde operatietechniek naast klinische uitkomsten duurzaamheid mee te nemen in de overwegingen. Eventueel hogere kosten (bijv. investering voor reusable instrumenten, investering in technologische ontwikkeling) zullen niet opwegen tegen de voordelen van duurzamer werken. Daarnaast heeft de investering in technologische ontwikkeling van open chirurgie naar minimaal invasieve chirurgie (laparoscopie, robot) geleid tot een kortere opnameduur voor de patiënt met daarbij gepaard gaand lagere kosten voor het postoperatieve traject (Laudicella, 2016; Diaz, 2022).

Aanvaardbaarheid, haalbaarheid en implementatie

De keuze van een operatietechniek ligt bij de zorgverlener en de patiënt, en wordt bepaald door veel verschillende factoren (bijv. (kosten-)effectiviteit, risico op complicaties, tijd tot herstel, indicatie). De werkgroep vermoedt dat duurzaamheid met betrekking tot de keuze in operatietechnieken nog niet als doorslaggevende factor beschouwd wordt. Het vergt bewustwording over de impact van de verschillende interventies en hun hotspots om duurzaamheid mee te kunnen laten wegen in een beslissing. Daarnaast zal het aanvaarden van het meenemen van duurzaamheid in de keuze voor een operatietechniek een mogelijke drempel zijn. Het is van belang dat patiëntveiligheid voorop blijft staan, maar indien er gelijke klinische uitkomsten zijn zal dit meegenomen kunnen worden in de beslissing voor een specifieke operatietechniek. De werkgroep kiest, ondanks de zeer lage bewijskracht, voor een sterke aanbeveling met betrekking tot de aandacht voor duurzaamheidsaspecten.

Aanbevelingen

<u>Rationale van de aanbeveling: weging van argumenten voor en tegen de interventies</u>

Op basis van de gevonden literatuur is de bewijskracht voor duurzaamheidsuitkomsten laag tot zeer laag. Overwegingen richten zich voornamelijk op R1-Refuse, R2-Reduce en R3-Redesign. De werkgroep acht het uiterst belangrijk om meer bewustwording op het gebied van duurzaamheid te creëren in de zorg.

Wees bewust dat robot-geassisteerde chirurgie een grotere (negatieve) impact heeft op het milieu dan andere operatietechnieken. Dit wordt met name veroorzaakt door het grote energieverbruik en de inzet van disposables bij robot-geassisteerde chirurgie.

Indien de klinische effectiviteit van de toe te passen operatietechnieken gelijk wordt ingeschat, zet dan de meest duurzame operatietechniek in.

Indien chirurgie wordt toegepast:

- Bij de indicatiestelling, laat duurzaamheid meewegen in de te kiezen operatietechniek. (R1-Refuse).
- Besteed aandacht aan het reduceren van het gebruik van disposables (R2-Reduce).
- Optimaliseer de inzet van duurzame energie en energiezuinige apparatuur (R2-Reduce).
- Zet in op Redesign (R3). Duurzaamheid moet worden meegenomen in het ontwerp van nieuwe en huidige technologieën. Realiseer een samenwerking met de industrie om dit te bewerkstelligen.

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Bijlagen bij module 1 'Operatietechnieken'

Appendix 1. Evidence table for LCA studies

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
Power (2012)	Journal of Endourology Journal information Peer-reviewed journal exclusively focused on minimally invasive and robotic urology, applications, and clinical outcomes. Critical review: Peer reviewed article. Not in specific LCA journal.	Type of study: LCA Objective: To assess the additional climate impact of minimally invasive surgery (MIS) as compared with traditional open surgery (where MIS includes both laparoscopy and robotically-assisted laparoscopy to achieve cholecystectomy, appendectomy, bariatric surgery, colon surgery, hysterectomy, salpingo-oophorectomy/tubal ligation, prostatectomy, nephrectomy, and natural orifice surgeries) LCA-method: EIO-LCA (GHG Protocol) Setting and country: Inpatient and outpatient clinics in the US Facility: Memorial Sloan-Kettering Cancer Center, New York City, NY, USA Years of data collection:	Goal and scope[1]: Quantitate the carbon footprint of MIS in the US Functional unit(s)[2]: One year of minimally invasive surgical procedures performed in the United States (2009; n=2,520,223) System boundaries: Operating theatre door to door (intraoperative period, inferred from text) Included stages: Pharmaceuticals (transport, capture and compression included), disposal Stated excluded components: Production, (other) transport, energy use, reuse, non-CO2 pharmaceuticals (all other lifecycle stages were considered equivalent to open surgery/laparotomy) Inventory database: -	Minimally invasive surgeries' CO_2 footprint is based on used CO_2 for insufflation (transport, capture, compression, packaging and use) and disposal of surgical instruments (laparoscopic trocars). All other emissions were considered equivalent to open surgery. For transportation the Memorial Sloan-Kettering Cancer was used as index case. Number of miles for CO_2 cylinders were calculated. Carbon footprint calculator based on U.S. Department of Transportation (US DOT) fuel efficiency data and Greenhouse Gas Protocol initiative (GHGPI) mobile guides were used to estimate the carbon emissions. Carbon dioxide capture and compression were calculated using the Input-Output Life cycle assessment (EIO-LCA) model (i.e. based on economic activity of the	1. Climate Change • CO_2 emission used for insufflation: 303 tonnes CO_2 • CO_2 emission from CO_2 capture/compression: 351,400 tonnes CO_2. Wherein 251,000 can be attributed to industrial gas manufacturing, 83,700 to power generation and supply and 16,700 to gas extraction. • CO_2 emission used for transportation: 2970 tonnes CO_2 • CO_2 emission from incineration of disposable instruments (laparoscopic trocars and robotic instruments): 1251 Tonnes CO_2 Total CO_2 emissions from minimally invasive surgery were estimated at 355,924 tonnes/year more in comparison to open surgery. 2. Waste A total of 208,441 kg of plastic biomedical waste from disposable trocar and laparoscopic instrument use for MIS per year. This	This LCA of MIS in the US, shows that the biggest contributor in CO_2 emissions is the capture/compression of CO_2 for insufflation. The industrial gas manufacturing in this part contributes most. Followed by the actual use of the CO_2 for insufflation, the transportation of the gas and the incineration of the disposable instruments.	Authors conclusion The CO_2 emissions of MIS in the US, when considering both direct and indirect factors, have a significant environmental impact. This should be considered to reduce healthcare's CO_2 footprint while maximizing healthcare quality. Limitations study Not all disposable instruments were included in the analysis and emissions related to e.g. the manufacturing process, transportation and energy use of the disposable instruments were not taken into account. Emissions related to the preoperative and postoperative stay were not included. This can vary between the different surgery procedures and the length of this stay can have an effect on the eventual CO_2 footprint. . Next to that, electricity use was considered equivalent, however it is expected to differ

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
		2009 Surgical discipline(s): Gastroenterology, Obstetrics & Gynecology, Urology & Nephrology Funding and conflict of interest: Supported by The Sidney Kimmel Center for Prostate and Urologic Cancers and by Award Number U54CA137788/U54CA132378 from the National Cancer Institute. No competing financial interests exist.	Allocation: No Normalization & Weighting: No Impacts reported: Yes Contribution analysis: Yes Scenario analysis: No Comparative analysis: No Sensitivity analysis: No Uncertainty analysis: No Variance analysis: No	largest medical CO_2 supplier). To calculate the annual use of CO_2 for MIS the number of procedures were identified in national databases. Average operative times were estimated based on institutional data. Number of cylinders and CO_2 emissions were calculated from this data. Data for the number of disposable instruments, specifically laparoscopic trocars, were obtained from US market engineering research (2004). Weight of a laparoscopic trocar was estimated. Data for robot-assisted procedures were based on Intuitive Surgical procedure numbers, instrument catalogue unloaded weights an using a general rule of 10 uses before disposal. The carbon footprint was estimated with the assumption that incinerating 1 kg of plastic produces approximately 6 kg of CO_2.	consisted of 186,000 kg of plastic from laparoscopic trocars (6,200,000 trocars) and 22,441 kg of plastic from robotic instruments. 3. Acidification No results in this study. 4. Eutrophication No results in this study. 5. Human Toxicity No results in this study. 6. Ecotoxicity No results in this study. 7. Ozone Depletion No results in this study.		between the operating techniques. In particular MIS versus open surgery. MIS uses electricity driven instruments and cameras and thereby the robot uses robotic arms which require electricity.
Woods (2015)	International Journal of Medical Robotics and Computer Assisted Surgery	Type of study: LCA Objective:	Goal and scope[1]: Quantitate the CO_2 footprint of robotically-assisted laparoscopy (RA-	150 staging procedures (50 per arm) for endometrial cancer for the three surgical modalities	1. Climate change The CO_2 footprint for all 150 endometrial staging procedures, including solid	Comparing the three surgical modalities, the RA-LSC turns out to have the biggest CO_2 footprint.	Authors conclusion An increased environmental impact of RA-LSC and LSC over LAP is

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
	Journal information International Journal of Medical Robotics and Computer Assisted Surgery is a cross-disciplinary journal presenting the latest developments in robotics and computer assisted technologies for medical applications. Critical review: Peer reviewed article. Not in specific LCA journal.	To assess the climate impact three surgical modalities for endometrial cancer staging: laparotomy, laparoscopy, robotic-assisted laparoscopy LCA-method: Attributional LCA (PAS 2050, GHG Protocol) Setting and country: Hospital in the US Facility: Albert Einstein College of Medicine, New York City, NY, USA Years of data collection: 2008-2011 Surgical discipline(s): Obstetrics & gynecology; Oncology Funding and conflict of interest: The authors declare no potential conflicts of interest.	LSC), laparoscopy (LSC) and laparotomy (LAP) Functional unit(s)[2]: One endometrial staging procedure System boundaries: Operating theatre door to door (intraoperative period, inferred from text) Included stages: Energy, waste/disposal Stated excluded components: Production, transport, pharmaceuticals, reuse Inventory database: - Allocation: No Normalization & Weighting: No Impacts reported: Yes Contribution analysis: Yes Scenario analysis: No Comparative analysis:	were reviewed. Collected information: patient age, body mass index (BMI), procedure type, operative time, history of prior abdominal surgery, length of stay, uterine weight and instruments used. Waste production and energy expenditure were determined for each surgical modality and included in the analysis. Solid waste was determined by weighing items used within procedures (drapes, gowns, gloves, consumables, sterile wrap, single-use devices) and multiplying weights by use data taken from OR records. Energy consumption was determined by using operative time records and multiplying duration of the procedure per unit time of four categories: environmental (HVAC, lighting), equipment, instruments, robotic system. Assessment methodology was adapted from the British Standards Institute Publicly Available Specification 2050 (BSI PAS 2050) and the Greenhouse	waste and energy consumed, was corresponding with 4498 CO_2e, averaging 30 kg CO_2e/patient. A robotically-assisted laparoscopy (RA-LSC) procedure resulted in a CO_2 footprint of 40.3 kg CO_2e/patient, based on energy use and waste. The CO_2 emission from this energy use was 26 kg CO_2, calculated by energy use (kWh) and operative time (min). A laparoscopy (LSC) procedure emitted 29.2 kg CO_2e/patient. The CO_2 emission from this energy use was 18 kg CO_2. A laparotomy (LAP) resulted in the emission of 22.7 kg CO_2e/patient. The CO_2 emission from this energy use was 14.4 kg CO_2. 2. Waste The RA-LSC group produced a total amount of 14.3 kg (14.3 kg CO_2e/patient) of solid waste, which existed of 6.90 kg consumable waste (6.90 kg CO_2e/patient), 2.47 kg single-use device waste (2.47 kg CO_2e/patient), 4.03 kg infection control waste (4.03 kg CO_2e/patient) and 0.88 kg waste from sterile wraps (0.88 kg CO_2e/patient). The LSC group produced 11.2 kg (11.2 kg CO_2e/patient) of	Emissions from both energy use and waste are greatest in the RA-LSC group. The energy use of all groups seem comparable, but because of the use of the Da Vinci robot, the RA-LSC energy consumption turns out highest. The energy use for equipment is highest in the LSC group. The biggest contributors in waste in the RA-LSC group are consumables and infection control waste, in the LSC group consumables and single-use devices and in the LAP group consumables. Energy use adds more to the CO_2 footprint than waste.	identified. The future healthcare sustainability research should include development of strategies to mitigate the environmental effects of healthcare while improving safety, quality and cost-effectiveness. Limitations Emissions for transport, manufacturing and disposal of instruments and goods and emissions based on preoperative and postoperative stay (length of stay) were not taken into account.

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
			Yes Sensitivity analysis: No Uncertainty analysis: No Variance analysis: Yes (ANOVA) Characteristics of study population by surgical modality RA-LSC Age (years): 63.0 BMI (kg/m^2): 36.2 Prior abdominal surgery (%): 56 Uterine weight (g) 205.1 LSC Age (years): 60.3 BMI (kg/m^2): 31.5 Prior abdominal surgery (%): 52 Uterine weight (g) 166.31 LAP Age (years): 62.7 BMI (kg/m^2): 35.5 Prior abdominal surgery (%): 60 Uterine weight (g) 495.47	Gas Protocol. Data on energy and waste were obtained from the National Energy Foundation (NEF), the US Energy Information Administration and previous studies.	solid waste, which existed of 6.03 kg consumable waste (6.03 kg CO_2e/patient), 3.35 kg single-use device waste (3.35 kg CO_2e/patient), 1.60 kg infection control waste (1.60 kg CO_2e/patient) and 0.99 kg waste from sterile wraps (0.99 kg CO_2e/patient). The LAP group produced 8.3 kg (8.3 kg CO_2e/patient) of solid waste, which existed of 5.86 kg consumable waste (5.86 kg CO_2e/patient), 0.82 kg single-use device waste (0.82 kg CO_2e/patient), 1.60 kg infection control waste (1.60 kg CO_2e/patient) and 0.44 kg waste from sterile wraps (0.44 kg CO_2e/patient). The solid waste production of RA-LSC represented a 74% increase over LAP and a 36% increase over LSC. 3. Acidification No results in this study. 4. Eutrophication No results in this study. 5. Human Toxicity No results in this study. 6. Ecotoxicity No results in this study. 7. Ozone Depletion No results in this study.		

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
Thiel (2015)	Environmental Science & Technology Journal information ES&T is an impactful environmental science and technology research journal that aims to be transformational and direction-setting, publishing rigorous and robust papers for a multidisciplinary and diverse audience of scientists, policy makers and the broad environmental community. Critical review: Peer reviewed article.	Type of study: LCA Objective: To assess the environmental impacts of four different surgical approaches to hysterectomy: vaginal, abdominal, laparoscopic, and robotic LCA-method: Hybrid LCA (ISO 14040-44) Setting and country: Hospital in the US Facility: Magee-Womens Hospital of the University of Pittsburgh Medical Center, Pittsburgh, PA, USA Years of data collection: 2011 Surgical discipline(s): Obstetrics & gynecology Funding and conflict of interest: Financial support for the data collection came from Grant Number ULI RR024153 from the National Center for Research Resources (NCRR), a component of the National Institutes of	Goal and scope[1]: Quantitate the environmental emissions of a vaginal, an abdominal, a laparoscopic, and a robotic hysterectomy. Functional unit(s)[2]: One hysterectomy System boundaries: Operating theatre door to door (intraoperative period) Included stages: Production, transport, energy use, pharmaceuticals, reuse, disposal/waste Stated excluded components: Infrastructure including machines and building; chemical manufacturing and cleaning products; hot water Inventory database: USLCI, EcoInvent Allocation: Impacts of resuable materials and equipment were apportioned based on estimated lifespan/number of uses.	This research used a hybrid LCA framework, by incorporating process LCA data and Economic Input Output LCA (EIO-LCA) data. Monte Carlo simulations were used to quantify the variability and uncertainty in emissions for each component of a hysterectomy. Waste audits were conducted from the surgeries of patients that underwent an abdominal, a laparoscopic or a robotic hysterectomy for noncancer related reasons. For the course of 1 year, waste from 62 cases of each type of hysterectomy were quantified and characterized (15 abdominal, vaginal and robotic, 17 laparoscopic). Materials were matched with the most relevant unit process within either USLCI and EcoInvent. For complex items of medical equipment an economic input-output approach was taken (i.e. based on the price paid for each item). Patient records were used to calculate both pathogenic waste (uterine weight) and quantities of anesthesia	1. Climate change This study reported a difference in greenhouse gas (GHG) emissions between the four approaches for a hysterectomy. Robotic hysterectomies have the highest impact (100%) in greenhouse gas emissions, followed by the laparoscopic (65-70%), abdominal (35-40%) and vaginal approach (30-35%). The laparoscopic approach resulted in 30-35% less contribution to GHG emissions than a robotic approach, abdominal and vaginal approaches in between 60-70% less contribution in comparison to the robotic approach. Biggest contributors were: the use of anaesthetic gases (in all surgical modalities) and single-use surgical instruments (for laparoscopic and robotic approach). 2. Waste The robotic approach for a hysterectomy produced the highest amount of waste, following the laparoscopic, abdominal and vaginal approaches. Robotic hysterectomies produced 13.7 kg municipal solid waste (MSW) per case, which resulted in a total of 30%	This life cycle assessment shows the biggest environmental impact is attributable to the robotic and laparoscopic surgical approaches for a hysterectomy. Within these modalities, the use of single-use instruments, single-use materials (gowns, gloves, etc.) and anesthetic gases are the biggest contributors.	Authors conclusion The trend is towards MIS that drives up the amount of pollution generated within the OR. Limitations The environmental impact of postoperative stay was not taken into account.

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
		Health (NIH), and NIH Roadmap for Medical Research. Support for graduate researchers came from Award No. 050434 from the National Science Foundation (NSF) Integrative Education and Research Traineeship (IGERT). The authors declare no competing financial interest.	<u>Normalization & Weighting:</u> No <u>Impacts reported:</u> Yes (graphically) <u>Contribution analysis:</u> Yes <u>Scenario analysis:</u> No <u>Comparative analysis:</u> Yes <u>Sensitivity analysis:</u> No <u>Uncertainty analysis:</u> Yes (Monte Carlo) <u>Variance analysis:</u> No	and abdominal insufflation. Transportation impacts were calculated based on distances between facilities, according to waste hauling data from the relevant facility. Impacts of resuable materials and equipment were based on estimated lifespan/number of uses. Data on the sterilization process for reusable materials and linens was sourced from the literature. <u>Characterization methods:</u> Impacts were calculated using TRACI 2.1 for both process LCA and EIO-LCA. Embodied energy was calculated using cumulative energy demand (CED) version 1.08 developed by EcoInvent version 2.0 and PRé Consultants for process LCA and the energy analysis function found on the EIO-LCA tool.	more waste compared to the average of the other approaches. This consisted of 22% by weight by gowns, drapes and bluewrap (SMS PP), 50% gloves and other plastics, 18% paper and 5% cotton. Abdominal hysterectomies had an average of 9.2 kg of MSW production and produced the largest amount of cotton waste (blue towels, laparotomy pads) at 1 kg per average surgery (11% of the MSW by weight). Across all four surgeries, SMS PP material were the majority of the MSW by weight, from 22% of the weight of a robotic hysterectomy and 35% for a laparoscopic hysterectomy. Other types of plastics, from thin film packaging wrappers to hard plastic trays, made up a minimum of 36% of the total MSW weight for vaginal hysterectomies and a maximum of 46% for robotic hysterectomies. <u>3. Acidification</u> The robotic approach had the highest impact on acidification (100%), followed by the laparoscopic (70-75%), abdominal (25%) and lastly the vaginal approach (20%).		

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					The big difference between the robotic and laparoscopic approach in comparison to the vaginal and abdominal approach can be attributed to the use of single-use surgical instruments. <u>4. Eutrophication</u> The robotic approach had the highest impact on eutrophication (100%), followed by the laparoscopic (70-75%), abdominal (60-65%) and lastly the vaginal approach (55%). MSW, single-use surgical instruments and single-use materials are the biggest contributors. <u>5. Human Toxicity</u> The impact was divided into two subcategories: carcinogenic and non-carcinogenic potential. The robotic approach had the highest impact in both Nocarcinogenic and non-carcinogenic potential categories (100%). The carcinogenic and non-carcinogenic impact of the laparoscopic approach resulted in respectively 80% and 85-90%. For the abdominal approach 90-100% and 80-90% and for the		

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					vaginal approach 80% and 70-75%. Single-use materials contributed most in all surgical modalities. 6. Ecotoxicity The robotic approach had the highest impact on ecotoxicity (100%), followed by the laparoscopic (90-95%), abdominal (90%) and lastly the vaginal approach (75%). Single-use materials contributed most in all surgical modalities. 7. Ozone Depletion The robotic approach had the highest impact on ozone depletion (100%), followed by the laparoscopic (60-65%), abdominal and the vaginal approach (0-5%). The use of single-use surgical instruments contributed most.		

[1]Goals and scope: 'Phase of life cycle assessment in which the aim of the study, and in relation to that, the breadth and depth of the study is established'
[2]Functional unit: Quantified description of the function of a product or process that serves as the reference basis for all calculations regarding impact assessment.

Appendix 2. Critical appraisal of LCAs (based on Drew, 2021)

Drew (2021) developed a critical appraisal *pro forma*, based on Weidema's guidelines for critical review of LCA (Weidema, 1997). This scoring system consists of 16 appraisal criteria, which are divided between the different phases of an LCA. It addresses a range of study quality indicators, such as internal validity, external validity, consistency, transparency, and bias. The percentage score provides an indication of the overall study quality. A higher score indicates a higher overall study quality. The points that can be obtained are displayed in the column labeled "appraisal criteria".

Appraisal criteria	**Indicator(s)**	**Key effect modifiers**	**Power (2012)**	**Thiel (2015)**	**Woods (2015)**
Phase 1: Goal & Scope (13 points)					
Study goal is clearly stated, including the study's rationale (1), intended application (1), and intended audience (1)	Transparency		3	3	3
Lifecycle assessment method is clearly stated (1)	Transparency	Process-based life-cycle assessment, which is well suited to product-level analysis, may underestimate environmental impacts (i.e. from truncation error); economic input-output lifecycle assessment (EIO-LCA), which uses aggregate data and is well-suited to sector-level analysis, may overestimate environmental impacts	1	1	1
Functional unit is clearly defined and measurable (1), justified (1), and consistent with the study's intended application (1)	Consistency		0	3	0
The system to be studied is adequately described with clearly stated system boundaries (1), lifecycle stages (1), and appropriate justification of any omitted stages (1)	Transparency; Bias	Assessments with narrow system boundaries that exclude a number of lifecycle stages are prone to underestimating life-cycle environmental impacts	1	2	1
The system covers production (1), use/reuse (1) and disposal (1) of materials and energy (half mark if only for energy and vice versa)	Internal Validity, Completeness		2	3	2
Phase 2: Inventory analysis (7 points)					
The data collection process is clearly explained, including the source(s) of foreground material weights and energy values (1); the source(s) of reference data (e.g. inventory database; 1); and what data are included (e.g. production and disposal of unit processes; 1)	Transparency, Internal Validity		3	3	3
Representativeness of the data is discussed (1), differences in electricity generating mix are accounted for (1), and the potential significance of exclusions or assumptions is addressed (1)	Internal validity; External validity		0	2	0

Allocation procedures, where necessary, are described and appropriately justified (1; mark given if no allocation used)	Transparency; Bias		1	1	1
Phase 3: Impact assessment (6 points)					
Impact categories (1), characterization method (1), and software used (1) are documented transparently	Transparency		1	2	1
Results are clearly reported in the context of the functional unit (1) (0.5 if graphically, 0 if only normalized results reported)	Consistency; Transparency		1	0	1
A contribution analysis is performed and clearly reported (1), and hotspots are identified (1)			2	2	2
Phase 4: Interpretation (9 points)					
Conclusions are consistent with the goal and scope (1) and supported by the impact assessment results (1)	Internal validity; Consistency		0	2	2
Results are contextualized through the use of sensitivity analysis (1) and uncertainty analysis (1)	Internal validity		0	1	0
Limitations are adequately discussed (1), and the potential impact of omissions or assumptions on the study's outcomes are described (1)	Bias		1	0	1
The assessment has been critically appraised (i.e. peer review if journal article or independent, external critical review if report/thesis; 1)	Bias		1	1	1
Source(s) of funding and any potential conflict(s) of interest are disclosed (1), and are unlikely to be a source of bias (1)	Bias		2	2	1
		Total (/35)	19	28	20
		Percentage score	**54%**	**80%**	**57%**

Table of excluded studies

Author and year	Reason for exclusion
Terra 2021	Wrong outcome, wrong population, wrong intervention, wrong study design
Alshowaikh 2021	Wrong outcome
McKenzie 2021	Wrong outcome, wrong population
Scarcella 2021	Wrong outcome, wrong intervention, wrong study design
Sugita 2021	Wrong outcome, wrong intervention, wrong study design
Hirano 2021	Wrong outcome, wrong comparison
Kagiyama 2021	Wrong outcome, wrong population, wrong study design
Bakr 2021	Wrong outcome, wrong population, wrong study design
Wang 2021	Wrong outcome, wrong population
AlJamal 2021	Wrong outcome, wrong study design
Bertolo 2021	Wrong outcome, wrong study design
Sun 2020	Wrong outcome, wrong study design
Mahmud 2020	Wrong outcome, wrong population
Scott 2020	Wrong outcome, wrong population, wrong study design
Leitsmann 2021	Wrong outcome, wrong population, wrong study design
Simianu 2020	Wrong outcome, wrong study design
Lenfant 2021	Wrong outcome, wrong study design
Hanaoka 2021	Wrong outcome, wrong study design
Tampio 2021	Wrong outcome, wrong population
Patel 2020	Wrong outcome, wrong population
Sobel 2020	Wrong outcome, wrong study design
Fulla 2020	Wrong outcome, wrong study design
Kim 2020	Wrong outcome, foreign language, wrong study design
Rassweiler 2020	Wrong outcome, wrong population, wrong intervention
Aggarwal 2020	Wrong outcome, wrong study design
Khoraki 2020	Wrong outcome
Grewal 2020	Wrong population, wrong intervention
Chen 2019	Wrong outcome, wrong population, wrong study design
Pennington 2019	Wrong outcome, wrong population, wrong intervention
Akpinar 2019	Wrong outcome, wrong study design
Weidert 2019	Wrong outcome, wrong population, wrong intervention, wrong study design
Rosenfeld 2018	Wrong outcome
Han 2019	Wrong outcome, wrong study design
Abdelmoaty 2019	Wrong outcome
Sardari Nia 2019	Wrong outcome, wrong population, wrong study design
Schuetze 2019	Wrong outcome, wrong population, wrong study design
Laviana 2018	Wrong outcome, wrong intervention
Gao 2018	Wrong population, wrong intervention
Hahn 2017	Wrong outcome, wrong intervention
Patti 2017	Wrong outcome, wrong study design
Manning 2018	Wrong outcome, wrong study design
Moukarzel 2017	Wrong outcome, wrong comparison
Unger 2017	Wrong intervention
Pellegrino 2017	Wrong outcome, wrong study design
Kaminski 2017	Wrong outcome, wrong population, wrong intervention
Agzarian 2016	Wrong outcome, wrong population
Pellegrino 2017	Wrong outcome, wrong study design
Hollis 2016	Wrong outcome
van der Steen-Banasik 2016	Wrong outcome, wrong intervention
Manjila 2016	Wrong outcome, wrong population, wrong intervention
Schwein 2017	Wrong outcome, wrong population, wrong intervention, wrong study design
El Hachem 2016	Wrong outcome
Lee 2016	Wrong outcome, wrong population
Rault 2016	Wrong population, wrong intervention
Herling 2016	Wrong outcome
Shrikhande 2015	Wrong outcome, wrong study design
Ludwig 2015	Wrong comparison
Suh 2016	Wrong outcome
Park 2015	Wrong outcome, wrong comparison, wrong population
Weinberg 2015	Wrong outcome
Rossi 2015	Wrong outcome, wrong intervention
Park 2015	Wrong outcome
Stark 2015	Wrong outcome, wrong intervention, wrong study design
Gupta 2014	Wrong outcome, wrong study design

Author and year	Reason for exclusion
Liu 2014	Wrong outcome
Angioli 2015	Wrong outcome
Asimakopoulos 2014	Wrong outcome
Sumila 2014	Wrong outcome, wrong study design
Lukens 2014	Wrong outcome
Tapper 2014	Wrong outcome
Datino 2014	Wrong outcome, wrong intervention
Hart 2013	Wrong outcome, wrong comparison
Liang 2014	Wrong outcome, wrong comparison
Barzilay 2014	Wrong outcome, wrong comparison
Koutlidis 2014	Wrong outcome, wrong intervention
Ozyigit 2014	Wrong outcome, wrong population, wrong intervention
Chesson 2013	Wrong outcome
Lee 2013	Wrong outcome, wrong study design
Grandhi 2012	Wrong outcome, wrong population, wrong intervention
Fleming 2012	Wrong outcome
Ferguson 2012	Wrong outcome
Liu 2012	Wrong outcome
Hyde 2012	Wrong outcome, wrong population, wrong intervention
Guillotreau 2012	Wrong outcome
Behera 2012	Wrong outcome
Norbash 2011	Wrong outcome, wrong study design
Thakur 2012	Wrong outcome, wrong study design
Camps 2011	Wrong outcome, wrong study design
Rebuck 2011	Wrong outcome, wrong study design
Barnett 2010	Wrong outcome
Bondiau 2010	Wrong outcome, foreign language, wrong intervention
Judd 2010	Wrong outcome
Holtz 2010	Wrong outcome
Riga 2010	Wrong outcome, wrong intervention
Smith 2010	Wrong outcome
Siu 2010	Wrong outcome
Cosentino 2009	Wrong outcome, wrong intervention
Schmidt 2009	Wrong outcome, wrong intervention, wrong population
Gibbs 2009	Wrong outcome, wrong comparison, wrong population
Hyams 2008	Wrong outcome, wrong intervention
Schabowsky 2008	Wrong outcome, wrong comparison, wrong population
Steinberg 2008	Wrong outcome, wrong study design
Marecik 2008	Wrong outcome, wrong study design, wrong population
Nakadi 2006	Wrong outcome
Van Brakel2004	Wrong outcome, wrong study design, wrong population
Balaji 2004	Wrong outcome, wrong comparison
Fuchs 2002	Wrong outcome, wrong study design
Chiu 2000	Wrong outcome, wrong comparison
Puri 2021	Wrong outcome, wrong intervention
Darwood 2021	Wrong outcome, wrong intervention, wrong population
Lin 2021	Wrong outcome
Lemos 2021	Wrong outcome, wrong population
Mun 2021	Wrong outcome, wrong intervention
Liu 2021	Wrong outcome, wrong population
Gerull 2021	Wrong outcome, wrong population
Buschbaum 2015	Wrong outcome, wrong intervention
Pizzighella 2021	Wrong outcome, wrong comparison
Ross 2021	Wrong outcome, wrong intervention
Yun 2021	Wrong outcome, wrong population
Petro 2021	Wrong outcome, wrong population
Perile 2021	Wrong outcome, wrong intervention, wrong study design
Kim 2021	Wrong outcome, wrong intervention, wrong study design, wrong population
Peak 2021	Wrong outcome
Ishii 2020	Wrong outcome, wrong population, wrong study design
Rodin 2020	Wrong outcome, wrong comparison
Belline 2020	Wrong outcome, wrong comparison
Law 2020	Wrong outcome, wrong intervention
Emile 2020	Wrong outcome, wrong comparison
Cotter 2020	Wrong outcome, wrong study design
Rose 2019	Wrong comparison

Author and year	Reason for exclusion
Bayne 2019	Wrong outcome, wrong comparison, wrong study design
Benabid 2019	Wrong outcome, wrong intervention, wrong population
Ciocirlan 2019	Wrong intervention, wrong study design
Vercellini 2018	Wrong outcome, wrong population, wrong study design
Raheem 2017	Wrong outcome, wrong intervention, wrong comparison, wrong population
Sanguedolce 2017	Wrong outcome, wrong comparison
Scheurs 2018	Wrong outcome, wrong intervention, wrong study design, wrong population
Prins 2017	Wrong outcome, wrong population, wrong intervention
Rogers 2017	Wrong outcome, wrong comparison
Johnson 2017	Wrong outcome, wrong study design
Backelandt 2016	Wrong outcome
Zaman 2016	Wrong outcome, wrong comparison
Mathuriya 2016	Wrong outcome, wrong intervention, wrong population
Chi 2015	Wrong outcome, wrong population
White 2015	Wrong outcome, wrong comparison
Biehn Stewart 2014	Wrong outcome
Smorgick 2014	Wrong outcome
Woelk 2014	Wrong outcome
Pai 2014	Wrong outcome
Vuckovic 2013	Wrong outcome, wrong intervention
Geraerts 2013	Wrong outcome
Weisz 2013	Wrong outcome, wrong pupulation
Eldefrawy 2013	Wrong study design, wrong intervention
Nayeemuddin 2013	Wrong outcome, wrong study design
Ahmed 2012	Wrong outcome
Leitao 2012	Wrong study design
Nakamura 2012	Wrong population, wrong study design
Michel 2012	Wrong outcome, wrong intervention
Linte 2011	Wrong outcome, wrong intervention, wrong population
Cheetham 2010	Wrong outcome, wrong study design
Pow-Sang 2007	Wrong outcome
Lund 2004	Wrong outcome, wrong study design
Perrier 2002	Foreign language
Hoque 2021	Wrong outcome, wrong intervention, wrong study design
Sharma 2021	Wrong outcome
Jia 2021	Wrong outcome, wrong comparison
Marlicz 2020	Wrong outcome, wrong comparison
Shetty 2020	Wrong outcome, wrong comparison, wrong population
Stroberg 2020	Wrong outcome, wrong comparison
Ji 2020	Wrong outcome, wrong study design
Merola 2020	Wrong outcome
Garbin 2019	Wrong outcome, wrong study design
Lin 2019	Wrong outcome, wrong comparison, wrong population
Kim 2018	Wrong outcome, wrong comparison
Takizawa 2018	Wrong outcome, wrong study design
Redondo 2017	Wrong outcome, wrong comparison
Mateen 2017	Wrong outcome, wrong intervention
Cheng 2017	Wrong outcome, wrong intervention
Singh 2013	Wrong outcome, wrong comparison
Gomes 2011	Wrong outcome
Nct 2018	Registered trial, wrong outcome, wrong intervention
Nct 2019	Registered trial, wrong outcome, wrong comparison
Nct 2009	Registered trial, wrong outcome, wrong comparison
Nct 2016	Registered trial, wrong outcome
Nct 2013	Registered trial, wrong outcome, wrong intervention
Actrn 2021	Registered trial, wrong outcome, wrong intervention
Nct 2017	Registered trial, wrong outcome, wrong intervention
Nct 2016	Registered trial, wrong outcome, wrong comparison
Jang 2019	Wrong outcome, wrong comparison
Lu 2015	Wrong outcome, wrong intervention
Mukherjee 2009	Wrong outcome, wrong intervention, wrong study design, wrong population
Borwn-Clerk 2008	Wrong outcome, wrong intervention, wrong study design, wrong population
Fischer 2007	Wrong outcome, wrong intervention, wrong study design
Ro 2005	Wrong outcome, wrong population, wrong study design
Lee 2005	Wrong outcome
Maassen 2004	Wrong outcome, wrong intervention, wrong population

Author and year	Reason for exclusion
Nebot 2003	Wrong outcome, wrong comparison
Luketich 2002	Wrong outcome, wrong comparison, wrong population
Li 2000	Wrong outcome, wrong comparison, wrong population

Literature search strategy

Zoekverantwoording
Algemene informatie

Richtlijn: Duurzaamheid	
Uitgangsvraag: UV1 - Wat is het effect op duurzaamheid van robotchirurgie in vergelijking met laparoscopisch-geassisteerde chirurgie of conventionele open chirurgie bij patiënten met indicatie voor een operatie?	
Database(s): Medline (PubMed), Embase (OVID), Web of Science, Cochrane Library, Emcare (OVID)	Datum: 7-12-2021
Periode: 2000-..	Talen: nvt
Literatuurspecialist: Jan W. Schoones (LUMC)	
BMI zoekblokken: voor verschillende opdrachten wordt (deels) gebruik gemaakt van de zoekblokken van BMI-Online https://blocks.bmi-online.nl/ Bij gebruikmaking van een volledig zoekblok zal naar de betreffende link op de website worden verwezen.	
Toelichting: -	
In de databases Medline (PubMed), Embase (OVID), Web of Science, Cochrane Library, en Emcare (OVID) is op 7-12-2021 met relevante zoektermen gezocht naar systematische reviews, RCTs, observationele studies, ander vergelijkend onderzoek (bijv. case control, cohort-onderzoek), en life cycle assessments (LCA's) over UV1 - Wat is het effect op duurzaamheid van robotchirurgie in vergelijking met laparoscopisch-geassisteerde chirurgie of conventionele open chirurgie bij patiënten met indicatie voor een operatie? De literatuurzoekactie leverde 202 unieke treffers op.	

Zoekopbrengst

	MEDLINE (PubMed)	Embase (OVID)	Web of Science	Cochrane Library	Emcare (OVID)	Ontdubbeld
	111	110	72	11	50	202

Zoekstrategie
MEDLINE (PubMed)

(("Robotic Surgical Procedures"[Mesh] OR "Robotic Surgical Procedures"[tw] OR "Robotic Surgical Procedure"[tw] OR "Robotic Surgical"[tw] OR "Robotic Surgical*"[tw] OR "Robotic Surgery"[tw] OR "Robotic Surg*"[tw] OR "Robot Surgical Procedures"[tw] OR "Robot Surgical Procedure"[tw] OR "Robot Surgical"[tw] OR "Robot Surgical*"[tw] OR "Robot Surgery"[tw] OR "Robot Surg*"[tw] OR "Robot Assisted Surg*"[tw] OR "Robot Assisted Surgery"[tw] OR "Robot Enhanced Procedure"[tw] OR "Robot Enhanced Procedures"[tw] OR "Robot Enhanced Surg*"[tw] OR "Robot Enhanced Surgery"[tw] OR "Robotic Assisted Surg*"[tw] OR "Robotic Assisted Surgery"[tw] OR "Robot Assisted Procedure"[tw] OR "Robot Assisted Procedures"[tw] OR "Robotic Assisted Procedure"[tw] OR "Robotic Assisted Procedures"[tw] OR "Da Vinci robot"[tw] OR "Da Vinci robots"[tw] OR "Da Vinci robotic"[tw] OR "Da Vinci robotics"[tw] OR "Da Vinci robot*"[tw] OR "Surgery robot"[tw] OR "Surgery robots"[tw] OR "Surgery robotic"[tw] OR "Surgery robotics"[tw] OR "Surgery robot*"[tw] OR "Surgical robot"[tw] OR "Surgical robots"[tw] OR "Surgical robotic"[tw] OR "Surgical robotics"[tw] OR "Surgical robot*"[tw] OR "Da Vinci"[tw] OR (("Surgical Procedures Operative"[Mesh] OR "surgery"[Subheading] OR "surgery"[tw] OR "surgical"[tw] OR "surgical*"[tw] OR "Surgeons"[mesh] OR "surgeon"[tw] OR "surgeons"[tw] OR "surgeon*"[tw] OR "neurosurgery"[tw] OR "neurosurgical"[tw] OR "neurosurgical*"[tw] OR "neurosurgeon"[tw] OR "neurosurgeons"[tw] OR "neurosurgeon*"[tw] OR "radiosurgery"[tw] OR "radiosurgical"[tw] OR "radiosurgical*"[tw] OR "radiosurgeon"[tw] OR "radiosurgeons"[tw] OR "radiosurgeon*"[tw]) AND ("Robotics"[Mesh] OR "Robotics"[tw] OR "Robot"[tw] OR "Robots"[tw] OR "Robotic"[tw] OR "Robot*"[tw] OR "Telerobotics"[tw] OR "Telerobot*"[tw]))) AND ("Laparoscopy"[Mesh] OR "Laparoscopy"[tw] OR "Laparoscop*"[tw] OR "Laparotomy"[Mesh] OR "Laparotomy"[tw] OR "Laparotom*"[tw] OR "Minimally Invasive Surgical Procedures"[Mesh] OR "Minimally Invasive Surgery"[tw] OR "Minimally Invasive"[tw] OR "Minimal Surgical"[tw] OR "Minimal Access"[tw] OR "open surgery"[tw] OR ("Surgical Procedures Operative"[Mesh] NOT "Robotic Surgical Procedures"[Mesh]) OR "surgery"[Subheading] OR "conventional surgery"[tw] OR "Endoscopy"[Mesh] OR "Endoscopy"[tw] OR "endoscop*"[tw]) AND ("Acidification potential"[tw] OR "acidification"[tw] OR "air pollution control"[tw] OR "AP in kg SO2 equivalents"[tw] OR "Biodiversity"[Mesh] OR "Biodiversity"[tw] OR "Carbon Footprint"[mesh] OR "carbon footprint"[tw] OR "carbon footprint*"[tw] OR "CFC-11 equiv*"[tw] OR "Climate Change"[Mesh] OR "climate change"[tw] OR "Climatic change"[tw] OR "CO2 emission"[tw] OR "CO2 emissions"[tw] OR "CO2 equiva*"[tw] OR "CO2 footprint"[tw] OR "CO2 footprint*"[tw] OR "conservation of natural resources"[mesh] OR "conservation of natural resources"[tw] OR "Disposable Equipment"[Mesh] OR "Disposable"[tw] OR "Disposables"[tw] OR "eco toxic*"[tw] OR "eco toxicity"[tw] OR "ecoefficien*"[tw] OR "eco-efficien*"[tw] OR "ecoefficiency"[tw] OR "eco-efficiency"[tw] OR "ecological footprint"[tw] OR "ecological footprint*"[tw] OR "ecological sustainability"[tw] OR "ecotoxic*"[tw] OR "ecotoxicity"[tw] OR "Emission reduction strategy"[tw] OR "Emission reduction"[tw] OR **"Environment"[Mesh:noexp]** OR "environmental impact"[tw] OR "environmental impact*"[tw] OR "environmental impacts"[tw] OR "environmental pollut*"[tw] OR "Environmental Pollution"[Mesh] OR "environmental pollution"[tw] OR "environmental protection"[tw] OR "environmental sustainab*"[tw] OR "environmental sustainability"[tw] OR **"Environmental*"[ti]** OR "EP in kg PO4 equivalent"[tw] OR "Equipment reuse"[mesh] OR "Equipment reuse"[tw] OR "Eutrophication potential"[tw] OR "Eutrophication"[Mesh] OR "eutrophication"[tw] OR "FAETP in kg DCB equivalent"[tw] OR "Freshwater Aquatic Ecotoxicity Potential"[tw] OR "Global Warming"[mesh] OR "Global Warming"[tw] OR "Green deal"[tw] OR "Green surgery"[tw] OR "Greenhouse Effect"[mesh] OR "greenhouse effect*"[tw] OR "greenhouse effects"[tw] OR "greenhouse gas emission"[tw] OR "greenhouse gas emissions"[tw] OR "Greenhouse Gas"[tw] OR "Greenhouse Gases"[mesh] OR "Greenhouse Gases"[tw] OR "greening"[tw] OR "GWP in kg CO2 equivalents"[tw] OR "H+ moles equivalents"[tw] OR "hospital waste"[tw] OR "HTTP in kg Dichlorobenzene equivalent"[tw] OR

"Human Toxicity Potential"[tw] OR "kg 2.4-D equivalents"[tw] OR "kg CFC-11 equivalent"[tw] OR "kg N equivalents"[tw] OR "kg NOx equivalents"[tw] OR "LCA"[tw] OR "LCAs"[tw] OR "life cycle analysis"[tw] OR "life cycle assess*"[tw] OR "life cycle assessment"[tw] OR "life cycle inventories"[tw] OR "life cycle inventory"[tw] OR "Medical Waste Disposal"[mesh] OR "Medical Waste"[mesh] OR "medical waste"[tw] OR "N equiv*"[tw] OR "Ozone Depletion"[Mesh] OR "ozone depletion"[tw] OR "Photochemical Ozone Depletion Potential"[tw] OR "Plastic overuse"[tw] OR "POCP in kg ethane equivalent"[tw] OR "preservation of natural resources"[tw] OR "recycle*"[tw] OR "Recycling"[mesh] OR "recycling"[tw] OR "Refuse Disposal"[Mesh] OR "Refuse Disposal"[tw] OR "reusable"[tw] OR "Reusables"[tw] OR "reuse"[tw] OR "reused"[tw] OR "reusing"[tw] OR "Rising Sea Level"[tw] OR "Rising Sea Levels"[tw] OR "Sea Level Rise"[mesh] OR "Sea Level Rise"[tw] OR "Smog"[mesh] OR "smog"[tw] OR "SO2 equiv*"[tw] OR "sustainability"**[ti]** OR "Sustainable Development"[Mesh] OR "Sustainable Development"[tw] OR "Waste Disposal"[tw] OR "Waste Disposal, Fluid"[mesh] OR "Waste Management"[mesh] OR "Waste"[tw] OR "waste"[tw] OR "Waste Water"[Mesh] OR "Waste Water"[tw] OR "wastes"[tw] OR "Wastewater"[tw] OR "Water Purification"[Mesh] OR "Water Purification"[tw] OR (("plastic*"[tw] OR "microplastic*"[tw]) AND ("soop"[tw] OR "soup"[tw] OR "pollution"[tw] OR "overuse"[tw] OR "contamination"[tw])) OR (("Plastic"[tw] OR "plastics"[tw]) AND "overuse"[tw]) OR ("hydrogen*"[tw] AND "moles"[tw] AND "equiv*"[tw]) OR ("Dichlorobenzen*"[tw] AND "equiv*"[tw]) OR ("2,4-D"[tw] AND "equiv*"[tw]) OR ("NOx"[tw] AND "equiv*"[tw]) OR ("ethane"[tw] AND "equiv*"[tw]) OR ("PO4"[tw] AND "equiv*"[tw]) OR ("DCB"[tw] AND "equiv*"[tw]) OR ("sustainability"[tw] AND ("environment*"[tw] OR "carbon"[tw])) OR (("Carbon Dioxide"[mesh] OR "Carbon Dioxide"[tw] OR "CO2"[tw]) AND ("pollution"[tw] OR "emission"[tw] OR "emissions"[tw] OR "waste"[tw] OR "environment"[tw] OR "environmental*"[tw] OR "footprint"[tw] OR "footprint*"[tw] OR "sustainable"[tw] OR "hazard"[tw] OR "hazard*"[tw]))) AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])) AND **(***("Meta-Analysis"[Publication Type] OR "Meta-Analysis as Topic"[Mesh] OR metaanaly*[tiab] OR meta-analy*[tiab] or metanaly*[tiab] OR "Systematic Review"[Publication Type] OR systematic[sb] OR "Cochrane Database Syst Rev"[Journal] or prisma[tiab] OR preferred reporting items[tiab] OR prospero[tiab] OR ((systemati*[ti] OR scoping[ti] OR umbrella[ti] OR structured literature[ti]) AND (review*[ti] OR overview*[ti])) OR systematic review*[tiab] OR scoping review*[tiab] OR umbrella review*[tiab] OR structured literature review*[tiab] OR systematic qualitative review*[tiab] OR systematic quantitative review*[tiab] OR systematic search and review[tiab] OR systematized review[tiab] OR systematised review[tiab] OR systemic review[tiab] OR systematic literature review*[tiab] OR systematic integrative literature review*[tiab] OR systematically review*[tiab] OR scoping literature review*[tiab] OR systematic critical review[tiab] OR systematic integrative review*[tiab] OR systematic evidence review[tiab] OR Systematic integrative literature review*[tiab] OR Systematic mixed studies review*[tiab] OR Systematized literature review*[tiab] OR Systematic overview*[tiab] OR Systematic narrative review*[tiab] OR ((systemati*[tiab] OR literature[tiab] OR database*[tiab] OR data-base*[tiab] OR structured[tiab] OR comprehensive*[tiab] OR systemic*[tiab]) AND search*[tiab]) OR (Literature[ti] AND review[ti] AND (database*[tiab] OR data-base*[tiab] OR search*[tiab])) OR ((data extraction[tiab] OR data source*[tiab]) AND study selection[tiab]) OR (search strategy[tiab] AND selection criteria[tiab]) OR (data source*[tiab] AND data synthesis[tiab]) OR medline[tiab] OR pubmed[tiab] OR embase[tiab] OR Cochrane[tiab] OR ((critical[ti] OR rapid[ti]) AND (review*[ti] OR overview*[ti] OR synthes*[ti])) OR (((critical*[tiab] OR rapid*[tiab]) AND (review*[tiab] OR overview*[tiab] OR synthes*[tiab]) AND (search*[tiab] OR database*[tiab] OR data-base*[tiab]))) OR metasynthes*[tiab] OR meta-synthes*[tiab])* **OR** ("Randomized Controlled Trial"[Publication Type] OR random*[tiab] OR pragmatic clinical trial*[tiab] OR practical clinical trial*[tiab] OR non-inferiority trial*[tiab] OR noninferiority trial*[tiab] OR superiority trial*[tiab] OR equivalence clinical trial*[tiab]) NOT (("Animals"[Mesh]) OR "Models, Animal"[Mesh] NOT humans[mh]) NOT (letter[pt] OR comment[pt] OR editorial[pt])) **OR ("Comparative Study"[Publication Type] OR "comparison"[tiab] OR "comparative"[tiab] OR "compar*"[tiab] OR "Epidemiologic studies"[mesh:noexp] OR "case control studies"[mesh] OR "cohort studies"[mesh] OR "Controlled Before-After Studies"[mesh] OR "Case control"[tw] OR cohort*[tw] OR "Cohort analy*"[tw] OR "Follow up stud*"[tw] OR "observational stud*"[tw] OR Longitudinal[tw] OR Retrospective*[tw] OR prospective*[tw] OR consecutive*[tw] OR Cross sectional[tw] OR "Cross-sectional studies"[mesh] OR "historically controlled study"[mesh] OR "interrupted time series analysis"[mesh])** OR ("life cycle assess*"[tw] OR "life cycle assessment"[tw] OR "life cycle inventory"[tw] OR "LCA"[tw] OR "LCAs"[tw] OR "life cycle inventory"[tw] OR "life cycle inventories"[tw])**)**

Embase (OVID)

((exp "Robot Assisted Surgery"/ OR exp "robotic surgical device"/ OR "Robotic Surgical Procedures".mp OR "Robotic Surgical Procedure".mp OR "Robotic Surgical".mp OR "Robotic Surgical*".mp OR "Robotic Surgery".mp OR "Robotic Surg*".mp OR "Robot Surgical Procedures".mp OR "Robot Surgical Procedure".mp OR "Robot Surgical".mp OR "Robot Surgical*".mp OR "Robot Surgery".mp OR "Robot Surg*".mp OR "Robot Assisted Surg*".mp OR "Robot Assisted Surgery".mp OR "Robot Enhanced Procedure".mp OR "Robot Enhanced Procedures".mp OR "Robot Enhanced Surg*".mp OR "Robot Enhanced Surgery".mp OR "Robotic Assisted Surg*".mp OR "Robotic Assisted Surgery".mp OR "Robot Assisted Procedure".mp OR "Robot Assisted Procedures".mp OR "Robotic Assisted Procedure".mp OR "Robotic Assisted Procedures".mp OR "Da Vinci robot".mp OR "Da Vinci robots".mp OR "Da Vinci robotic".mp OR "Da Vinci robotics".mp OR "Da Vinci robot*".mp OR "Surgery robot".mp OR "Surgery robots".mp OR "Surgery robotic".mp OR "Surgery robotics".mp OR "Surgery robot*".mp OR "Surgical robot".mp OR "Surgical robots".mp OR "Surgical robotic".mp OR "Surgical robotics".mp OR "Surgical robot*".mp OR "Da Vinci".mp OR ((exp "Surgery"/ OR "surgery".fs OR "surgery".mp OR "surgical".mp OR "surgical*".mp OR exp "Surgeon"/ OR "surgeon".mp OR "surgeons".mp OR "surgeon*".mp OR "neurosurgery".mp OR "neurosurgical".mp OR "neurosurgical*".mp OR "neurosurgeon".mp OR "neurosurgeons".mp OR "neurosurgeon*".mp OR "radiosurgery".mp OR "radiosurgical".mp OR "radiosurgical*".mp OR "radiosurgeon".mp OR "radiosurgeons".mp OR "radiosurgeon*".mp) AND ("Robotics"/ OR "Robotics".mp OR exp "Robot"/ OR exp "Medical Robot"/ OR "Robot".mp OR "Robots".mp OR "Robotic".mp OR "Robot*".mp OR "Telerobotics".mp OR "Telerobot*".mp))) AND (exp "Laparoscopy"/ OR "Laparoscopy".mp OR "Laparoscop*".mp OR "Laparotomy"/ OR "Laparotomy".mp OR "Laparotom*".mp OR "Minimally Invasive Surgery"/ OR "Minimally Invasive Surgery".mp OR "Minimally Invasive".mp OR "Minimal Surgical".mp OR "Minimal Access".mp OR "open surgery"/ OR "open surgery".mp OR (exp "Surgery"/ NOT (exp "Robot Assisted Surgery"/ OR exp "robotic surgical device"/)) OR "su".fs OR "conventional surgery".mp OR exp "Endoscopy"/ OR "Endoscopy".mp OR "endoscop*".mp) AND ("Carbon Footprint"/ OR "carbon footprint".mp OR "carbon footprint*".mp OR exp "Climate Change"/ OR "climate change".mp OR "CO2 emission".mp OR "CO2 emissions".mp OR "CO2 footprint".mp OR "CO2 footprint*".mp OR exp "environmental protection"/ OR "conservation of natural resources".mp OR "environmental protection".mp OR "Disposable Equipment"/ OR "Disposables".mp OR

"Disposable".mp OR "ecological footprint".mp OR "ecological footprint*".mp OR "ecological sustainability".mp OR exp "environmental impact"/ OR "environmental impact".mp OR "environmental impact*".mp OR "environmental impacts".mp OR "environmental pollut*".mp OR exp "pollution"/ OR "environmental pollution".mp OR "environmental sustainab*".mp OR "environmental sustainability"/ OR "environmental sustainability".mp OR "Global Warming"/ OR "Global Warming".mp OR "Greenhouse Effect"/ OR "greenhouse effect*".mp OR "greenhouse effects".mp OR "greenhouse gas emission".mp OR "greenhouse gas emissions".mp OR "Greenhouse Gas"/ OR "greening".mp OR "hospital waste".mp OR "life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp OR exp "Waste Disposal"/ OR exp "Hospital Waste"/ OR "medical waste".mp OR "Rising Sea Level".mp OR "Rising Sea Levels".mp OR "Sea Level Rise"/ OR "Sea Level Rise".mp OR "sustainability".**ti** OR "Waste Disposal".mp OR "waste water recycling"/ OR "Recycling"/ OR "recycling".mp OR "recycle*".mp OR "Equipment reuse".mp OR "Reusables".mp OR "reusable".mp OR "reuse".mp OR "reused".mp OR "reusing".mp OR exp "Waste Disposal"/ OR exp "Waste Management"/ OR "Plastic overuse".mp OR "Green surgery".mp OR "Emission reduction".mp OR "Emission reduction strategy".mp OR "air pollution control"/ OR "air pollution control".mp **OR "Environment"/ OR "Environmental*".ti** OR "acidification"/ OR "soil acidification"/ OR "ocean acidification"/ OR "acidification".mp OR "Acidification potential".mp OR "AP in kg SO2 equivalents".mp OR "eco-efficiency".mp OR "ecoefficiency".mp OR "eco-efficien*".mp OR "ecoefficien*".mp OR "ecotoxicity"/ OR "ecotoxicity".mp OR "ecotoxic*".mp OR "eco toxicity".mp OR "eco toxic*".mp OR "EP in kg PO4 equivalent".mp OR exp "Eutrophication"/ OR "eutrophication".mp OR "Eutrophication potential".mp OR "FAETP in kg DCB equivalent".mp OR "Freshwater Aquatic Ecotoxicity Potential".mp OR "GWP in kg CO2 equivalents".mp OR "H+ moles equivalents".mp OR "HTTP in kg Dichlorobenzene equivalent".mp OR "Human Toxicity Potential".mp OR "kg 2.4-D equivalents".mp OR "kg CFC-11 equivalent".mp OR "kg N equivalents".mp OR "kg NOx equivalents".mp OR "life cycle analysis".mp OR "ozone depletion".mp OR "Photochemical Ozone Depletion Potential".mp OR "POCP in kg ethane equivalent".mp OR "smog".mp OR exp "Waste"/ OR "waste".mp OR "wastes".mp OR "Ozone Depletion"/ OR "Smog"/ OR "Equipment reuse".mp OR "Greenhouse Gases".mp OR "Greenhouse Gas".mp OR "SO2 equiv*".mp OR "CO2 equiva*".mp OR "CFC-11 equiv*".mp OR "N equiv*".mp OR exp "Biodiversity"/ OR "Biodiversity".mp OR "Climatic change".mp OR "Green deal".mp OR "preservation of natural resources".mp OR "Refuse Disposal".mp OR exp "Wastewater"/ OR "Waste Water".mp OR "Wastewater".mp OR exp "Water Management"/ OR "Water Purification".mp OR (("plastic*".mp OR "microplastic*".mp) AND ("soop".mp OR "soup".mp OR "pollution".mp OR "overuse".mp OR "contamination".mp)) OR "Sustainable Development"/ OR "Sustainable Development".mp OR (("Plastic".mp OR "plastics".mp) AND "overuse".mp) OR ("hydrogen*".mp AND "moles".mp AND "equiv*".mp) OR ("Dichlorobenzen*".mp AND "equiv*".mp) OR ("2,4-D".mp AND "equiv*".mp) OR ("NOx".mp AND "equiv*".mp) OR ("ethane".mp AND "equiv*".mp) OR ("PO4".mp AND "equiv*".mp) OR ("DCB".mp AND "equiv*".mp) OR ("sustainability".mp AND ("environment*".mp OR "carbon".mp)) OR (("Carbon Dioxide"/ OR "Carbon Dioxide".mp OR "CO2".mp) AND ("pollution".mp OR "emission".mp OR "emissions".mp OR "waste".mp OR "environment".mp OR "environmental*".mp OR "footprint".mp OR "footprint*".mp OR "sustainable".mp OR "hazard".mp OR "hazard*".mp))) NOT (conference review or conference abstract).pt AND (2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022).yr) AND ((exp "meta analysis"/ OR exp "meta analysis (topic)"/ OR metaanaly*.ti,ab OR "meta analy*".ti,ab OR metanaly*.ti,ab OR "systematic review"/ OR "cochrane database of systematic reviews".jn OR prisma.ti,ab OR prospero.ti,ab OR (((systemati* OR scoping OR umbrella OR "structured literature") ADJ3 (review* OR overview*)).ti,ab) OR ((systemic* ADJ1 review*).ti,ab) OR (((systemati* OR literature OR database* OR "data base*") ADJ10 search*).ti,ab) OR (((structured OR comprehensive* OR systemic*) ADJ3 search*).ti,ab) OR (((literature ADJ3 review*).ti,ab) AND (search*.ti,ab OR database*.ti,ab OR "data base*".ti,ab)) OR (("data extraction".ti,ab OR "data source*".ti,ab) AND "study selection".ti,ab) OR ("search strategy".ti,ab AND "selection criteria".ti,ab) OR ("data source*".ti,ab AND "data synthesis".ti,ab) OR medline.ab OR pubmed.ab OR embase.ab OR cochrane.ab OR (((critical OR rapid) ADJ2 (review* OR overview* OR synthes*)).ti) OR ((((critical* OR rapid*) ADJ3 (review* OR overview* OR synthes*)).ab) AND (search*.ab OR database*.ab OR "data base*".ab)) OR metasynthes*.ti,ab OR "meta synthes*".ti,ab) OR (exp "clinical trial"/ OR exp "randomization"/ OR exp "single blind procedure"/ OR exp "double blind procedure"/ OR exp "crossover procedure"/ OR exp "placebo"/ OR exp "prospective study"/ OR rct.ti,ab OR random*.ti,ab OR "single blind".ti,ab OR "randomised controlled trial".ti,ab OR exp "randomized controlled trial"/ OR placebo*.ti,ab) OR (exp "Comparative Study"/ OR "comparison".ti,ab OR "comparative".ti,ab OR "compar*".ti,ab OR "major clinical study"/ OR "clinical study"/ OR "case control study"/ OR "family study"/ OR "longitudinal study"/ OR "retrospective study"/ OR "prospective study"/ OR "cohort analysis"/ OR cohort*.ti,ab OR (("case control" ADJ1 (study OR studies)).ti,ab) OR (("follow up" ADJ1 (study OR studies)).ti,ab) OR (observational ADJ1 (study OR studies)) OR ((epidemiologic ADJ1 (study OR studies)).ti,ab) OR (("cross sectional" ADJ1 (study OR studies)).ti,ab)) OR ("life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "life cycle inventory".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp))

Web of Science

(TS=("Robot Assisted Surgery" OR "robotic surgical device" OR "Robotic Surgical Procedures" OR "Robotic Surgical Procedure" OR "Robotic Surgical" OR "Robotic Surgical*" OR "Robotic Surgery" OR "Robotic Surg*" OR "Robot Surgical Procedures" OR "Robot Surgical Procedure" OR "Robot Surgical" OR "Robot Surgical*" OR "Robot Surgery" OR "Robot Surg*" OR "Robot Assisted Surg*" OR "Robot Assisted Surgery" OR "Robot Enhanced Procedure" OR "Robot Enhanced Procedures" OR "Robot Enhanced Surg*" OR "Robot Enhanced Surgery" OR "Robotic Assisted Surg*" OR "Robotic Assisted Surgery" OR "Robot Assisted Procedure" OR "Robot Assisted Procedures" OR "Robotic Assisted Procedure" OR "Robotic Assisted Procedures" OR "Da Vinci robot" OR "Da Vinci robots" OR "Da Vinci robotic" OR "Da Vinci robotics" OR "Da Vinci robot*" OR "Surgery robot" OR "Surgery robots" OR "Surgery robotic" OR "Surgery robotics" OR "Surgery robot*" OR "Surgical robot" OR "Surgical robots" OR "Surgical robotic" OR "Surgical robotics" OR "Surgical robot*" OR "Da Vinci" OR (("Surgery" OR "surgery" OR "surgical" OR "surgical*" OR "Surgeon" OR "surgeon" OR "surgeons" OR "surgeon*" OR "neurosurgery" OR "neurosurgical" OR "neurosurgical*" OR "neurosurgeon" OR "neurosurgeons" OR "neurosurgeon*" OR "radiosurgery" OR "radiosurgical" OR "radiosurgical*" OR "radiosurgeon" OR "radiosurgeons" OR "radiosurgeon*") AND ("Robotics" OR "Robotics" OR "Robot" OR "Medical Robot" OR "Robot" OR "Robots" OR "Robotic" OR "Robot*" OR "Telerobotics" OR "Telerobot*"))) AND TS=("Laparoscopy" OR "Laparoscopy" OR "Laparoscop*" OR "Laparotomy" OR "Laparotomy" OR "Laparotom*" OR "Minimally Invasive Surgery" OR

"Minimally Invasive Surgery" OR "Minimally Invasive" OR "Minimal Surgical" OR "Minimal Access" OR "open surgery" OR "open surgery" OR ("Surgery" NOT ("Robot Assisted Surgery" OR "robotic surgical device")) OR "conventional surgery" OR "Endoscopy" OR "Endoscopy" OR "endoscop*") AND (TS=("Carbon Footprint" OR "carbon footprint" OR "carbon footprint*" OR "Climate Change" OR "climate change" OR "CO2 emission" OR "CO2 emissions" OR "CO2 footprint" OR "CO2 footprint*" OR "environmental protection" OR "conservation of natural resources" OR "environmental protection" OR "Disposable Equipment" OR "Disposables" OR "Disposable" OR "ecological footprint" OR "ecological footprint*" OR "ecological sustainability" OR "environmental impact" OR "environmental impact" OR "environmental impact*" OR "environmental impacts" OR "environmental pollut*" OR "pollution" OR "environmental pollution" OR "environmental sustainab*" OR "environmental sustainability" OR "environmental sustainability" OR "Global Warming" OR "Global Warming" OR "Greenhouse Effect" OR "greenhouse effect*" OR "greenhouse effects" OR "greenhouse gas emission" OR "greenhouse gas emissions" OR "Greenhouse Gas" OR "greening" OR "hospital waste" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assess*" OR "life cycle assessment" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories" OR "Waste Disposal" OR "Hospital Waste" OR "medical waste" OR "Rising Sea Level" OR "Rising Sea Levels" OR "Sea Level Rise" OR "Sea Level Rise" OR "Waste Disposal" OR "waste water recycling" OR "Recycling" OR "recycling" OR "recycle*" OR "Equipment reuse" OR "Reusables" OR "reusable" OR "reuse" OR "reused" OR "reusing" OR "Waste Disposal" OR "Waste Management" OR "Plastic overuse" OR "Green surgery" OR "Emission reduction" OR "Emission reduction strategy" OR "air pollution control" OR "air pollution control" OR "acidification" OR "soil acidification" OR "ocean acidification" OR 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"Sustainable Development" OR "Biodiversity" OR "Climatic change" OR "Green deal" OR "preservation of natural resources" OR "Refuse Disposal" OR "Waste Water" OR "Wastewater" OR "Water Purification" OR (("plastic*" OR "microplastic*") AND ("soop" OR "soup" OR "pollution" OR "overuse" OR "contamination")) OR (("Plastic" OR "plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))) OR **TI=("environmental*" OR "sustainab*")**) NOT DT=(meeting abstract) AND PY=(2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022)) AND (TI=**(**(*"Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR/4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR/4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR/4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR/4 ("review*" OR "overview*" OR "synthes*") NEAR/4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*")* **OR** ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") **OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR/1 (study OR studies))) OR (("follow up" NEAR/1 (study OR studies))) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies))) OR (("cross sectional" NEAR/1 (study OR studies)))) OR** ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")**)** OR AB=**(**(*"Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR/4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR/4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR/4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR/4 ("review*" OR "overview*" OR "synthes*") NEAR/4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*")* **OR** ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") **OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR/1 (study OR studies))) OR (("follow up" NEAR/1 (study OR studies))) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies))) OR (("cross sectional" NEAR/1 (study OR studies)))) OR** ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories"))

Cochrane Library

("Robot Assisted Surgery" OR "robotic surgical device" OR "Robotic Surgical Procedures" OR "Robotic Surgical Procedure" OR "Robotic Surgical" OR "Robotic Surgical*" OR "Robotic Surgery" OR "Robotic Surg*" OR "Robot Surgical Procedures" OR "Robot Surgical Procedure" OR "Robot Surgical" OR "Robot Surgical*" OR "Robot Surgery" OR "Robot Surg*" OR "Robot Assisted Surg*" OR "Robot Assisted Surgery" OR "Robot Enhanced Procedure" OR "Robot Enhanced Procedures" OR "Robot Enhanced Surg*" OR "Robot Enhanced Surgery" OR "Robotic Assisted Surg*" OR "Robotic Assisted Surgery" OR "Robot Assisted Procedure" OR "Robot Assisted Procedures" OR "Robotic Assisted Procedure" OR "Robotic Assisted Procedures" OR "Da Vinci robot" OR "Da Vinci robots" OR "Da Vinci robotic" OR "Da Vinci robotics" OR "Da Vinci robot*" OR "Surgery robot" OR "Surgery robots" OR "Surgery robotic" OR "Surgery robotics" OR "Surgery robot*" OR "Surgical robot" OR "Surgical robots" OR "Surgical robotic" OR "Surgical robotics" OR "Surgical robot*" OR "Da Vinci" OR (("Surgery" OR "surgery" OR "surgical" OR "surgical*" OR "Surgeon" OR "surgeon" OR "surgeons" OR "surgeon*" OR "neurosurgery" OR "neurosurgical" OR "neurosurgical*" OR "neurosurgeon" OR "neurosurgeons" OR "neurosurgeon*" OR "radiosurgery" OR "radiosurgical" OR "radiosurgical*" OR "radiosurgeon" OR "radiosurgeons" OR "radiosurgeon*") AND ("Robotics" OR "Robotics" OR "Robot" OR "Medical Robot" OR "Robot" OR "Robots" OR "Robotic" OR "Robot*" OR "Telerobotics" OR "Telerobot*"))):ti,ab,kw AND ("Laparoscopy" OR "Laparoscopy" OR "Laparoscop*" OR "Laparotomy" OR "Laparotomy" OR "Laparotom*" OR "Minimally Invasive Surgery" OR "Minimally Invasive Surgery" OR "Minimally Invasive" OR "Minimal Surgical" OR "Minimal Access" OR "open surgery" OR "open surgery" OR ("Surgery" NOT ("Robot Assisted Surgery" OR "robotic surgical device")) OR "conventional surgery" OR "Endoscopy" OR "Endoscopy" OR "endoscop*"):ti,ab,kw AND (("Carbon Footprint" OR "carbon footprint" OR "carbon footprint*" OR "Climate Change" OR "climate change" OR "CO2 emission" OR "CO2 emissions" OR "CO2 footprint" OR "CO2 footprint*" OR "environmental protection" OR "conservation of natural resources" OR "environmental protection" OR "Disposable Equipment" OR "Disposables" OR "Disposable" OR "ecological footprint" OR "ecological footprint*" OR "ecological sustainability" OR "environmental impact" OR "environmental impact" OR "environmental impact*" OR "environmental impacts" OR "environmental pollut*" OR "pollution" OR "environmental pollution" OR "environmental sustainab*" OR "environmental sustainability" OR "environmental sustainability" OR "Global Warming" OR "Global Warming" OR "Greenhouse Effect" OR "greenhouse effect*" OR "greenhouse effects" OR "greenhouse gas emission" OR "greenhouse gas emissions" OR "Greenhouse Gas" OR "greening" OR "hospital waste" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assess*" OR "life cycle assessment" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories" OR "Waste Disposal" OR "Hospital Waste" OR "medical waste" OR "Rising Sea Level" OR "Rising Sea Levels" OR "Sea Level Rise" OR "Sea Level Rise" OR "Waste Disposal" OR "waste water recycling" OR "Recycling" OR "recycling" OR "recycle*" OR "Equipment reuse" OR "Reusables" OR "reusable" OR "reuse" OR "reused" OR "reusing" OR "Waste Disposal" OR "Waste Management" OR "Plastic overuse" OR "Green surgery" OR "Emission reduction" OR "Emission reduction strategy" OR "air pollution control" OR "air pollution control" OR "acidification" OR "soil acidification" OR "ocean acidification" OR "acidification" OR "Acidification potential" OR "AP in kg SO2 equivalents" OR "eco-efficiency" OR "ecoefficiency" OR "eco-efficien*" OR "ecoefficien*" OR "ecotoxicity" OR "ecotoxicity" OR "ecotoxic*" OR "eco toxicity" OR "eco toxic*" OR "EP in kg PO4 equivalent" OR "Eutrophication" OR "eutrophication" OR "Eutrophication potential" OR "FAETP in kg DCB equivalent" OR "Freshwater Aquatic Ecotoxicity Potential" OR "GWP in kg CO2 equivalents" OR "H+ moles equivalents" OR "HTTP in kg Dichlorobenzene equivalent" OR "Human Toxicity Potential" OR "kg 2.4-D equivalents" OR "kg CFC-11 equivalent" OR "kg N equivalents" OR "kg NOx equivalents" OR "life cycle analysis" OR "ozone depletion" OR "Photochemical Ozone Depletion Potential" OR "POCP in kg ethane equivalent" OR "smog" OR "Waste" OR "waste" OR "wastes" OR "Ozone Depletion" OR "Smog" OR "Equipment reuse" OR "Greenhouse Gases" OR "Greenhouse Gas" OR "SO2 equiv*" OR "CO2 equiva*" OR "CFC-11 equiv*" OR "N equiv*" OR "Biodiversity" OR "Climatic change" OR "Green deal" OR "preservation of natural resources" OR "Refuse Disposal" OR "Waste Water" OR "Wastewater" OR "Water Purification" OR (("plastic*" OR "microplastic*") AND ("soop" OR "soup" OR "pollution" OR "overuse" OR "contamination")) OR "Sustainable Development" OR "Sustainable Development" OR (("Plastic" OR "plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))):ti,ab,kw OR **("environmental" OR "sustainability"):ti**)

Emcare (OVID)

((exp "Robot Assisted Surgery"/ OR exp "robotic surgical device"/ OR "Robotic Surgical Procedures".mp OR "Robotic Surgical Procedure".mp OR "Robotic Surgical".mp OR "Robotic Surgical*".mp OR "Robotic Surgery".mp OR "Robotic Surg*".mp OR "Robot Surgical Procedures".mp OR "Robot Surgical Procedure".mp OR "Robot Surgical".mp OR "Robot Surgical*".mp OR "Robot Surgery".mp OR "Robot Surg*".mp OR "Robot Assisted Surg*".mp OR "Robot Assisted Surgery".mp OR "Robot Enhanced Procedure".mp OR "Robot Enhanced Procedures".mp OR "Robot Enhanced Surg*".mp OR "Robot Enhanced Surgery".mp OR "Robotic Assisted Surg*".mp OR "Robotic Assisted Surgery".mp OR "Robot Assisted Procedure".mp OR "Robot Assisted Procedures".mp OR "Robotic Assisted Procedure".mp OR "Robotic Assisted Procedures".mp OR "Da Vinci robot".mp OR "Da Vinci robots".mp OR "Da Vinci robotic".mp OR "Da Vinci robotics".mp OR "Da Vinci robot*".mp OR "Surgery robot".mp OR "Surgery robots".mp OR "Surgery robotic".mp OR "Surgery robotics".mp OR "Surgery robot*".mp OR "Surgical robot".mp OR "Surgical robots".mp OR "Surgical robotic".mp OR "Surgical robotics".mp OR "Surgical robot*".mp OR "Da Vinci".mp OR ((exp "Surgery"/ OR "surgery".mp OR "surgical".mp OR "surgical*".mp OR exp "Surgeon"/ OR "surgeon".mp OR "surgeons".mp OR "surgeon*".mp OR "neurosurgery".mp OR "neurosurgical".mp OR "neurosurgical*".mp OR "neurosurgeon".mp OR "neurosurgeons".mp OR "neurosurgeon*".mp OR "radiosurgery".mp OR "radiosurgical".mp OR "radiosurgical*".mp OR "radiosurgeon".mp OR "radiosurgeons".mp OR "radiosurgeon*".mp) AND ("Robotics"/ OR "Robotics".mp OR exp "Robot"/ OR exp "Medical Robot"/ OR "Robot".mp OR "Robots".mp OR "Robotic".mp OR "Robot*".mp OR "Telerobotics".mp OR "Telerobot*".mp))) AND (exp "Laparoscopy"/ OR "Laparoscopy".mp OR "Laparoscop*".mp OR "Laparotomy"/ OR "Laparotomy".mp OR "Laparotom*".mp OR "Minimally Invasive Surgery"/ OR "Minimally Invasive Surgery".mp OR "Minimally Invasive".mp OR "Minimal Surgical".mp OR "Minimal Access".mp OR "open surgery"/ OR "open surgery".mp OR (exp "Surgery"/ NOT (exp "Robot Assisted Surgery"/ OR exp "robotic surgical device"/)) OR "conventional surgery".mp OR exp "Endoscopy"/ OR "Endoscopy".mp OR "endoscop*".mp) AND ("Carbon Footprint"/ OR "carbon footprint".mp OR "carbon footprint*".mp OR exp "Climate Change"/ OR "climate change".mp OR "CO2 emission".mp OR "CO2 emissions".mp OR "CO2 footprint".mp OR "CO2 footprint*".mp OR exp "environmental protection"/ OR "conservation of natural resources".mp OR "environmental protection".mp OR "Disposable Equipment"/ OR "Disposables".mp OR "Disposable".mp OR "ecological footprint".mp OR "ecological footprint*".mp OR "ecological sustainability".mp OR exp "environmental impact"/ OR "environmental impact".mp OR "environmental impact*".mp OR "environmental impacts".mp OR "environmental pollut*".mp OR exp "pollution"/ OR "environmental pollution".mp OR "environmental sustainab*".mp OR "environmental sustainability"/ OR "environmental 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"Emission reduction strategy".mp OR "air pollution control"/ OR "air pollution control".mp OR "Environment"/ OR "Environmental*".ti OR "acidification"/ OR "soil acidification"/ OR "ocean acidification"/ OR "acidification".mp OR "Acidification potential".mp OR "AP in kg SO2 equivalents".mp OR "eco-efficiency".mp OR "ecoefficiency".mp OR "eco-efficien*".mp OR "ecoefficien*".mp OR "ecotoxicity"/ OR "ecotoxicity".mp OR "ecotoxic*".mp OR "eco toxicity".mp OR "eco toxic*".mp OR "EP in kg PO4 equivalent".mp OR exp "Eutrophication"/ OR "eutrophication".mp OR "Eutrophication potential".mp OR "FAETP in kg DCB equivalent".mp OR "Freshwater Aquatic Ecotoxicity Potential".mp OR "GWP in kg CO2 equivalents".mp OR "H+ moles equivalents".mp OR "HTTP in kg Dichlorobenzene equivalent".mp OR "Human Toxicity Potential".mp OR "kg 2.4-D equivalents".mp OR "kg CFC-11 equivalent".mp OR "kg N equivalents".mp OR "kg NOx equivalents".mp OR "life cycle analysis".mp OR "ozone depletion".mp OR "Photochemical Ozone Depletion Potential".mp OR "POCP in kg ethane equivalent".mp OR "smog".mp OR exp "Waste"/ OR "waste".mp OR "wastes".mp OR "Ozone Depletion"/ OR "Smog"/ OR "Equipment reuse".mp OR "Greenhouse Gases".mp OR "Greenhouse Gas".mp OR "SO2 equiv*".mp OR "CO2 equiva*".mp OR "CFC-11 equiv*".mp OR "N equiv*".mp OR exp "Biodiversity"/ OR "Biodiversity".mp OR "Climatic change".mp OR "Green deal".mp OR "preservation of natural resources".mp OR "Refuse Disposal".mp OR exp "Wastewater"/ OR "Waste Water".mp OR "Wastewater".mp OR exp "Water Management"/ OR "Water Purification".mp OR (("plastic*".mp OR "microplastic*".mp) AND ("soop".mp OR "soup".mp OR "pollution".mp OR "overuse".mp OR "contamination".mp)) OR "Sustainable Development"/ OR "Sustainable Development".mp OR (("Plastic".mp OR "plastics".mp) AND "overuse".mp) OR ("hydrogen*".mp AND "moles".mp AND "equiv*".mp) OR ("Dichlorobenzen*".mp AND "equiv*".mp) OR ("2,4-D".mp AND "equiv*".mp) OR ("NOx".mp AND "equiv*".mp) OR ("ethane".mp AND "equiv*".mp) OR ("PO4".mp AND "equiv*".mp) OR ("DCB".mp AND "equiv*".mp) OR ("sustainability".mp AND ("environment*".mp OR "carbon".mp)) OR (("Carbon Dioxide"/ OR "Carbon Dioxide".mp OR "CO2".mp) AND ("pollution".mp OR "emission".mp OR "emissions".mp OR "waste".mp OR "environment".mp OR "environmental*".mp OR "footprint".mp OR "footprint*".mp OR "sustainable".mp OR "hazard".mp OR "hazard*".mp))) NOT (conference review or conference abstract).pt AND (2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022).yr) AND ((exp "meta analysis"/ OR exp "meta analysis (topic)"/ OR metaanaly*.ti,ab OR "meta analy*".ti,ab OR metanaly*.ti,ab OR "systematic review"/ OR "cochrane database of systematic reviews".jn OR prisma.ti,ab OR prospero.ti,ab OR (((systemati* OR scoping OR umbrella OR "structured literature") ADJ3 (review* OR overview*)).ti,ab) OR ((systemic* ADJ1 review*).ti,ab) OR (((systemati* OR literature OR database* OR "data base*") ADJ10 search*).ti,ab) OR (((structured OR comprehensive* OR systemic*) ADJ3 search*).ti,ab) OR (((literature ADJ3 review*).ti,ab) AND (search*.ti,ab OR database*.ti,ab OR "data base*".ti,ab)) OR (("data extraction".ti,ab OR "data source*".ti,ab) AND "study selection".ti,ab) OR ("search strategy".ti,ab AND "selection criteria".ti,ab) OR ("data source*".ti,ab AND "data synthesis".ti,ab) OR medline.ab OR pubmed.ab OR embase.ab OR cochrane.ab OR (((critical OR rapid) ADJ2 (review* OR overview* OR synthes*)).ti) OR ((((critical* OR rapid*) ADJ3 (review* OR overview* OR synthes*)).ab) AND (search*.ab OR database*.ab OR "data base*".ab)) OR metasynthes*.ti,ab OR "meta synthes*".ti,ab) OR (exp "clinical trial"/ OR exp "randomization"/ OR exp "single blind procedure"/ OR exp "double blind procedure"/ OR exp "crossover procedure"/ OR exp "placebo"/ OR exp "prospective study"/ OR rct.ti,ab OR random*.ti,ab OR "single blind".ti,ab OR "randomised controlled trial".ti,ab OR exp "randomized controlled trial"/ OR placebo*.ti,ab) OR (exp "Comparative Study"/ OR "comparison".ti,ab OR "comparative".ti,ab OR "compar*".ti,ab OR "major clinical study"/ OR "clinical study"/ OR "case control study"/ OR "family study"/ OR "longitudinal study"/ OR "retrospective study"/ OR "prospective study"/ OR "cohort analysis"/ OR cohort*.ti,ab OR (("case control" ADJ1 (study OR studies)).ti,ab) OR (("follow up" ADJ1 (study OR studies)).ti,ab) OR (observational ADJ1 (study OR studies)) OR ((epidemiologic ADJ1 (study OR studies)).ti,ab) OR (("cross sectional" ADJ1 (study OR studies)).ti,ab)) OR ("life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "life cycle inventory".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp))

Module 2: Reusables versus disposables

Samenvatting

Uitgangsvraag
2.1 Wat is het effect van het gebruik van reusables in vergelijking met disposables op duurzaamheidsaspecten?
2.2 Wat is het effect van het gebruik van reusable medische hulpmiddelen in vergelijking met disposable medische hulpmiddelen op duurzaamheidsaspecten?

GRADE
Zeer laag tot Laag

Overwegingen: focus op Refuse (R1), Reduce (R2), Redesign (R3), Reuse (R4)

Aanbevelingen

Gebruik bij voorkeur reusables, omdat disposables een grotere (negatieve) impact hebben op het milieu (R4-Reuse).

- Beoordeel kritisch of het gebruik van een product daadwerkelijk nodig is (R1-Refuse). Indien disposables toch noodzakelijk zijn bij de operatie, probeer dan het gebruik te minimaliseren (R2-Reduce) en een duurzamere variant te gebruiken (R1-Refuse, R2-Reduce).
- Om de milieu-impact van reusables te verlagen: optimaliseer het reiniging en sterilisatie proces (bijv. gebruik van duurzame energie, energiezuinige apparatuur en meerdere instrumenten per ronde) en het transport (bijv. duurzame manier van transport en verkorten van de transport afstand).
- Geef de voorkeur aan reusables met de langste levensduur, omdat dit de laagste (negatieve) impact heeft op het milieu.

Zet in op Redesign (R3) van o.a. producten, instrumenten en apparatuur. De industrie zal duurzaamheid moeten includeren in het (her)ontwerp.

- Herontwerp van disposable naar (semi) reusable door industrie.
- Neem afvalverwerking mee in het herontwerp. Denk hierbij aan gebruik van minder soorten materialen, duidelijke aanduiding hoe te scheiden voor de gebruiker, stimuleren van circulariteit.
- Na reusables hebben hybride instrumenten een voorkeur boven disposable instrumenten.

Uitgangsvraag module 2 'reusables versus disposables'

2.1 Wat is het effect van het gebruik van reusables in vergelijking met disposables op duurzaamheidsaspecten?

2.2 Wat is het effect van het gebruik van reusable medische hulpmiddelen in vergelijking met disposable medische hulpmiddelen op duurzaamheidsaspecten?

Inleiding

De afgelopen decennia is er sprake van een toename in het aantal disposables in de klinische praktijk. Deze toename is te wijten aan de verschuiving van reusables naar disposables vanwege zorgen over steriliteit, gebruiksgemak, complexe apparatuur die niet goed schoon te maken is en het mogelijk falen van reusables (Siu, 2016). Omdat disposables maar eenmalig kunnen worden gebruikt, leidt dit tot hoge productiecijfers en relatief veel afval, wat een extra belasting op het milieu geeft. Het is echter onduidelijk welke impact het gebruik van reusables op het milieu heeft, in vergelijking met disposables. In deze module worden gekozen duurzaamheidsuitkomsten van disposables en reusables toegelicht en met elkaar vergeleken. Hierbij is onderscheidt gemaakt tussen algemene disposables/reusables en specifiek disposable/reusable medische instrumenten door twee deelvragen op te stellen.

Search and select

A systematic review of the literature was performed to answer the following questions:

PICO1: *What is the difference in sustainability of reusables compared to disposables in the operating room for patients who undergo surgery?*

P = patients who underwent a surgical procedure

I = reusables, such as: surgical gowns, scrub caps, gloves, glasses, perioperative textiles (i.e. blue drapes, band aids), packing materials, or laryngeal masks

C = disposables, such as: surgical gowns, scrub caps, gloves, glasses, perioperative textiles (blue drapes, band aids), packing materials or laryngeal masks

O = climate change (CO_2 footprint/Global Warming Potential (GWP)), waste, acidification, eutrophication, human toxicity, ecotoxicity, ozone depletion

PICO2: *What is the difference in sustainability of reusable medical devices compared to disposable medical devices in the operating room for patients who undergo surgery?*

P = patients who underwent a surgical procedure

I = reusable medical devices, such as: specula, instruments, scopes (e.g reusable instruments in a surgical tool kit: scissor, Kocher, tweezer, scalpel, needle driver, ligasure, harmonic, stapler, surgical drill; reusable scopes: duodenoscope, ureterorenoscope, bronchoscope, cystoscope, laryngeal scope; reusable meniscal sutures; reusable suture anchors).

C = disposable medical devices, such as: specula, instruments, scopes (e.g disposable instruments in a surgical tool kit: scissor, Kocher, tweezer, scalpel, needle driver, vessel sealer, stapler, surgical drill; disposable scopes: duodenoscope, ureterorenoscope, bronchoscope, cystoscope, laryngeal scope; disposable meniscal sutures; disposable suture anchors).

O = climate change (CO_2 footprint/Global Warming Potential (GWP)), waste, acidification, eutrophication, human toxicity, ecotoxicity, ozone depletion

<u>Relevant outcome measures</u>

Life cycle assessment (LCA) is a methodological tool used to quantitatively analyse the life cycle of products/activities within the context of environmental impact. The assessment comprises all stages needed to produce and use a product, from the initial development to the treatment of waste (the total life cycle). An LCA is mainly based on four phases: 1) goal and scope definition, 2) inventory analysis, 3) impact assessment, and 4) interpretation. The third phase is the life cycle impact assessment (LCIA), in which emissions and resource extractions are translated into a limited number of environmental impact scores by means of so-called characterisation factors. The ReCiPe model is a method for the impact assessment in an LCA (Huijbregts, 2016, Huijbregts, 2017). To determine the outcome measures regarding environmental impact, the ReCiPe model of the National Institute for Public Health and the Environment (in Dutch: Rijksinstituut voor Volksgezondheid en Milieu, RIVM) was used.

The outcomes determined by the working group are based on the ReCiPe framework. The working group considered climate change (CO_2 footprint/Global Warming Potential) and waste as a *critical* outcome measure for decision making; and acidification, eutrophication, human toxicity, ecotoxicity and ozone depletion as an *important* outcome measure for decision making.

A priori, the working group did not define the outcome measures listed above but used the definitions used in the studies.

Outcomes focused on environmental life cycle assessment (LCA) impact categories are relatively new in healthcare. Given the variety in scopes and methods of performing and reporting LCAs, the working group did not a priori define the minimal important difference. Differences between the techniques were evaluated by the working group after data extraction.

A glossary including the outcome measures is found in Module 1 'operatietechnieken'.

Search and select (Methods)

The databases Pubmed (via NCBI), Embase (via OVID), Web of Science (via Webofscience), Cochrane (via Cochrane library) and Emcare (via OVID) were searched with relevant search terms from 2000 until 7 December 2021. The detailed search strategy is depicted under the tab Methods. The systematic literature search resulted in 694 hits in total. Studies for this module were selected based on the following criteria:

- Systematic reviews (searched in at least two databases, with a detailed search strategy, risk of bias assessment and results of individual studies available), randomized controlled trials, (observational) comparative studies, life cycle assessments, CO_2 footprint studies and environmental impact studies;
- Full-text English language publication; and
- Studies according to the PICO. Studies that compared disposables with reusables related to the OR and included at least one of the following outcomes: climate change, waste, acidification, eutrophication, human toxicity, ecotoxicity, ozone depletion.

After reading the full text, 19 studies were included in the literature summary of this module.

Results

Nineteen studies were included in the analysis of the literature (sub question 1.1: 8, sub question 1.2: 11). Important study characteristics and results are summarized in the evidence tables (Appendix 1). The quality assessment of the studies is summarized in Appendix 2.

Summary of literature – Sub-question 2.1 reusables versus disposables

<u>Description of studies</u>

Drew (2021) describes a systematic review of life cycle assessments (LCAs) in anaesthetic and surgical care. It aims to summarize the state of LCA practice via review of literature assessing the environmental impact of related services, procedures, equipment and pharmaceuticals. The review was guided by using STARR-LCA, which is a PRISMA-based framework. Studies were included if they assessed the environmental impact(s) of (1) an operating room(s) using LCA, (2) a specific surgical procedure(s) using LCA or (3) equipment or pharmaceuticals used in surgical settings. In total 44 studies were included. Of these studies, one study examined the impact contributions from ORs generally, 10 studies from specific surgical procedures and 33 assessed the environmental impact from provision and use of surgical or anaesthetic equipment or pharmaceuticals. Eligible studies varied in terms of quality, completeness and risk of bias, with critical appraisal scores varying between 44% and 89%. Relevant outcome measures included climate change, waste, acidification, eutrophication, human toxicity, ecotoxicity and ozone depletion.

Grimmond (2012) compared the environmental impact of a reusable sharps container system with a single-use one. A life cycle assessment (LCA) framework was used to assess the climate impact of the two different sharps container systems. The single use sharps containers (SSC) were evaluated for over a 12-month period prior to Northwestern Memorial Hospital's transition to a reusable-based system. The reusable sharps containers (RSC) (certified for 500 applications) were assessed over the following 12-month period, excluding the transition month from the analysis to avoid data overlap. Data was collected regarding the size, type, and number of reusable sharps containers used, as well as protocols with information about the changeout when the containers were full. Data was extracted from a variety of industry and government sources and combined with a Life Cycle Inventory (LCI)/LCA tool developed by the Waterman Group UK, which included all the energy dependent processes required for any needle collection system. The outcome measures were climate change and waste. A limitation was that this study is conducted in the USA with all processes related to 1 hospital, which might limit the generalizability.

Grimmond (2021) compared the global warming potential (GWP) of hospitals converting from single-use sharps containers (SSC) to reusable sharps containers (RSC) by using an attributional LCA model. The intervention was the conversion from SSC to RSC in 40 NHS hospitals in the United Kingdom. A 12-month period of usage of SSC was compared with a 12-month usage of RSC. The functional unit was total fill line litres (FLL) of sharps containers needed to dispose of sharps for a 1-year period. SSC and RSC usage details in 17 baseline hospitals immediately prior to 2018 were applied to the RSC usage details of the 40 trusts using RSC in 2019. The outcome measures were climate change and waste. A limitation could be that the results of SSC has been extrapolated from 17 hospitals to 40 and therefore the representativeness of data might not be accurate.

Hicks (2016) conducted an LCA to compare the environmental impact of reusable patient hospital gowns coated with nanoscale silver (nAg) product compared to the use of nAg-coated disposable gowns in a case study. First, the environmental impact of 4600 ug nAg was determined (the amount added to a hospital gown). Second, the life cycle impacts of nAg-enabled reusable hospital gowns per one wear are modelled and midpoint environmental data are compared. The outcome measures were climate change acidification, eutrophication, human toxicity, ecotoxicity and ozone depletion. Limitations were that only one attachment and synthesis process was analyzed, the environmental impact of excess silver during synthesis and the silver lost was not explored, and that the comparisons of reusable and disposable gowns relied on prior work and utilizes only one impact category.

McGain (2010) modelled the financial and environmental costs of two commonly used anaesthetic drug trays using LCA. This study was performed at a single-centre in Australia. Three trays were compared: 1) reusable tray, 2) single-use tray, and 3) single-use tray with cotton and paper. Data was collected directly from measurements and from databases (EcoInvent). The single-use trays were plastic Chinese-made trays (group 2, 3), and the reusable trays (group 1) were Australian-made nylon trays. The outcome measure was climate change. Since not all data was available, a European energy mix was used, although the Chinese energy mix might be more coal reliant and thus have a higher environmental impact.

McPherson (2019) examined the life cycle carbon footprint of disposable sharps containers (DSC) and reusable sharps containers (RSC) over a 12-month period of facility-wide usage at a hospital geographically distant from manufacturing and processing plants, and include all unit processes in manufacture, transport, washing and treatment and disposal stages. A cradle to-grave life cycle inventory (LCI) and a product-system assessment tool were utilized. This study was perfect in a multi-centre setting in the US. The outcome measures were climate change and waste. A few limitations were considered. First, the assumption was made regarding the location of the polymer manufacturer for DSC, since there was no actual data available. Second, a UK database was used to measure the impact of transport.

Vozzola (2018) conducted an LCA to assess the environmental impacts of two different cleanroom coveralls: reusable and disposable. This study is an analysis from cradle to crave, quantifying parameters such as energy use and GHG emissions, including different phases: raw material extraction, production, packaging, transport, reuse and disposal in the USA. The outcome measures were climate change and waste. Although Vozzola did compare the packaging material between the reusable and disposable cleanroom coveralls, it was not exactly quantified. The packaging materials vary between the supply companies, and in this study representative materials are used for the different companies, which are therefore not precisely defined per company. This means the data used may deviate from the actual data.

Vozzola (2020) analysed the life cycle of reusable versus disposable gowns to assess the environmental impact of these surgical gowns in the USA. An LCA was conducted according to the standards from the International Organization for Standardization. The Environmental Clarity, Inc. LCA database was used to evaluate the life cycles of both surgical gown systems. The outcome measures were climate change and waste.

Summary of literature – Sub-question 2.2 reusable medical devices versus disposable medical devices

Description of studies

Davis (2018) compared the environmental impact of single-use flexible ureteroscopes with reusable flexible ureteroscopes. An LCA of the LithoVue single-use digital flexible ureteroscope and Olympus Flexible Video Ureteroscope (URV-F) was performed. Data on raw material extraction, manufacturing, reuse and disposal of the instruments was obtained. The solid waste generated (kg) and energy consumed (kWh) during each case were quantified and used to calculate the CO_2 footprint. The outcome measures were climate change and waste. It should be mentioned that data are compared per case, while reusable ureteroscopes can be used multiple times. This might underestimate the actual environmental impact.

Donahue (2020) applied life cycle assessment methods to evaluate the carbon footprints of 3 vaginal specula: a single-use acrylic model and two reusable stainless steel models (grade 304 speculum and grade 316 speculum). Data were obtained regarding packaging composition and weight. As there were no data available on production processes, assumptions were made. For the acrylic specula injection molding was assumed and for the reusable specula a combination of hot extrusion, milling/turning, deformation and heat treatment was assumed, based on literature. The transportation was based on manufacturer and general industry data. Reuse for the steel reusable specula was estimated based on autoclave manufacturer specifications. Disposal was modelled with the use of the EPA WARM model, which estimates the average greenhouse gas (GHG) emissions that are associated with disposal of various materials in the USA. Outcome measure was climate change.

Eckelman (2012) assessed the environmental impacts of two types of laryngeal mask airways (LMAs): single-use and reusable (40 lifetime uses) by an LCA. The functional unit was 40 cycles, which meant 40 disposable LMA uses or 40 uses of 1 reusable LMA in the Yale New Haven Hospital, USA. Raw material extraction, production, packaging, transport, reuse and disposal were included in the analysis. The material composition and weights were established on the basis of manufacturer information and density testing. Materials were matched with the most appropriate Life Cycle Inventory (LCI) records from EcoInvent (database). Production processes for hard and soft plastics were assumed to be injection molding and thermoforming, respectively. Data was obtained from distributors to estimate distances and mode of transport. Reprocessing of reusable LMAs was estimated using data from Yale New Haven Hospital and autoclave specifications. Disposal was modelled using US average statistics for solid waste. Outcome measures were climate change, acidification, eutrophication, human toxicity, ecotoxicity and ozone depletion.

Ibbotson (2013) The environmental and financial impacts of three surgical scissors which are (1) disposable scissors made of plastic (fibre reinforced), (2) disposable scissors made of stainless steel, and (3) reusable scissors made of stainless steel were assessed using an LCA and life cycle costing method. Data was compared for the use of 4,500 cycles in Germany. The data on raw material, manufacturing (including electricity consumption), transport, and disposal process were obtained from a medical company in Europe. Missing data (e.g. sterilization processes for reusable scissors) were obtained from the literature or expert opinion. Electricity data that was missing was adjusted from the International Energy Agency (IEA). Incineration of plastics, cardboard and municipal solid waste were assumed based on Swiss plants in 2000 (from EcoInvent). The outcome measures were climate change, acidification, eutrophication, human toxicity, ecotoxicity and ozone depletion. Due to missing data another energy mix and recycling data was used. Data sources were not comparable between the scissors, since the plastic disposable and stainless steel reusable data was obtained from company data and the stainless steel disposable scissor data was obtained from literature.

Leiden (2020) compared a reusable and a disposable instrument set for one single surgery lumbar fusion in Germany. Data on manufacturing was based on weight, material and form of instruments, data of transportation on mode and calculated distances between producer, distributor, and hospital and washing and steam sterilization data was specific to a German hospital. Disposal was modelled using EcoInvent waste incineration processes. Outcome measures were climate change and acidification. An important limitation could be that only one surgery is compared, which seems invalid for the reusable set. In the sensitivity analysis the impact of the reusable set for 300 use cycles is quantified, however this is compared to one use cycle of the disposable set, and therefore not accurate. Furthermore, the comparison was made between a reusable set comprising six boxes with eleven trays (weight 45.5 kg) with a very lean disposable set (2 kg). For comparison purposes it is also important to note that sterilisation was performed outside the hospital, which increases the environmental impact because of transportation.

McGain (2012) assessed the environmental and financial impacts of a single-use and a reusable venous catheter insertion kit at the Western Health group of hospitals in Australia. They also investigated the effect of the source of electricity on CO_2 emissions. The functional unit was the use of one central venous catheter kit to aid insertion of a single-use, central venous catheter in an operating room. Data on the components was obtained by weighing and manufacturer data. Direct data regarding materials and energy were collected using a "time-in-motion" study. Other inputs were acquired from LCI databases or industry data. Electricity and hot and cold water used by the washer and sterilizer were measured. Data on waste disposal processes were obtained indirectly from industry data. The outcome measure was climate change. A limitation of the study was that the reusable insertion kit is compared to the disposable for one use of inserting the single-use central venous catheter. Calculating the difference between the outcomes when reusing this kit is not taken into account and could yet obtain more accurate results.

McGain (2017) assessed the environmental and financial impact of reusable and single-use anaesthetic equipment through a consequential LCA approach. Five scenarios were assessed and included: (1) "all reusable anaesthetic equipment", (2) "all disposable anaesthetic equipment except for reusable handles for direct laryngoscopes", (3) "all disposable/single-use anaesthetic equipment (including single-use direct laryngoscope handles; modelled practice)", (4) "replace only reusable face masks with single-use face masks", (5) "replace only direct laryngoscope reusable blades with single-use blades". Data on equipment were obtained from two hospitals in Melbourne, Australia in 2015 and each piece of equipment was weighed with an electronic balance. Sterilization records and input from one hospital were used to define sterilization mode and load information. Washer and steam sterilizer utility usage data were taken from a previous study by the same authors, while electricity consumption of a standard H_2O_2 sterilizer was directly measured over several days. All other data were sourced from inventory databases based on average industry inputs. Outcome measures were climate change, eutrophication, waste, human toxicity and ecotoxicity.

Namburar (2022) performed an audit of waste generated during endoscopic procedures at a low and high endoscopy volume academic medical centre in the USA over a 5-day work period in 2020. Colonoscopies, upper endoscopies, and endoscopic retrograde cholangiopancreatography were included. The waste from the pre-procedure area, examination room and post-procedure area was collected. In the high volume hospital the waste from endoscope reprocessing was also obtained. An estimation of the contribution of single-use (compared to reusable) waste was made in the following three scenarios: (1) all reusable endoscopes, (2) colonoscopies and ERCPs were performed with single-use endoscopes (colonoscopes/duodenoscopes) and (3) all single-use endoscopes. Outcome measure was waste. The study aims to estimate the environmental impact of an endoscopic procedure, however, only describes the amount of waste and does not calculate the actual environmental impact.

Rizan (2021) assessed environmental and financial impacts of hybrid and single-use instruments in laparoscopic cholecystectomy using an LCA. The number of three types of instruments (clip appliers, laparoscopic scissors, ports) were included in the analysis (two small diameter ports, two large diameter ports, one laparoscopic scissor and one laparoscopic clip applier). The stages of raw material extraction, manufacture, transport, disposal and decontamination for reusable components of hybrid instruments were included. Data was obtained from manufacturers and databases. Outcomes were climate change, acidification, eutrophication, human toxicity, ecotoxicity and ozone depletion.

Sanchez (2020) assessed the environmental and economic impacts of reusable and disposable blood pressure cuffs by using LCA. Data on materials and manufacturing was gathered through manufacturer information and physical testing (by weighing component on a scale), components were identified and matched with information from inventory databases (US-EI LCI database), and the US EPA database was used for transport packaging information. Multiple cleaning scenarios were developed to represent a diversity of clinical settings in using and cleaning. For disposal data landfill and incineration were included. The lifespan of the reusable cuff is taken to be three years, as described in the manufacturer's specifications. Outcome measures were climate change, acidification, eutrophication, human toxicity, ecotoxicity and ozone depletion. There is data uncertainty associated with some of the modelling parameters (e.g. energy, blood pressure cuff materials).

Sherman (2018) assessed the environmental and financial impacts of three different types of rigid laryngoscope handle and tongue blade: plastic single-use, metal single-use, and stainless steel reusable by using LCA and life cycle costing. To determine the material composition of handles and blades a combination of manufacturer specifications, deconstruction, and density testing were used, and after each material was weighed. Foreground data were collected, including transportation mode and distance; washer and autoclave-related energy, water, and chemical use. Reusable components were assumed to have a lifespan of 4000 uses and require refurbishment every 40 uses, according to rated lifetimes of each component. For disposal data recycling, incineration and landfill were included. Outcome measures were climate change, acidification, eutrophication, human toxicity, ecotoxicity and ozone depletion.

Results

In this module the results and environmental hotspots are presented in a separate table per outcome measure to provide an overview. A more detailed summary of the methods, results, and interpretation is depicted in the evidence table. The results could not be pooled due to different functional units, assumptions, methods, and comparison. Therefore, results from sub question 2.1 (n=8: Grimmond, 2012; Grimmond, 2021; Hicks, 2016; McGain, 2010; McPherson, 2019; Vozzola, 2018; Vozzola, 2020) and sub question 2.2 (n= 11: Davis, 2018; Donahue, 2020; Eckelman, 2012; Ibbotson, 2013; Leiden, 2020; McGain, 2012; McGain, 2017; Rizan, 2021; Sanchez, 2020; Scherman, 2018) are presented in one overview.

1. Climate Change

Seventeen out of 18 studies reported on the outcome climate change (Grimmond, 2012; Grimmond, 2021; McPherson, 2019; Hicks, 2016; McGain, 2010; Vozzola, 2018; Vozzola, 2020; Davis, 2019; Donahue, 2020; Eckelman, 2012; Ibbotson, 2013; Leiden, 2020; McGain, 2012; McGain, 2017; Rizan, 2021; Sanchez, 2020; Sherman, 2018). The 17 studies contained 15 comparisons. A summary of the results is presented in Table 1. Most studies resulted in a difference in favour of reusables.

Table 1. Outcome climate change: summary of results

Study	Comparison	Functional unit	Outcomes climate change	Hotspots	Difference
Comparison 1.1 Disposable versus reusable sharps containers					
Grimmond (2012)	Disposable sharps containers	Provision for 100 occupied hospital beds (OB) over one year	GWP: 24.2 $MTCO_2$ eq 100-OB year	Manufacturing process	83.5% in favour of reusables.
	Reusable sharps containers		GWP: 4.0 $MTCO_2$ eq 100-OB year	Washing process	
Grimmond (2021)	Disposable sharps containers	Total fill line litres (FLL) of sharps containers needed to dispose of sharps for 1-year period in 40 hospitals.	GWP: 3896.4 $MTCO_2$ eq for SSC	Manufacturing process	83.9% in favour of reusables.
	Reusable sharps containers		GWP: 628.9 $MTCO_2$ eq for SSC	Transport	
McPherson (2019)	Disposable sharps containers	Provision of sharps containers at one healthcare facility for one year	GWP: 248.62 $MTCO_2$ eq	Manufacturing process	65.3% in favour of reusables.
	Reusable sharps containers		GWP: 86.19 $MTCO_2$ eq	Transport	
Comparison 1.2 Disposable versus reusable patient hospital gowns					
Hicks (2016)	Disposable patient gownscoated with nAg (nanosilver)	-4600 ug of nAg (amount added to hospital gown) -Per one wear and laundering (over a lifetime of 75 wearings)	Synthesis nanosilver (nAg): GWP: 1.17 x 10^{-3} kg CO_2 eq. nAg attachment: GWP: 7.90 x 10^{-2} kg CO_2 eq per gown. Reapplication nAg for every gown (75 times)	The impact is greater to attach the nAg to the textile than it is to synthesize it.	94.1% in favour of reusables.
	Reusable patient gowns coated with nAg (nanosilver)		Reapplication nAg at each set of 17 launderings (± 4.4 times)		
Comparison 1.3 Disposable versus reusable anaesthetic drug trays					
McGain (2010)	Disposable drug trays	Use of one plastic anesthetic drug tray (+/- use of 2 cotton gauzes and 1 paper towel)	126 g CO_2 + cotton/paper: 203 g CO_2	Tray production	16 g CO_2, in favour of reusables.
	Reusable drug trays		110 g of CO_2 + cotton/paper: 187 g CO_2	Tray washing	
Comparison 1.4 Disposable versus reusable cleanroom coveralls					
Vozzola (2018)	Disposable coveralls (made from HDPE and PP)	1,000 garment uses	CO_2 footprint HDPE: 712 kg CO_2 eq and PP: 1220 kg CO_2 eq	Manufacturing process	27.4% (HDPE) resp. 57.6% (PP) in favour of reusables.
	Reusable cleanroom coveralls		CO_2 footprint: 517 kg CO_2 eq	Laundry process	
Comparison 1.5 Disposable versus reusable surgical gowns					

Vozzola (2020)	Disposable surgical gown	1,000 uses of an extra large, single-piece, long- sleeved surgical gown in an operating room setting	GWP: 1636 kg CO_2eq	Manufacturing process	66% in favour of reusables.
	Reusable surgical gown		GWP: 557 kg CO_2eq	Laundry process	
Comparison 1.6 Disposable flexible ureteroscopes versus reusable flexible ureteroscopes					
Davis (2019)	Single-use flexible ureteroscope	Use of one ureteroscope during one endourologic case	CO_2 footprint per case is 4.43 kg CO_2 eq	Manufacturing process	Comparable, however comparison per case and not the whole life cycle of reusable ureteroscope.
	Reusable flexible ureteroscope (typically 16 uses before repair and 180 uses before decommissioning)		CO_2 footprint per case is 4.47 kg CO_2 eq	Washing/sterilization	
Comparison 1.7 Disposable versus reusable specula					
Donahue (2020)	Single-use acrylic speculum and the	Completion of 20 gynaecologic examinations using a speculum	17.54 kg CO_2 eq	Material production and manufacturing	67.4% (grade 304) 62.9% (grade 316) in favour of reusables.
	Reusable stainless steel grade 304 speculum		5.72 kg CO_2 eq	Use/reprocessing	
	Reusable stainless steel grade 316 speculum		6.51 kg CO_2 eq	Use/reprocessing	
Comparison 1.8 Disposable versus reusable laryngeal airway masks (LMAs)					
Eckelman (2012)	Single-use laryngeal mask airways (LMAs)	Maintenance of 40 airways	11.3 kg CO_2eq	Production material	34.5% in favour of reusables.
	Reusable laryngeal mask airways (LMAs)		7.4 kg CO_2eq	Production of steam for the autoclave	
Comparison 1.9 Disposable versus reusable surgical scissors					
Ibbotson (2013)	Disposable scissors made of plastic (fibre reinforced)	4,500 use cycles of surgical scissors during 18 years	5500 kg CO_2-eq*	Manufacturing process	Difference of 9450 kg CO_2-eq and 4950 kg CO_2-eq in favour of reusables.
	Disposable scissors made of stainless steel		10,000 kg CO_2-eq*	Manufacturing process	
	Reusable scissors made of stainless steel		550 kg CO_2-eq*	Usage: Washing, disinfection, sterilization and repair/service	
Comparison 1.10 Disposable versus reusable surgical instrument set					
Leiden (2020)	Disposable instrument set for single-level lumbar fusion surgeries	The surgical instrument set required for one single-level lumbar fusion surgery involving the implantation of four screws and two rods	GWP: 10-20%	Production process	80-90% in favour of disposable. However, 1 surgery as functional unit (FU).
	Reusable instrument set for single-level lumbar fusion surgeries		GWP: 100%	Sterilization process	
Comparison 1.11 Disposable versus reusable central venous catheter insertion kit					
McGain (2012)	Single-use central venous catheter insertion kits	Use of one central venous catheter kit to aid insertion of a single-use, central venous catheter in an operating room.	407 grams of CO_2	Plastic use	804 grams of CO_2 in favour of single-use. However, 1 use as functional unit (FU).
	Reusable central venous catheter insertion kits		1211 grams of CO_2	Washing and sterilization process	
Comparison 1.12 Anaesthetic equipment (including anesthetic circuits, face masks, LMAs, direct and videolaryngoscope blades and handles)					
McGain (2017)	Single-use anesthetic equipment	Use of breathing circuits, face masks, LMAs, and direct and videolaryngoscopes at one hospital over one year	(1) completely reusable - 5575 kg CO_2 eq	Washer electricity	Converting from single-use to reusable leads to an increase of almost 10% (Australia). Converting from single-use to reusable in US or UK/Europe leads to a decrease of the impact (US
	Reusable anesthetic equipment		(2) mainly single-use except for reusable laryngoscope handles - 5095 kg CO_2 eq	Purchasing single use face masks and single-use direct laryngoscope blades	
			(3) completely single-use - 5775 kg CO_2 eq	Purchasing single-use items	
			(4) reusables (except the single-use face masks) - 6556 kg CO_2 eq	Washing process and purchasing single use face masks	

			(5) reusables (except single-use laryngoscope blades) - 6763 kg CO_2 eq	Washing process and purchasing single-use laryngoscope blades	50% and UK/Europe 85%).
Comparison 1.13 Hybrid and single-use instrument in laparoscopic cholecystectomy					
Rizan (2021)	Hybrid instruments in laparoscopic cholecystectomy	The number of three types of instruments (clip appliers, laparoscopic scissors and ports) typically required to perform one laparoscopic cholecystectomy	1756 g CO_2 eq	Single-use components and decontamination of reusables.	76% in favour of hybrid instruments.
	Single-use instruments in laparoscopic cholecystectomy		7194 g CO_2 eq	Manufacturing and raw material extraction process, transportation and waste.	
Comparison 1.14 Disposable versus reusable blood pressure cuffs					
Sanchez (2020)	Disposable blood pressure (BP) cuffs	Providing blood pressure readings for a clinic room or ward, under four different health care delivery scenarios.	Using 4 different scenarios: (1) Day office, (2) 1 Day Ambulatory Procedure, (3) 1 Day Regular Ward and (4) 1 Day ICU. Reusable cuffs have a lesser impact. See results in table study (Sanchez, 2020) *(see evidence table for more detailed information)*	Material and manufacturing process	Reusable cuffs have a lesser impact.
	Reusable BP cuffs			Production of chemical wipes for cleaning	
Comparison 1.15 Disposable versus reusable laryngoscope handles and blades					
Sherman (2018)	Single-use laryngoscope handles and blades	One handle or one blade for a single patient encounter.	Different cleaning scenarios (low-level disinfection levels (LDL), high-level disinfection levels (HDL) and sterilization) are included in the analysis. The most favourable scenario for the handles and blades is the reusable stainless steel, treated to HDL standards.	Material manufacturing and device assembly.	The single-use handle has a 25 times bigger CO_2 footprint compared to the reusable version.
	Reusable laryngoscope handles and blades			Reprocessing and source of cleaning.	

*Read from figure (Ibbotson, 2013)

2. Waste

Seven out of 18 studies reported on the outcome waste (Grimmond, 2012; Grimmond, 2021; McPherson, 2019; Vozzola, 2020; Davis, 2018; McGain, 2017; Namburar, 2022). The seven studies contained 5 comparisons. A summary of the results is presented in Table 2. All studies resulted in a difference in favour of reusables.

Table 2. Outcome measure waste: summary of results

Study	Comparison	Functional unit	Outcomes waste	Difference
Comparison 2.1 Disposable versus reusable sharps containers				
Grimmond (2012)	Disposable sharps containers	Provision for 100 occupied hospital beds (OB) over one year	30,920 kg plastic waste and 5020 kg of cardboard boxes	30,979 kg resp. 4904 kg more waste for disposable
	Reusable sharps containers		123 kg of plastic waste and 116 kg of waste from carboard boxes	
Grimmond (2021)	Disposable sharps containers	Total fill line litres (FLL) of sharps containers needed to dispose of sharps for 1-year period in 40 hospitals.	928.7 kg incinerated plastic and 136.6 kg of cardboard boxes	1065.3 kg waste more for disposable
	Reusable sharps containers		No waste since reused or recycled.	
McPherson (2019)	Disposable sharps containers	Provision of sharps containers at one healthcare facility for one year	31.8 tonnes of landfilled plastic, 18.8 tonnes of incinerated plastic and 8.2 tonnes of cardboard boxes	50.2 tonnes of plastic and 8.1 tonnes of carboard boxes more for disposable
	Reusable sharps containers		0.4 tonnes of plastic waste and 0.1 kg of waste from carboard boxes	

Comparison 2.2 Disposable versus reusable surgical gowns				
Vozzola (2020)	Disposable surgical gown	1,000 uses of an extra large, single-piece, long-sleeved surgical gown in an operating room setting	Solid waste 265 kg (gown manufacturing 224 kg, packaging and manufacturing and supply chain 40.3 kg, end of life 0.505 kg)	184.5 kg more for disposable
	Reusable surgical gown		Solid waste 35.5-43.4 kg (gown manufacturing 0-7.9 kg, packaging and manufacturing and supply chain 35.5 kg, end of life 0.008 kg)	
Comparison 2.3 Disposable flexible ureteroscopes versus reusable flexible ureteroscopes				
Davis (2018)	Single-use flexible ureteroscope	Use of one ureteroscope during one endourologic case	Solid waste 0.3 kg CO_2 per case	0.295 kg CO_2 more for disposable
	Reusable flexible ureteroscope (typically 16 uses before repair and 180 uses before decommissioning)		Solid waste 0.005 kg CO_2 per case	
Comparison 2.4 Five scenarios of anaesthetic equipment (including anesthetic circuits, face masks, LMAs, direct and videolaryngoscope blades and handles)				
McGain (2017)*	Single-use anesthetic equipment	Use of breathing circuits, face masks, LMAs, and direct and video laryngoscopes at one hospital over one year	1. 250 kg	More waste in case of the use of disposables (range 250-1542).
	Reusable anesthetic equipment		2. 1222 kg	
			3. 1542 kg	
			4. 375 kg	
			5. 917 kg	
Comparison 2.5 Disposable versus reusable endoscopes				
Namburar (2022)	All reusable endoscopes	N/A	43,500 metric tons	17400 metric tons more for single-use compared to reusable
	Colonoscopies and ERCPs were performed with single-use endoscopes (colonoscopes/duodenoscopes		54,375 metric tons	
	All single-use endoscopes.		60,900 metric tons	

*Five scenarios: (1) "all reusable anaesthetic equipment", (2) "all disposable anaesthetic equipment except for reusable handles for direct laryngoscopes", (3) " all disposable/single-use anaesthetic equipment (including single-use direct laryngoscope handles; modelled practice)", (4) "replace only reusable face masks with single-use face masks", (5) "replace only direct laryngoscope reusable blades with single-use blades".

3. Acidification

Seven out of 18 studies reported on the outcome acidification (Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; Leiden, 2020; Rizan, 2021; Sanchez, 2020; Sherman, 2018). The seven studies contained seven comparisons. A summary of the results is presented in Table 3. Most studies resulted in a difference in favour of reusables.

Table 3. Outcome measure acidification: summary of results

Study	Comparison	Functional unit	Outcomes acidification	Hotspots	Difference
Comparison 3.1 Disposable versus reusable patient hospital gowns					
Hicks (2016)	Disposable patient gownscoated with nAg (nanosilver)	-4600 ug of nAg (amount added to hospital gown) -Per one wear and laundering (over a lifetime of 75 wearings)	* Synthesis nAg: 9.99 x 10^{-4} mol H+ equivalents. nAg attachment 2.66 x 10^{-2} H+ * Reapplication nAg for every gown (75 times)	The impact is greater to attach the nAg to the textile than it is to synthesize it	94.3% in favour of reusables.
	Reusable patient gowns coated with nAg (nanosilver)		Reapplication nAg at each set of 17 launderings (± 4.4 times)		
Comparison 3.2 Disposable versus reusable laryngeal airway masks (LMAs)					
Eckelman (2012)	Single-use laryngeal mask airways (LMAs)	Maintenance of 40 airways	100%	N/A	70-80% in favour of reusables.
	Reusable laryngeal mask airways (LMAs)		20-30%	N/A	
Comparison 3.3 Disposable versus reusable surgical instrument set					
Ibbotson (2013)	Disposable scissors made of plastic (fibre reinforced)	4,500 use cycles of surgical scissors during 18 years	20 kg SO_2-equivalents*	Manufacturing process	Difference of 89.2 kg SO_2-eq and 19.2 kg SO_2-eq in
	Disposable scissors made of stainless steel		90 kg SO_2-equivalents*	Manufacturing process	

	Reusable scissors made of stainless steel		0.8 kg SO2-equivalents*	Usage: Washing, disinfection, sterilization and repair/service	favour of reusables.
Comparison 3.4 Disposable versus reusable surgical scissors					
Leiden (2020)	Disposable instrument set for single-level lumbar fusion surgeries	The surgical instrument set required for one single-level lumbar fusion surgery involving the implantation of four screws and two rods	30-40%	Production process	60-70% in favour of disposable. However, 1 surgery as functional unit (FU).
	Reusable instrument set for single-level lumbar fusion surgeries		100%	Sterilization process	
Comparison 3.5 Hybrid and single-use instrument in laparoscopic cholecystectomy					
Rizan (2021)	Hybrid instruments in laparoscopic cholecystectomy	The number of three types of instruments (clip appliers, laparoscopic scissors and ports) typically required to perform one laparoscopic cholecystectomy	Ports: 2.08 g SO_2 eq Laparoscopic clip applier: 1.18 g SO_2 eq Laparoscopic scissors: 1.44 g SO_2 eq	N/A	* Ports 76.6% in favour of hybrid instruments. * Laparoscopic clip applier 86.2% in favour of hybrid instruments. * Laparoscopic scissors 67.7% in favour of hybrid instruments.
	Single-use instruments in laparoscopic cholecystectomy		Ports 8.91 SO_2 eq Laparoscopic clip applier 8.53 g SO_2 eq Laparoscopic scissors: 4.46 g SO_2 eq	N/A	
Comparison 3.6 Disposable versus reusable blood pressure cuffs					
Sanchez (2020)	Disposable blood pressure (BP) cuffs	Providing blood pressure readings for a clinic room or ward, under four different health care delivery scenarios.	Using 4 different scenarios: (1) Day office, (2) 1 Day Ambulatory Procedure, (3) 1 Day Regular Ward and (4) 1 Day ICU. Reusable cuffs have a lesser impact. See results in table study (Sanchez, 2020) (see evidence table for more detailed information)	N/A N/A	Reusable cuffs have a lesser impact in this category.
Comparison 3.7 Disposable versus reusable laryngoscope handles and blades					
Sherman (2018)	Single-use laryngoscope handles and blades	One handle or one blade for a single patient encounter.	Different cleaning scenarios (low-level disinfection levels (LDL), high-level disinfection levels (HDL) and sterilization) are included in the analysis. The most favourable scenario for the handles and blades is the reusable stainless steel, treated to HDL standards. *(see figure 2 (Sherman; 2018) and evidence table for more detailed information)*	N/A	Compared to reusable stainless steel handle, treated to HDL. *Choosing LDL: 70% increase *Choosing sterilization: 200% increase. *The single-use handle has a 33 times impact in the outcome acidification compared to the reusable version. Compared to reusable steel tongue blade treated to (the minimum) HDL standards. *Choose sterilization: 250% increase *Single-use options for the blades will result in 5-10 times increase.
	Reusable laryngoscope handles and blades			N/A	

*Read from figure (Ibbotson, 2013)

4. Eutrophication

Seven out of 18 studies reported on the outcome eutrophication (Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; McGain, 2017; Rizan, 2021; Sanchez, 2020; Sherman, 2018). The seven studies contained seven comparisons. A summary of the results is presented in Table 4. The majority of the studies resulted in favour of reusables.

Table 4. Outcome measure eutrophication: summary of results

Study	Comparison	Functional unit	Outcomes eutrophication	Difference
4.1 Disposable versus reusable patient hospital gowns				
Hicks (2016)	Disposable patient gownscoated with nAg (nanosilver)	-4600 ug of nAg (amount added to hospital gown) -Per one wear and laundering (over a lifetime of 75 wearings)	*Synthesis nAg: 5.83 x 10^{-5} kg N equivalents. nAg attachment 2.63 x 10^{-4} kg N equivalents *Reapplication nAg for every gown (75 times)	94.1% in favour of reusables.
	Reusable patient gowns coated with nAg (nanosilver)		Reapplication nAg at each set of 17 launderings (± 4.4 times)	
4.2 Disposable versus reusable laryngeal airway masks (LMAs)				
Eckelman (2012)	Single-use laryngeal mask airways (LMAs)	Maintenance of 40 airways	100%	0-10% in favour of reusables.
	Reusable laryngeal mask airways (LMAs)		90-100%	
4.3 Disposable versus reusable surgical scissors				
Ibbotson (2013)	Disposable scissors made of plastic (fibre reinforced)	4,500 use cycles of surgical scissors during 18 years	Freshwater: 0.55 kg P equivalents* Marine: 6 kg N equivalents*	<u>Freshwater</u>: Difference of 0.7 kg P eq and 0.25 kg P eq in favour of reusables. <u>Marine</u>: Difference of 9.8 kg N eq and 5.8 kg N eq in favour of reusables.
	Disposable scissors made of stainless steel		Freshwater: 1 kg P equivalents* Marine: 10 kg N equivalents*	
	Reusable scissors made of stainless steel		Freshwater: 0.3 kg P equivalents* Marine: 0.2 kg N equivalents*	
4.4 Five scenarios of anaesthetic equipment (including anesthetic circuits, face masks, LMAs,				
McGain (2017)	Single-use anesthetic equipment	Use of breathing circuits, face masks, LMAs, and direct and videolaryngoscopes at one hospital over one year	(1) completely reusable – 0.000 kg P eq	The differences are very small. The outcomes resulted all in a low impact on eutrophication.
	Reusable anesthetic equipment		(2) mainly single-use except for reusable laryngoscope handles – 0.12 kg P eq	
			(3) completely single-use – 0.12 kg P eq	
			(4) reusables (except the single-use face masks) – 0.04 kg P eq	
			(5) reusables (except single-use laryngoscope blades) – 0.07 kg P eq	
4.5 Hybrid and single-use instrument in laparoscopic cholecystectomy				
Rizan (2021)	Hybrid instruments in laparoscopic cholecystectomy	The number of three types of instruments (clip appliers, laparoscopic scissors and ports) typically required to perform one laparoscopic cholecystectomy	<u>Freshwater</u>: Ports: 0.17 g P eq Laparoscopic clip applier: 0.12 g P eq Laparoscopic scissors: 0.17 g P eq <u>Marine</u>: Ports: 0.07 g N eq Laparoscopic clip applier: 0.06 g N eq Laparoscopic scissors: 0.04 g N eq	The differences are very small. Overall, the hybrid instruments have a lower environmental impact in this category.
	Single-use instruments in laparoscopic cholecystectomy		<u>Freshwater</u>: Ports: 0.43 g P eq Laparoscopic clip applier: 0.62 g P eq Laparoscopic scissors: 0.26 g P eq <u>Marine</u>: Ports: 0.12 g N eq Laparoscopic clip applier: 0.09 g N eq Laparoscopic scissors: 0.05 g N eq	
4.6 Disposable versus reusable blood pressure cuffs				
Sanchez (2020)	Disposable blood pressure (BP) cuffs	Providing blood pressure readings for a clinic room or ward, under four different health care delivery scenarios.	Using 4 different scenarios: (1) Day office, (2) 1 Day Ambulatory Procedure, (3) 1 Day Regular Ward and (4) 1 Day ICU. Reusable cuffs have a lesser impact. See results in table	Reusable cuffs have a lower impact in this category.

			study (Sanchez, 2020) (see evidence table for more detailed information)	
4.7 Disposable versus reusable laryngoscope handles and blades				
Sherman (2018)	Single-use laryngoscope handles and blades	One handle or one blade for a single patient encounter.	Different cleaning scenarios (low-level disinfection levels (LDL), high-level disinfection levels (HDL) and sterilization) are included in the analysis. The most favourable scenario for the handles and blades is the reusable stainless steel, treated to HDL standards. Choosing LDL will result in a 160% increase of eutrophication impact. Sterilization will lead to a 100% increase. The single-use handle has a 65 times bigger impact on eutrophication compared to the reusable version. Sterilization will lead to a 150% increase compared to HDL. Single-use options for the blades will result in 8-15 times increase of impact on eutrophication.	The reusable handles and blades have a lower impact in this category.
	Reusable laryngoscope handles and blades			

*Read from figure (Ibbotson, 2013)

5. Human toxicity

Seven out of 18 studies reported on the outcome human toxicity (Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; McGain, 2017; Rizan, 2021; Sanchez, 2020; Sherman, 2018). A summary of the results is presented in Table 5. Most studies resulted in favour of reusables.

Table 5. Outcome measure human toxicity: summary of results

Study	**Comparison**	**Functional unit**	**Outcomes human toxicity**	**Difference**
Comparison 5.1 Disposable versus reusable patient hospital gowns				
Hicks (2016)	Disposable patient gownscoated with nAg (nanosilver)	-4600 ug of nAg (amount added to hospital gown) -Per one wear and laundering (over a lifetime of 75 wearings)	*Carcinogenics: Synthesis nAg: 4.66 x 10^{-10} CTUh. nAg attachment: 4.28 x 10^{-9} CTUh *Non-carcinogenics: Synthesis nAg: 6.37 x 10^{-9} CTUh. nAg attachment: 4.28 x 10^{-8} CTUh *Reapplication nAg for every gown (75 times)	Very small differences.
	Reusable patient gowns coated with nAg (nanosilver)		Reapplication nAg at each set of 17 launderings (± 4.4 times)	
Comparison 5.2 Disposable versus reusable laryngeal airway masks (LMAs)				
Eckelman (2012)	Single-use laryngeal mask airways (LMAs)	Maintenance of 40 airways	HH cancer: 100% HH non cancer: 100% HH air pollutants: 100%	70-100% in favour of reusables.
	Reusable laryngeal mask airways (LMAs)		HH cancer: 0-10% HH non cancer: 0-10% HH air pollutants: 20-30%	
Comparison 5.3 Disposable versus reusable surgical scissors				
Ibbotson (2013)	Disposable scissors made of plastic (fibre reinforced)	4,500 use cycles of surgical scissors during 18 years	750 kg 1.4-DB equivalents *	Differences 550 and 7550 kg 1.4-DB equivalents in favour of reusable.
	Disposable scissors made of stainless steel		7750 kg 1.4-DB equivalents *	
	Reusable scissors made of stainless steel		200 kg 1.4-DB equivalents *	
Comparison 5.4 Five scenarios of anaesthetic equipment (including anesthetic circuits, face masks, LMAs, direct and videolaryngoscope blades and handles)				
McGain (2017)	Single-use anesthetic equipment	Use of breathing circuits, face masks, LMAs, and direct and videolaryngoscopes at one hospital over one year	(1) completely reusable – 12 kg 1.4-DB eq	Difference 1011 kg 1.4-DB equivalents in favour of reusables.
	Reusable anesthetic equipment		(2) mainly single-use except for reusable laryngoscope handles – 713 kg 1.4-DB eq	
			(3) completely single-use – 1023 kg 1.4-DB eq	
			(4) reusables (except the single-use face masks) – 195 kg 1.4-DB eq	

			(5) reusables (except single-use laryngoscope blades) –491 kg 1.4-DB eq	
Comparison 5.5 Hybrid and single-use instrument in laparoscopic cholecystectomy				
Rizan (2021)	Hybrid instruments in laparoscopic cholecystectomy	The number of three types of instruments (clip appliers, laparoscopic scissors and ports) typically required to perform one laparoscopic cholecystectomy	Carcinogenic: Ports: 43 g 1.4-DCB eq Laparoscopic clip applier: 45 g 1.4-DCB eq Laparoscopic scissors: 65 g 1.4-DCB eq Noncarcinogenic: Ports: 390 g 1.4-DCB eq Laparoscopic clip applier: 576 g 1.4-DCB eq Laparoscopic scissors: 952 g 1.4-DCB eq	Carcinogenic: *Ports 63.2% in favour of hybrid instruments. *Laparoscopic clip applier 77.8% in favour of hybrid instruments. *Laparoscopic scissors 28.6% in favour of hybrid instruments. Noncarcinogenic: *Ports 96.1% in favour of hybrid instruments. *Laparoscopic clip applier 99.3% in favour of hybrid instruments. *Laparoscopic scissors 93.4% in favour of hybrid instruments.
	Single-use instruments in laparoscopic cholecystectomy		Carcinogenic: Ports: 117 g 1.4-DCB eq) Laparoscopic clip applier: 203 g 1.4-DCB eq Laparoscopic scissors: 91 g 1.4-DCB eq Noncarcinogenic: Ports: 1013 g 1.4-DCB eq Laparoscopic clip applier: 2871 g 1.4-DCB eq Laparoscopic scissors: 1386 g 1.4-DCB eq	
Comparison 5.6 Disposable versus reusable blood pressure cuffs				
Sanchez (2020)	Disposable blood pressure (BP) cuffs	Providing blood pressure readings for a clinic room or ward, under four different health care delivery scenarios.	Using 4 different scenarios: (1) Day office, (2) 1 Day Ambulatory Procedure, (3) 1 Day Regular Ward and (4) 1 Day ICU. Reusable cuffs have a lesser impact. See results in table study (Sanchez, 2020) (see evidence table for more detailed information)	Reusable cuffs have a lesser impact in this category.
Comparison 5.7 Disposable versus reusable laryngoscope handles and blades				
Sherman (2018)	Single-use laryngoscope handles and blades	One handle or one blade for a single patient encounter.	Different cleaning scenarios (low-level disinfection levels (LDL), high-level disinfection levels (HDL) and sterilization) are included in the analysis. The most favourable scenario for the handles and blades is the reusable stainless steel, treated to HDL standards. *(see figure 2 (Sherman; 2018) and evidence table for more detailed information)*	The single-use handles and blades have a greater impact in this category.
	Reusable laryngoscope handles and blades			

*Assessed from Figure (Ibbotson, 2013)

6. Ecotoxicity

Seven out of 18 studies reported on the outcome ecotoxicity (Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; McGain, 2017; Rizan, 2021; Sanchez, 2020; Sherman, 2018). A summary of the results is presented in Table 5. Most studies resulted in favour of reusables.

Table 6. Outcome measure ecotoxicity: summary of results

Study	Comparison	Functional unit	Outcomes ecotoxicity	Difference
Comparison 6.1 Disposable versus reusable patient hospital gowns				
Hicks (2016)	Disposable patient gownscoated with nAg (nanosilver)	-4600 ug of nAg (amount added to hospital gown) -Per one wear and laundering (over a lifetime of 75 wearings)	Synthesis nAg: 2.36×10^{-2} CTUe nAg attachment: 1.51×10^{-1} CTUe Reapplication nAg for every gown (75 times)	Very small differences
	Reusable patient gowns coated with nAg (nanosilver)		Reapplication nAg at each set of 17 launderings (± 4.4 times)	
Comparison 6.2 Disposable versus reusable laryngeal airway masks (LMAs)				
Eckelman (2012)	Single-use laryngeal mask airways (LMAs)	Maintenance of 40 airways	100%	80-90% in favour of reusables.
	Reusable laryngeal mask airways (LMAs)		10-20%	
Comparison 6.3 Disposable versus reusable surgical scissors				
Ibbotson (2013)	Disposable scissors made of plastic (fibre reinforced)	4,500 use cycles of surgical scissors during 18 years	Terrestrial ecotoxicity: 0.4 kg 1.4-DB eq * Freshwater ecotoxicity: 55 kg 1.4-DB eq *	Terrestrial: Small differences 0.37 and 1.97 kg 1.4-DB eq in favour of reusable
	Disposable scissors made of stainless steel		Terrestrial ecotoxicity: 2 kg 1.4-DB eq * Freshwater ecotoxicity: 500 kg 1.4-DB eq *	

	Reusable scissors made of stainless steel		Terrestrial ecotoxicity: 0.03 kg 1.4-DB eq * Freshwater ecotoxicity: 4 kg 1.4-DB eq *	Freshwater: Differences 51 and 496 kg 1.4-DB eq in favour of reusable
Comparison 6.4 Five scenarios of anaesthetic equipment (including anaesthetic circuits, face masks, LMAs, direct and video laryngoscope blades, handles)				
McGain (2017)	Single-use anesthetic equipment	Use of breathing circuits, face masks, LMAs, and direct and video laryngoscopes at one hospital over one year	(1) completely reusable – *Terrestrial ecotoxicity* 0.011 kg 1.4-DB eq *Freshwater ecotoxicity* 0.7 kg 1.4-DB eq *Marine ecotoxicity* 0.7 kg 1.4-DB eq	Differences in favour of reusables.
	Reusable anesthetic equipment		(2) mainly single-use except for reusable laryngoscope handles – *Terrestrial ecotoxicity* 0.4 kg 1.4-DB eq *Freshwater ecotoxicity* 91 kg 1.4-DB eq *Marine ecotoxicity* 94.5 kg 1.4-DB eq	
			(3) completely single-use – *Terrestrial ecotoxicity* 0.405 kg 1.4-DB eq *Freshwater ecotoxicity* 93.4 kg 1.4-DB eq *Marine ecotoxicity* 97.2 kg 1.4-DB eq	
			(4) reusables (except the single-use face masks) – *Terrestrial ecotoxicity* 0.118 kg 1.4-DB eq *Freshwater ecotoxicity* 3.1 kg 1.4-DB eq *Marine ecotoxicity* 2.8 kg 1.4-DB eq	
			(5) reusables (except single-use laryngoscope blades) – *Terrestrial ecotoxicity* 0.2 kg 1.4-DB eq *Freshwater ecotoxicity* 88 kg 1.4-DB eq *Marine ecotoxicity* 92.3 kg 1.4-DB eq	
Comparison 6.5 Hybrid and single-use instrument in laparoscopic cholecystectomy				
Rizan (2021)	Hybrid instruments in laparoscopic cholecystectomy	The number of three types of instruments (clip appliers, laparoscopic scissors and ports) typically required to perform one laparoscopic cholecystectomy	*Terrestrial ecotoxicity:* Ports: 1171 g 1.4-DCB eq Laparoscopic clip: 3976 g 1.4-DCB eq Laparoscopic scissors: 5628 g 1.4-DCB eq *Freshwater ecotoxicity*: Ports: 17 g 1.4-DCB eq Laparoscopic clip: 36 g 1.4-DCB eq Laparoscopic scissors: 97 g 1.4-DCB eq *Marine ecotoxicity:* Ports: 23 g 1.4-DCB eq Laparoscopic clip: 47 g 1.4-DCB eq Laparoscopic scissors: 122 g 1.4-DCB eq	_Terrestrial_ *Ports 71.7% in favour of hybrid instruments. *Laparoscopic clip 79.9% in favour of hybrid instruments. *Laparoscopic scissors 63% in favour of hybrid instruments. _Freshwater:_ *Ports 56.4% in favour of hybrid instruments. *Laparoscopic clip 79.5% in favour of hybrid instruments. *Laparoscopic scissors 6.2% in favour of single-use instruments. _Marine_ *Ports 57.4% in favour of hybrid instruments. *Laparoscopic clip 79.6% in favour of hybrid instruments. *Laparoscopic scissors 3.3% in favour of single-use instruments.
	Single-use instruments in laparoscopic cholecystectomy		*Terrestrial ecotoxicity:* Ports: 4142 g 1.4-DCB eq Laparoscopic clip applier: 19,767 g 1.4-DCB eq Laparoscopic scissors: 8939 g 1.4-DCB eq *Freshwater ecotoxicity:* Ports: 39 g 1.4-DCB eq Laparoscopic clip applier: 176 g 1.4-DCB eq Laparoscopic scissors: 91 g 1.4-DCB eq *Marine ecotoxicity:* Ports: 54 g 1.4-DCB eq Laparoscopic clip applier: 230 g 1.4-DCB eq Laparoscopic scissors: 118 g 1.4-DCB eq	
Comparison 6.6 Disposable versus reusable blood pressure cuffs				
Sanchez (2020)	Disposable blood pressure (BP) cuffs	Providing blood pressure readings for a clinic room or ward, under four different health care delivery scenarios.	Using 4 different scenarios: (1) Day office, (2) 1 Day Ambulatory Procedure, (3) 1 Day Regular Ward and (4) 1 Day ICU. Reusable cuffs have a lesser impact. See results in table study (Sanchez, 2020) (see evidence table for more detailed information)	Reusable cuffs have a lesser impact in this category.
Comparison 6.7 Disposable versus reusable laryngoscope handles and blades				
Sherman (2018)	Single-use laryngoscope handles and blades	One handle or one blade for a single patient encounter.	Different cleaning scenarios (LDL, HDL,sterilization) are included in the analysis. The most favourable scenario for	The single-use handles and blades

			the handles and blades is the reusable stainless steel, treated to HDL standards. *(see figure 2 (Sherman; 2018) and evidence table for more detailed information)*	have a bigger impact in this category.

7. Ozone depletion

Seven out of 18 studies reported on the outcome ozone depletion (Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; McGain, 2017; Rizan, 2021; Sanchez, 2020; Sherman, 2018). A summary of the results is presented in Table 7. Most studies resulted in favour of reusables.

Table 7. Outcome measure ozone depletion: summary of results

Study	Comparison	Functional unit	Outcomes ozone depletion	Difference
Comparison 7.1 Disposable versus reusable patient hospital gowns				
Hicks (2016)	Disposable patient gownscoated with nAg (nanosilver)	-4600 ug of nAg (amount added to hospital gown) -Per one wear and laundering (over a lifetime of 75 wearings)	Carcinogenics: Synthesis nAg: 1.29 x 10^{-10} kg CFC-11 eq nAg attachment: 5.70 x 10^{-9} kg CFC-11 eq Reapplication nAg for every gown (75 times)	Very small differences
	Reusable patient gowns coated with nAg (nanosilver)		Reapplication nAg at each set of 17 launderings (± 4.4 times)	
Comparison 7.2 Disposable versus reusable laryngeal airway masks (LMAs)				
Eckelman (2012)	Single-use laryngeal mask airways (LMAs)	Maintenance of 40 airways	100%	70-80% in favour of reusables.
	Reusable laryngeal mask airways (LMAs)		20-30%	
Comparison 7.3 Disposable versus reusable surgical scissors				
Ibbotson (2013)	Disposable scissors made of plastic (fibre reinforced)	4,500 use cycles of surgical scissors during 18 years	Ozone depletion: 0.0001 kg CFC-11 eq*	Very small differences
	Disposable scissors made of stainless steel		Ozone depletion: 0.00055 kg CFC-11 eq*	
	Reusable scissors made of stainless steel		Ozone depletion: 0.00004 kg CFC-11 eq	
Comparison 7.4 Hybrid and single-use instrument in laparoscopic cholecystectomy				
Rizan (2021)	Hybrid instruments in laparoscopic cholecystectomy	The number of three types of instruments (clip appliers, laparoscopic scissors and ports) typically required to perform one laparoscopic cholecystectomy	Ports: 0.0004 g CFC11 eq Laparoscopic clip: g 1.4-DCB eq Laparoscopic scissors: 0.0001 g CFC11 eq	Very small impact and differences.
	Single-use instruments in laparoscopic cholecystectomy		Ports: 0.0013 g CFC11 eq Laparoscopic clip: 0.0002 g CFC11 eq Laparoscopic scissors: 0.0005 g CFC11 eq	
Comparison 7.5 Disposable versus reusable blood pressure cuffs				
Sanchez (2020)	Disposable blood pressure (BP) cuffs	Providing blood pressure readings for a clinic room or ward, under four different health care delivery scenarios.	Using 4 different scenarios: (1) Day office, (2) 1 Day Ambulatory Procedure, (3) 1 Day Regular Ward and (4) 1 Day ICU. Reusable cuffs have a lesser impact. See results in table study (Sanchez, 2020) (see evidence table for more detailed information)	Reusable cuffs have a lesser impact in this category.
Comparison 7.6 Disposable versus reusable laryngoscope handles and blades				
Sherman (2018)	Single-use laryngoscope handles and blades	One handle or one blade for a single patient encounter.	Different cleaning scenarios (low-level disinfection levels (LDL), high-level disinfection levels (HDL) and sterilization) are included in the analysis. The most favourable scenario for the handles and blades is the reusable stainless steel, treated to HDL standards. *(see figure 2 (Sherman; 2018) and evidence table for more detailed information)*	The single-use handles and blades have a bigger impact in this category.

Level of evidence of the literature

The working group assessed the level of evidence of LCAs using GRADE and used the critical appraisal of LCAs (Drew, 2021) to provide an indication of the study quality. See module 1 'operatietechnieken' for more details.

1. Climate Change

Seventeen studies reported on the outcome climate change (Grimmond, 2012; Grimmond, 2021; McPherson, 2019; Hicks, 2016; McGain, 2010; Vozzola, 2018; Vozzola, 2020; Davis, 2019; Donahue, 2020; Eckelman, 2012; Ibbotson, 2013; Leiden, 2020; McGain, 2012; McGain, 2017; Rizan, 2021; Sanchez, 2020; Sherman, 2018). The 17 studies contained 15 comparisons. The level of evidence starts at grade high. The level of evidence was downgraded with 2 levels to *low* because of heterogeneity of interventions and varying methods (bias due to indirectness, -1), and limited internal validity and limited representativeness of the data (imprecision, -1).

2. Waste

Seven studies reported on the outcome waste (Grimmond, 2012; Grimmond, 2021; McPherson, 2019; Vozzola, 2020; Davis, 2018; McGain, 2017; Namburar, 2022). As six out of seven studies contain LCAs, the level of evidence starts at grade high. The level of evidence was downgraded with 2 levels to *low* because of heterogeneity of interventions and varying methods (bias due to indirectness, -1), and limited internal validity and limited representativeness of the data (imprecision, -1).

3. Acidification

Seven LCAs reported on the outcome acidification (Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; Leiden, 2020; Rizan, 2021; Sanchez, 2020; Sherman, 2018). The level of evidence starts at grade high. The level of evidence was downgraded to *very low* because of risk of bias (-1; assumptions are not clearly described), heterogeneity of interventions and methods (bias due to indirectness, -2), and limited internal validity and limited representativeness of the data (imprecision, -1).

4. Eutrophication

Seven LCAs reported on the outcome eutrophication (Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; Leiden, 2020; Rizan, 2021; Sanchez, 2020; Sherman, 2018). The level of evidence starts at grade high. The level of evidence was downgraded to *very low* because of risk of bias (-1; assumptions are not clearly described), heterogeneity of interventions and methods (bias due to indirectness, -2), and limited internal validity and limited representativeness of the data (imprecision, -1).

5. Human toxicity

Seven LCAs reported on the outcome human toxicity (Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; Leiden, 2020; Rizan, 2021; Sanchez, 2020; Sherman, 2018). The level of evidence starts at grade high. The level of evidence was downgraded to *very low* because of risk of bias (-1; assumptions are not clearly described), heterogeneity of interventions and methods (bias due to indirectness, -2), and limited internal validity and limited representativeness of the data (imprecision, -1).

6. Ecotoxicity

Seven LCAs reported on the outcome ecotoxicity (Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; Leiden, 2020; Rizan, 2021; Sanchez, 2020; Sherman, 2018). The level of evidence starts at grade high. The level of evidence was downgraded to *very low* because of risk of bias (-1;

assumptions are not clearly described), heterogeneity of interventions and methods (bias due to indirectness, -2), and limited internal validity and limited representativeness of the data (imprecision, -1).

7. Ozone depletion
Seven LCAs reported on the ozone depletion (Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; Leiden, 2020; Rizan, 2021; Sanchez, 2020; Sherman, 2018). The level of evidence starts at grade high. The level of evidence was downgraded to *very low* because of risk of bias (-1; assumptions are not clearly described), heterogeneity of interventions and methods (bias due to indirectness, -2), and limited internal validity and limited representativeness of the data (imprecision, -1).

Conclusions

1. Climate Change

Low GRADE	The evidence suggests that reusables have less impact on climate change when compared to disposables in the operating room for patients who undergo surgery. *Sources: Grimmond, 2012; Grimmond, 2021; McPherson, 2019; Hicks, 2016; McGain, 2010; Vozzola, 2018; Vozzola, 2020; Davis, 2019; Donahue, 2020; Eckelman, 2012; Ibbotson, 2013; Leiden, 2020; McGain, 2012; McGain, 2017; Rizan, 2021; Sanchez, 2020; Sherman, 2018*

2. Waste

Low GRADE	The evidence suggests that reusables decrease waste when compared to disposables in the operating room for patients who undergo surgery. *Sources: Grimmond, 2012; Grimmond, 2021; McPherson, 2019; Vozzola, 2020; Davis, 2018; McGain, 2017; Namburar, 2022*

3. Acidification

Very low GRADE	The evidence is very uncertain about the effect on acidification when reusables are compared to disposables in the operating room for patients who undergo surgery. *Sources: Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; Leiden, 2020; Rizan, 2021; Sanchez, 2020; Sherman, 2018*

4. Eutrophication

Very low GRADE	The evidence is very uncertain about the effect on eutrophication when reusables are compared to disposables in the operating room for patients who undergo surgery. *Sources: Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; Leiden, 2020; Rizan, 2021; Sanchez, 2020; Sherman, 2018*

5. Human toxicity

Very low GRADE	The evidence is very uncertain about the effect on human toxicity when reusables are compared to disposables in the operating room for patients who undergo surgery.

	Sources: Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; McGain, 2017; Rizan, 2021; Sanchez, 2020; Sherman, 2018

6. Ecotoxicity

Very low GRADE	The evidence is very uncertain about the effect on ecotoxicity when reusables are compared to disposables in the operating room for patients who undergo surgery. *Sources: Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; McGain, 2017; Rizan, 2021; Sanchez, 2020; Sherman, 2018*

7. Ozone depletion

Very low GRADE	The evidence is very uncertain about the effect on ozone depletion when reusables are compared to disposables in the operating room for patients who undergo surgery. *Sources: Hicks, 2016; Eckelman, 2012; Ibbotson, 2013; Rizan, 2021; Sanchez, 2020; Sherman, 2018*

Overwegingen – van bewijs naar aanbeveling

Voor- en nadelen van de interventie en de kwaliteit van het bewijs

Er is literatuuronderzoek verricht naar de milieu-impact van disposables en reusables die worden gebruikt op operatiekamers. Negentien studies zijn gevonden (PICO1 n=8; PICO2 n=9). Hiervan zijn zeventien studies een LCAs, één studie is een review (Drew, 2021) en één studie behelst een observationeel onderzoek (Namburar, 2022). De studies vergelijken verschillende producten en instrumenten, bijvoorbeeld: naaldencontainers, operatiejassen, anesthesie medicatietrays, scopes, specula, anesthesieapparatuur, bloeddrukbanden en chirurgisch instrumentarium. De bewijskracht voor de cruciale uitkomstmaten ‘climate change’ en ‘waste’ komt uit op *laag*. De bewijskracht voor de belangrijke uitkomstmaten komt uit op *zeer laag*. Zo kunnen er op basis van de literatuur geen harde conclusies geformuleerd worden.

De LCAs (n=17) zijn kritisch beoordeeld op basis van de beoordeling volgens Drew (2021). De kwaliteit van de studies wordt hiermee beoordeeld op basis van de methodologie van een LCA. Dit scoresysteem bestaat uit 16 beoordelingscriteria, die zijn verdeeld over de verschillende fasen van een LCA. Het behandelt een reeks indicatoren voor studiekwaliteit, zoals *interne validiteit*, *externe validiteit*, *consistentie*, *transparantie* en *bias*. De procentuele score geeft een indicatie van de algehele studiekwaliteit. Een hogere score duidt op een hogere algehele studiekwaliteit (zie bijlage 2). Een beknopt overzicht van de scores staat weergegeven in tabel 1.

Tabel 1. Beoordeling LCAs volgens Drew (2021)

Uitgangsvraag 2.1		**Uitgangsvraag 2.2**	
Grimmond (2012)	71%	Davis (2018)	60%
Grimmond (2021)	71%	Donahue (2020)	83%
Hicks (2016)	77%	Eckelman (2012)	86%
McGain (2010)	80%	Ibbotson (2013)	76%
McPherson (2019)	77%	Leiden (2020)	73%
Vozzola (2018)	80%	McGain (2012)	83%
Vozzola (2020)	80%	McGain (2017)	66%
		Rizan (2021)	83%
		Sanchez (2020)	80%
		Scherman (2018)	86%

Figuur 1. *Prioriteitsvolgorde circulariteit strategieën*

Indien disposables en reusables met elkaar worden vergeleken, moet de gehele levenscyclus en levensduur van de producten in acht worden genomen. Indien een reusable bijvoorbeeld 75 keer kan worden hergebruikt, wordt dit vergeleken met 75 disposable producten voor eenmalig gebruikt. In drie van de 19 LCAs is eenmalig gebruik van zowel het disposable als het reusable product vergeleken (Davis, 2018; Leiden, 2020; McGain, 2012). Hierbij is dus niet de gehele levensduur van de reusable variant meegenomen, wat leidt tot een ongelijke vergelijking. In andere LCA's wordt aangetoond dat bij meermalig gebruik van de reusable de negatieve milieu-impact afneemt, in vergelijking met de disposable variant (Drew, 2021; Grimmond, 2012; Grimmond, 2021; Hicks, 2016; McGain, 2010; McPherson, 2019; Vozzola, 2018; Vozzola, 2020; Donahue, 2020; Eckelman, 2012; Ibbotson, 2013; Sanchez, 2020; Sherman, 2018). Deze dertien LCA's impliceren dat het gebruik van reusables een lagere milieu-impact heeft in vergelijking tot het gebruik van disposables.
McGain (2017) vergeleek reusable en disposable anesthesie apparatuur en concludeerde dat de milieu-impact van hetzelfde type apparatuur (bijvoorbeeld reusable) kan variëren tussen verschillende continenten. Waar de disposables een lagere milieu-impact lijken te hebben in Australië, suggereren de resultaten dat de impact voor reusables lager zijn in de VS, VK en in Europa. Dit komt door het verschil in energiemix. Er zijn verschillende primaire energiebronnen, waaruit secundaire energie voor direct gebruik (zoals elektriciteit) wordt geproduceerd. Steenkool als energiebron voor de energiemix, zoals in Australië, leidt tot een grotere milieu impact voor de reusables in vergelijking tot het gebruik van een andere energiemix (zoals bijv. energiebronnen van wind- en zonne-energie). De 'hotspot' in de levenscyclus van disposables is het productieproces.

Geïdentificeerde hotspots uit de studies worden geëvalueerd middels het '10R model circulariteit (zie Figuur 1, gebaseerd op Cramer, 2014; Hanemaaijer; 2018; Potting, 2016; Reike, 2018). Deze R-ladder laat zien dat de hoogste prioriteit om duurzaam te werken 'refuse' is, oftewel, niet gebruiken. Hoe lager het grondstofgebruik, des te hoger op de R-ladder en hoe dichter je bij circulair werken bent.

Refuse (R1) en Reduce (R2)

De werkgroep adviseert om kritisch te beoordelen of het gebruik van een product daadwerkelijk nodig is (R1-Refuse). Aangezien LCA's laten zien dat het gebruik van disposables de grootste negatieve milieu-impact heeft (met als 'hotspot' het productieproces), adviseert de werkgroep daarnaast om zoveel mogelijk met reusables te werken en disposables niet te gebruiken (R1-Refuse).

Indien het gebruik van disposables noodzakelijk lijkt te zijn, wees dan bewust van de hogere impact en probeer de hoeveelheid zo laag mogelijk te houden (R2-Reduce). Bepaal van tevoren de mate van inzet van een product of instrument. Bijvoorbeeld of een disposable multifunctioneel instrument (coaguleren en snijden) de voorkeur heeft of dat een reusable bipolaire schaar kan worden gebruikt. Dit scheelt zowel kosten als een minder negatieve milieu-impact.

Daarnaast draagt een kleinere verpakking bij aan verlaging van de milieu-impact door minder materiaalgebruik. Indien er minder opslagruimte nodig is, kunnen met minder reisbewegingen ook hetzelfde aantal producten worden getransporteerd.

Redesign (R3)

Duurzaamheid zal als standaard moeten worden meegenomen in het (her)ontwerp van producten en instrumenten. De industrie zal leidend moeten zijn, door het aanbieden van producten met een langere levensduur. Hierbij moet goed worden samengewerkt om tot kwalitatief goede en duurzame producten te komen.

In het ontwerp van disposables liggen ook kansen om de milieu-impact te beperken. Rizan (2021) vergelijkt hybride instrumentarium (deels reusable en deels disposable) met geheel disposable, waarbij het hybride instrumentarium milieuvriendelijker blijkt te zijn. Indien het niet mogelijk is om een chirurgisch instrument geheel reusable te maken en dezelfde functie te laten uitoefenen (bijvoorbeeld vanwege het niet kunnen reinigen en steriliseren door complex ontwerp), zou de ontwikkeling tot een hybride instrument de milieu-impact kunnen verlagen. Hier ligt de uitdaging voor ontwerpers om reusables of hybride instrumenten te ontwikkelen met dezelfde functie als de huidige disposables. Indien het onderdeel weer hergebruikt kan worden, leidt dit uiteindelijk tot minder grondstofverbruik en een lagere impact op het milieu.

Daarnaast zal de afvalverwerkingsfase moeten worden meegenomen in het ontwerp. Een product moet gemakkelijk te demonteren zijn (indien het uit meerdere onderdelen bestaat) en het moet duidelijk zijn uit welke materialen het bestaat, zodat afvalscheiding wordt vereenvoudigd.

Verder zal bij ontwikkeling van nieuwe producten of herontwerp van bestaande producten infectiepreventie moeten worden meegenomen. Zoek hierbij de samenwerking met infectiepreventie voor een adequate risicoafweging waarbij de risico's van een infectie/besmetting afgezet wordt tegen verduurzamingsmaatregelen.

Denk bij herontwerp ook aan een andere manier van het gebruik van instrumenten. Een standaard disposable hechting verwijder set wordt steriel verpakt en bestaat geheel uit disposable materialen. De vraag is of het nodig is om met een steriel set te werken, en of het disposable moet zijn. In overleg met de arbeidshygiënist of deskundige infectiepreventie is het mogelijk om alternatieven te exploreren.

Re-use (R4)

In de loop van de tijd is binnen de gezondheidszorg een wegwerpcultuur ontstaan en zijn de disposables niet meer weg te denken. Ook de grondstof schaarste zal op den duur problemen kunnen opleveren in de toeleveringsketen van disposables en daarnaast zal dit kunnen leiden tot een toename in kosten.

De meeste studies wijzen erop dat reusables een minder grote negatieve impact hebben op het milieu in vergelijking met disposables. Bij studies waar disposables een lagere milieu-impact hebben, handteren de studies een andere energiemix dan wij in Europa hebben (McGain, 2017) of nemen ze niet de gehele levensduur van de reusables mee (Davis, 2018; Leiden, 2020; McGain, 2012). Deze laatste studies (Davis, 2018; Leiden, 2020; McGain, 2012) laten wel dezelfde hotspots zien als studies waarbij de reusables een lagere milieu-impact hebben (Drew, 2021; Grimmond, 2012; Grimmond, 2021; Hicks, 2016; McGain, 2010; McPherson, 2019; Vozzola, 2018; Vozzola, 2020; Donahue, 2020; Eckelman, 2012; Ibbotson, 2013; Sanchez, 2020; Sherman, 2018), namelijk het productieproces van de disposables. Vanwege het productieproces, is de verwachting dat gebruik van disposables een grotere impact heeft op het milieu dan de reusables. Een ‘schone’ elektrische bron (bijvoorbeeld zonne- of windenergie) kan de impact van het productieproces verlagen (Grimmond, 2012; McPherson, 2019). De overstap van een CO_2-intensief naar een minder CO_2-intensief elektriciteitsnet resulteert in een reductie van CO_2-uitstoot (Donahue, 2020). Ongeacht welk elektriciteitsnet wordt gebruikt, de CO_2-uitstoot van reusables blijft lager in vergelijking met disposables.
Bij reusables geeft het reiniging en sterilisatieproces de grootste milieubelasting. Daarbij horen de volgende hotspots: energie en stoom voor autoclaven, transport, waterverbruik en de hoeveelheid instrumenten die tegelijkertijd worden gesteriliseerd (Donahue, 2020; Eckelman, 2012; Grimmond, 2012; Grimmond, 2021; McPherson, 2019). Eckelman (2012) vergelijkt het effect van alternatieve vervoerswijzen met spoorweg transport. Het effect van alternatieve vervoerswijzen (vervoer over de weg of door de lucht) ten opzichte van spoorweg transport is vrij klein voor reusables. Daarentegen leidt dit bij disposables tot een groot verschil ten opzichte van spoorweg transport, met name bij het vervoer door de lucht (sterke toename in CO_2-uitstoot).
Daarnaast rijst de vraag of het mogelijk is om disposable instrumenten opnieuw te gebruiken. Indien de fabrikant aangeeft dat dit niet mogelijk is, wordt hergebruik in de praktijk nagenoeg niet uitgevoerd. De fabrikant is dan niet meer verantwoordelijk, maar de eindgebruiker is dat zelf. Dit weerhoudt eindgebruikers om toch te hergebruiken. Geadviseerd wordt om actief samenwerking op te zoeken met de industrie om de mogelijkheden te onderzoeken en in te zetten op optimalisatie van de wetgeving (Medical Device Regulation – MDR) met als doel de regels rondom hergebruik te verruimen.

Repair (R5), Refurbish (R6), Remanufacture (R7)

De factoren R5-Repair, R6-Refurbish en R7-Remanufacture hangen nauw met elkaar samen. Eckelman (2012) stelt dat verkorting van de levensduur van reusables direct effect heeft op de uitstoot van broeikasgassen. Het verlengen van de hergebruikcyclus van reusable laryngeal mask airways (LMA) van 10 naar 100 cycli leidt tot een daling van 58% in CO_2-uitstoot. Voordat een product of apparaat wordt afgedankt, is het dus van belang om opnieuw te kijken of de levensduur verlengd kan worden. De werkgroep adviseert om het repareren of opknappen van producten standaard te overwegen.

Repurpose (R8), Recycling (R9), Recover (R10)

Indien een instrument of product niet meer gebruikt kan worden waarvoor het is bedoeld, kan worden gekeken naar een nieuw doeleinde (R8-Repurpose). Grimmond (2012) laat zien dat terugwinning van energie en materialen de milieu-impact van het productieproces kan verlagen (R9-Recycling en R10-Recover). Een voorbeeld is het inzamelen van gebruikte middelen met als doel om hoogwaardig gebruikte materialen terug te winnen (zoals bijvoorbeeld het inzamelen van staplers).

Waarden en voorkeuren van patiënten (en evt. hun verzorgers)
Voor de patiënt en zorgverlener is het van belang dat instrumenten en producten die worden gebruikt in de zorgverlening veilig en effectief zijn. Daarnaast heeft duurzaamheid van het product ook indirect een positief effect op de gezondheid van de mens. De werkgroep vindt het van belang om duurzaamheid mee te nemen in de keuze tussen reusable en disposable producten in het ziekenhuis/zorginstellingen.

Kosten (middelenbeslag)
Grimmond (2012) berekent een kostenbesparing van 19% bij het overstappen van disposables naar reusables. In de praktijk worden veelal op korte termijn beslissingen gemaakt wat betreft de keuze voor een instrument of product. Op de korte termijn is een disposable vaak goedkoper, echter een reusable zal initieel duurder zijn bij aanschaf maar door het hergebruik zal het zich in de meeste gevallen terugbetalen.

Aanvaardbaarheid, haalbaarheid en implementatie
De keuze voor reusables of disposables ligt bij de zorgverlener, wat wordt bepaald door veel verschillende factoren (bijvoorbeeld gebruiksgemak, patiëntvriendelijkheid veiligheid, effectiviteit). Kennisgebrek over de impact van disposables en reusables op het milieu zal een rol spelen in het maken van een beslissing. Het vergt bewustwording over de impact van de verschillende interventies en hun hotspots om duurzaamheid mee te kunnen laten wegen in een beslissing. De werkgroep voorziet echter geen grote barrières met betrekking tot aanvaardbaarheid, haalbaarheid en implementatie. Echter zal de Raad van Bestuur van ziekenhuizen het verschil moeten maken middels het prioriteren van financiële investeringen in duurzaamheid.

Aanbevelingen

Rationale van de aanbeveling: weging van argumenten voor en tegen de interventies
Op dit moment is de bewijskracht van LCA's laag tot zeer laag. Hoewel de literatuur heterogeen is en enkele methodologische beperkingen omvat, heeft de werkgroep een voorkeur voor het gebruik van reusables. Dit mede op basis van de opinie van de werkgroep, het gevoel van urgentie en praktijk ervaring. De werkgroep kiest dan ook voor een sterke aanbeveling met betrekking tot de aandacht voor duurzaamheidsuitkomsten.

Gebruik bij voorkeur reusables, omdat disposables een grotere (negatieve) impact hebben op het milieu (R4-Reuse).

- Beoordeel kritisch of het gebruik van een product daadwerkelijk nodig is (R1-Refuse). Indien disposables toch noodzakelijk zijn bij de operatie, probeer dan het gebruik te minimaliseren (R2-Reduce) en een duurzamere variant te gebruiken (R1-Refuse, R2-Reduce).
- Om de milieu-impact van reusables te verlagen: optimaliseer het reiniging en sterilisatie proces (bijv. gebruik van duurzame energie, energiezuinige apparatuur en meerdere instrumenten per ronde) en het transport (bijv. duurzame manier van transport en verkorten van de transport afstand).
- Geef de voorkeur aan reusables met de langste levensduur, omdat dit de laagste (negatieve) impact heeft op het milieu.

Zet in op Redesign (R3) van o.a. producten, instrumenten en apparatuur. De industrie zal duurzaamheid moeten includeren in het (her)ontwerp.

- Herontwerp van disposable naar (semi) reusable door industrie.

- Neem afvalverwerking mee in het herontwerp. Denk hierbij aan gebruik van minder soorten materialen, duidelijke aanduiding hoe te scheiden voor de gebruiker, stimuleren van circulariteit.
- Na reusables hebben hybride instrumenten een voorkeur boven disposable instrumenten.

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Bijlagen bij module 2 'Reusables versus disposables'

Appendix 1. Evidence tables

Evidence table for systematic reviews

Study reference	Study characteristics	Product/service characteristics	Intervention (I) and Comparison / control (C)	Follow-up	Outcome measures and effect size	Comments
Drew (2021)	SR of LCAs in anaesthetic and surgical care. It aims to summarize the state of LCA practice via review of literature assessing the environmental impact of related services, procedures, equipment and pharmaceuticals. Literature search up to may 2020 The review was guided by using STARR-LCA, which is a PRISMA-based framework. Study design: LCA Setting and Country: Anaesthetic and surgical care, Canada. Source of funding and conflicts of interest: None stated.	Inclusion criteria SR: Studies which assessed the environmental impact(s) of (1) an operating room(s) using LCA, (2) a specific surgical procedure(s) using LCA or (3) equipment or pharmaceuticals used in surgical settings. Exclusion criteria SR: No access, no English language, no research in relation to healthcare, healthcare related but not related to surgery or anaesthesiology, no use of LCAs. 44 included studies	These studies examined the impact contributions from **(A)** ORs generally (n=1) **(B)** specific surgical procedures (n=10) **(C)** provision and use of surgical or anaesthetic equipment or pharmaceuticals (n=33)	End-point of follow-up: N/A For how many participants were no complete outcome data available? N/A	**(A)** Operating rooms The climate impact of the hospitals' surgical suites ranged from 3,200,000 to 5,200,000 kg CO_2e per year and between 146 and 232 kg CO2e per operation (when compared on a caseload basis). **(B)** Surgical procedures The outcomes on climate change were found to vary considerably (6-1,007 kg CO_2e). See figure 2 (Drew, 2021). **(C)** Equipment and materials and pharmaceuticals Most disposable equipments/materials were more harmful for the environment compared to reusables. Figure 4 (Drew, 2021) includes the other outcome measures for provision and use of disposables relative to functionally equivalent reusables. For use of pharmaceuticals, GHG emissions from propofol were considerably lower than inhalational agents (i.e., desflurane, isoflurane and sevoflurane).	Authors conclusion: LCA data indicates the environmental burden attributable to the services is substantial and effective mitigation strategies are already available. Eligible studies varied in terms of quality, completeness and risk of bias, with critical appraisal scores varying between 44% and 89%. **(A)** Only one study is found comparing different ORs on environmental impact and identifying hotpots. Results could not be pooled. **(B)** The studies varied considerably in their system boundaries and functional units, which leads to heterogeneity of the studies. Results could not be pooled. **(C)** Functional units varied considerably between the studies. There is a high degree of heterogeneity, in terms of studied items and methodology. Interpretation of results **(A)** For the OR certain emission hotspots were identified: use

Study reference	Study characteristics	Product/service characteristics	Intervention (I) and Comparison / control (C)	Follow-up	Outcome measures and effect size	Comments
						of anaesthetic gases and use of HVAC. **(B)** OR energy was a great hotspot, mainly due to HVAC. Next to that provision and use of anaesthetic gases and production of equipment and consumables contribute mainly. **(C)** Considering the life cycle of single-use items, the most contributing phase is the production phase. Single-use items are more often worse for the environment compared to reusables. When using reusables the energy source has to be taken into account, since the reuse phase is the biggest contributor, which requires energy.

Evidence table for LCA studies

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
Grimmond (2012)	Waste Management & Research Journal information The journal for a sustainable circular economy. Fully peer-reviewed international journal that publishes original review articles relating to both the theory and practice of waste management and research. Mass flow analyses, life cycle assessments, policy planning and system administration, innovative processes and technologies and their engineering features and cost effectiveness are among the key issues that WM&R seeks to cover through well documented reports on new concepts, systems, practical experience (including case studies), and theoretical and experimental research work. Critical review: Peer reviewed journal. Not a specific LCA journal, however inclusion of LCA studies in scope of the journal.	Type of study: LCA Objective: To assess the climate impacts of two different sharps container systems (disposable and reusable) over a 12 month period. LCA-method: Attributional LCA Setting and country: Hospital US Facility: Northwestern Memorial Hospital (NMH, Chicago) Years of data collection: - Surgical discipline(s): Nonspecific Funding and conflict of interest: None	Goal and scope[1]: Comparison of contribution of disposable (DSC) or reusable sharps containers (RSC) to the global warming potential (GWP). Functional unit(s)[2]: Provision for 100 occupied hospital beds over one year System boundaries: Cradle to grave Included stages: Raw material extraction, production, packaging, transport, reuse, disposal Stated excluded components: Infrastructure and assets were excluded from both systems ("in accordance with product LCA principles") Inventory database: GaBi Allocation: No Normalization & Weighting: Results normalized to 100 occupied beds/year Impacts reported: Yes Contribution analysis: Yes Scenario analysis: No Comparative analysis: Yes Sensitivity analysis: Yes; tests impact of distribution distances by assuming RSCs were made	An LCA framework was used to assess the climate impacts of two different sharps container systems (disposable and reusable) over a 12-month period. Data was collected regarding the size, type, and number of containers used, as well as modification protocols. Both systems were taken into account from cradle to grave. The data comes from a variety of industry and government sources and combined with an LCI/LCA tool developed by the Waterman Group UK. Characterization methods: IPCC	1. Climate Change Annual greenhouse gas (GHG) emissions resulted in a Global Warming Potential (GWP) of 139.1 metric tons of (MT) CO_2 equivalents for DSC and 25.1 $MTCO_2$ equivalents for reusable sharps containers (RSC). Stratified to 100 hospital beds over one year this resulted in 24.2 $MTCO_2$ equivalents GWP per 100 OB-year for DSC and 4.0 $MTCO_2$ equivalents GWP per 100 OB-year for RSC. Use of RSC reduces GWP by 83.5%. 2. Waste Annual waste for DSC resulted in 30,920 kg landfilled plastic and 5020 kg of cardboard boxes for 34,396 manufactured and 33, 759 landfilled DSC (chemotherapy DSC were incinerated). Whereas RSC only caused 123 kg of plastic waste (calculated for the end of life of the RSC, during the study no RSC were landfilled) and 116 kg of waste from carboard boxes (this were the chemotherapy DSC, which were used in both systems if there was an indication for chemotherapy). In total 2481 RSC were manufactured and 47 containers were landfilled. 3. Acidification No results in this study.	Use of RSC leads to reduction of GWP and waste. The manufacturing process is the biggest contributor in GWP for DSC, and thereby gives the largest difference between the two containment systems. This is a function of resin weight; container manufacturing and low annual RSC manufacturing emissions because of their long lasting life span. The washing process is the biggest contributor for RSC. Decanting and washing contributed for 52.5% of the systems total GWP. The sensitivity analysis showed that the choice of a 'clean' electrical source (e.g. windfarm vs. coal) can alter manufacturing GWP by 15% in the US. Thereby, it showed that water usage in RSC processing was associated with 40% of this process and reduction of water volumes would reduce GWP.	Authors conclusion RSC significantly reduced GWP over DSC, with manufacturing and transport as the major contributors to the GWP of DSC. Larger containers have little GWP impact, transport distances and electricity sources are important factors. Limitations study The study is conducted in the USA with all processes related to 1 hospital, outcomes might changes for other hospitals and countries.

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
			at the DSC facility, and vice versa; tests impact of equal sized container volumes; tests impact of alternative electricity grids; tests transport vehicle load capacity; tests alternate disposal methods, e.g. shredding. Uncertainty analysis: No Variance analysis: Yes		4. Eutrophication No results in this study. 5. Human Toxicity No results in this study. 6. Ecotoxicity No results in this study. 7. Ozone Depletion No results in this study.	Reclamation of energy and material will reduce manufacturing GWP in both systems. Costs were reduced by 19.2% by using RSC.	
Grimmond (2021)	BMJ open Journal information BMJ Open is an online, open access journal, dedicated to publishing medical research from all disciplines and therapeutic areas. Critical review: Peer reviewed. Not in specific LCA journal or LCA in scope of the journal.	Type of study: LCA Objective: To compare global warming potential (GWP) of hospitals converting from single- use sharps containers to reusable sharps containers (SSC, RSC). LCA-method: Attributional LCA Setting and country: Acute care hospital trusts in the UK Facility: 40 UK NHS hospital trusts using RSC Years of data collection: 2018-2019 Surgical discipline(s): Nonspecific	Goal and scope[1]: To compare the life-cycle carbon footprint of 12-months usage of SSC with 12 months usage of RSC. Functional unit(s)[2]: Total fill line litres (FLL) of sharps containers needed to dispose of sharps for 1-year period in 40 trusts. System boundaries: Cradle to grave Included stages: Manufacture, transport, decanting and decontamination and treatment and disposal Stated excluded components: Capital machinery, infrastructure, vehicle life-cycle, labor, SC contents, non-GHG emissions Inventory database: Gabi database	The global warming potential (GWP) of hospitals converting from single-use sharps containers (SSC) to reusable sharps containers (RSC) were compared by using an attributional LCA model. The intervention in this study was conversion from SSC to RSC. Twelve months of usage of SSC was compared with twelve months usage of RSC. SSC and RSC usage details in 17 baseline trusts immediately prior to 2018 were applied to the RSC usage details of the 40 trusts using RSC in 2019. The outcome measure was GWP. This was calculated in carbon dioxide equivalents (CO_2 equivalents) generated in the manufacture, transport, service and disposal of 12 months,	1. Climate Change Annual greenhouse gas (GHG) emissions in 40 trusts resulted in a Global Warming Potential (GWP) of 3896.4 metric tons of (MT) CO_2 equivalents for SSC and 628.9 MTCO_2 equivalents for RSC (-83.9%). 2. Waste Annual waste for SSC resulted in 928.7 kg incinerated plastic and 136.6 kg of cardboard boxes for 1 748 851 manufactured and 1 748 851 incinerated SSC. Whereas RSC were not incinerated – all parts were either reused or recycled. Waste in the RSC study-year came from SSCs used in study-year. 3. Acidification No results in this study. 4. Eutrophication No results in this study. 5. Human Toxicity	Use of RSC leads to reduction of GWP and waste. The manufacturing process is the biggest contributor in GWP for SSC, and thereby gives the largest difference between the two containment systems. Transport is the biggest contributor for RSC. It resulted in 442 MT CO_2 equivalents of the total of 628.9 MT CO_2 equivalents annually for 40 hospital trusts. The sensitivity analysis showed that that changes achieved by changing processes/geography within life stages, were not mirrored in the final GWP comparisons, which in all but one alternative	Authors conclusion RSC achieved significant GHG reductions over SSC, container manufacture was the largest contributor in SSC, for RSC it was transport. RSC lifespans can be reduced and achieve marked GWP reductions over SSC. Adoption of reusable over SSC can reduce GHG emissions permanently with minimal staff behavioural change. Limitations study Results of SSC has been extrapolated from 17 trusts to 40 trusts and therefore the representativeness of data might not be accurate.

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
		Funding and conflict of interest:	Allocation: Yes, annual emissions for RSC manufacturing were determined by dividing total manufacturing GHG by the years of life expectancy. Normalization & Weighting: No Impacts reported: Yes Contribution analysis: Yes Scenario analysis: No Comparative analysis: Yes Sensitivity analysis: Yes; tests impact of larger vehicle size, transport distances, polymer and container manufacturing geographies, larger SSC container size and changing the lifespan from a base of 18 years to 1 year, theoretically maximum of 66 years and the 'break-point' at which life span RSC GWP matches SSC GWP. Uncertainty analysis: No Variance analysis: No	hospital-wide usage of both sharps containment systems in the 40 trusts. Characterization methods: IPCC	No results in this study. 6. Ecotoxicity No results in this study. 7. Ozone Depletion No results in this study.	scenario did not achieve changes for more than 5%. This was the RSC lifespan of 1 year, which was an academic exercise and is not expected in real life. Using larger vehicles for transport and optimization for reprocessing medical devices is recommended to lower GHG.	
Hicks (2016)	Environmental Science: Nano from 'The Royal Society of Chemistry' Journal information Information on the design and demonstration of engineered nanomaterials for environment-based applications and on the interactions of engineered, natural, and	Type of study: LCA Objective: To compare environmental impact of reusable patient hospital gowns coated with nAg (nanosilver) product to the use of disposable gowns. LCA-method:	Goal and scope[1]: Analysis of the lifecycle impact of the synthesis of nAg, its application to textiles in a hospital setting and laundering of the textile. Functional unit(s)[2]: - 4600 ug of nAg (amount added to hospital gown)	An LCA was conducted to compare the environmental impact of reusable patient hospital gowns coated with nAg product compared to the use of disposable gowns. First, the environmental impact of synthesis and attachment of 4600 ug nAg was determined (the amount added to a	1. Climate Change Results using nanosilver (nAg) as an antimicrobial agent for patient hospital gowns. Given the observed loss of nAg, the silver could be reapplied at each set of 17 launderings for reusable gowns and needed to be reapplied for every single disposable gown. Greenhouse gas (GHG) emissions for synthesis of 4600 ug nanosilver	Nanosilver (nAg) can be used for patient hospital gowns due to its antimicrobial nature. The results show it is necessary to synthesize the nAg and thereafter attach the silver to the gown. The impact is greater to attach the nAg to the textile than it is to	Authors conclusion The energy consumption was found to be much less during the lifetime of the reusable hospital gown than continuously using disposables. This suggests that nAg-enabling of reusable hospital gowns may be a method for simultaneously lowering the environmental impact

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
	incidental nanomaterials with biological and environmental systems. • Novel nanomaterial-based applications for water, air, soil, food, and energy sustainability • Nanomaterial interactions with biological systems and nanotoxicology • Environmental fate, reactivity, and transformations of nanoscale materials • Nanoscale processes in the environment • Sustainable nanotechnology including rational nanomaterial design, life cycle assessment, risk/benefit analysis Critical review: Peer reviewed journal. Not a specific LCA journal, however inclusion of LCA studies in scope of the journal.	Attributional LCA Setting and country: USA Facility: Hospital case study Years of data collection: Not defined. Surgical discipline(s): Nonspecific Funding and conflict of interest: U.S. Environmental Protection Agency Assistance Agreement No. RD 83558001-0 funded this research.	- Per one wear and laundering (over a lifetime of 75 wearings) System boundaries: Cradle to grave Included stages: Raw materials acquisition, manufacturing, use, end of life Stated excluded components: - Inventory database: Ecoinvent database (v 2.2) Allocation: No Normalization & Weighting: No Impacts reported: Yes Contribution analysis: Yes Scenario analysis: Yes Comparative analysis: Yes Sensitivity analysis: Yes Uncertainty analysis: Yes Variance analysis: No	hospital gown). Second the life cycle impacts of nanoscale silver (nAg)-enabled reusable hospital gowns per one wear are modelled and midpoint environmental data are compared. Characterization methods: TRACI	resulted in a Global Warming Potential (GWP) of 1.17 x 10^{-3} kg CO_2 equivalents. Nanosilver attachment resulted in 7.90 x 10^{-2} kg CO_2 equivalents per hospital gown. 2. Waste No results in this study. 3. Acidification Acidification for synthesis of 4600 ug nanosilver resulted in 9.99 x 10^{-4} mol H^+ equivalents. Nanosilver attachment resulted in 2.66 x 10^{-2} mol H^+ equivalents per hospital gown. 4. Eutrophication Eutrophication for synthesis of 4600 ug nanosilver resulted in 5.83 x 10^{-5} kg N equivalents. Nanosilver attachment resulted in 2.63 x 10^{-4} kg equivalents per hospital gown. 5. Human Toxicity Human toxicity in carcinogenics for synthesis of 4600 ug nanosilver resulted in 4.66 x 10^{-10} CTUh. Nanosilver attachment resulted in 4.28 x 10^{-9} CTUh per hospital gown. Human toxicity in non-carcinogenics for synthesis of 4600 ug nanosilver resulted in 6.37 x 10^{-9} CTUh. Nanosilver attachment resulted in 4.28 x 10^{-8} CTUh per hospital gown.	synthesize it. For reusable gowns the silver could be reapplied at each set of 17 launderings. This means the attachment has to be applied more often in disposable gowns, which would lead to a higher environmental impact. Next to that, the sensitivity analysis shows reapplying the nAg every wash cycle for the reusable gown leads to a higher environmental impact compared to the disposable gown. After 28 cycles the impact of the reusable gown is lower compared to the disposable gown. When reapplying after every 17^{th} cycle, the reusable gown has a lower impact compared to the disposable already at first use. This study shows that disposable patient hospital gowns coated with nAg lead to a higher environmental impact for compared nAg coated reusable gowns.	and maintaining the antimicrobial performance needed to combat pathogen transmission. Limitations study Only one attachment and synthesis process was analysed. The environmental impact of excess silver during synthesis and the silver lost is not explored. The comparisons of reusable and disposable gowns relies on prior work and utilizes only one impact category.

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					6. Ecotoxicity Ecotoxicity for synthesis of 4600 ug nanosilver resulted in 2.36 x 10^{-2} CTUe. Nanosilver attachment resulted in 1.51 x 10^{-1} CTUe per hospital gown. 7. Ozone Depletion Ozone depletion for synthesis of 4600 ug nanosilver resulted in 1.29 x 10^{-10} kg CFC-11 equivalents. Nanosilver attachment resulted in 5.70 x 10^{-9} kg CFC-11 equivalents per hospital gown.		
McGain (2010)	Anaesthesia and Intensive Care Journal information Anaesthesia and Intensive Care is an international journal publishing timely, peer reviewed articles that have educational value and scientific merit for clinicians and researchers associated with anaesthesia, intensive care medicine, and pain medicine. It is the official journal of the Australian Society of Anaesthetists, the Australian and New Zealand Intensive Care Society and the New Zealand Society of Anaesthetists. Critical review:	Type of study: LCA Objective: To assess the environmental and financial impacts of two types of commonly used plastic anesthetic drug trays: a single-use polyurethane tray made in China and reusable (300 uses) nylon tray made in Australia. Impacts and financial costs of two cotton gauzes and one paper towel, which are included with most single-use trays, were separately modelled. LCA-method: Attributional LCA Setting and country: Australia	Goal and scope[1]: To compare the financial and environmental costs of two commonly used anaesthetic drug trays. Functional unit(s)[2]: Use of one plastic anesthetic drug tray (+/- use of 2 cotton gauzes and 1 paper towel) System boundaries: Cradle to grave Included stages: Raw material extraction, production, packaging, transport, reuse, disposal Stated excluded components: Existing infrastructure for energy extraction and transportation was not included, nor was agricultural machinery, farm establishment, and forest establishment ("acquisition and	The financial and environmental costs of two commonly used anaesthetic drug trays were modelled using LCA. This study was performed at the Western Hospital in Melbourne, Victoria. The reusable tray, the single-use tray and the single-use tray with cotton and paper were compared. Data was collected directly from measurements and from databases (EcoInvent). The single-use trays were plastic Chinese-made trays and the reusable trays were Australian made nylon trays. Since not all data was directly available, an some data were also not available as average data, for the single-use trays the European energy mix is used, however the	1. Climate Change The reusable tray produced 110 g of CO_2 (95% CI 98 to 122 g CO_2), the single use tray alone produced 126 g CO_2 (95% CI 104 to 151 g) with a mean difference of 16 g CO_2 (95% CI -8 to 40 g CO_2). The single use tray with cotton and paper produced 203 g CO_2 (95% CI 166 to 268 g CO_2). 2. Waste No results in this study. 3. Acidification No results in this study. 4. Eutrophication No results in this study. 5. Human Toxicity No results in this study. 6. Ecotoxicity No results in this study.	CO_2 production of single-use trays was only a non-significant 15% greater. However, when modelling the single-use tray with cotton and paper the CO_2 production increased notably. For the reusable tray, the washing process contributes most to the total impact. For the disposable tray this is the production process of the polyurethane tray. For the cotton gauzes and paper towel, the production of the gauzes has the greatest impact.	Authors conclusion The author concludes that financial and environmental savings of a hospital converting to reusable trays are important, and that it seems difficult to justify persisting with single-use drug trays, particularly with added cotton gauze. Limitations study Data were average industry data and not directly measured (as with most LCA models). Data from tray manufacturers were unavailable, therefore data of average manufacturing effects were used. For the single-use trays the European energy mix is used, however the Chinese

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
	Peer reviewed. Not in specific LCA journal or LCA in scope of the journal.	Facility: Western Health, Melbourne, Victoria, Australia Years of data collection: - Surgical discipline(s): Anaesthesiology Funding and conflict of interest: None	infrastructure costs of machines or items that are already in place are routinely not included in LCAs") Inventory database: EcoInvent Allocation: No Normalization & Weighting: No Impacts reported: Yes Contribution analysis: Yes, although alignment between reported contributions and lifecycle stages not totally clear. Scenario analysis: No Comparative analysis: Yes Sensitivity analysis: No Uncertainty analysis: Yes, Monte Carlo analysis. Variance analysis: No	Chinese energy mix might be more coal reliant. Characterization methods: -	7. Ozone Depletion No results in this study.		energy mix might be more coal reliant.
McPherson (2019)	PeerJ Journal information: The open access journal for life and environment Critical review: Peer reviewed journal, not a specific LCA journal and not mentioned in scope. However focus on environment in this journal.	Type of study: LCA Objective: To assess the climate impacts of two different sharps container systems (disposable and reusable) over a 12 month period at Loma Linda University Health in California, USA, which is located considerably further away from manufacturers and reprocessors than is Northwestern Memorial	Goal and scope[1]: To compare the climate impacts of two different sharps container systems over a 12 month period. Functional unit(s)[2]: Provision of sharps containers at one healthcare facility for one year System boundaries: Cradle to grave Included stages: Raw material extraction, production, packaging, transport, reuse, disposal	This study followed a very similar methodology as that by Grimmond et al., 2012, including the use of the same cradle-to-grave LCI and calculation tool. The disposable sharps containment system was assessed for a 12 month period prior to Loma Linda University Health's (LLUH) transition to a reusable-based system. The reusable system (certified for 500 uses) was assessed for another 12 month period two years later	1. Climate Change Annual greenhouse gas (GHG) emissions resulted in a Global Warming Potential (GWP) of 248.62 metric tons of (MT) CO_2 equivalents for DSC and 86.19 $MTCO_2$ equivalents for reusable sharps containers (RSC). Adjusted patient days (APD) were used as the workload indicator to which results were normalized. This resulted in 8.37 $MTCO_2$ equivalents per 10,000 APD for DSC and 2.90 $MTCO_2$ equivalents per 10,000 APD for RSC. Use of RSC reduces GWP by	Use of RSC leads to reduction of GWP and waste. The manufacturing process is the biggest contributor in GWP for DSC, and thereby gives the largest difference between the two systems. It is predominantly a function of the energy required for the higher total polymer weight needed to be annually manufactured and molded for DSC.	Authors conclusion Large RSC transport distances less the differential between DSC and RSC GHG, however RSC still achieved significant GHG reductions over DSC. Transport and electricity cleanliness are key. RSC lifespan has minimal effect on GHG emissions. Purchasing decisions can contribute to reduction strategies. Institution wide adoption of RSC can

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		Hospital (previously studied). LCA-method: Attributional LCA Setting and country: Hospital USA Facility: Loma Linda University Health, San Bernardino, CA, USA Years of data collection: - Surgical discipline(s): Nonspecific Funding and conflict of interest: Brett McPherson and Mihray Sharip declare no conflict of interest. Terry Grimmond is an international consultant in sharps injury prevention and waste management to healthcare and associated industries. Daniels Health, the manufacturer did not review, sight or have input into the design, content, methodology, results, write-up of the study or choice of journal for publication. Daniels Health granted $2500 towards the cost of	Stated excluded components: Capital machinery and infrastructure, vehicles, labor, sharps container contents, as well as any inputs and outputs that constituted less than 1% or the systems total mass or energy (article cites "British Standards Institute, 2011 " PAS2050 guide) Inventory database: GaBi Allocation: No Normalization & Weighting: Yes, results normalised to 10,000 Adjusted Patient Days Impacts reported: Yes Contribution analysis: Yes Scenario analysis: No Comparative analysis: Yes Sensitivity analysis: Yes, reducing reusable container lifespan, alternate electricity grids, reprocessing optimization. Uncertainty analysis: No Variance analysis: Yes	once the transition was complete. Data were directly collected from LLUH regarding size, type, and number of containers used, as well as changeout protocols. Disposable sharps containers (DSCs) were made from US-sourced polymer in Illinois, packaged in cardboard, transported 3,200km to LLUH, and autoclaved and landfilled in California post-use. Reusable sharps containers (RSCs) were made in Michigan from Korean-sourced polymer, transported 3,500km in reusable transport containers, and reprocessed in California 440km from LLUH. Instead of normalizing the results to occupied beds, as was the case in Grimmond et al., 2012, total 'Adjusted Patient Days' was instead used as the workload indicator to which results were normalized. Characterization methods: IPCC	162.4 $MTCO_2eq$ (65.3%, P<0.001, RR 2.27-3.71). 2. Waste Annual waste for DSC resulted in 31.8 tonnes of landfilled plastic, 18.8 tonnes of incinerated plastic and 8.2 tonnes of cardboard boxes for 48,460 manufactured and 35,925 landfilled DSC (chemotherapy DSC were incinerated). Whereas RSC only caused 0.4 tonnes of plastic waste (Tonnes of chemo/pharma DSC incinerated; 412 chemo DSC were used during RSC year) and 0.1 kg of waste from carboard boxes (this were the chemotherapy DSC, which were used in both systems if there was an indication for chemotherapy). In total 3195 RSC were manufactured and 0 containers were landfilled (all parts were either reused or recycled). 3. Acidification No results in this study. 4. Eutrophication No results in this study. 5. Human Toxicity No results in this study. 6. Ecotoxicity No results in this study. 7. Ozone Depletion	Transport is the biggest contributor for RSC. Although more DSC required transportation, the daily transport of RSC resulted in similar GHG over the year between RSC and DSC. The sensitivity analysis revealed variations in RSC lifespan contributed little to the GHG result. It showed that differing electricity sources can alter the GHG contribution of the manufacturing process. It can alter DSC GHG by 23% and RSC GHG by 10%. RSC reprocessing accounted for 5.6% of the RSC life cycle. Material reclamation could reduce DSC life cycle GHG.	reduce GHG with minimal staff behavior change. Limitations study A limitation was the assumption made in the location of the polymer manufacturer for DSC. It was assumed to be close to the DSC manufacturer. Second, the use of the UK database for transport (because it used tonne.km).

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		the study, which covered approximately 10% of expenses. No other grant or funding was received from any funding agency in the public, commercial, or not-for-profit sectors. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.			No results in this study.		
Vozzola (2018)	PDA Journal of Pharmaceutical Science an Technology Journal information PDA JPST is the primary source of peer-reviewed scientific and technical papers on topics related to pharmaceutical/biopharmaceutical manufacturing, sterile product production, aseptic processing, pharmaceutical microbiology, quality, packaging science, and other topics relevant to PDA members. PDA JPST is an internationally recognized source that receives over a quarter of a million visitors annually. Critical review: Peer reviewed journal, not a specific LCA journal and not mentioned in scope.	Type of study: LCA Objective: To assess the environmental impacts of two different cleanroom coveralls: reusable and disposable LCA-method: Attributional LCA Setting and country: USA Facility: - Years of data collection: - Surgical discipline(s): Nonspecific Funding and conflict of interest:	Goal and scope[1]: To compare market representative reusable versus disposable cleanroom coveralls (defined as a single-piece, long-sleeve extra-large (XL) zip up garment). The scope was cradle to end of life. Functional unit(s)[2]: 1,000 garment uses System boundaries: Cradle to grave Included stages: Raw material extraction, production, packaging, transport, reuse, disposal Stated excluded components: The collection and reuse activities and credits were outside of the boundary of this study. The eventual landfill activities were also outside of the boundary of this study. Inventory database:	An LCA was conducted to assess the environmental impacts of two different cleanroom coveralls: reusable and disposable. This study is an analysis from cradle to crave, quantifying parameters such as energy use and GHG emissions, including different phases: Raw material extraction, production, packaging, transport, reuse and disposal. Characterization methods: -	1. Climate Change The CO_2 footprint of reusable coveralls resulted in 517 kg CO_2 equivalents for 1000 uses. The disposable (HDPE) resulted in 712 kg CO_2 equivalents and the disposable (PP) in 1220 kg CO_2 equivalents per 1000 uses. Switching to reusable resulted in a 27-58% decrease of the carbon footprint. For the disposable HDPE and PP coverall the manufacturing process contributed most to the CO_2 footprint (resp. 414 kg CO_2eq and 823 kg CO_2eq, 58-68% of cradle to end of life GHG). For the reusable PET coverall this resulted in 115 kg CO_2eq (22% of cradle to end of life GHG) The packaging manufacturing contributed for the reusable PET 4.4 % (22.8 kg CO_2eq) of the cradle to end of life GHG, for the	The reusable coveralls have a lower environmental impact and produce less waste compared to the disposable variant. The biggest contributor in CO_2 footprint for the disposable coverall is the manufacturing process (58-68%). For the reusable variant this is the laundry process (65%).	Authors conclusion It is absolutely clear that the environmental benefit of reusable coveralls is significant. Limitations study Packaging materials vary between supply companies and in this study representative materials are used for the different companies, however these are not precisely defined per company.

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	For this study, only a 'portion' of the LCI data were reviewed externally by industry experts. The report was internally reviewed by four members of the commissioning body	The European Change Consortium (partners of the consortium include drape and tape industry groups) commissioned Environmental Clarity, Inc to undertake the LCA	Environmental Clarity Allocation: No Normalization & Weighting: No Impacts reported: Yes Contribution analysis: Yes, only for NRE consumption and GHG emissions. Scenario analysis: Yes, different transportation scenarios. Comparative analysis: Yes Sensitivity analysis: No Uncertainty analysis: No Variance analysis: No		disposable HDPE 6.8% (48.4 kg CO_2eq) and for the disposable PP 4% (48.4 kg CO_2eq). The laundry process contributed for the reusable PET 65 % (336 kg CO_2eq) of the cradle to end of life GHG, for the disposable HDPE 20% (143 kg CO_2eq) and for the disposable PP 17% (204 kg CO_2eq). The sterilization process contributed for the reusable PET 0.21% (1.08 kg CO_2eq) of the cradle to end of life GHG, for the disposable HDPE 0.065% (0.461kg CO_2eq) and for the disposable PP 0.054% (0.657 kg CO_2eq). The use phase transport contributed for the reusable PET 8.1% (42.1 kg CO_2eq) of the cradle to end of life GHG, for the disposable HDPE 14% (99.9 kg CO_2eq) and for the disposable PP 11% (132 kg CO_2eq). The End-of-Life contributed for the reusable PET 0% (0 kg CO_2eq) of the cradle to end of life GHG, for the disposable HDPE 0.87% (6.19 kg CO_2eq) and for the disposable PP 8.35% (0.69 kg CO_2eq). 2. Waste Solid waste includes: Disposable coveralls, biological waste, and plastic and paper packaging. In		

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					this study, 100% of the reusable cleanroom coveralls were reused in other industries at the end-of-life stage and therefore not included as solid waste. The waste generation of reusable coveralls resulted in 10.2 kg for 1000 uses. The disposable (HDPE) resulted in 171 kg and the disposable (PP) in 238 kg per 1000 uses. 3. Acidification No results in this study. 4. Eutrophication No results in this study. 5. Human Toxicity No results in this study. 6. Ecotoxicity No results in this study. 7. Ozone Depletion No results in this study.		
Vozzola (2020)	AORN Journal Journal information The AORN Journal will be an indispensable resource recognized for scholarly, evidence-based, peer-reviewed articles that convey standards of excellence and innovations in the delivery of perioperative nursing.	Type of study: LCA Objective: To assess the environmental impacts of two types of surgical gown: disposable and reusable LCA-method: Attributional LCA Setting and country:	Goal and scope[1]: Assessment of environmental impacts of disposable versus reusable surgical gowns. Functional unit(s)[2]: 1,000 uses of an extra large, single-piece, long-sleeved surgical gown in an operating room setting System boundaries: Cradle to grave Included stages:	LCA of reusable versus disposable gowns to assess the environmental impact of these surgical gowns in the USA. An LCA was conducted according to the standards from the International Organization for Standardization. The Environmental Clarity, Inc, LCA database was used to evaluate the life cycles of both surgical gown systems. The outcome	1. Climate Change The total GWP for 1,000 uses of the reusable surgical gown is 557 kg CO_2eq, and for the disposable 1636 kg CO_2eq. By selecting the reusable surgical gown, this will result in a 66% reduction of GWP. The gown manufacturing and supply chain resulted for 1,000 uses of the reusable gown in 134 kg CO_2eq and for the disposable gown 1495 kg CO_2eq.	The reusable surgical gown has lesser impact on the environment in terms of Climate Change and waste. The biggest contributor for the disposable gown is the manufacturing process, as well for the GWP as in waste production.	Authors conclusion The current study adds to the body of evidence that shows the environmental superiority of reusable surgical gowns. Limitations study Comfort was not taken into the analysis, although this is a factor for scrubbed surgical team members.

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
	Journal content supports the clinical, research/quality improvement, education, and management strategies related to the nurse's role in caring for patients before, during, or after operative and other invasive and interventional procedures in ambulatory and inpatient settings. Critical review: Peer-reviewed, however no specific LCA journal or LCA taken into the scope of the journal.	USA Facility: - Years of data collection: - Surgical discipline(s): Nonspecific Funding and conflict of interest: All authors declare affiliations that could be perceived as posing a potential conflict of interest (all authors are consultants for the American Reusable Textile Association and the International Association for Healthcare Textiles, and are involved in Environmental Clarity, Inc.) This study was funded by The American Reusable Textile Association (ARTA) Life Cycle Assessment Committee, Shawnee Mission, KS.	Raw material extraction, production, packaging, transport, use, reuse, disposal Stated excluded components: - Inventory database: Environmental Clarity Inc. Allocation: No Normalization & Weighting: No Impacts reported: Yes Contribution analysis: Yes Scenario analysis: No Comparative analysis: No Sensitivity analysis: Yes, modelled 0% and 100% reuse of end-of-life reusable gowns in other industries; if disposable gowns were instead manufactured in the US, 10% more energy efficient laundry processes. Uncertainty analysis: No Variance analysis: No	Climate Change was expressed as GWP, in kg of CO2 equivalents. Characterization methods: -	The packaging manufacturing and supply chain resulted for 1,000 uses of the reusable gown in 76.7 kg CO_2eq and for the disposable gown in 121 kg CO_2eq. Laundry resulted in 278 kg CO_2eq for the reusable gown, and there was 0 kg CO_2eq used for the disposable gowns. The sterilization of the gowns resulted in 19.8 kg CO_2eq for the reusable and 6.26 kg CO_2eq for the disposable gown. The use phase transport of 1,000 reusable gowns resulted in 38.7 kg CO_2eq for the reusable gown and 2.47 kg CO_2eq for the disposable gown. The end of life contribution to the GWP resulted in 1.40 kg CO_2eq for the reusable variant and 10.9 kg CO_2eq for the disposables. 2. Waste Solid waste per 1,000 uses/1,000 gowns resulted in 35.5-43.4 kg for the reusable and 265 kg for the disposable gown. Gown manufacturing resulted in 0-7.9 kg solid waste for the reusable and 224 kg solid waste	For the reusable surgical gown the laundry phase has the greatest impact.	Economic measurements are not included. The blue water comparisons' accuracy is limited due to lack of data on water content of soiled gowns. Not all disposable gowns are produced in Chine or sterilized with ethylene oxide (what is used in this study). Packaging of disposable and reusables vary.

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					for the disposable gown (1,000 uses/gowns). Packaging manufacturing and supply chain yielded 35.5 kg solid waste for the reusable gown and 40.3 kg for the disposable (1,000 uses/gowns). End of life resulted in 0-0.00842 kg solid waste for the reusable and 0.505 for disposable gowns (1,000 uses/gowns). 3. Acidification No results in this study. 4. Eutrophication No results in this study. 5. Human Toxicity No results in this study. 6. Ecotoxicity No results in this study. 7. Ozone Depletion No results in this study.		
Davis (2018)	Journal of Endourology Journal information Peer-reviewed journal and innovative videojournal companion exclusively focused on minimally invasive and robotic urology, applications, and clinical outcomes. Critical review:	Type of study: LCA Objective: To assess the climate impacts of two types of flexible ureteroscopes: single-use (LithoVue™, Boston Scientific) and reusable (Olympus Flexible Video; typically 16 uses before repair and 180 uses before decommissioning)	Goal and scope[1]: To compare the environmental impacts of single-use and reusable ureteroscopes. Functional unit(s)[2]: Use of one ureteroscope during one endourologic case System boundaries: Cradle to grave Included stages:	The environmental impact of single-use flexible ureteroscopes with reusable flexible ureteroscopes were compared. An LCA of the LithoVue (Boston Scientific) single-use digital flexible ureteroscope and Olympus Flexible Video Ureteroscope (URV-F) was performed. Data on raw	1. Climate Change The CO_2 footprint per case was calculated. For the single-use ureteroscope the total CO_2 footprint per case is 4.43 kg CO_2 equivalents. This consisted of manufacturing costs, solid waste and sterilization. The manufacturing costs resulted in 3.83 kg CO_2, solid waste in 0.3 kg CO_2 and sterilization 0.3 kg CO_2 .	The study suggests the data on environmental costs are comparable between the disposable and reusable ureteroscope. However, the comparison is per case and not for the whole life cycle of a reusable ureteroscope, so this might interfere with the results. It is expected that with the high	Authors conclusion The carbon footprint of the single use and reusable ureteroscopes is comparable. Informed clinicians should be willing to advocate for changes within the healthcare delivery and within the manufacturing industry to maintain healthcare quality, cost-effectiveness and safety in the future.

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
	Peer reviewed article. Not in specific LCA journal.	LCA-method: Attributional LCA Setting and country: Hospital Australia Facility: Austin Hospital, Melbourne, Victoria, Australia Years of data collection: - Surgical discipline(s): Urology & Nephrology Funding and conflict of interest: -	Raw material extraction, production, reuse, disposal Stated excluded components: - Inventory database: - Allocation: No Normalization & Weighting: No Impacts reported: Yes Contribution analysis: Yes Scenario analysis: No Comparative analysis: Yes Sensitivity analysis: No Uncertainty analysis: No Variance analysis: No	material extraction, manufacturing, reuse and disposal of the instruments was obtained. The solid waste generated (kg) and energy consumed (kWh) during each case were quantified and used to calculate the CO2 footprint. The outcome measures were Climate Change (CO2 footprint) and waste. Characterization methods: -	The total CO_2 footprint of the reusable ureteroscope was 4.47 kg CO_2 per case. This consisted of manufacturing costs (0.06 kg CO_2), washing/sterilization (3.95 kg CO_2), repackaging theatre wrap (<0.005 kg CO_2), repair costs (0.45 kg CO_2) and solid waste (0.005 kg CO_2). 2. Waste Solid waste for the disposable ureteroscope resulted in 0.3 kg CO_2 per case. Solid waste for the reusable ureteroscope resulted in 0.005 kg CO_2 per case. 3. Acidification No results in this study. 4. Eutrophication No results in this study. 5. Human Toxicity No results in this study. 6. Ecotoxicity No results in this study. 7. Ozone Depletion No results in this study.	manufacturing impact of the disposable variant, this impact after multiple uses will exceed the environmental impact of the reusable variant.	Limitations study The data are compared per case. However, reusable ureteroscopes can be used multiple times. This is not included in the analysis and could potentially lead to a lower environmental impact for reusable ureteroscopes.
Donahue (2020)	American Journal of Obstetrics & Gynecology Journal information The American Journal of Obstetrics and Gynecology, "The Gray Journal", covers the full	Type of study: LCA Objective: To assess the climate impacts of three types of vaginal specula that are commonly used in practice	Goal and scope[1]: To compare the environmental impacts of three types of vaginal specula (one single-use and two reusable models) Functional unit(s)[2]:	Life cycle assessment methods were applied to evaluate the carbon footprints of 3 vaginal specula: a single-use acrylic model and two reusable stainless steel models (reusable stainless	1. Climate Change Donahue (2020) demonstrated the reusable grade 304 speculum produces fewer life cycle CO_2e emissions than the equivalent number of disposable acrylic specula after 2 completed examinations (2.11 kg CO_2e	The study shows the disposable acrylic speculum has the biggest negative environmental impact. This is mainly due to material production and manufacturing. This phase	Authors conclusion By using acrylic specula for over a period of 1 year (5875 disposable acrylic specula), 5153 kg CO2e and 5462 kg solid waste were produced. By changing to steel grade

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	spectrum of Obstetrics and Gynecology. The aim of the Journal is to publish original research (clinical and translational), reviews, opinions, video clips, podcasts and interviews that will have an impact on the understanding of health and disease and that has the potential to change the practice of women's health care. An important focus is the diagnosis, treatment, prediction and prevention of obstetrical and gynecological disorders. The Journal also publishes work on the biology of reproduction, and content which provides insight into the physiology and mechanisms of obstetrical and gynecological diseases. Critical review: Peer reviewed, not a specific LCA journal.	(a single-use acrylic model and two reusable stainless steel models) LCA-method: Attributional LCA Setting and country: USA Facility: Michigan Medicine, University of Michigan, Ann Arbor, MI, USA Years of data collection: - Surgical discipline(s): Obstetrics & Gynecology Funding and conflict of interest: The authors report no conflict of interest.	Completion of 20 gynaecologic examinations using a speculum System boundaries: Cradle to grave Included stages: Raw material extraction, production, transportation, reuse, and disposal Stated excluded components: Excluded components were inks, bulk packaging, autoclave production, illumination pack for plastic specula, and lubrication (expected to have minimal impacts on results). Inventory database: EcoInvent, IDEMAT, GREET, EPA WARM Allocation: No Normalization & Weighting: No Impacts reported: Yes Contribution analysis: Yes Scenario analysis: No Comparative analysis: Yes Sensitivity analysis: Yes, Sensitivity analysis reports impacts based on different numbers of uses (1-500), autoclave loading practices, regional electricity grids, reprocessing method (autoclave vs H_2O_2) Uncertainty analysis: No	steel grade 304 speculum and the reusable stainless steel grade 316 speculum). The data were obtained regarding speculum and packaging composition and weight. There were no data available on production processes for the specula. For this reason, assumptions were made. For the acrylic specula injection molding was assumed and for the reusable specula a combination of hot extrusion, milling/turning, deformation and heat treatment was assumed, based on literature. The transportation was based on manufacturer and general industry data. Reuse for the steel reusable specula was estimated based on autoclave manufacturer specifications. Disposal was modeled with the use of the EPA WARM model, which estimates the average greenhouse gas (GHG) emissions that are associated with disposal of various materials in the United States (US). Characterization methods: IPCC	compared to 2.63 kg CO_2e). The reusable grade 316 produces fewer life cycle CO_2e emissions after 3 completed examinations (3.11 kg CO_2e compared to 3.51 kg CO_2e). The reusable stainless steel grade 304 speculum is less carbon intensive to produce compared to the grade 316 speculum, which is the reason why the grade 304 remains less in its total life cycle CO_2e emissions over a wide range of uses. After 500 examinations the difference becomes more apparent (grade 316 – 107.52, grade 304 – 101.31 and acrylic – 438.55 kg CO_2e). The contribution of the stages differs between the specula. The largest contributor for the disposable acrylic speculum is material production and manufacturing (90.6%), followed by transportation (6.5%) and waste/end-of-life (2.9%). For the reusable stainless steel grade 304 speculum the largest source of CO_2 emissions is use/reprocessing (74.1%), followed by material production and manufacturing (24.9%) and transportation (0.46%). The biggest contributor in total life cycle emissions for the grade 316 speculum was use/reprocessing (65.2%),	offers opportunities to decrease this impact. For the reusable stainless steel specula the main contributor is the energy used to power autoclaves. Here is an opportunity to reduce this by increasing the efficiency of energy-use and by making a transition to more renewable energy sources. In the sensitivity analysis it became clear that the impact increased significantly when shifting to individually sterilizing the specula, instead of sterilizing multiple at the same time (increase of 189-219%). However, doubling the autoclave load (4 Pouches (base case) to 8 Pouches (full load)) did not have a great difference in the overall impact (20-39% decrease in greenhouse gas emissions). Changing from the most carbon intensive electricity grid to the least carbon intensive resulted in a 33-36% reduction of CO_2e emissions. Regardless of the grid used, the stainless steel life cycle greenhouse gas	304 of grade 316 specula (100 uses average), greenhouse gas emissions could have been reduced by 75& and 74% respectively with a significant decline in end-of-life waste generation (both 64.43 kg). Health systems might consider environmental impact in addition to costs and clinical efficacy when choosing medical instruments. Limitations study Multiple assumptions were made in the analysis, mainly regarding production and reprocessing, due to lack of data from manufacturers and other sources. The authors choose to use the less carbon intensive approach for the acrylic specula and the more carbon intensive approach for the steel specula, to ensure any difference shown would be robust. Next to that, the study was further limited by the lack of life cycle data on high level disinfectants such as glutaraldehyde, ortho-phthalaldehyde and peracetic acid.

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
			Variance analysis: No		followed by production (34.4%) and transportation (0.4%). 2. Waste No results in this study. 3. Acidification No results in this study. 4. Eutrophication No results in this study. 5. Human Toxicity No results in this study. 6. Ecotoxicity No results in this study. 7. Ozone Depletion No results in this study.	emission remained lower than the acrylic specula. Using high level disinfectant instead of autoclave sterilization, resulted in a 11-12% increase in greenhouse gas emissions.	
Eckelman (2012)	Anesthesia & Analgesia Journal information The "The Global Standard in Anesthesiology," provides practice-oriented, clinical research you need to keep current and provide optimal care to your patients. Brings peer reviewed articles on the latest advances in drugs, preoperative preparation, patient monitoring, pain management, pathophysiology, and many other timely topics. Critical review:	Type of study: LCA Objective: To assess the environmental impacts of two types of laryngeal mask airways (LMAs): single-use (Unique™) and reusable (Classic™; 40 lifetime uses) LCA-method: Attributional LCA Setting and country: USA Facility: Yale-New Haven Hospital, New Haven, CT, USA	Goal and scope[1]: Compare the environmental impact of a disposable and a reusable LMA, from cradle to grave. Functional unit(s)[2]: Maintenance of 40 airways System boundaries: Cradle to grave Included stages: Raw material extraction, production, packaging, transport, reuse, disposal Stated excluded components: Excluded components were bulk packaging, machinery, and small components such as inks and labels on the	The environmental impacts of two types of laryngeal mask airways (LMAs): single-use (Unique™) and reusable (Classic™; 40 lifetime uses) were assessed by using a life cycle assessment method. Raw material extraction, production, packaging, transport, reuse and disposal were included in the analysis. The material composition and weights were established on the basis of manufacturer information and density testing. Materials were matched with the most appropriate Life Cycle Inventory (LCI)	1. Climate Change Eckelman (2012) demonstrated the results on climate change specifically to be 7.4 kg CO_2e of GHG over its life cycle for the reusable LMA and 11.3 kg CO_2e for the disposable LMA. For all outcomes in this study, results are expressed in percentages, whereas the LMA with the highest impact is defined as 100% and the other LMA is relatively compared to the LMA with the highest impact. For the outcome climate change, the disposable LMA had the highest impact (100%) compared to the reusable LMA (65%). The largest source for the disposable LMA is the polymerization of PVC (23%), which is the main	This study demonstrates the disposable LMA has a bigger environmental impact compared to the reusable LMA. In the outcome measure climate change, this is mainly due to the production of the material for the disposable LMAs that is used. A change of material production, or a change in type of material which has a lesser impact on the environment could be a way to help reduce the impact for the disposable LMA. Next to that the biggest contributor for the reusable LMA is the production of steam for	Authors conclusion The results suggest the reusable LMA has a lower life cycle environmental impact compared to the disposable LMA at Yale New Haven Hospital, across all categories of concern. Limitations study This study did not analyse the environmental health impacts during the use of an LMA, where intraoperative exposure to some parts of the plastics could contribute increasing the outcome human toxicity.

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
	Peer reviewed, not a specific LCA journal.	 Years of data collection: - Surgical discipline(s): Anesthesiology Funding and conflict of interest: The authors declare no conflict of interest. Funding came from the department of anesthesiology, Yale School of Medicine.	packaging and on the sterilization indicator strips (expected to have negligible impacts) Inventory database: Ecoinvent Allocation: No Normalization & Weighting: No Impacts reported: Yes Contribution analysis: No (hotspots reported in text) Scenario analysis: No Comparative analysis: Yes Sensitivity analysis: Yes, tests alternative assumptions including transport mode, autoclave loading, number of reuse cycles (10-100), waste pathways, and labour. Uncertainty analysis: No Variance analysis: No	records from EcoInvent (database). Production processes for hard and soft plastics were assumed to be injection molding and thermoforming, respectively. Data was obtained from distributors to estimate distances and mode of transport. Reprocessing of reusable LMAs was estimated using data from Yale New Haven Hospital and autoclave specifications. Disposal was modelled using US average statistics for solid waste. Characterization methods: BEES	material used. The majority of the remaining contributors are polycarbonate production (14%), transportation via truck (15%), thermoforming (13%) and waste disposable (11%). The majority of the GHG emissions for the reusable LMA (77%) is from natural gas production and combustion, which is to produce steam for the autoclave. 2. Waste No results in this study. 3. Acidification For the outcome acidification, the disposable LMA had the highest impact (100%) compared to the reusable LMA (20-30%). 4. Eutrophication For the outcome eutrophication, the disposable LMA had the highest impact (100%) compared to the reusable LMA (90-100%). 5. Human Toxicity The human toxicity, stated as human health (HH) in this study, was defined in three different groups: HH cancer, HH noncancer and HH air pollutants. For the outcome HH cancer, the disposable LMA had the highest impact (100%) compared to the reusable LMA (0-10%). For the outcome HH noncancer, the disposable LMA	the autoclave. If this could be done in some other way, the environmental impact of the reusable LMA could decrease. Alternate assumptions are also made in this study. It shows the effect of alternate modes of transport, compared to the base case (rail), was quite small for the reusable LMA but more interesting for the disposable LMA, leading to a decrease in GHG emissions (-9%) changing to transport by road, and an increase (+81%) by using air transportation. Individually autoclaving the reusable LMA resulted in an increase of life cycle GHG emissions by >400%, whereas loading with 10 LMAs per cycle (compared to the base case 5 per cycle) resulted in a decrease of 25%. Using a more capital intensive option to increase the energy efficiency of the machines by 10% results in a decrease of GHG emissions of 8%. The human toxicity impacts are dominated by the production and use of	

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					had the highest impact (100%) compared to the reusable LMA (0-10%) and the outcome HH air pollutants, resulted in the highest impact for yet the disposable LMA (100%) compared to 20-30% for the reusable LMA. 6. <u>Ecotoxicity</u> For the outcome ecotoxicity, the disposable LMA had the highest impact (100%) compared to the reusable LMA (10-20%). 7. <u>Ozone Depletion</u> For the outcome ozone depletion, the disposable LMA had the highest impact (100%) compared to the reusable LMA (20-30%).	plastics for the disposable LMA. Increasing the amount of PVC by 10% leads to a 5% increase in cancer and noncancer effects. Premature disposal of the reusable LMA has its direct effects on GHG emissions, by a >50% increase if the LMA is disposed at 10 reuse cycles. Extending the reuse cycle of reusable LMAs to 80 cycles (doubling lifetime) results in a decrease of GHG emissions by 9%. In waste management, by switching from 100% incineration to 100% landfill, reduces the impacts across all categories by 5-10%. Including the labor for cleaning impacts (base case not included) resulted only in a nominally increase for total GHG emissions and water impacts of reusable LMAs.	
Ibbotson (2013)	International Journal of Life Cycle Assessment <u>Journal information</u> The International Journal of Life Cycle Assessment is	<u>Type of study:</u> LCA <u>Objective:</u> To assess the environmental and	<u>Goal and scope[1]:</u> Assess the environmental and financial impacts of three surgical scissors, to compare their eco-efficiency.	The environmental and financial impacts of three surgical scissors which are (1) disposable scissors made of plastic (fibre reinforced), (2) disposable	1. <u>Climate Change</u> Ibbotson (2013) reported the results on climate change graphically in Figure 4 of the article (Ibbotson, 2013). The figure shows the results on a log	The study shows that the reusable stainless steel scissor is the choice with the lowest environmental impact in all the impact categories investigated.	<u>Authors conclusion</u> The eco-efficiency results indicated that the stainless steel reusable scissor is the option with the lowest

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
	the first journal devoted entirely to Life Cycle Assessment and closely related methods. The Int J Life Cycle Assess is a forum for scientists developing LCA and LCM (Life Cycle Management); LCA and LCM practitioners; managers concerned with environmental aspects of products; governmental environmental agencies responsible for product quality; scientific and industrial societies involved in LCA development, and ecological institutions and bodies. Critical review: Peer reviewed, specific LCA journal.	financial impacts of three types of surgical scissors: disposable plastic reinforced scissors, disposable stainless steel scissors, and reusable stainless steel scissors LCA-method: Attributional LCA Setting and country: Hospital in Germany Facility: - Years of data collection: - Surgical discipline(s): Nonspecific Funding and conflict of interest: -	Functional unit(s)[2]: 4,500 use cycles of surgical scissors during 18 years System boundaries: Cradle to grave Included stages: Raw material extraction, production, packaging, transport, reuse, disposal Stated excluded components: - Inventory database: EcoInvent, Australian Data 2007 Allocation: No Normalization & Weighting: No Impacts reported: Yes, graphically with log scale. Contribution analysis: Only for ReCiPe endpoint and CED results. Scenario analysis: No Comparative analysis: Yes Sensitivity analysis: Yes, tests alternative electricity mixes, sterilization processes (gamma and gas), disposal method (incineration and recycling). Uncertainty analysis: No Variance analysis: No	scissors made of stainless steel and (3) reusable scissors made of stainless steel were assessed using a life cycle assessment and life cycle costing method. The data was compared for the use of 4,500 cycles if usage in Germany. The data on raw material, manufacturing (including electricity consumption), transport, and disposal process were obtained from a medical company in Europe. Missing data (e.g. sterilization processes for reusable scissors) were obtained from the literature or expert opinion. Electricity data that was missing was adjusted from the International Energy Agency (IEA). Incineration of plastics, cardboard and municipal solid waste were assumed based on Swiss plants in 2000 (from EcoInvent). Characterization methods: CED Method, ReCiPe	scale and the outcomes are extracted from this figure. It demonstrates that after 4,500 use cycles the disposable stainless steel scissor has the highest impact in this category (+/- 10,000 kg CO_2-equivalents), followed by the disposable plastic scissor (+/- 5500 kg CO_2-equivalents) and eventually the reusable stainless steel scissor (+/- 550 kg CO_2-equivalents). 2. Waste No results in this study. 3. Acidification Ibbotson (2013) reported the results on acidification in Figure 4 of the article (Ibbotson, 2013). The figure shows the results on a log scale and the outcomes are extracted from this figure. It demonstrates that after 4,500 use cycles the disposable stainless steel scissor has the highest impact in this category (+/- 90 kg SO_2-equivalents), followed by the disposable plastic scissor (+/- 20 kg CO_2-equivalents) and eventually the reusable stainless steel scissor (+/- 0.8 kg SO_2-equivalents). 4. Eutrophication Ibbotson (2013) reported the results on eutrophication in Figure 4 of the article (Ibbotson, 2013). The figure shows the results on a log scale and the outcomes are extracted from	This is followed by the disposable plastic scissor and eventually the disposable stainless steel scissor, which has the highest impact. The hotspots for the disposable scissors were found in the material and manufacturing process and for the reusable scissor this was found in the usage phase, which could be appointed to the washing, disinfection and sterilization cycles and the repair and service cycles.	environmental impact and is next to that, cheapest. Limitations study Data sources were not comparable between the scissors, since the plastic disposable and stainless steel reusable data was obtained from company data and the stainless steel disposable scissor data was obtained from literature. Data on electricity was not available (located in Asian countries), so another energy mix was used. This also accounted for other data like recycling data. This results in a situation that could not be totally applicable for the German situations studied.

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					this figure. Freshwater and marine eutrophication are described separately. Regarding freshwater eutrophication, the results demonstrate that after 4,500 use cycles the disposable stainless steel scissor has the highest impact in this category (+/- 1 kg P-equivalents), followed by the disposable plastic scissor (+/- 0.55 kg P-equivalents) and eventually the reusable stainless steel scissor (+/- 0.3 kg P-equivalents). Next to that, with regard to marine eutrophication, the results demonstrate that after 4,500 use cycles the disposable stainless steel scissor has the highest impact in this category (+/- 10 kg N-equivalents), followed by the disposable plastic scissor (+/- 6 kg N-equivalents) and eventually the reusable stainless steel scissor (+/- 0.2 kg N-equivalents). 5. <u>Human Toxicity</u> Ibbotson (2013) reported the results on human toxicity in Figure 4 of the article (Ibbotson, 2013). The figure shows the results on a log scale and the outcomes are extracted from this figure. It demonstrates that after 4,500 use cycles the disposable stainless steel scissor has the highest impact in this category (+/- 7750 kg 1.4-DB equivalents), followed by the disposable plastic scissor (+/-		

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					750 kg 1.4-DB equivalents) and eventually the reusable stainless steel scissor (+/- 200 kg 1.4-DB equivalents). 6. <u>Ecotoxicity</u> Ibbotson (2013) reported the results on ecotoxicity graphically in Figure 4 of the article (Ibbotson, 2013). The figure shows the results on a log scale and the outcomes are extracted from this figure. Terrestrial and freshwater ecotoxicity are described separately. Regarding terrestrial ecotoxicity, the results demonstrate that after 4,500 use cycles the disposable stainless steel scissor has the highest impact in this category (+/- 2 kg 1.4-DB equivalents), followed by the disposable plastic scissor (+/- 0.4 kg 1.4-DB equivalents) and eventually the reusable stainless steel scissor (+/- 0.03 kg 1.4-DB equivalents). Next to that, with regard to freshwater ecotoxicity, the results demonstrate that after 4,500 use cycles the disposable stainless steel scissor has the highest impact in this category (+/- 500 kg 1.4-DB equivalents), followed by the disposable plastic scissor (+/- 55 kg 1.4-DB equivalents) and eventually the reusable stainless steel scissor (+/- 4 kg 1.4-DB equivalents). 7. <u>Ozone Depletion</u>		

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					Ibbotson (2013) reported the results on ozone depletion in Figure 4 of the article (Ibbotson, 2013). The figure shows the results on a log scale and the outcomes are extracted from this figure. It demonstrates that after 4,500 use cycles the disposable stainless steel scissor has the highest impact in this category (0.00055 kg CFC-11 equivalents), followed by the disposable plastic scissor (0.0001 kg CFC-11 equivalents) and eventually the reusable stainless steel scissor (+/- 0.00004 kg CFC-11 equivalents).		
Leiden (2020)	Resources, Conservation & Recycling <u>Journal information</u> Open Access journal with independent editorial board and peer-review process. Contributions from research, which consider sustainable management and conservation of resources are welcomed. The journal emphasizes the transformation processes involved in a transition toward more sustainable production and consumption systems. Emphasis is upon technological, economic, institutional and policy aspects of specific	<u>Type of study:</u> LCA <u>Objective:</u> To assess the environmental impacts of two types of instrument set for single-level lumbar fusion surgeries: disposable (Neo Pedicle Screw System from Neo Medical SA) and reusable (Viper 2 from DePuy Synthes, 300 uses). <u>LCA-method:</u> Attributional LCA <u>Setting and country:</u> Hospitals in Germany <u>Facility</u>: -	<u>Goal and scope[1]:</u> To compare whether reusable or disposable surgical instrument sets for single-level lumbar fusion surgeries are advantageous from an environmental perspective. Also, the identification of hotspots for designing future sustainable surgical instruments. <u>Functional unit(s)[2]:</u> The surgical instrument set required for one single-level lumbar fusion surgery involving the implantation of four screws and two rods <u>System boundaries:</u> Cradle to grave <u>Included stages:</u>	The difference in contribution to the environmental impact of a disposable and a reusable surgery instrument set for lumbar fusion surgeries are investigated. The data compares the reusable and the disposable set for one single surgery in Germany. The data on manufacturing was based on weight, material and form of instruments, transportation on mode and calculated distances between producer, distributor, and hospital and washing and steam sterilization was specific to a German hospital. Disposal was modelled using EcoInvent waste incineration processes.	1. <u>Climate Change</u> Leiden (2020) reported the results in percentages. They are displayed as percentage of the maximum value of each impact category. For the outcome climate change, the reusable set had the highest impact (100%) compared to the disposable set (10-20%) after 1 surgery. For the disposable surgical set the production phase had the biggest contribution and for the reusable set the sterilization process. 2. <u>Waste</u> No results in this study. 3. <u>Acidification</u> Leiden (2020) reported the results in percentages. They are displayed as percentage of the maximum value of each impact	This study suggests the reusable surgical set has a bigger environmental impact compared to the disposable set. The limitation is that the disposable and reusable set are compared for 1 surgery. Since the reusable set can be reused for several times, this can influence the results over time. A sensitivity analysis has be conducted, where the reusable set has been reused. However, it is still compared to the base case of the disposable set (1 surgery). This does not reflect reality in the results.	<u>Authors conclusion</u> The authors conclude the environmental impact of the disposable system was significantly lower in all impact categories. This is mainly due to the high impact of the steam sterilization process and the big size of the reusable instruments sets. <u>Limitations study</u> A limitation is that the disposable and reusable set are compared for 1 surgery. Since the reusable set can be reused for several times, this can influence the results over time. A sensitivity analysis has be conducted, where the

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
	resource management practices, such as conservation, recycling and resource substitution, and of "systems-wide" strategies, such as resource productivity improvement, the restructuring of production and consumption profiles and the transformation of industry. Critical review: Peer reviewed, not a specific LCA journal.	Years of data collection: - Surgical discipline(s): Neurology Funding and conflict of interest: The study was funded by Neo Medical S.A., but it is stated that Neo Medical S.A. had no direct influence on the results of the study.	Raw material extraction, production, packaging, transport, reuse, disposal Stated excluded components: - Inventory database: EcoInvent Allocation: No Normalization & Weighting: No Impacts reported: No Contribution analysis: Yes Scenario analysis: No Comparative analysis: Yes Sensitivity analysis: Yes, tests alternate assumption, including: number of usage cycles for the reusable set (300-500) and loan (distributor rechecks and replaces missing components between each use) vs. consignment system (i.e. in-hospital reprocessing with requests to distributor for missing components) Uncertainty analysis: No Variance analysis: No	 Characterization methods: CML, ReCiPe	category. For the outcome climate Acidification, the reusable set had the highest impact (100%) compared to the disposable set (30-40%) after 1 surgery. For the disposable surgical set the production phase had the biggest contribution and for the reusable set the sterilization process. 4. Eutrophication No results in this study. 5. Human Toxicity No results in this study. 6. Ecotoxicity No results in this study. 7. Ozone Depletion No results in this study.	The biggest hotspots are clearly stated. The sterilization process is the biggest contributor to the environmental impact for the reusable set and for the disposable set the production process is most contributory.	reusable set has been reused. However, it is still compared to the base case of the disposable set (1 surgery). This does not reflect reality in the results.
McGain (2012)	Anesthesia & Analgesia Journal information The "The Global Standard in Anesthesiology," provides practice-oriented, clinical research you need to keep current and provide optimal care to your patients. Brings	Type of study: LCA Objective: To assess the environmental and financial impacts of two types of central venous catheter insertion kits: single-use and reusable	Goal and scope[1]: To compare the financial costs and environmental impacts of the life cycles of reusable and single-use venous catheter insertion kits and what effect the source of electricity has on the CO_2 emissions. Functional unit(s)[2]:	McGain (2012) assessed the environmental and financial impacts of two type of central venous catheter insertion kits (single-use and disposable) at the Western Health group of hospitals in Melbourne, Victoria, Australia. Next to the	1. Climate Change McGain (2012) described the results on climate change. One reusable kit produced 1211 grams of CO_2 in total and one disposable kit 407 grams of CO_2. There is no comparison of multiple usage of the reusable kit. The biggest contributor for the reusable kit is the washing	The environmental and financial impacts of two type of central venous catheter insertion kits (single-use and disposable) are assessed. The results show the reusable kit has a bigger environmental impact compared to the	Authors conclusion For hospitals using coal-fired electricity, the environmental effects are greater when using reusable kits instead of single-use. Reducing the environmental impact of the reusable kit is possible by focusing on the

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
	peer reviewed articles on the latest advances in drugs, preoperative preparation, patient monitoring, pain management, pathophysiology, and many other timely topics. Critical review: Peer reviewed, not a specific LCA journal.	LCA-method: Attributional LCA Setting and country: Hospital in Australia Facility: Western Health, Melbourne, Victoria, Australia Years of data collection: - Surgical discipline(s): Anaesthesia Funding and conflict of interest: The authors declare no conflict of interest. They received funding through grants from the Australian and New Zealand Intensive Care Society and Sustainability Victoria.	Use of one central venous catheter kit to aid insertion of a single-use, central venous catheter in an operating room. System boundaries: Cradle to grave Included stages: Raw material extraction, production, packaging, transport, reuse, disposal Stated excluded components: Existing equipment (e.g. washers and sterilizers) were not included; Cotton gauze and antiseptic were not included ("because they were common to insertion of all central venous catheters") Inventory database: EcoInvent Allocation: No Normalization & Weighting: No Impacts reported: Yes, only GWP and water use impacts reported, impacts from other categories determined to be 'similar or of minor importance' Contribution analysis: Yes Scenario analysis: No Comparative analysis: Yes Sensitivity analysis: Yes, tests altered electricity source for the reusable kit: brown coal (base case), gas	environmental and financial impacts, they investigated the effect of the source of electricity upon CO_2 emissions. The functional unit was the use of one central venous catheter kit to aid insertion of a single-use, central venous catheter in an operating room. Data on the components of the central venous catheter kits was obtained by weighing with an electronic balance and receiving data from the manufacturer. Direct data regarding materials and energy required to reprocess reusable kits (i.e. from the washer and sterilizer) were collected using a "time-in-motion" study. Most other inputs were acquired from LCI databases or industry data. Electricity requirements (kWh) and volumes of hot (gas heated) and cold water used by the washer and sterilizer were measured. Data on waste disposal processes were obtained indirectly from industry data (sodium hypochlorite or incineration). Characterization methods: -	and sterilization process (256 resp. 830 grams of CO_2), whereas for the single-use kit this is the plastic used (284 grams of CO_2). A sensitivity analysis showed the influence of different energy mixes on the outcome for the reusable kit, with a Monte Carlo analysis to calculate confidence intervals (CI). Using a brown coal energy mix for the reusable kit resulted in 1211 (95% CI 1099-1323) grams of CO_2 emissions, hospital gas cogeneration in 436 (95% CI 410-473) grams of CO_2 emissions, United States electricity mix in 764 (95% CI 509-1174) grams of CO_2 emissions and a European electricity mix in 572 (95% CI 470-713) grams of CO_2 emissions. 2. Waste No results in this study. 3. Acidification No results in this study. 4. Eutrophication No results in this study. 5. Human Toxicity No results in this study. 6. Ecotoxicity No results in this study. 7. Ozone Depletion No results in this study.	disposable kit. However, this is calculated for one use of each kit. Reusing the reusable kit could influence results. The biggest contributor for the reusable kit is the washing and sterilization process. whereas for the single-use kit this is the use of plastic. The washing and sterilization process could be a hotspot to minimalize the impact, as well as for the disposable kit a different source of material could be of great value.	inefficiencies and energy sources of steam sterilizers. Limitations study A limitation of the study could be that the reusable insertion kit is compared to the disposable for one use of inserting the single-use central venous catheter. Reusable kits were assumed to have lifespan of 300 uses (metal components requiring sharpening every 100 uses) based on a conservative estimate from staff within the study hospital's sterile supplies department, however this seems not to be included in the analysis. Calculating the difference between the outcomes when reusing this kit is not taken into account and could yet obtain more accurate results.

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
			cogeneration, American standard supply, European standard supply Uncertainty analysis: Yes, Monte Carlo analysis Variance analysis: No				
McGain (2017)	British Journal of Anaesthesia Journal information The British Journal of Anaesthesia (BJA) publishes high-impact original work in all branches of anaesthesia, critical care medicine, pain medicine and perioperative medicine including fundamental, translational and clinical sciences, clinical practice, technology, education and training. In addition, the Journal publishes review articles, important case reports, correspondence and special articles of general interest. Critical review: Peer reviewed, not a specific LCA journal.	Type of study: LCA Objective: To assess environmental and financial impacts of reusable and single-use anesthetic equipment. LCA-method: Consequential LCA Setting and country: Hospitals in Australia Facility: Western Health, Melbourne, Victoria, Australia Years of data collection: - Surgical discipline(s): Anaesthesia Funding and conflict of interest: The authors declare no conflict of interest. They received funding for the project from the Australian and New Zealand College of	Goal and scope[1]: To compare the consequences from changing from one pattern of equipment to another (single-use/reusable), looking whether new labour would be required or where the next kilowatt hour of electricity would be sourced from. Thereby the environmental and financial consequences were defined. Functional unit(s)[2]: Use of breathing circuits, face masks, LMAs, and direct and videolaryngoscopes at one hospital over one year System boundaries: Cradle to grave Included stages: Raw material extraction, production, packaging, transport, reuse, disposal Stated excluded components: Existing oil, gas, mining, energy, and transport infrastructure was not included; Maintenance and depreciation of washers and sterilizers were not included ("these would be	McGain (2017) assessed environmental and financial impacts of reusable and single-use anesthetic equipment through the exploration of 2 base cases and 3 modelled scenarios using a consequential LCA approach. The first base case was situated at a hospital in Melbourne, Australia with "mainly single-use" anesthetic equipment (reusable anesthetic circuits, face masks, 'Proseal'VR (Teleflex, Westneath, Ireland) LMAs, and direct and videolaryngoscope blades and handles. The second base case was situated at another hospital in Melbourne, Australia with "mainly single-use" anesthetic equipment (disposable anesthetic circuits, single-use face masks, LMAs, and direct laryngoscope blades, but using reusable direct laryngoscope handles and reusable videolaryngoscopes). The five scenarios included:	1. Climate Change McGain (2017) described the five scenarios as following: (1) completely reusable, (2) mainly single-use except for reusable laryngoscope handles, (3) completely single-use (4) reusables (except the single-use face masks), (5) reusables (except single-use laryngoscope blades) in an Australian hospital. Using reusables (scenario 1) had a higher impact [5575 kg CO_2 equivalents (95% CI 5542-5608)] compared to using mainly single use [scenario 2; 5095 kg CO_2 equivalents (95% CI 4614-5658)]. For the reusable approach (4807 kg CO_2 equivalents (86%)) was for washer electricity and 387 kg CO_2 equivalents (7%) for H_2O_2 sterilizer electricity, with all other contributing for 381 kg CO_2 equivalents (7%). For scenario 2 (mainly single-use), the majority of the CO_2 emissions (2695 kg CO_2 equivalents, 52%) was for purchasing single use face masks (n=9900) and 1396 kg CO_2 equivalents (27%) for the single-use direct laryngoscope blades (n=9900) and all other items contributed for 1052 kg CO_2	The results of this study result in a clear overview on how environmental impacts of the same type of equipment (e.g. reusable) can vary between different continents. Where the single-use equipment seem to have a lower environmental impact in Australia, the results suggest the impact is lower in the USA, UK and in Europe. This is due to the energy mix used in the different continents. In Australia the impact of single-use equipment is lower compared to the other continents, where it is beneficial for the environment to use the reusable anaesthetic equipment.	Authors conclusion The financial and environmental impact of anaesthetic equipment are investigated. Using single-use equipment costs more than using reusables, in all scenarios. Converting from single-use to reusable leads to an increase in CO_2 emissions of almost 10%, where it decreases when converting in the US (50%) and UK/Europe (85%). Limitations study Sterilization records and input from senior Central Sterile and Supply Department staff at hospital 1 were used to define sterilization mode and load information, when 2 hospitals were involved. Comparing or using data from both hospitals would have been more accurate. This also accounts for electricity consumption of the sterilizer.

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
		anesthetists (project grant 13/025)	unaltered by the presence or absence of reusable anesthetic equipment") Inventory database: EcoInvent Allocation: No Normalization & Weighting: Yes, results were normalized to average annual per capita environmental impacts in Australia. Impacts reported: Yes Contribution analysis: No Scenario analysis: Yes Comparative analysis: Yes Sensitivity analysis: No Uncertainty analysis: Yes, Monte Carlo analysis Variance analysis: No	"completely single-use", "reusables except for single-use face masks", "reusables except for single-use laryngoscope blades", "reusables (Europe)", "reusables (USA)". Data on equipment were obtained from two hospitals in Melbourne, Australia in 2015 and each piece of equipment was weighed with an electronic balance (accurate to within 1g). Sterilization records and input from senior Central Sterile and Supply Department staff at hospital 1 were used to define sterilization mode and load information. Washer and steam sterilizer utility usage data were taken from a previous study by the same authors (0.15 kWh and 40 litres of water per kg of anesthetic equipment steam sterilized), while electricity consumption of a standard H2O2 sterilizer was directly measured over several days at hospital 1. Characterization methods: -	equivalents (21%). Scenario 3 resulted in 5775 kg CO_2 equivalents. Scenarios 4 and 5 led to 6556 and 6763 kg CO_2 equivalents emissions respectively, because 365 and 550 washer loads, respectively, remained. The substitution of one reusable with a single-use item (Scenarios 4 and 5) led to higher CO_2 emissions than either completely reusable or single-use equipment (Scenarios 1–3). An analysis was performed to model results as if the hospital was based in UK/Europe. This led to different results compared to when the hospital was based in Australia. By switching from single-use (5095 kg CO2 equivalents) to reusable anaesthetic equipment, this would have led in a decrease of 84% (802 kg CO2 equivalents). This can be explained by the majority of the next kilowatt hour of UK/European electricity generation arising from renewables (mainly wind). 2. Waste Using reusables (scenario 1) resulted in less waste (250 kg) compared to using mainly single use (scenario 2; 1222 kg of waste). Scenario 3 had the highest amount of waste (1542 kg) and scenarios 4 and 5 led to 375 and 917 kg of waste, respectively.		

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					3. <u>Acidification</u> No results in this study. 4. <u>Eutrophication</u> These outcomes resulted all in a low impact on eutrophication. Using reusables (scenario 1) resulted in 0.000 kg P equivalents whereas using mainly single use (scenario 2) led to 0.12 kg P equivalents. Scenario 3, 4 and 5 led to 0.12, 0.04 and 0.07 kg P equivalents, respectively. 5. <u>Human Toxicity</u> Using reusables (scenario 1) resulted in 12 kg 1.4-DB equivalents whereas scenario 2 resulted in the highest impact of all scenarios (713 kg 1.4-DB equivalents). Scenario 3, 4 and 5 led to 1.023, 195 and 491 kg 1.4-DB equivalents, respectively. 6. <u>Ecotoxicity</u> The outcome ecotoxicity was divided in three different outcomes: terrestrial, freshwater and marine ecotoxicity. For terrestrial ecotoxicity, using reusables (scenario 1) resulted in 0.011 kg 1.4-DB equivalents whereas scenario 2 resulted in 0.4 kg 1.4-DB equivalents. Scenario 3, 4 and 5 led to 0.405, 0.118 and 0.2 kg 1.4-DB equivalents, respectively. For freshwater ecotoxicity, using reusables		

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					(scenario 1) resulted in 0.7 kg 1.4-DB equivalents whereas scenario 2 resulted in 91 kg 1.4-DB equivalents. Scenario 3, 4 and 5 led to 93.4, 3.1 and 88 kg 1.4-DB equivalents, respectively. For marine ecotoxicity, using reusables (scenario 1) resulted in 0.7 kg 1.4-DB equivalents whereas scenario 2 resulted in 94.5 kg 1.4-DB equivalents. Scenario 3, 4 and 5 led to 97.2, 2.8 and 92.3 kg 1.4-DB equivalents, respectively. Moreover, using single-use equipment (scenario 2 and 3) has the highest impact on ecotoxicity. 7. Ozone Depletion No results in this study.		
Namburar (2022)	BMJ Journals Gut Journal information Gut is a leading international journal in gastroenterology and hepatology and has an established reputation for publishing first class clinical research of the alimentary tract, the liver, biliary tree and pancreas. Gut is an official journal of the British Society of Gastroenterology and has two companion titles: Frontline Gastroenterology for	Type of study: Waste audit (cross-sectional study) Objective: To measure the amount of waste generated during endoscopic procedures and to understand the impact on waste of changing from reusable to single use endoscopes in the USA. LCA-method: - Setting and country:	Goal and scope[1]: Quantify waste associated with endoscopic procedures. Functional unit(s)[2]: N/A System boundaries: N/A Included stages: Pre-procedure area, examination room and post-procedure area Stated excluded components: Sharp objects in separate containers Inventory database: N/A Allocation: No	Namburar (2022) performed an audit of waste generated during endoscopic procedures at a low and high endoscopy volume academic medical center (VA White River Junction, Vermont, USA and Darthmouth Hitchcock Medical Center, New Hampshire, USA) over a 5-day work period in 2020. Colonoscopies, upper endoscopies and endoscopic retrograde cholangiopancreatography (ERCP) were included. The waste from the pre-procedure area,	1. Climate Change No results in this study. 2. Waste The annual waste produced during endoscopic procedures in the US for the three different scenarios show that the 'all reusable' endoscopes (scenario 1) produce the least amount of waste (43,500 metric tons of waste for 18 million endoscopies annually in the US), followed by using single-use colonoscopes/duodenoscopes (scenario 2; 54,375 metric tons of waste) and all single-use endoscopes (scenario 3; 60,900 metric tons of waste).	The study suggests the least amount of waste is produced by using 'all reusable' endoscopes. When only focusing on waste, this should be the best option following the three given scenarios. However there are no further calculations regarding environmental impact. With these calculations, as the authors suggest in the discussion, this would give a better overview of the environmental impact of the procedures, taking the whole life cycle into of the	Authors conclusion The quantitative assessment shows that endoscopic procedures generate a large amount of waste from disposable instruments. Net waste is increase by using single-use endoscopes. Limitations study The study suggests to estimate the environmental impact of an endoscopic procedure, however only describes the amount of waste and does not calculate the

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
	education and practice and BMJ Open Gastroenterology for sound science clinical research. Critical review: Peer reviewed, not a specific LCA journal.	Two US academic medical centers in the USA Facility: VA White River Junction, Vermont, USA and Darthmouth Hitchcock Medical Center, New Hampshire, USA Years of data collection: 2020 Surgical discipline(s): Gastro-enterology Funding and conflict of interest: The authors declare no conflict of interest and have not received funding.	Normalization & Weighting: Yes, results were normalized to the annual endoscopy procedures in the US. Impacts reported: N/A Contribution analysis: Yes Scenario analysis: No Comparative analysis: Yes Sensitivity analysis: Yes Uncertainty analysis: No Variance analysis: No	examination room and post-procedure area was collected and documented as mass and volume. In the high volume hospital the waste from endoscope reprocessing was also obtained. An estimation of the contribution of single-use (compared to reusable) waste was made in the following three scenarios: (1) all reusable endoscopes, (2) colonoscopies and ERCPs were performed with single-use endoscopes (colonoscopes/duodenoscopes) and (3) all single-use endoscopes. The outcome measure was waste. Characterization methods: N/A	3. Acidification No results in this study. 4. Eutrophication No results in this study. 5. Human Toxicity No results in this study. 6. Ecotoxicity No results in this study. 7. Ozone Depletion No results in this study.	endoscopes (and procedures) into account.	actual environmental impact.
Rizan (2021)	Surgical Endoscopy Journal information This journal is positioned at the interface between various medical and surgical disciplines, it serves as a focal point for the international surgical community to exchange information on practice, theory, and research. Critical review: Peer reviewed, not a specific LCA journal	Type of study: LCA Objective: To assess environmental and financial impacts of hybrid and single-use instruments in laparoscopic cholecystectomy. LCA-method: Attributional LCA and consequential approach Setting and country: UK	Goal and scope[1]: Quantify reduction of the environmental (and financial) impact of hybrid surgical instruments compared to single-use. Functional unit(s)[2]: The number of three types of instruments (clip appliers, laparoscopic scissors and ports) typically required to perform one laparoscopic cholecystectomy. System boundaries: Cradle to grave Included stages:	Rizan (2021) assessed environmental and financial impacts of hybrid and single-use instruments in laparoscopic cholecystectomy using life cycle assessment. The number of three types of instruments (clip appliers, laparoscopic scissors and ports) typically required to perform one laparoscopic cholecystectomy were included in the analysis (two small diameter ports, two large diameter ports, one laparoscopic scissor	1. Climate Change The carbon footprint of the hybrid laparoscopic instruments is lower compared to the single-use instruments. Compared to its single-use equivalent, the hybrid clip applier's carbon footprint was 17% (445 g vs 2559 g CO_2 eq), the scissor 33% (378g vs 1139 g CO_2 eq) and the four ports 27% (933 g vs 3495 CO_2 eq). All combined, the carbon footprint of using all hybrid instruments was 24% of that of single-use equivalents (1756 g vs 7194 g CO_2 eq), saving 5.4 kg CO_2 eq. The majority of	The CO_2 footprint of using hybrid scissors, ports and clip appliers was 76% lower than using single-use equivalents, saving 5.4 kg CO2eq per operation. Overall, the environmental impact of the hybrid instruments are lower compared to the single-use instruments. This is mainly due to the manufacturing and raw material extraction process.	Authors conclusion The CO_2 footprint of using hybrid instruments for laparoscopic cholecystectomy is around a quarter of that for single-use equivalents and the financial costs around half. Limitations study Data is limited by assumptions (as with all LCAs), however clearly explained.

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
		Facility: - Years of data collection: 2020 Surgical discipline(s): Gastro-enterology Funding and conflict of interest: Funded by Surgical Innovations Ltd., but played no pared in scientific conduct, analysis or writing of the manuscript. No conflict of interest was stated.	Raw material extraction, manufacture, transport, disposal, decontamination for reusable components of hybrid instruments Stated excluded components: Other reusable instruments and consumables used to perform a laparoscopic cholecystectomy Inventory database: Ecoinvent, Industry data Allocation: No Normalization & Weighting: No Impacts reported: Yes Contribution analysis: Yes Scenario analysis: Yes Comparative analysis: Yes Sensitivity analysis: Yes, tests altered electricity source decontamination and changing way of transport Uncertainty analysis: No Variance analysis: No	and one laparoscopic clip applier). The stages of raw material extraction, manufacture, transport, disposal and decontamination for reusable components of hybrid instruments were included. Data was obtained from manufacturers and databases. Characterization methods: ReCiPe	the carbon footprint of the hybrid instruments was due to single-use components (mean 62%, range 43-79%), followed by decontamination of reusable components (mean 37%, range 21-56%). For the single-use instruments the biggest hotspots were raw material extraction and manufacturing (mean 57%, range 52-61%), followed by onward transportation (mean 29%, range 24-36%) and waste (mean 14%, range 12-16%). The scenario modelling resulted in the following results. When packaging and decontaminating separately, the CO2 footprint of the hybrid clip applier increased 3.7-fold to 1650 g CO2 eq. The scissor increases to 394 g CO2 eq per use (4% increase) and the ports 999 g CO2 eq per use (7% increase). For all hybrid instruments, CO2 footprint was lower than the single-use equivalents when used more than twice. The CO2 footprint of the decontamination process of hybrid instruments increased with 54% when using Australian electricity, which increased the CO2 footprint of the hybrid instruments by 11-30%, but this remained lower than the single-use equivalents (63-77%). Shipping in place of airfreight (for single-use items) reduced the CO2 footprint by 22-33%. Using three hybrid 5 mm ports		

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					and one 10 mm port (635 g CO2 eq/operation) resulted in a 32% reduction compared to the base case (5 mm single-use ports based on a dual pack). 2. Waste No results in this study. 3. Acidification Rizan (2021) reported the results of the three different instruments. The ports had the highest impact in this category (single-use vs. hybrid, 8.91 vs. 2.08 g SO2 eq), followed by the laparoscopic clip applier (single-use vs. hybrid, 8.53 vs. 1.18 g SO2 eq) and the laparoscopic scissors (single-use vs. hybrid, 4.46 vs. 1.44 g SO2 eq). 4. Eutrophication Rizan (2021) reported the results of the three different instruments on eutrophication divided in two categories: freshwater and marine eutrophication. The laparoscopic clip applier had the highest impact in the category “freshwater eutrophication” (single-use vs. hybrid, 0.62 vs. 0.12 g SO2 eq), followed by the ports (single-use vs. hybrid, 0.43 vs. 0.17 g SO2 eq) and the laparoscopic scissors (single-use vs. hybrid, 0.26 vs. 0.17 g SO2 eq). For the category “marine eutrophication” this resulted in the highest impact for the ports		

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					(single-use vs. hybrid, 0.12 vs. 0.07 g SO2 eq), followed by the laparoscopic clip applier (single-use vs. hybrid, 0.09 vs. 0.06 g SO2 eq) and the laparoscopic scissors (single-use vs. hybrid, 0.05 vs. 0.04 g SO2 eq). 5. Human Toxicity Rizan (2021) reported the results of the three different instruments on human toxicity divided in two categories: carcinogenic and non-carcinogenic human toxicity. Overall, the hybrid instruments have a lower environmental impact in this category. The laparoscopic clip applier had the highest impact in the category "carcinogenic human toxicity" (single-use vs. hybrid, 203 vs. 45 g 1.4-DCB eq), followed by the ports (single-use vs. hybrid, 117 vs. 43 g 1.4-DCB eq) and the laparoscopic scissors (single-use vs. hybrid, 91 vs. 65 g 1.4-DCB eq). Although, the hybrid port has a higher impact than the hybrid laparoscopic scissor. For the category "noncarcinogenic human toxicity" the results were as following (from greatest environmental impact to lowest impact): Single-use laparoscopic clip applier (2871 g 1.4-DCB eq), single-use laparoscopic scissor (1386 g 1.4-DCB eq), single-use ports (1013 g 1.4-DCB eq), hybrid laparoscopic scissor (952 g 1.4-DCB eq), hybrid		

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					laparoscopic clip applier (576 g 1.4-DCB eq) and hybrid ports (390 g 1.4-DCB eq). 6. <u>Ecotoxicity</u> Rizan (2021) reported the results of the three different instruments on ecotoxicity divided in three categories: “terrestrial”, “freshwater” and “marine” ecotoxicity. Overall, the hybrid instruments have a lower environmental impact in this category, except for the laparoscopic scissors in freshwater and marine ecotoxicity. For terrestrial ecotoxicity, the results were as following (from greatest environmental impact to lowest impact): Single-use laparoscopic clip applier (19,767 g 1.4-DCB eq), single-use laparoscopic scissor (8939 g 1.4-DCB eq), hybrid laparoscopic scissor (5628 g 1.4-DCB eq), single-use ports (4142 g 1.4-DCB eq), hybrid laparoscopic clip applier (3976 g 1.4-DCB eq) and hybrid ports (1171 g 1.4-DCB eq). For freshwater ecotoxicity, the results were as following (from greatest environmental impact to lowest impact): Single-use laparoscopic clip applier (176 g 1.4-DCB eq), hybrid laparoscopic scissor (97 g 1.4-DCB eq), single-use laparoscopic scissor (91 g 1.4-DCB eq), single-use ports (39 g 1.4-DCB eq), hybrid laparoscopic clip applier (36 g		

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					1.4-DCB eq) and hybrid ports (17 g 1.4-DCB eq). For marine ecotoxicity, the results were as following (from greatest environmental impact to lowest impact): Single-use laparoscopic clip applier (230 g 1.4-DCB eq), hybrid laparoscopic scissor (122 g 1.4-DCB eq), single-use laparoscopic scissor (118 g 1.4-DCB eq), single-use ports (54 g 1.4-DCB eq), hybrid laparoscopic clip applier (47 g 1.4-DCB eq) and hybrid ports (23 g 1.4-DCB eq).. 7. Ozone Depletion Rizan (2021) reported the results of the three different instruments on ozone depletion as following (from greatest environmental impact to lowest impact): Single-use ports (0.0013 g CFC11 eq), single-use laparoscopic clip applier (0.0008 g CFC11 eq), single-use laparoscopic scissor (0.0005 g CFC11 eq), hybrid ports (0.0004 g CFC11 eq), hybrid laparoscopic clip applier (0.0002 g CFC11 eq) and hybrid laparoscopic scissor (0.0001 g CFC11 eq).		
Sanchez (2020)	Resources, Conservation & Recycling Journal information Open Access journal with independent editorial board and peer-review process.	Type of study: LCA Objective: To assess the environmental and economic impacts of reusable and disposable blood pressure (BP) cuffs.	Goal and scope[1]: To compare the environmental and economic performance for reusable and disposable BP cuffs, with a focus on cuff design and materials, cleaning agents and processes. This because	Sanchez (2020) assessed the environmental and economic impacts of reusable and disposable blood pressure cuffs by using life cycle assessment. Data on materials and manufacturing was	1. Climate Change Sanchez (2020) reported outcomes using 4 different scenarios: (1) Day office, (2) 1 Day Ambulatory Procedure, (3) 1 Day Regular Ward and (4) 1 Day ICU. Within these scenarios, a division was made between: reusable incineration (1	The overall results show the reusable blood pressure cuff has a lower environmental impact on all impact categories compared to the disposable cuff. The main contributors for the disposable cuff are the	Authors conclusion Environmental considerations will never be paramount in decision making around medical devices or healthcare delivery, however this work shows there are many opportunities to

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
	Contributions from research, which consider sustainable management and conservation of resources are welcomed. The journal emphasizes the transformation processes involved in a transition toward more sustainable production and consumption systems. Emphasis is upon technological, economic, institutional and policy aspects of specific resource management practices, such as conservation, recycling and resource substitution, and of "systems-wide" strategies, such as resource productivity improvement, the restructuring of production and consumption profiles and the transformation of industry. Critical review: Peer reviewed, not a specific LCA journal.	LCA-method: LCA Setting and country: Outpatient clinic and ambulatory procedure rooms, regular ward and ICU in the US Facility: Yale-New Haven Health (YNHH) System in New Haven, Connecticut, USA. Years of data collection: - Surgical discipline(s): - Funding and conflict of interest: The authors declare no conflict of interest. Funding: Dept. of Civil and Environmental Engineering, Northeastern University	disposables come into favor despite lack of information about environmental costs. Functional unit(s)[2]: Providing blood pressure readings for a clinic room or ward, under four different health care delivery scenarios. System boundaries: Cradle to grave Included stages: Materials and manufacturing, transport, usage, cleaning, disposal Stated excluded components: - Inventory database: US-EI LCI database Allocation: No Normalization & Weighting: Yes Impacts reported: Yes Contribution analysis: Yes Scenario analysis: Yes Comparative analysis: Yes Sensitivity analysis: Yes Uncertainty analysis: No Variance analysis: No	gathered through a combination of manufacturer information and physical testing, by weighing component on a scale. Components were identified and matched with information from inventory databases (US-EI LCI database). US EPA database was used for transport packaging information. Multiple cleaning scenarios were developed to represent a diversity of clinical settings in using and cleaning. Only landfill and incineration were included for disposal data and recycling was not taken into account ("as recycling is uncommon (though possible) given the types of plastics an mixed materials employed in the BP cuffs"). Characterization methods: TRACI	cleaning/encounter or 1 cleaning/day), reusable landfill (1 cleaning/encounter or 1 cleaning/day), disposable incineration (1 cleaning/encounter or 1 cleaning/day), disposable landfill (1 cleaning/encounter or 1 cleaning/day). The results of these different scenarios are summarized in the supplemental material of the study (Sanchez, 2020). For the outcome measure climate change, the overall results show reusable blood pressure cuffs have a lesser environmental impact compared to the disposable variant. The biggest contributor for the disposable is the material and manufacturing process, whereas for the reusable blood pressure cuff the main contributor is the production of the chemical wipes (which are used for cleaning). 2. Waste No results in this study. 3. Acidification The disposable blood pressure cuffs have a higher environmental impact considering acidification compared to the reusable variant. For the disposable cuff, this is especially related to the manufacturing process. For the reusable variant the biggest	production process and the disposal. For the reusable cuff this is mainly due to the production process of the cleaning wipes. However, the environmental impact of the reusable blood pressure cuff remains lower compared to the disposable.	reduce resource use, waste and environmental impact. Limitations study There is data uncertainty associated with some of the modelling parameters (e.g. energy and BP cuff materials).

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					contributor is the production of the cleaning wipes. 4. Eutrophication The disposable blood pressure cuffs have a higher environmental impact considering eutrophication compared to the reusable variant. For the disposable cuff, this is especially related to the manufacturing process and the disposal of the cuffs. For the reusable variant the biggest contributor is the production of the cleaning wipes and partly the disposal of these wipes. 5. Human Toxicity The disposable blood pressure cuffs have a higher environmental impact considering human toxicity (non-carcinogens and carcinogens) compared to the reusable variant. For the disposable cuff, this is especially related to the manufacturing process and the disposal of the cuffs. For the reusable variant this is mainly due to the production of the cleaning wipes. 6. Ecotoxicity The disposable blood pressure cuffs have a higher environmental impact considering ecotoxicity compared to the reusable variant. For the disposable cuff,		

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					this is especially related to the manufacturing process and the disposal of the cuffs. For the reusable variant this is mainly due to the production of the cleaning wipes. 7. Ozone Depletion The disposable blood pressure cuffs have a higher environmental impact considering ozone depletion compared to the reusable variant. This is especially related to the manufacturing process.		
Sherman (2018)	Anesthesia & Analgesia Journal information The "The Global Standard in Anesthesiology," provides practice-oriented, clinical research you need to keep current and provide optimal care to your patients. Brings peer reviewed articles on the latest advances in drugs, preoperative preparation, patient monitoring, pain management, pathophysiology, and many other timely topics. Critical review: Peer reviewed, not a specific LCA journal.	Type of study: LCA Objective: To assess the environmental and financial impacts of three different types of rigid laryngoscope handle and tongue blade: plastic single-use, metal single-use, and stainless steel reusable (under a range of cleaning options: low-level disinfection, high-level disinfection, sterilization) LCA-method: Attributional LCA Setting and country: US Facility: Yale-New Haven Hospital, New Haven, CT, USA	Goal and scope[1]: To obtain environmental and financial impacts, since it is not clear, to facilitate anaesthesiologists making the best choice considering environmental and economic perspectives. Device efficacy was presumed equivalent. Functional unit(s)[2]: One handle or one blade for a single patient encounter System boundaries: Cradle to grave Included stages: Raw material extraction, production, packaging, transport, use, reuse, disposal Stated excluded components:	Sherman (2018) assessed the environmental and financial impacts of three different types of rigid laryngoscope handle and tongue blade: plastic single-use, metal single-use, and stainless steel reusable (under a range of cleaning options: low-level disinfection, high-level disinfection, sterilization) by using life cycle assessment and life cycle costing at the Yale-New Haven Hospital, New Haven, CT, USA. To determine the material composition of handles and blades a combination of manufacturer specifications, deconstruction, and density testing were used, and after each material was weighed. Foreground	1. Climate Change Sherman (2018) reported outcomes on climate change on both laryngoscope handles and blades (reusable or single-use) as well as on different cleaning scenarios (low-level disinfection levels (LDL), high-level disinfection levels (HDL) and sterilization). The most favorable scenario for the handles is the reusable stainless steel handle, treated to HDL. Choosing LDL will result in a 40% increase of the CO_2 footprint (0.08 kg CO_2 eq per use). Sterilization will lead to a 400% increase (0.23 kg CO_2 eq per use). The single-use handle has a 25 times bigger CO_2 footprint compared to the reusable version (1.41 kg CO_2 eq and 1.60 kg CO_2 eq for the plastic and metal handles, respectively). The most favorable scenario for the blades is the reusable steel tongue	The environmental impact of the reusable stainless steel laryngoscope blades and handles is lowest. The greater impact of the disposable variants is due to the material manufacturing and device assembly. The reusables create emissions mainly from reprocessing and are thus reliable on the source of cleaning.	Authors conclusion The results demonstrate a clear benefit of reusable laryngoscope handles and blades over single-use alternatives, with HLD as the least polluting reprocessing method. Limitations study The outcomes are only expressed in percentages (except climate change). It would give a more clear view of the absolute impact if the absolute numbers were stated. The authors state there is an uncertainty test undertaken, however that is not the case.

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
		Years of data collection: - Surgical discipline(s): Anesthesiology Funding and conflict of interest: The authors declare no conflict of interest. J.D.S. was supported by an Anesthesia Patient Safety Foundation award. L.A.R. was supported by a Provost's award for undergraduate research at Northeastern University. M.J.E. was supported by departmental start-up funds at Northeastern University.	Machinery and capital equipment; building operations Inventory database: EcoInvent, US-EI Allocation: No Normalization & Weighting: No Impacts reported: Yes Contribution analysis: Yes, only GWP Scenario analysis: Yes, various cleaning options Comparative analysis:: Yes Sensitivity analysis: Yes, assuming a 100% recycling scenario (figure 2) Uncertainty analysis: No Variance analysis: No	data specific to Yale-New Haven Hospital (YNHH) were collected, including transportation mode and distance; washer and autoclave-related energy, water, and chemical use (based on machine specification and apportioned based on an assumed full-load). Reusable components were assumed to have a lifespan of 4000 uses and require refurbishment every 40 uses, according to rated lifetimes of each component (i.e. 1/4000th of the manufacturing, transportation, and disposal impacts were assigned to 1 use of a reusable device). Standard US waste management was assumed: 6% of plastics are recycled, 30%–70% of metals, and remaining solid waste is either landfilled (80%) or incinerated (20%). Characterization methods: TRACI	blade treated to (the minimum) HDL standards. Sterilization will lead to a 400% increase (0.22 kg CO_2 eq per use) compared to HDL (0.06 kg CO_2 eq per use). Single-use options for the blades will result in an 6-8 times increase of CO_2 footprint (0.38 kg CO_2 eq and 0.44 kg CO_2 eq for the plastic and metal blades, respectively). 2. Waste No results in this study. 3. Acidification Sherman (2018) reported outcomes on acidification on both laryngoscope handles and blades (reusable or single-use) as well as on different cleaning scenarios (low-level disinfection levels (LDL), high-level disinfection levels (HDL) and sterilization). The most favorable scenario for the handles is the reusable stainless steel handle, treated to HDL. Choosing LDL will result in a 70% increase of the CO2 footprint. Sterilization will lead to a 200% increase. The single-use handle has a 33 times bigger CO2 footprint compared to the reusable version. The most favorable scenario for the blades is the reusable steel tongue blade treated to (the minimum) HDL standards. Sterilization will lead to a 350% increase compared to HDL. Single-use options for the blades		

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					will result in an 5-10 times increase of CO2 footprint. 4. <u>Eutrophication</u> Sherman (2018) reported outcomes on eutrophication on both laryngoscope handles and blades (reusable or single-use) as well as on different cleaning scenarios (low-level disinfection levels (LDL), high-level disinfection levels (HDL) and sterilization). The most favorable scenario for the handles is the reusable stainless steel handle, treated to HDL. Choosing LDL will result in a 160% increase of the CO2 footprint. Sterilization will lead to a 100% increase. The single-use handle has a 65 times bigger CO2 footprint compared to the reusable version. The most favorable scenario for the blades is the reusable steel tongue blade treated to (the minimum) HDL standards. Sterilization will lead to a 150% increase compared to HDL. Single-use options for the blades will result in an 8-15 times increase of CO2 footprint. 5. <u>Human Toxicity</u> Sherman (2018) reported outcomes on human toxicity on both laryngoscope handles and blades (reusable or single-use) as well as on different cleaning scenarios (low-level disinfection levels (LDL), high-level disinfection levels (HDL) and		

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					sterilization). This outcome is divided in carcinogenics as well as noncarcinogenics. For the carcinogenics, the most favorable scenario for the handles is the reusable stainless steel handle, treated to HDL. Choosing LDL will result in a 200% increase of the CO2 footprint. Sterilization will lead to a 150% increase. The single-use handle has a 45 (plastic) and 250 (steel) times bigger CO2 footprint compared to the reusable version. The most favorable scenario for the blades is the reusable steel tongue blade treated to (the minimum) HDL standards. Sterilization will lead to a 150% increase compared to HDL. Single-use options for the blades will result in an 7-160 times increase of CO2 footprint. For the noncarcinogenics, the most favorable scenario for the handles is the reusable stainless steel handle, treated to HDL. Choosing LDL will result in a 100% increase of the CO2 footprint. Sterilization will lead to a 150% increase. The single-use handle has a 135 (plastic) and 180 (steel) times bigger CO2 footprint compared to the reusable version. The most favorable scenario for the blades is the reusable steel tongue blade treated to (the minimum) HDL standards. Sterilization will lead to a 200% increase		

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					compared to HDL. Single-use options for the blades will result in an 10-42 times increase of CO2 footprint. 6. Ecotoxicity Sherman (2018) reported outcomes on ecotoxicity on both laryngoscope handles and blades (reusable or single-use) as well as on different cleaning scenarios (low-level disinfection levels (LDL), high-level disinfection levels (HDL) and sterilization). This outcome is divided in carcinogenics as well as noncarcinogenics. For the carcinogenics, the most favorable scenario for the handles is the reusable stainless steel handle, treated to HDL. Choosing LDL will result in a 400% increase of the CO2 footprint. Sterilization will lead to a 100% increase. The single-use handle has a 130 (plastic) and 225 (steel) times bigger CO2 footprint compared to the reusable version. The most favorable scenario for the blades is the reusable steel tongue blade treated to (the minimum) HDL standards. Sterilization will lead to a 150% increase compared to HDL. Single-use options for the blades will result in an 13-95 times increase of CO2 footprint. 7. Ozone Depletion		

Study	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					Sherman (2018) reported outcomes on ozone depletion on both laryngoscope handles and blades (reusable or single-use) as well as on different cleaning scenarios (low-level disinfection levels (LDL), high-level disinfection levels (HDL) and sterilization). This outcome is divided in carcinogenics as well as noncarcinogenics. For the carcinogenics, the most favorable scenario for the handles is the reusable stainless steel handle, treated to HDL. Choosing LDL will result in a 3000% increase of the CO2 footprint. Sterilization will lead to a 200% increase. The single-use handle has a 17 times bigger CO2 footprint compared to the reusable version. The most favorable scenario for the blades is the reusable steel tongue blade treated to (the minimum) HDL standards. Sterilization will lead to a 300% increase compared to HDL. Single-use options for the blades will result in an 3-7 times increase of CO2 footprint.		

[1]Goals and scope: 'Phase of life cycle assessment in which the aim of the study, and in relation to that, the breadth and depth of the study is established'

[2]Functional unit: Quantified description of the function of a product or process that serves as the reference basis for all calculations regarding impact assessment

Appendix 2. Critical appraisal of LCAs (based on Drew, 2021)

Drew (2021) developed a critical appraisal *pro forma*, based on Weidema's guidelines for critical review of LCA (Weidema, 1997). This scoring system consists of 16 appraisal criteria, which are divided between the different phases of an LCA. It addresses a range of study quality indicators, such as internal validity, external validity, consistency, transparency, and bias. The percentage score provides an indication of the overall study quality. A higher score indicates a higher overall study quality. The points that can be obtained are displayed in the column labeled "appraisal criteria".

Appraisal criteria	**Indicator(s)**	**Key effect modifiers**	**Grimmond (2012)**	**Grimmond (2021)**	**Hicks (2016)**	**McGain (2010)**	**McPherson (2019)**	**Vozzola (2018)**	**Vozzola (2020)**	**Davis (2018)**	**Donahue (2020)**
Phase 1: Goal & Scope (13 points)											
Study goal is clearly stated, including the study's rationale (1), intended application (1), and intended audience (1)	Transparency		2	2	2	2	2	3	3	2	3
Lifecycle assessment method is clearly stated (1)	Transparency	Process-based life-cycle assessment, which is well suited to product-level analysis, may underestimate environmental impacts (i.e. from truncation error); economic input-output lifecycle assessment (EIO-LCA), which uses aggregate data and is well-suited to sector-level analysis, may overestimate environmental impacts	1	1	1	1	1	1	1	0	0
Functional unit is clearly defined and measurable (1), justified (1), and consistent with the study's intended application (1)	Consistency		1	2	2	1	2	3	2	3	2
The system to be studied is adequately described with clearly stated system boundaries (1), lifecycle stages (1), and appropriate justification of any omitted stages (1)	Transparency; Bias	Assessments with narrow system boundaries that exclude a number of lifecycle stages are prone to underestimating life-cycle environmental impacts	2	2	2	3	2	3	2	2	3
The system covers production (1), use/reuse (1) and disposal (1) of materials and energy (half mark if only for energy and vice versa)	Internal Validity, Completeness		3	3	3	3	3	3	3	3	3
Phase 2: Inventory analysis (7 points)											
The data collection process is clearly explained, including the source(s) of	Transparency, Internal Validity		3	3	2	3	3	3	3	2	3

Appraisal criteria	Indicator(s)	Key effect modifiers	Grimmond (2012)	Grimmond (2021)	Hicks (2016)	McGain (2010)	McPherson (2019)	Vozzola (2018)	Vozzola (2020)	Davis (2018)	Donahue (2020)
foreground material weights and energy values (1); the source(s) of reference data (e.g. inventory database; 1); and what data are included (e.g. production and disposal of unit processes; 1)											
Representativeness of the data is discussed (1), differences in electricity generating mix are accounted for (1), and the potential significance of exclusions or assumptions is addressed (1)	Internal validity; External validity		2	1	1	2	2	2	2	0	2
Allocation procedures, where necessary, are described and appropriately justified (1; mark given if no allocation used)	Transparency; Bias		1	1	1	1	1	0.5	1	1	1
Phase 3: Impact assessment (6 points)											
Impact categories (1), characterization method (1), and software used (1) are documented transparently	Transparency		2	2	3	2	2	3	1	1	3
Results are clearly reported in the context of the functional unit (1) (0.5 if graphically, 0 if only normalized results reported)	Consistency; Transparency		1	1	1	1	1	1	1	1	1
A contribution analysis is performed and clearly reported (1), and hotspots are identified (1)			2	2	2	2	2	1	2	2	2
Phase 4: Interpretation (9 points)											
Conclusions are consistent with the goal and scope (1) and supported by the impact assessment results (1)	Internal validity; Consistency		2	2	2	2	2	2	2	2	2
Results are contextualized through the use of sensitivity analysis (1) and uncertainty analysis (1)	Internal validity		1	1	2	1	1	1	1	0	1
Limitations are adequately discussed (1), and the potential impact of omissions or assumptions on the study's outcomes are described (1)	Bias		0	1	1	2	1	1	2	0	1
The assessment has been critically appraised (i.e. peer review if journal	Bias		1	1	1	1	1	0	1	1	1

Appraisal criteria	Indicator(s)	Key effect modifiers	Grimmond (2012)	Grimmond (2021)	Hicks (2016)	McGain (2010)	McPherson (2019)	Vozzola (2018)	Vozzola (2020)	Davis (2018)	Donahue (2020)
article or independent, external critical review if report/thesis; 1)											
Source(s) of funding and any potential conflict(s) of interest are disclosed (1), and are unlikely to be a source of bias (1)	Bias		1	1	1	1	1	0.5	1	1	1
		Total (/35)	25	25	27	28	27	28	28	21	29
		Percentage score	**71%**	**71%**	**77%**	**80%**	**77%**	**80%**	**80%**	**60%**	**83%**

Appraisal criteria	Indicator(s)	Key effect modifiers	Eckelman (2012)	Ibbotson (2013)	Leiden (2020)	McGain (2012)	McGain (2017)	Rizan (2021)	Sanchez (2020)	Sherman (2018)
Phase 1: Goal & Scope (13 points)										
Study goal is clearly stated, including the study's rationale (1), intended application (1), and intended audience (1)	Transparency		3	3	2	2	1	3	3	3
Lifecycle assessment method is clearly stated (1)	Transparency	Process-based life-cycle assessment, which is well suited to product-level analysis, may underestimate environmental impacts (i.e. from truncation error); economic input-output lifecycle assessment (EIO-LCA), which uses aggregate data and is well-suited to sector-level analysis, may overestimate environmental impacts	1	1	1	1	1	1	1	1
Functional unit is clearly defined and measurable (1), justified (1), and consistent with the study's intended application (1)	Consistency		3	3	3	1	0	2	2	3
The system to be studied is adequately described with clearly stated system boundaries (1), lifecycle stages (1), and appropriate justification of any omitted stages (1)	Transparency; Bias	Assessments with narrow system boundaries that exclude a number of lifecycle stages are prone to underestimating life-cycle environmental impacts	3	2	2	2	3	3	2	2
The system covers production (1), use/reuse (1) and disposal (1) of materials and energy (half mark if only for energy and vice versa)	Internal Validity, Completeness		3	3	3	3	3	3	3	3
Phase 2: Inventory analysis (7 points)										

Appraisal criteria	Indicator(s)	Key effect modifiers	Eckelman (2012)	Ibbotson (2013)	Leiden (2020)	McGain (2012)	McGain (2017)	Rizan (2021)	Sanchez (2020)	Sherman (2018)
The data collection process is clearly explained, including the source(s) of foreground material weights and energy values (1); the source(s) of reference data (e.g. inventory database; 1); and what data are included (e.g. production and disposal of unit processes; 1)	Transparency, Internal Validity		3	3	2	3	3	3	3	3
Representativeness of the data is discussed (1), differences in electricity generating mix are accounted for (1), and the potential significance of exclusions or assumptions is addressed (1)	Internal validity; External validity		1	1	1	2	2	0	1	2
Allocation procedures, where necessary, are described and appropriately justified (1; mark given if no allocation used)	Transparency; Bias		1	1	1	1	1	1	1	1
Phase 3: Impact assessment (6 points)										
Impact categories (1), characterization method (1), and software used (1) are documented transparently	Transparency		3	3	3	2	2	3	3	3
Results are clearly reported in the context of the functional unit (1) (0.5 if graphically, 0 if only normalized results reported)	Consistency; Transparency		1	0.5	0	1	1	1	1	1
A contribution analysis is performed and clearly reported (1), and hotspots are identified (1)			1	1	2	2	1	2	2	2
Phase 4: Interpretation (9 points)										
Conclusions are consistent with the goal and scope (1) and supported by the impact assessment results (1)	Internal validity; Consistency		2	2	2	2	1	2	2	2
Results are contextualized through the use of sensitivity analysis (1) and uncertainty analysis (1)	Internal validity		1	1	1	2	1	1	1	1
Limitations are adequately discussed (1), and the potential impact of omissions or assumptions on the study's outcomes are described (1)	Bias		1	1	1	2	0	1	1	0

Appraisal criteria	Indicator(s)	Key effect modifiers	Eckelman (2012)	Ibbotson (2013)	Leiden (2020)	McGain (2012)	McGain (2017)	Rizan (2021)	Sanchez (2020)	Sherman (2018)
The assessment has been critically appraised (i.e. peer review if journal article or independent, external critical review if report/thesis; 1)	Bias		1	1	1	1	1	1	1	1
Source(s) of funding and any potential conflict(s) of interest are disclosed (1), and are unlikely to be a source of bias (1)	Bias		2	0	1	2	2	2	1	2
		Total (/35)	30	26.5	25.5	29	23	29	28	30
		Percentage score	**86%**	**76%**	**73%**	**83%**	**66%**	**83%**	**80%**	**86%**

Literature search strategy

Zoekverantwoording UV 2.1

Algemene informatie

Richtlijn: Duurzaamheid	
Uitgangsvraag: UV2.1 - Wat is het effect van het gebruik van reusables in vergelijking disposables op duurzaamheidsaspecten?	
Database(s): Medline (PubMed), Embase (OVID), Web of Science, Cochrane Library, Emcare (OVID)	Datum: 7-12-2021
Periode: 2000-2021	Talen: nvt
Literatuurspecialist: Jan W. Schoones	
BMI zoekblokken: voor verschillende opdrachten wordt (deels) gebruik gemaakt van de zoekblokken van BMI-Online https://blocks.bmi-online.nl/ Bij gebruikmaking van een volledig zoekblok zal naar de betreffende link op de website worden verwezen.	
Toelichting:	
Te gebruiken voor richtlijnen tekst: In de databases Medline (PubMed), Embase (OVID), Web of Science, Cochrane Library, en Emcare (OVID) is op 7-12-2021 met relevante zoektermen gezocht naar systematische reviews, RCTs , observationele studies, ander vergelijkend onderzoek (bijv. case control, cohort-onderzoek), en life cycle assessments (LCA's) over UV2.1 - Wat is het effect van het gebruik van reusables in vergelijking disposables op duurzaamheidsaspecten? De literatuurzoekactie leverde 676 unieke treffers op.	

Zoekopbrengst

	MEDLINE (PubMed)	Embase (OVID)	Web of Science	Cochrane Library	Emcare (OVID)	Ontdubbeld
	248	445	194	6	113	676

Zoekstrategie

MEDLINE (PubMed)

(("Equipment Reuse"[mesh] OR "reusable biopsy forceps"[tw] OR "reusable drape"[tw] OR "reusable drapes"[tw] OR "reusable equipment"[tw] OR "reusable flexible optical scope"[tw] OR "reusable flexible optical scopes"[tw] OR "reusable forceps"[tw] OR "reusable laryngeal mask"[tw] OR "reusable laryngeal masks"[tw] OR "reusable medical equipment"[tw] OR "reusable medical equipment packaging"[tw] OR "reusable scissor"[tw] OR "reusable scissors"[tw] OR "reusable scope"[tw] OR "reusable scopes"[tw] OR "reusable sharps container"[tw] OR "reusable sharps containers"[tw] OR "reusable specula"[tw] OR "reusable speculum"[tw] OR "reusable surgical attire"[tw] OR "reusable surgical attires"[tw] OR "reusable surgical clamp"[tw] OR "reusable surgical clamps"[tw] OR "reusable surgical clip"[tw] OR "reusable surgical clips"[tw] OR "reusable surgical kit"[tw] OR "reusable surgical kits"[tw] OR "reusable suture anchor"[tw] OR "reusable suture anchors"[tw] OR "reusable trocar"[tw] OR "reusable trocars"[tw] OR "reusable ureteroscope"[tw] OR "reusable ureteroscopes"[tw] OR "recyclable biopsy forceps"[tw] OR "recyclable drape"[tw] OR "recyclable drapes"[tw] OR "recyclable equipment"[tw] OR "recyclable flexible optical scope"[tw] OR "recyclable flexible optical scopes"[tw] OR "recyclable forceps"[tw] OR "recyclable laryngeal mask"[tw] OR "recyclable laryngeal masks"[tw] OR "recyclable medical equipment"[tw] OR "recyclable medical equipment packaging"[tw] OR "recyclable scissor"[tw] OR "recyclable scissors"[tw] OR "recyclable scope"[tw] OR "recyclable scopes"[tw] OR "recyclable sharps container"[tw] OR "recyclable sharps containers"[tw] OR "recyclable specula"[tw] OR "recyclable speculum"[tw] OR "recyclable surgical attire"[tw] OR "recyclable surgical attires"[tw] OR "recyclable surgical clamp"[tw] OR "recyclable surgical clamps"[tw] OR "recyclable surgical clip"[tw] OR "recyclable surgical clips"[tw] OR "recyclable surgical kit"[tw] OR "recyclable surgical kits"[tw] OR "recyclable suture anchor"[tw] OR "recyclable suture anchors"[tw] OR "recyclable trocar"[tw] OR "recyclable trocars"[tw] OR "recyclable ureteroscope"[tw] OR "recyclable ureteroscopes"[tw] OR (("Equipment Reuse"[mesh] OR "reusables"[tw] OR "reusable"[tw] OR "reusabl*"[tw] OR "reuse"[tw] OR "re usables"[tw] OR "re usable"[tw] OR "re usabl*"[tw] OR "re use"[tw] OR "recyclable"[tw] OR "recyclables"[tw] OR "recycl*"[tw] OR "re cyclable"[tw] OR "re cycl*"[tw] OR "Recycling"[Mesh] OR "reprocess"[tw] OR "reprocessing"[tw] OR "reprocess*"[tw]) AND ("biopsy forceps"[tw] OR "Surgical Drapes"[Mesh] OR "drape"[tw] OR "drapes"[tw] OR "Surgical Equipment"[Mesh] OR "equipment"[tw] OR "flexible optical scope"[tw] OR "flexible optical scopes"[tw] OR "forceps"[tw] OR "Laryngeal Masks"[Mesh] OR "laryngeal mask"[tw] OR "laryngeal masks"[tw] OR "medical equipment"[tw] OR "medical equipment packaging"[tw] OR "scissor"[tw] OR "scissors"[tw] OR "Endoscopes"[Mesh] OR "scopes"[tw] OR "Endoscopes"[tw] OR "Endoscope"[tw] OR "sharps container"[tw] OR "sharps containers"[tw] OR "sharps bin"[tw] OR "sharps bins"[tw] OR "specula"[tw] OR "speculum"[tw] OR "Surgical Attire"[Mesh] OR "surgical attire"[tw] OR "surgical attires"[tw] OR "Surgical Shoe Covers"[tw] OR "Surgical Shoe Cover"[tw] OR "Surgical Gowns"[tw] OR "Surgical Gown"[tw] OR "Masks"[Mesh] OR "Mask"[tw] OR "Masks"[tw] OR "Respirators"[tw] OR

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**"Environment"[Mesh:noexp]** OR "environmental impact"[tw] OR "environmental impact*"[tw] OR "environmental impacts"[tw] OR "environmental pollut*"[tw] OR "Environmental Pollution"[Mesh] OR "environmental pollution"[tw] OR "environmental protection"[tw] OR "environmental sustainab*"[tw] OR "environmental sustainability"[tw] OR **"Environmental*"[tw]** OR "EP in kg PO4 equivalent"[tw] OR "Eutrophication potential"[tw] OR "Eutrophication"[Mesh] OR "eutrophication"[tw] OR "FAETP in kg DCB equivalent"[tw] OR "Freshwater Aquatic Ecotoxicity Potential"[tw] OR "Global Warming"[mesh] OR "Global Warming"[tw] OR "Green deal"[tw] OR "Green surgery"[tw] OR "Greenhouse Effect"[mesh] OR "greenhouse effect*"[tw] OR "greenhouse effects"[tw] OR "greenhouse gas emission"[tw] OR "greenhouse gas emissions"[tw] OR "Greenhouse Gas"[tw] OR "Greenhouse Gases"[mesh] OR "Greenhouse Gases"[tw] OR "greening"[tw] OR "GWP in kg CO2 equivalents"[tw] OR "H+ moles equivalents"[tw] OR "hospital waste"[tw] OR "HTTP in kg Dichlorobenzene equivalent"[tw] OR "Human Toxicity Potential"[tw] OR "kg 2.4-D equivalents"[tw] OR "kg CFC-11 equivalent"[tw] OR "kg N equivalents"[tw] OR "kg NOx equivalents"[tw] OR "LCA"[tw] OR "LCAs"[tw] OR "life cycle analysis"[tw] OR "life cycle assess*"[tw] OR "life cycle assessment"[tw] OR "life cycle inventories"[tw] OR "life cycle inventory"[tw] OR "Medical Waste Disposal"[mesh] OR "Medical Waste"[mesh] OR "medical waste"[tw] OR "N equiv*"[tw] OR "Ozone Depletion"[Mesh] OR "ozone depletion"[tw] OR "Photochemical Ozone Depletion Potential"[tw] OR "Plastic overuse"[tw] OR "POCP in kg ethane equivalent"[tw] OR "preservation of natural resources"[tw] OR "Refuse Disposal"[Mesh] OR "Refuse Disposal"[tw] OR "Rising Sea Level"[tw] OR "Rising Sea Levels"[tw] OR "Sea Level Rise"[mesh] OR "Sea Level Rise"[tw] OR "Smog"[mesh] OR "smog"[tw] OR "SO2 equiv*"[tw] OR "sustainability"**[tw]** OR "Sustainable Development"[Mesh] OR "Sustainable Development"[tw] OR "Waste Disposal"[tw] OR 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"hazard"[tw] OR "hazard*"[tw]))) AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])) AND **(***("Meta-Analysis"[Publication Type] OR "Meta-Analysis as Topic"[Mesh] OR metaanaly*[tiab] OR meta-analy*[tiab] or metanaly*[tiab] OR "Systematic Review"[Publication Type] OR systematic[sb] OR "Cochrane Database Syst Rev"[Journal] or prisma[tiab] OR preferred reporting items[tiab] OR prospero[tiab] OR ((systemati*[ti] OR scoping[ti] OR umbrella[ti] OR structured literature[ti]) AND (review*[ti] OR overview*[ti])) OR systematic review*[tiab] OR scoping review*[tiab] OR umbrella review*[tiab] OR structured literature review*[tiab] OR systematic qualitative review*[tiab] OR systematic quantitative review*[tiab] OR systematic search and review[tiab] OR systematized review[tiab] OR systematised review[tiab] OR systemic review[tiab] OR systematic literature review*[tiab] OR systematic integrative literature review*[tiab] OR systematically review*[tiab] OR scoping literature review*[tiab] OR systematic critical review[tiab] OR systematic integrative review*[tiab] OR systematic evidence review[tiab] OR Systematic integrative literature review*[tiab] OR Systematic mixed studies review*[tiab] OR Systematized literature review*[tiab] OR Systematic overview*[tiab] OR Systematic narrative review*[tiab] OR ((systemati*[tiab] OR literature[tiab] OR database*[tiab] OR data-base*[tiab] OR structured[tiab] OR comprehensive*[tiab] OR systemic*[tiab]) AND search*[tiab]) OR (Literature[ti] AND review[ti] AND (database*[tiab] OR data-base*[tiab] OR search*[tiab])) OR ((data extraction[tiab] OR data source*[tiab]) AND study selection[tiab]) OR (search strategy[tiab] AND selection criteria[tiab]) OR (data source*[tiab] AND data synthesis[tiab]) OR medline[tiab] OR pubmed[tiab] OR embase[tiab] OR Cochrane[tiab] OR ((critical[ti] OR rapid[ti]) AND (review*[ti] OR overview*[ti] OR synthes*[ti])) OR (((critical*[tiab] OR rapid*[tiab]) AND (review*[tiab] OR overview*[tiab] OR synthes*[tiab]) AND (search*[tiab] OR database*[tiab] OR data-base*[tiab]))) OR metasynthes*[tiab] OR meta-synthes*[tiab])* **OR** ("Randomized Controlled Trial"[Publication Type] OR random*[tiab] OR pragmatic clinical trial*[tiab] OR practical clinical trial*[tiab] OR non-inferiority trial*[tiab] OR noninferiority trial*[tiab] OR superiority trial*[tiab] OR equivalence clinical trial*[tiab]) NOT (("Animals"[Mesh]) OR "Models, Animal"[Mesh] NOT humans[mh]) NOT (letter[pt] OR comment[pt] OR editorial[pt]) **OR ("Comparative Study"[Publication Type] OR "comparison"[tiab] OR "comparative"[tiab] OR "compar*"[tiab] OR "Epidemiologic studies"[mesh:noexp] OR "case control studies"[mesh] OR "cohort studies"[mesh] OR "Controlled Before-After Studies"[mesh] OR "Case control"[tw] OR cohort*[tw] OR "Cohort analy*"[tw] OR "Follow up stud*"[tw] OR "observational stud*"[tw] OR Longitudinal[tw] OR Retrospective*[tw] OR prospective*[tw] OR consecutive*[tw] OR Cross sectional[tw] OR "Cross-sectional studies"[mesh] OR "historically controlled study"[mesh] OR "interrupted time series analysis"[mesh]) OR** ("life cycle assess*"[tw] OR "life cycle assessment"[tw] OR "life cycle inventory"[tw] OR "LCA"[tw] OR "LCAs"[tw] OR "life cycle inventory"[tw] OR "life cycle inventories"[tw])**)**

Embase (OVID)

((exp "Recycling"/ OR "reusable biopsy forceps".mp OR "reusable drape".mp OR "reusable drapes".mp OR "reusable equipment".mp OR "reusable flexible optical scope".mp OR "reusable flexible optical scopes".mp OR "reusable forceps".mp OR "reusable laryngeal mask".mp OR "reusable laryngeal masks".mp OR "reusable medical equipment".mp OR "reusable medical equipment packaging".mp OR "reusable scissor".mp OR "reusable scissors".mp OR "reusable scope".mp OR "reusable scopes".mp OR "reusable sharps container".mp OR "reusable sharps containers".mp OR "reusable specula".mp OR "reusable speculum".mp OR "reusable surgical attire".mp OR "reusable surgical attires".mp OR "reusable surgical clamp".mp OR "reusable surgical clamps".mp OR "reusable surgical clip".mp OR "reusable surgical clips".mp OR "reusable surgical kit".mp OR "reusable surgical kits".mp OR "reusable suture anchor".mp OR "reusable suture anchors".mp OR "reusable trocar".mp OR "reusable trocars".mp OR "reusable ureteroscope".mp OR "reusable ureteroscopes".mp OR "recyclable biopsy forceps".mp OR "recyclable drape".mp OR "recyclable drapes".mp OR "recyclable equipment".mp OR "recyclable flexible optical scope".mp OR "recyclable flexible optical scopes".mp OR "recyclable forceps".mp OR "recyclable laryngeal mask".mp OR "recyclable laryngeal masks".mp OR "recyclable medical equipment".mp OR "recyclable medical equipment packaging".mp OR "recyclable scissor".mp OR "recyclable scissors".mp OR "recyclable scope".mp OR "recyclable scopes".mp OR "recyclable sharps container".mp OR "recyclable sharps containers".mp OR "recyclable specula".mp OR "recyclable speculum".mp OR "recyclable surgical attire".mp OR "recyclable surgical attires".mp OR "recyclable surgical clamp".mp OR "recyclable surgical clamps".mp OR "recyclable surgical clip".mp OR "recyclable surgical clips".mp OR "recyclable surgical kit".mp OR "recyclable surgical kits".mp OR "recyclable suture anchor".mp OR "recyclable suture anchors".mp OR "recyclable 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"singleuse".mp OR "singleuse*".mp OR "single usage".mp OR "single usage*".mp) AND (exp "biopsy forceps"/ OR "biopsy forceps".mp OR exp "Surgical Drape"/ OR "drape".mp OR "drapes".mp OR exp "Surgical Equipment"/ OR "equipment".mp OR "flexible optical scope".mp OR "flexible optical scopes".mp OR exp "Forceps"/ OR "forceps".mp OR exp "Laryngeal Mask"/ OR "laryngeal mask".mp OR "laryngeal masks".mp OR exp "medical Device"/ OR "medical equipment".mp OR "medical equipment packaging".mp OR exp "Scissors"/ OR "scissor".mp OR "scissors".mp OR exp "Endoscope"/ OR "scopes".mp OR "Endoscopes".mp OR "Endoscope".mp OR "sharps container"/ OR "sharps container".mp OR "sharps containers".mp OR "sharps bin".mp OR "sharps bins".mp OR "specula".mp OR "speculum".mp OR exp "Surgical Attire"/ OR "surgical attire".mp OR "surgical attires".mp OR "Surgical Shoe Covers".mp OR "Surgical Shoe Cover".mp OR "Surgical Gowns".mp OR "Surgical Gown".mp OR exp "Mask"/ OR "Mask".mp OR "Masks".mp OR "Respirators".mp OR "Respirator".mp OR exp "clamp"/ OR "surgical clamp".mp OR "surgical clamps".mp OR exp "Clip"/ OR "surgical clip".mp OR "surgical clips".mp OR "Forcep".mp OR "Forceps".mp OR "Surgical Clamp".mp OR "Surgical Clamps".mp OR exp "Surgical Hook"/ OR "Surgical Hook".mp OR "Surgical Hooks".mp OR "Surgical Instrument".mp OR "Surgical Instruments".mp OR "Surgical Plug".mp OR "Surgical Plugs".mp OR "Surgical Scissor".mp OR "Surgical Scissors".mp OR "Surgical Valve".mp OR "Surgical Valves".mp OR "Tantalum Clip".mp OR "Tantalum Clips".mp OR exp "Stapler"/ OR "Surgical Staplers".mp OR "Surgical Stapler".mp OR "surgical kit".mp OR "surgical kits".mp OR exp "Suture Anchor"/ OR "suture anchor".mp OR "suture anchors".mp OR "Bone Anchor".mp OR "Bone Anchors".mp OR exp "Trocar"/ OR "trocar".mp OR "trocars".mp OR exp "Ureteroscope"/ OR "ureteroscope".mp OR "ureteroscopes".mp OR exp "Spectacles"/ OR "band aid".mp OR "band aids".mp OR "bandaid".mp OR "bandaids".mp OR "cap".mp OR "caps".mp OR "cover material".mp OR "cover materials".mp OR "covering material".mp OR "covering materials".mp OR "Eyeglasses".mp OR "glasses".mp OR ex "Glove"/ OR "glove".mp OR "gloves".mp OR exp "Surgical Gown"/ OR exp "Patient Gown"/ OR "gown".mp OR "gowns".mp OR "packing material".mp OR "packing materials".mp OR "patch".mp OR "patches".mp OR "spectacles".mp OR "surgery instrument".mp OR "surgery instruments".mp OR "surgical instrument".mp OR "surgical instruments".mp OR "medical device".mp OR "medical devices".mp OR "surgical device".mp OR "surgical devices".mp))) AND ("Carbon Footprint"/ OR "carbon footprint".mp OR "carbon footprint*".mp OR exp "Climate Change"/ OR "climate change".mp OR "CO2 emission".mp OR "CO2 emissions".mp OR "CO2 footprint".mp OR "CO2 footprint*".mp OR exp "environmental protection"/ OR "conservation of natural resources".mp OR "environmental protection".mp OR "ecological footprint".mp OR "ecological footprint*".mp OR "ecological sustainability".mp OR exp "environmental impact"/ 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"Emission reduction strategy".mp OR "air pollution control"/ OR "air pollution control".mp **OR "Environment"/ OR "Environmental*".mp** OR "acidification"/ OR "soil acidification"/ OR "ocean acidification"/ OR "acidification".mp OR "Acidification potential".mp OR "AP in kg SO2 equivalents".mp OR "eco-efficiency".mp OR "ecoefficiency".mp OR "eco-efficien*".mp OR "ecoefficien*".mp OR "ecotoxicity"/ OR "ecotoxicity".mp OR "ecotoxic*".mp OR "eco toxicity".mp OR "eco toxic*".mp OR "EP in kg PO4 equivalent".mp OR exp "Eutrophication"/ OR "eutrophication".mp OR "Eutrophication potential".mp OR "FAETP in kg DCB equivalent".mp OR "Freshwater Aquatic Ecotoxicity Potential".mp OR "GWP in kg CO2 equivalents".mp OR "H+ moles equivalents".mp OR "HTTP in kg Dichlorobenzene equivalent".mp OR "Human Toxicity Potential".mp OR "kg 2.4-D equivalents".mp OR "kg CFC-11 equivalent".mp OR "kg N equivalents".mp OR "kg NOx equivalents".mp OR "life cycle analysis".mp OR "ozone depletion".mp OR "Photochemical Ozone Depletion Potential".mp OR "POCP in kg ethane equivalent".mp OR "smog".mp OR exp "Waste"/ OR "waste".mp OR "wastes".mp OR "Ozone Depletion"/ OR "Smog"/ OR "Greenhouse Gases".mp OR "Greenhouse Gas".mp OR "SO2 equiv*".mp OR "CO2 equiva*".mp OR "CFC-11 equiv*".mp OR "N equiv*".mp OR exp "Biodiversity"/ OR "Biodiversity".mp OR "Climatic change".mp OR "Green deal".mp OR "preservation of natural resources".mp OR "Refuse Disposal".mp OR exp "Wastewater"/ OR "Waste Water".mp OR "Wastewater".mp OR exp "Water Management"/ OR "Water Purification".mp OR (("plastic*".mp OR "microplastic*") AND ("soop".mp OR "soup".mp OR "pollution".mp OR "overuse".mp OR "contamination".mp)) OR "Sustainable Development"/ OR "Sustainable Development".mp OR (("Plastic".mp OR "plastics".mp) AND "overuse".mp) OR ("hydrogen*".mp AND "moles".mp AND "equiv*".mp) OR ("Dichlorobenzen*".mp AND "equiv*".mp) OR ("2,4-D".mp AND "equiv*".mp) OR ("NOx".mp AND "equiv*".mp) OR ("ethane".mp AND "equiv*".mp) OR ("PO4".mp AND "equiv*".mp) OR ("DCB".mp AND "equiv*".mp) OR ("sustainability".mp AND ("environment*".mp OR "carbon".mp)) OR (("Carbon Dioxide"/ OR "Carbon Dioxide".mp OR "CO2".mp) AND ("pollution".mp OR "emission".mp OR "emissions".mp OR "waste".mp OR "environment".mp OR "environmental*".mp OR "footprint".mp OR "footprint*".mp OR "sustainable".mp OR "hazard".mp OR "hazard*".mp))) NOT (conference review or conference abstract).pt AND (2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022).yr) AND **(***(exp "meta analysis"/ OR exp "meta analysis (topic)"/ OR metaanaly*.ti,ab OR "meta analy*".ti,ab OR metanaly*.ti,ab OR "systematic review"/ OR "cochrane database of systematic reviews".jn OR prisma.ti,ab OR prospero.ti,ab OR (((systemati* OR scoping OR umbrella OR "structured literature") ADJ3 (review* OR overview*)).ti,ab) OR ((systemic* ADJ1 review*).ti,ab) OR (((systemati* OR literature OR database* OR "data base*") ADJ10 search*).ti,ab) OR (((structured OR comprehensive* OR systemic*) ADJ3 search*).ti,ab) OR (((literature ADJ3 review*).ti,ab) AND (search*.ti,ab OR database*.ti,ab OR "data base*".ti,ab)) OR (("data extraction".ti,ab OR "data source*".ti,ab) AND "study selection".ti,ab) OR ("search strategy".ti,ab AND "selection criteria".ti,ab) OR ("data source*".ti,ab AND "data synthesis".ti,ab) OR medline.ab OR pubmed.ab OR embase.ab OR cochrane.ab OR (((critical OR rapid) ADJ2 (review* OR overview* OR synthes*)).ti) OR ((((critical* OR rapid*) ADJ3 (review* OR overview* OR synthes*)).ab) AND (search*.ab OR database*.ab OR "data base*".ab)) OR metasynthes*.ti,ab OR "meta synthes*".ti,ab)* OR (exp "clinical trial"/ OR exp "randomization"/ OR exp "single blind procedure"/ OR exp "double blind procedure"/ OR exp "crossover procedure"/ OR exp "placebo"/ OR exp "prospective study"/ OR rct.ti,ab OR random*.ti,ab OR "single blind".ti,ab OR "randomised controlled trial".ti,ab OR exp "randomized controlled trial"/ OR placebo*.ti,ab) **OR (exp "Comparative Study"/ OR "comparison".ti,ab OR "comparative".ti,ab OR "compar*".ti,ab OR "major clinical study"/ OR "clinical study"/ OR "case control study"/ OR "family study"/ OR "longitudinal study"/ OR "retrospective study"/ OR "prospective study"/ OR "cohort analysis"/ OR cohort*.ti,ab OR (("case control" ADJ1 (study OR studies)).ti,ab) OR (("follow up" ADJ1 (study OR studies)).ti,ab) OR (observational ADJ1 (study OR studies)) OR ((epidemiologic ADJ1 (study OR studies)).ti,ab) OR (("cross sectional" ADJ1 (study OR studies)).ti,ab)) OR** ("life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "life cycle inventory".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp)**)**

Web of Science

((ti=("Equipment Reuse" OR "reusable biopsy forceps" OR "reusable drape" OR "reusable drapes" OR "reusable equipment" OR "reusable flexible optical scope" OR "reusable flexible optical scopes" OR "reusable forceps" OR "reusable laryngeal mask" OR "reusable laryngeal masks" OR "reusable medical equipment" OR "reusable medical equipment packaging" OR "reusable scissor" OR "reusable scissors" OR "reusable scope" OR "reusable scopes" OR "reusable sharps container" OR "reusable sharps containers" OR "reusable specula" OR "reusable speculum" OR "reusable surgical attire" OR "reusable surgical attires" OR "reusable surgical clamp" OR "reusable surgical clamps" OR "reusable surgical clip" OR "reusable surgical clips" OR "reusable surgical kit" OR "reusable surgical kits" OR "reusable suture anchor" OR "reusable suture anchors" OR "reusable trocar" OR "reusable trocars" OR "reusable ureteroscope" OR "reusable ureteroscopes" OR "recyclable biopsy forceps" OR "recyclable drape" OR "recyclable drapes" OR "recyclable equipment" OR "recyclable flexible optical scope" OR "recyclable flexible optical scopes" OR "recyclable forceps" OR "recyclable laryngeal mask" OR "recyclable laryngeal masks" OR "recyclable medical equipment" OR "recyclable medical equipment packaging" OR "recyclable scissor" OR "recyclable scissors" OR "recyclable scope" OR "recyclable scopes" OR "recyclable sharps container" OR "recyclable sharps containers" OR "recyclable specula" OR "recyclable speculum" OR "recyclable surgical attire" OR "recyclable surgical attires" OR "recyclable surgical clamp" OR "recyclable surgical clamps" OR "recyclable surgical clip" OR "recyclable surgical clips" OR "recyclable surgical kit" OR "recyclable surgical kits" OR "recyclable suture anchor" OR "recyclable suture anchors" OR "recyclable trocar" OR "recyclable trocars" OR "recyclable ureteroscope" OR "recyclable ureteroscopes" OR (("Equipment Reuse" OR "reusables" OR "reusable" OR "reusabl*" OR "reuse" OR "re usables" OR "re usable" OR "re usabl*" OR "re use" OR "recyclable" OR "recyclables" OR "recycl*" OR "re cyclable" OR "re cycl*" OR "Recycling" OR "reprocess" OR "reprocessing" OR "reprocess*") AND ("biopsy forceps" OR "Surgical Drapes" OR "drape" OR "drapes" OR "Surgical Equipment" OR "equipment" OR "flexible optical scope" OR "flexible optical scopes" OR "forceps" OR "Laryngeal Masks" OR "laryngeal mask" OR "laryngeal masks" OR "medical equipment" OR "medical equipment packaging" OR "scissor" OR "scissors" OR "Endoscopes" OR "scopes" OR "Endoscopes" OR "Endoscope" OR "sharps container" OR "sharps containers" OR "sharps bin" OR "sharps bins" OR "specula" OR "speculum" OR "Surgical Attire" OR "surgical attire" OR "surgical attires" OR "Surgical Shoe Covers" OR "Surgical Shoe Cover" OR "Surgical Gowns" OR "Surgical Gown" OR "Masks" OR "Mask" OR "Masks" OR "Respirators" OR "Respirator" OR "Surgical Instruments" OR "surgical clamp" OR "surgical clamps" OR "surgical clip" OR "surgical clips" OR "Forcep" OR "Forceps" OR "Surgical Clamp" OR "Surgical Clamps" OR "Surgical Hook" OR "Surgical Hooks" OR "Surgical Instrument" OR "Surgical Instruments" OR "Surgical Plug" OR "Surgical Plugs" OR "Surgical Scissor" OR "Surgical Scissors" OR "Surgical Valve" OR "Surgical Valves" OR "Tantalum Clip" OR "Tantalum Clips" OR "Surgical Staplers" OR "Surgical Stapler" OR "surgical kit" OR "surgical kits" OR "Suture Anchors" OR "suture anchor" OR "suture anchors" OR "Bone Anchor" OR "Bone Anchors" OR "trocar" OR "trocars" OR "Ureteroscopes" OR "ureteroscope" OR "ureteroscopes" OR "Eyeglasses" OR "band aid" OR "band aids" OR "bandaid" OR "bandaids" OR "cap" OR "caps" OR "cover material" OR "cover materials" OR "covering material" OR "covering materials" OR "Eyeglasses" OR "glasses" OR "glove" OR "gloves" OR "gown" OR "gowns" OR "packing material" OR "packing materials" OR "patch" OR "patches" OR "spectacles" OR "surgery instrument" OR "surgery instruments" OR "surgical instrument" OR "surgical 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OR "recyclable trocar" OR "recyclable trocars" OR "recyclable ureteroscope" OR "recyclable ureteroscopes" OR (("Equipment Reuse" OR "reusables" OR "reusable" OR "reusabl*" OR "reuse" OR "re usables" OR "re usable" OR "re usabl*" OR "re use" OR "recyclable" OR "recyclables" OR "recycl*" OR "re cyclable" OR "re cycl*" OR "Recycling" OR "reprocess" OR "reprocessing" OR "reprocess*") AND ("biopsy forceps" OR "Surgical Drapes" OR "drape" OR "drapes" OR "Surgical Equipment" OR "equipment" OR "flexible optical scope" OR "flexible optical scopes" OR "forceps" OR "Laryngeal Masks" OR "laryngeal mask" OR "laryngeal masks" OR "medical equipment" OR "medical equipment packaging" OR "scissor" OR "scissors" OR "Endoscopes" OR "scopes" OR "Endoscopes" OR "Endoscope" OR "sharps container" OR "sharps containers" OR "sharps bin" OR "sharps bins" OR "specula" OR "speculum" OR "Surgical Attire" OR "surgical attire" OR "surgical attires" OR "Surgical Shoe Covers" OR "Surgical Shoe Cover" OR "Surgical 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"disposable surgical clamps" OR "disposable surgical clip" OR "disposable surgical clips" OR "disposable surgical kit" OR "disposable surgical kits" OR "disposable suture anchor" OR "disposable suture anchors" OR "disposable trocar" OR "disposable trocars" OR "disposable ureteroscope" OR "disposable ureteroscopes" OR "single use biopsy forceps" OR "single use drape" OR "single use drapes" OR "single use equipment" OR "single use flexible optical scope" OR "single use flexible optical scopes" OR "single use laryngeal mask" OR "single use laryngeal masks" OR "single use medical equipment packaging" OR "single use scissor" OR "single use scissors" OR "single use scope" OR "single use scopes" OR "single use sharps container" OR "single use sharps containers" OR "single use specula" OR "single use speculum" OR "single use surgical attire" OR "single use surgical clamp" OR "single use surgical clamps" OR "single use surgical clip" OR "single use surgical clips" OR "single use surgical kit" OR "single use surgical kits" OR "single use suture anchor" OR "single use suture anchors" OR "single use trocar" OR "single use trocars" OR "single use ureteroscope" OR "single use ureteroscopes" OR (("Disposable Equipment" OR "disposable" OR "disposables" OR "dispos*" OR "single use" OR "single use*" OR "singleuse" OR "singleuse*" OR "single usage" OR "single usage*") AND ("biopsy forceps" OR "Surgical Drapes" OR "drape" OR "drapes" OR "Surgical Equipment" OR "equipment" OR "flexible optical scope" OR "flexible optical scopes" OR "forceps" OR "Laryngeal Masks" OR "laryngeal mask" OR "laryngeal masks" OR "medical equipment" OR "medical equipment packaging" OR "scissor" OR "scissors" OR "Endoscopes" OR "scopes" OR "Endoscopes" OR "Endoscope" OR "sharps container" OR "sharps containers" OR "sharps bin" OR "sharps bins" OR "specula" OR "speculum" OR "Surgical Attire" OR "surgical attire" OR "surgical attires" OR "Surgical Shoe Covers" OR "Surgical Shoe Cover" OR "Surgical Gowns" OR "Surgical Gown" OR "Masks" OR "Mask" OR "Masks" OR "Respirators" OR "Respirator" OR "Surgical Instruments" OR "surgical clamp" OR "surgical clamps" OR "surgical clip" OR "surgical clips" OR "Forcep" OR "Forceps" OR "Surgical Clamp" OR "Surgical Clamps" OR "Surgical Hook" OR "Surgical Hooks" OR "Surgical Instrument" OR "Surgical Instruments" OR "Surgical Plug" OR "Surgical Plugs" OR "Surgical Scissor"

OR "Surgical Scissors" OR "Surgical Valve" OR "Surgical Valves" OR "Tantalum Clip" OR "Tantalum Clips" OR "Surgical Staplers" OR "Surgical Stapler" OR "surgical kit" OR "surgical kits" OR "Suture Anchors" OR "suture anchor" OR "suture anchors" OR "Bone Anchor" OR "Bone Anchors" OR "trocar" OR "trocars" OR "Ureteroscopes" OR "ureteroscope" OR "ureteroscopes" OR "Eyeglasses" OR "band aid" OR "band aids" OR "bandaid" OR "bandaids" OR "cap" OR "caps" OR "cover material" OR "cover materials" OR "covering material" OR "covering materials" OR "Eyeglasses" OR "glasses" OR "glove" OR "gloves" OR "gown" OR "gowns" OR "packing material" OR "packing materials" OR "patch" OR "patches" OR "spectacles" OR "surgery instrument" OR "surgery instruments" OR "surgical instrument" OR "surgical instruments" OR "surgery instrument" OR "surgery instruments" OR "surgical instrument" OR "surgical instruments" OR "medical device" OR "medical devices" OR "surgical device" OR "surgical devices"))) OR ab=("Disposable Equipment" OR "disposable biopsy forceps" OR "disposable drape" OR "disposable drapes" OR "disposable equipment" OR "disposable flexible optical scope" OR "disposable flexible optical scopes" OR "disposable laryngeal mask" OR "disposable laryngeal masks" OR "disposable medical equipment packaging" OR "disposable scissor" OR "disposable scissors" OR "disposable scope" OR "disposable scopes" OR "disposable sharps container" OR "disposable sharps containers" OR "disposable specula" OR "disposable speculum" OR "disposable surgical attire" OR "disposable surgical clamp" OR "disposable surgical clamps" OR "disposable surgical clip" OR "disposable surgical clips" OR "disposable surgical kit" OR "disposable surgical kits" OR "disposable suture anchor" OR "disposable suture anchors" OR "disposable trocar" OR "disposable trocars" OR "disposable ureteroscope" OR "disposable ureteroscopes" OR "single use biopsy forceps" OR "single use drape" OR "single use drapes" OR "single use equipment" OR "single use flexible optical scope" OR "single use flexible optical scopes" OR "single use laryngeal mask" OR "single use laryngeal masks" OR "single use medical equipment packaging" OR "single use scissor" OR "single use scissors" OR "single use scope" OR "single use scopes" OR "single use sharps container" OR "single use sharps containers" OR "single use specula" OR "single use speculum" OR "single use surgical attire" OR "single use surgical clamp" OR "single use surgical clamps" OR "single use surgical clip" OR "single use surgical clips" OR "single use surgical kit" OR "single use surgical kits" OR "single use suture anchor" OR "single use suture anchors" OR "single use trocar" OR "single use trocars" OR "single use ureteroscope" OR "single use ureteroscopes" OR (("Disposable Equipment" OR "disposable" OR "disposables" OR "dispos*" OR "single use" OR "single use*" OR "singleuse" OR "singleuse*" OR "single usage" OR "single usage*") AND ("biopsy forceps" OR "Surgical Drapes" OR "drape" OR "drapes" OR "Surgical Equipment" OR "equipment" OR "flexible optical scope" OR "flexible optical scopes" OR "forceps" OR "Laryngeal Masks" OR "laryngeal mask" OR "laryngeal masks" OR "medical equipment" OR "medical equipment packaging" OR "scissor" OR "scissors" OR "Endoscopes" OR "scopes" OR "Endoscopes" OR "Endoscope" OR "sharps container" OR "sharps containers" OR "sharps bin" OR "sharps bins" OR "specula" OR "speculum" OR "Surgical Attire" OR "surgical attire" OR "surgical attires" OR "Surgical Shoe Covers" OR "Surgical Shoe Cover" OR "Surgical Gowns" OR "Surgical Gown" OR "Masks" OR "Mask" OR "Masks" OR "Respirators" OR "Respirator" OR "Surgical Instruments" OR "surgical clamp" OR "surgical clamps" OR "surgical clip" OR "surgical clips" OR "Forcep" OR "Forceps" OR "Surgical Clamp" OR "Surgical Clamps" OR "Surgical Hook" OR "Surgical Hooks" OR "Surgical Instrument" OR "Surgical Instruments" OR "Surgical Plug" OR "Surgical Plugs" OR "Surgical Scissor" OR "Surgical Scissors" OR "Surgical Valve" OR "Surgical Valves" OR "Tantalum Clip" OR "Tantalum Clips" OR "Surgical Staplers" OR "Surgical Stapler" OR "surgical kit" OR "surgical kits" OR "Suture Anchors" OR "suture anchor" OR "suture anchors" OR "Bone Anchor" OR "Bone Anchors" OR "trocar" OR "trocars" OR "Ureteroscopes" OR "ureteroscope" OR "ureteroscopes" OR "Eyeglasses" OR "band aid" OR "band aids" OR "bandaid" OR "bandaids" OR "cap" OR "caps" OR "cover material" OR "cover materials" OR "covering material" OR "covering materials" OR "Eyeglasses" OR "glasses" OR "glove" OR "gloves" OR "gown" OR "gowns" OR "packing material" OR "packing materials" OR "patch" OR "patches" OR "spectacles" OR "surgery instrument" OR "surgery instruments" OR "surgical instrument" OR "surgical instruments" OR "surgery instrument" OR "surgery instruments" OR "surgical instrument" OR "surgical instruments" OR "medical device" OR "medical devices" OR "surgical device" OR "surgical devices")))) AND (TS=("Carbon Footprint" OR "carbon footprint" OR "carbon footprint*" OR "Climate Change" OR "climate change" OR "CO2 emission" OR "CO2 emissions" OR "CO2 footprint" OR "CO2 footprint*" OR "environmental protection" OR "conservation of natural resources" OR "environmental protection" OR "ecological footprint" OR "ecological footprint*" OR "ecological sustainability" OR "environmental impact" OR "environmental impact" OR "environmental impact*" OR "environmental impacts" OR "environmental pollut*" OR "pollution" OR "environmental pollution" OR "environmental sustainab*" OR "environmental sustainability" OR "environmental sustainability" OR "Global Warming" OR "Global Warming" OR "Greenhouse Effect" OR "greenhouse effect*" OR "greenhouse effects" OR "greenhouse gas emission" OR "greenhouse gas emissions" OR "Greenhouse Gas" OR "greening" OR "hospital waste" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assess*" OR "life cycle assessment" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories" OR "Waste Disposal" OR "Hospital Waste" OR "medical waste" OR "Rising Sea Level" OR "Rising Sea Levels" OR "Sea Level Rise" OR "Sea Level Rise" OR "Waste Disposal" OR "waste water recycling" OR "Waste Disposal" OR "Waste Management" OR "Plastic overuse" OR "Green surgery" OR "Emission reduction" OR "Emission reduction strategy" OR "air pollution control" OR "air pollution control" OR "acidification" OR "soil acidification" OR "ocean acidification" OR "acidification" OR "Acidification potential" OR "AP in kg SO2 equivalents" OR "eco-efficiency" OR "ecoefficiency" OR "eco-efficien*" OR "ecoefficien*" OR "ecotoxicity" OR "ecotoxicity" OR "ecotoxic*" OR "eco toxicity" OR "eco toxic*" OR "EP in kg PO4 equivalent" OR "Eutrophication" OR "eutrophication" OR "Eutrophication potential" OR "FAETP in kg DCB equivalent" OR "Freshwater Aquatic Ecotoxicity Potential" OR "GWP in kg CO2 equivalents" OR "H+ moles equivalents" OR "HTTP in kg Dichlorobenzene equivalent" OR "Human Toxicity Potential" OR "kg 2.4-D equivalents" OR "kg CFC-11 equivalent" OR "kg N equivalents" OR "kg NOx equivalents" OR "life cycle analysis" OR "ozone depletion" OR "Photochemical Ozone Depletion Potential" OR "POCP in kg ethane equivalent" OR "smog" OR "Waste" OR "waste" OR "wastes" OR "Ozone Depletion" OR "Smog" OR "Greenhouse Gases" OR "Greenhouse Gas" OR "SO2 equiv*" OR "CO2 equiva*" OR "CFC-11 equiv*" OR "N equiv*" OR "Sustainable Development" OR "Sustainable Development" OR "Biodiversity" OR "Climatic change" OR "Green deal" OR "preservation of natural resources" OR "Refuse Disposal" OR "Waste Water" OR "Wastewater" OR "Water Purification" OR (("plastic*" OR "microplastic*") AND ("soop" OR "soup" OR "pollution" OR "overuse" OR "contamination")) OR (("Plastic" OR "plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))) OR **TI=("environmental*" OR "sustainab*")** OR **AB=("environmental*" OR**

"sustainab*") OR **AK=("environmental*" OR "sustainab*"))** NOT DT=(meeting abstract) AND PY=(2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022)) AND (TI=**(***("Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR/4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR/4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR/4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR/4 ("review*" OR "overview*" OR "synthes*") NEAR/4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*")* **OR** ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") **OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR/1 (study OR studies))) OR (("follow up" NEAR/1 (study OR studies))) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies))) OR (("cross sectional" NEAR/1 (study OR studies)))) OR** ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")**)** OR AB=**(***("Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR/4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR/4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR/4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR/4 ("review*" OR "overview*" OR "synthes*") NEAR/4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*")* **OR** ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") **OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR/1 (study OR studies))) OR (("follow up" NEAR/1 (study OR studies))) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies))) OR (("cross sectional" NEAR/1 (study OR studies)))) OR** ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")**)**)

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("Equipment Reuse" OR "reusable biopsy forceps" OR "reusable drape" OR "reusable drapes" OR "reusable equipment" OR "reusable flexible optical scope" OR "reusable flexible optical scopes" OR "reusable forceps" OR "reusable laryngeal mask" OR "reusable laryngeal masks" OR "reusable medical equipment" OR "reusable medical equipment packaging" OR "reusable scissor" OR "reusable scissors" OR "reusable scope" OR "reusable scopes" OR "reusable sharps container" OR "reusable sharps containers" OR "reusable specula" OR "reusable speculum" OR "reusable surgical attire" OR "reusable surgical attires" OR "reusable surgical clamp" OR "reusable surgical clamps" OR "reusable surgical clip" OR "reusable surgical clips" OR "reusable surgical kit" OR "reusable surgical kits" OR "reusable suture anchor" OR "reusable suture anchors" OR "reusable trocar" OR "reusable trocars" OR "reusable ureteroscope" OR "reusable ureteroscopes" OR "recyclable biopsy forceps" OR "recyclable drape" OR "recyclable drapes" OR "recyclable equipment" OR "recyclable flexible optical scope" OR "recyclable flexible optical scopes" OR "recyclable forceps" OR "recyclable laryngeal mask" OR "recyclable laryngeal masks" OR "recyclable medical equipment" OR "recyclable medical equipment packaging" OR "recyclable scissor" OR "recyclable scissors" OR "recyclable scope" OR "recyclable scopes" OR "recyclable sharps container" OR "recyclable sharps containers" OR "recyclable specula" OR "recyclable speculum" OR "recyclable surgical attire" OR "recyclable surgical attires" OR "recyclable surgical clamp" OR "recyclable surgical clamps" OR "recyclable surgical clip" OR "recyclable surgical clips" OR "recyclable surgical kit" OR "recyclable surgical kits" OR "recyclable suture anchor" OR "recyclable suture anchors" OR "recyclable trocar" OR "recyclable trocars" OR "recyclable ureteroscope" OR "recyclable ureteroscopes" OR (("Equipment Reuse" OR "reusables" OR "reusable" OR "reusabl*" OR "reuse" OR "re usables" OR "re usable" OR "re usabl*" OR "re use" OR "recyclable" OR "recyclables" OR "recycl*" OR "re cyclable" OR "re cycl*" OR "Recycling" OR "reprocess" OR "reprocessing" OR "reprocess*") AND ("biopsy forceps" OR "Surgical Drapes" OR "drape" OR "drapes" OR "Surgical Equipment" OR "equipment" OR "flexible optical scope" OR "flexible optical scopes" OR "forceps" OR "Laryngeal Masks" OR "laryngeal mask" OR "laryngeal masks" OR "medical equipment" OR "medical equipment packaging" OR "scissor" OR "scissors" OR "Endoscopes" OR "scopes" OR "Endoscopes" OR "Endoscope" OR "sharps container" OR "sharps containers" OR "sharps bin" OR "sharps bins" OR "specula" OR "speculum" OR "Surgical Attire" OR "surgical attire" OR "surgical attires" OR "Surgical Shoe Covers" OR "Surgical Shoe Cover" OR "Surgical Gowns" OR "Surgical Gown" OR "Masks" OR "Mask" OR "Masks" OR "Respirators" OR "Respirator" OR "Surgical Instruments" OR "surgical clamp" OR "surgical clamps" OR "surgical clip" OR "surgical clips" OR "Forcep" OR "Forceps" OR "Surgical Clamp" OR "Surgical Clamps" OR "Surgical Hook" OR "Surgical Hooks" OR "Surgical Instrument" OR "Surgical Instruments" OR "Surgical Plug" OR "Surgical Plugs" OR "Surgical Scissor" OR "Surgical Scissors" OR "Surgical Valve" OR "Surgical Valves" OR "Tantalum Clip" OR "Tantalum Clips" OR "Surgical Staplers" OR "Surgical Stapler" OR "surgical kit" OR "surgical kits" OR "Suture Anchors" OR "suture anchor" OR "suture anchors" OR "Bone Anchor" OR "Bone Anchors" OR "trocar" OR "trocars" OR "Ureteroscopes" OR "ureteroscope" OR "ureteroscopes" OR "Eyeglasses" OR "band aid" OR "band aids" OR "bandaid" OR "bandaids" OR "cap" OR "caps" OR "cover material" OR "cover materials" OR "covering material" OR "covering materials" OR "Eyeglasses" OR "glasses" OR "glove" OR "gloves" OR "gown" OR "gowns" OR "packing material" OR "packing materials" OR "patch" OR "patches" OR "spectacles" OR "surgery instrument" OR "surgery instruments" OR "surgical instrument" OR "surgical instruments" OR "surgery instrument" OR "surgery instruments" OR "surgical instrument" OR "surgical instruments" OR "medical device" OR "medical devices" OR "surgical device" OR "surgical devices"))):ti,ab,kw AND ("Disposable Equipment" OR "disposable biopsy forceps" OR "disposable drape" OR "disposable drapes" OR "disposable equipment" OR "disposable flexible optical scope" OR "disposable flexible optical scopes" OR "disposable laryngeal mask" OR "disposable laryngeal masks" OR "disposable medical equipment packaging" OR "disposable scissor" OR "disposable scissors" OR "disposable scope" OR "disposable scopes" OR "disposable sharps container" OR "disposable sharps containers" OR "disposable specula" OR "disposable speculum" OR "disposable surgical attire" OR "disposable surgical clamp" OR "disposable surgical clamps" OR "disposable surgical clip" OR "disposable surgical clips" OR "disposable surgical kit" OR "disposable surgical kits" OR "disposable suture anchor" OR "disposable suture anchors" OR 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Equipment" OR "disposable" OR "disposables" OR "dispos*" OR "single use" OR "single use*" OR "singleuse" OR "singleuse*" OR "single usage" OR "single usage*") AND ("biopsy forceps" OR "Surgical Drapes" OR "drape" OR "drapes" OR "Surgical Equipment" OR "equipment" OR "flexible optical scope" OR "flexible optical scopes" OR "forceps" OR "Laryngeal Masks" OR "laryngeal mask" OR "laryngeal masks" OR "medical equipment" OR "medical equipment packaging" OR "scissor" OR "scissors" OR "Endoscopes" OR "scopes" OR "Endoscopes" OR "Endoscope" OR "sharps container" OR "sharps containers" OR "sharps bin" OR "sharps bins" OR "specula" OR "speculum" OR "Surgical Attire" OR "surgical attire" OR "surgical attires" OR "Surgical Shoe Covers" OR "Surgical Shoe Cover" OR "Surgical Gowns" OR "Surgical Gown" OR "Masks" OR "Mask" OR "Masks" OR "Respirators" OR "Respirator" OR "Surgical Instruments" OR "surgical clamp" OR "surgical clamps" OR "surgical clip" OR "surgical clips" OR "Forcep" OR "Forceps" OR 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instrument" OR "surgery instruments" OR "surgical instrument" OR "surgical instruments" OR "medical device" OR "medical devices" OR "surgical device" OR "surgical devices"))):ti,ab,kw AND (("Carbon Footprint" OR "carbon footprint" OR "carbon footprint*" OR "Climate Change" OR "climate change" OR "CO2 emission" OR "CO2 emissions" OR "CO2 footprint" OR "CO2 footprint*" OR "environmental protection" OR "conservation of natural resources" OR "environmental protection" OR "ecological footprint" OR "ecological footprint*" OR "ecological sustainability" OR "environmental impact" OR "environmental impact" OR "environmental impact*" OR "environmental impacts" OR "environmental pollut*" OR "pollution" OR "environmental pollution" OR "environmental sustainab*" OR "environmental sustainability" OR "environmental sustainability" OR "Global Warming" OR "Global Warming" OR "Greenhouse Effect" OR "greenhouse effect*" OR "greenhouse effects" OR "greenhouse gas emission" OR "greenhouse gas emissions" OR "Greenhouse Gas" OR "greening" OR "hospital waste" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assess*" OR "life cycle assessment" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories" OR "Waste Disposal" OR "Hospital Waste" OR "medical waste" OR "Rising Sea Level" OR "Rising Sea Levels" OR "Sea Level Rise" OR "Sea Level Rise" OR "Waste Disposal" OR "waste water recycling" OR "Waste Disposal" OR "Waste Management" OR "Plastic overuse" OR "Green surgery" OR "Emission reduction" OR "Emission reduction strategy" OR "air pollution control" OR "air pollution control" OR "acidification" OR "soil acidification" OR "ocean acidification" OR "acidification" OR "Acidification potential" OR "AP in kg SO2 equivalents" OR "eco-efficiency" OR "ecoefficiency" OR "eco-efficien*" OR "ecoefficien*" OR "ecotoxicity" OR "ecotoxicity" OR "ecotoxic*" OR "eco toxicity" OR "eco toxic*" OR "EP in kg PO4 equivalent" OR "Eutrophication" OR "eutrophication" OR "Eutrophication potential" OR "FAETP in kg DCB equivalent" OR "Freshwater Aquatic Ecotoxicity Potential" OR "GWP in kg CO2 equivalents" OR "H+ moles equivalents" OR "HTTP in kg Dichlorobenzene equivalent" OR "Human Toxicity Potential" OR "kg 2.4-D equivalents" OR "kg CFC-11 equivalent" OR "kg N equivalents" OR "kg NOx equivalents" OR "life cycle analysis" OR "ozone depletion" OR "Photochemical Ozone Depletion Potential" OR "POCP in kg ethane equivalent" OR "smog" OR "Waste" OR "waste" OR "wastes" OR "Ozone Depletion" OR "Smog" OR "Greenhouse Gases" OR "Greenhouse Gas" OR "SO2 equiv*" OR "CO2 equiva*" OR "CFC-11 equiv*" OR "N equiv*" OR "Biodiversity" OR "Climatic change" OR "Green deal" OR "preservation of natural resources" OR "Refuse Disposal" OR "Waste Water" OR "Wastewater" OR "Water Purification" OR (("plastic*" OR "microplastic*") AND ("soop" OR "soup" OR "pollution" OR "overuse" OR "contamination")) OR "Sustainable Development" OR "Sustainable Development" OR (("Plastic" OR "plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))):ti,ab,kw OR **("environmental" OR "sustainability"):ti,ab,kw**)

Emcare (OVID)

((exp "Recycling"/ OR "reusable biopsy forceps".mp OR "reusable drape".mp OR "reusable drapes".mp OR "reusable equipment".mp OR "reusable flexible optical scope".mp OR "reusable flexible optical scopes".mp OR "reusable forceps".mp OR "reusable laryngeal mask".mp OR "reusable laryngeal masks".mp OR "reusable medical equipment".mp OR "reusable medical equipment packaging".mp OR "reusable scissor".mp OR "reusable scissors".mp OR "reusable scope".mp OR "reusable scopes".mp OR "reusable sharps container".mp OR "reusable sharps containers".mp OR "reusable specula".mp OR "reusable speculum".mp OR "reusable surgical attire".mp OR "reusable surgical attires".mp OR "reusable surgical clamp".mp OR "reusable surgical clamps".mp OR "reusable surgical clip".mp OR "reusable surgical clips".mp OR "reusable surgical kit".mp OR "reusable surgical kits".mp OR "reusable suture anchor".mp OR "reusable suture anchors".mp OR "reusable trocar".mp OR "reusable trocars".mp OR "reusable ureteroscope".mp OR "reusable ureteroscopes".mp OR "recyclable biopsy forceps".mp OR "recyclable drape".mp OR "recyclable drapes".mp OR "recyclable equipment".mp OR "recyclable flexible optical scope".mp OR "recyclable flexible optical scopes".mp OR "recyclable forceps".mp OR "recyclable laryngeal mask".mp OR "recyclable laryngeal masks".mp OR "recyclable medical equipment".mp OR "recyclable medical equipment packaging".mp OR "recyclable scissor".mp OR "recyclable scissors".mp OR "recyclable scope".mp OR "recyclable scopes".mp OR "recyclable sharps container".mp OR "recyclable sharps containers".mp OR "recyclable specula".mp OR "recyclable speculum".mp OR "recyclable surgical attire".mp OR "recyclable surgical attires".mp OR "recyclable surgical clamp".mp OR "recyclable surgical clamps".mp OR "recyclable surgical clip".mp OR "recyclable surgical clips".mp OR "recyclable surgical kit".mp OR "recyclable surgical kits".mp OR "recyclable suture anchor".mp OR "recyclable suture anchors".mp OR "recyclable trocar".mp OR "recyclable trocars".mp OR "recyclable ureteroscope".mp OR "recyclable ureteroscopes".mp OR ((exp "Recycling"/ OR "reusables".mp OR "reusable".mp OR "reusabl*".mp OR "reuse".mp OR "re usables".mp OR "re usable".mp OR "re usabl*".mp OR "re use".mp OR "recyclable".mp OR "recyclables".mp OR "recycl*".mp OR "re cyclable".mp OR "re cycl*".mp OR "reprocess".mp OR "reprocessing".mp OR "reprocess*".mp) AND (exp "biopsy forceps"/ OR "biopsy forceps".mp OR exp "Surgical Drape"/ OR "drape".mp OR "drapes".mp OR exp "Surgical Equipment"/ OR "equipment".mp OR "flexible optical scope".mp OR "flexible optical scopes".mp OR exp "Forceps"/ OR "forceps".mp OR exp "Laryngeal Mask"/ OR "laryngeal mask".mp OR "laryngeal masks".mp OR exp "medical Device"/ OR "medical equipment".mp OR "medical equipment packaging".mp OR exp "Scissors"/ OR "scissor".mp OR "scissors".mp OR exp "Endoscope"/ OR "scopes".mp OR "Endoscopes".mp OR "Endoscope".mp OR "sharps container"/ OR "sharps container".mp OR "sharps containers".mp OR "sharps bin".mp OR "sharps bins".mp OR "specula".mp OR "speculum".mp OR exp "Surgical Attire"/ OR "surgical attire".mp OR "surgical attires".mp OR "Surgical Shoe Covers".mp OR "Surgical Shoe Cover".mp OR "Surgical Gowns".mp OR "Surgical Gown".mp OR exp "Mask"/ OR "Mask".mp OR "Masks".mp OR "Respirators".mp OR "Respirator".mp OR exp "clamp"/ OR "surgical clamp".mp OR "surgical clamps".mp OR exp "Clip"/ OR "surgical clip".mp OR "surgical clips".mp OR "Forcep".mp OR "Forceps".mp OR "Surgical Clamp".mp OR "Surgical Clamps".mp OR exp "Surgical Hook"/ OR "Surgical Hook".mp OR "Surgical Hooks".mp OR "Surgical Instrument".mp OR "Surgical Instruments".mp OR "Surgical Plug".mp OR "Surgical Plugs".mp OR "Surgical Scissor".mp OR "Surgical Scissors".mp OR "Surgical Valve".mp OR "Surgical Valves".mp OR "Tantalum Clip".mp OR "Tantalum Clips".mp OR exp "Stapler"/ OR "Surgical Staplers".mp OR "Surgical Stapler".mp OR "surgical kit".mp OR "surgical kits".mp OR exp "Suture Anchor"/ OR "suture anchor".mp OR "suture anchors".mp OR "Bone Anchor".mp OR "Bone Anchors".mp OR exp "Trocar"/ OR "trocar".mp OR "trocars".mp OR exp "Ureteroscope"/ OR "ureteroscope".mp OR "ureteroscopes".mp OR exp "Spectacles"/ OR "band aid".mp OR "band aids".mp OR "bandaid".mp OR "bandaids".mp OR "cap".mp OR "caps".mp OR "cover material".mp OR "cover materials".mp OR "covering material".mp OR "covering materials".mp OR "Eyeglasses".mp OR "glasses".mp OR ex "Glove"/ OR "glove".mp OR "gloves".mp OR exp "Surgical Gown"/ OR exp "Patient Gown"/ OR "gown".mp OR "gowns".mp OR "packing material".mp OR "packing materials".mp OR "patch".mp OR "patches".mp OR "spectacles".mp OR "surgery instrument".mp OR "surgery instruments".mp OR "surgical instrument".mp OR "surgical instruments".mp OR "medical device".mp OR "medical devices".mp OR "surgical device".mp OR "surgical devices".mp))) AND (exp "Disposable Equipment"/ OR "disposable biopsy forceps".mp OR "disposable drape".mp OR "disposable drapes".mp OR "disposable equipment".mp OR "disposable flexible optical scope".mp OR "disposable flexible optical scopes".mp OR "disposable laryngeal mask".mp OR "disposable laryngeal masks".mp OR "disposable medical equipment packaging".mp OR "disposable scissor".mp OR "disposable scissors".mp OR "disposable scope".mp OR "disposable scopes".mp OR "disposable sharps container".mp OR "disposable sharps containers".mp OR "disposable specula".mp OR "disposable speculum".mp OR "disposable surgical attire".mp OR "disposable surgical clamp".mp OR "disposable surgical clamps".mp OR "disposable surgical clip".mp OR "disposable surgical clips".mp OR "disposable surgical kit".mp OR "disposable surgical kits".mp OR "disposable suture anchor".mp OR "disposable suture anchors".mp OR "disposable trocar".mp OR "disposable trocars".mp OR "disposable ureteroscope".mp OR "disposable ureteroscopes".mp OR "single use biopsy forceps".mp OR "single use drape".mp OR "single use drapes".mp OR "single use 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"singleuse".mp OR "singleuse*".mp OR "single usage".mp OR "single usage*".mp) AND (exp "biopsy forceps"/ OR "biopsy forceps".mp OR exp

"Surgical Drape"/ OR "drape".mp OR "drapes".mp OR exp "Surgical Equipment"/ OR "equipment".mp OR "flexible optical scope".mp OR "flexible optical scopes".mp OR exp "Forceps"/ OR "forceps".mp OR exp "Laryngeal Mask"/ OR "laryngeal mask".mp OR "laryngeal masks".mp OR exp "medical Device"/ OR "medical equipment".mp OR "medical equipment packaging".mp OR exp "Scissors"/ OR "scissor".mp OR "scissors".mp OR exp "Endoscope"/ OR "scopes".mp OR "Endoscopes".mp OR "Endoscope".mp OR "sharps container"/ OR "sharps container".mp OR "sharps containers".mp OR "sharps bin".mp OR "sharps bins".mp OR "specula".mp OR "speculum".mp OR exp "Surgical Attire"/ OR "surgical attire".mp OR "surgical attires".mp OR "Surgical Shoe Covers".mp OR "Surgical Shoe Cover".mp OR "Surgical Gowns".mp OR "Surgical Gown".mp OR exp "Mask"/ OR "Mask".mp OR "Masks".mp OR "Respirators".mp OR "Respirator".mp OR exp "clamp"/ OR "surgical clamp".mp OR "surgical clamps".mp OR exp "Clip"/ OR "surgical clip".mp OR "surgical clips".mp OR "Forcep".mp OR "Forceps".mp OR "Surgical Clamp".mp OR "Surgical Clamps".mp OR exp "Surgical Hook"/ OR "Surgical Hook".mp OR "Surgical Hooks".mp OR "Surgical Instrument".mp OR "Surgical Instruments".mp OR "Surgical Plug".mp OR "Surgical Plugs".mp OR "Surgical Scissor".mp OR "Surgical Scissors".mp OR "Surgical Valve".mp OR "Surgical Valves".mp OR "Tantalum Clip".mp OR "Tantalum Clips".mp OR exp "Stapler"/ OR "Surgical Staplers".mp OR "Surgical Stapler".mp OR "surgical kit".mp OR "surgical kits".mp OR exp "Suture Anchor"/ OR "suture anchor".mp OR "suture anchors".mp OR "Bone Anchor".mp OR "Bone Anchors".mp OR exp "Trocar"/ OR "trocar".mp OR "trocars".mp OR exp "Ureteroscope"/ OR "ureteroscope".mp OR "ureteroscopes".mp OR exp "Spectacles"/ OR "band aid".mp OR "band aids".mp OR "bandaid".mp OR "bandaids".mp OR "cap".mp OR "caps".mp OR "cover material".mp OR "cover materials".mp OR "covering material".mp OR "covering materials".mp OR "Eyeglasses".mp OR "glasses".mp OR ex "Glove"/ OR "glove".mp OR "gloves".mp OR exp "Surgical Gown"/ OR exp "Patient Gown"/ OR "gown".mp OR "gowns".mp OR "packing material".mp OR "packing materials".mp OR "patch".mp OR "patches".mp OR "spectacles".mp OR "surgery instrument".mp OR "surgery instruments".mp OR "surgical instrument".mp OR "surgical instruments".mp OR "medical device".mp OR "medical devices".mp OR "surgical device".mp OR "surgical devices".mp))) AND ("Carbon Footprint"/ OR "carbon footprint".mp OR "carbon footprint*".mp OR exp "Climate Change"/ OR "climate change".mp OR "CO2 emission".mp OR "CO2 emissions".mp OR "CO2 footprint".mp OR "CO2 footprint*".mp OR exp "environmental protection"/ OR "conservation of natural resources".mp OR "environmental protection".mp OR "ecological footprint".mp OR "ecological footprint*".mp OR "ecological sustainability".mp OR exp "environmental impact"/ OR "environmental impact".mp OR "environmental impact*".mp OR "environmental impacts".mp OR "environmental pollut*".mp OR exp "pollution"/ OR 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pollution control"/ OR "air pollution control".mp OR "Environment"/ OR "Environmental*".mp OR "acidification"/ OR "soil acidification"/ OR "ocean acidification"/ OR "acidification".mp OR "Acidification potential".mp OR "AP in kg SO2 equivalents".mp OR "eco-efficiency".mp OR "ecoefficiency".mp OR "eco-efficien*".mp OR "ecoefficien*".mp OR "ecotoxicity"/ OR "ecotoxicity".mp OR "ecotoxic*".mp OR "eco toxicity".mp OR "eco toxic*".mp OR "EP in kg PO4 equivalent".mp OR exp "Eutrophication"/ OR "eutrophication".mp OR "Eutrophication potential".mp OR "FAETP in kg DCB equivalent".mp OR "Freshwater Aquatic Ecotoxicity Potential".mp OR "GWP in kg CO2 equivalents".mp OR "H+ moles equivalents".mp OR "HTTP in kg Dichlorobenzene equivalent".mp OR "Human Toxicity Potential".mp OR "kg 2.4-D equivalents".mp OR "kg CFC-11 equivalent".mp OR "kg N equivalents".mp OR "kg NOx equivalents".mp OR "life cycle analysis".mp OR "ozone depletion".mp OR "Photochemical Ozone Depletion Potential".mp OR "POCP in kg ethane equivalent".mp OR "smog".mp OR exp "Waste"/ OR "waste".mp OR "wastes".mp OR "Ozone Depletion"/ OR "Smog"/ OR "Greenhouse Gases".mp OR "Greenhouse Gas".mp OR "SO2 equiv*".mp OR "CO2 equiva*".mp OR "CFC-11 equiv*".mp OR "N equiv*".mp OR exp "Biodiversity"/ OR "Biodiversity".mp OR "Climatic change".mp OR "Green deal".mp OR "preservation of natural resources".mp OR "Refuse Disposal".mp OR exp "Wastewater"/ OR "Waste Water".mp OR "Wastewater".mp OR exp "Water Management"/ OR "Water Purification".mp OR (("plastic*".mp OR "microplastic*") AND ("soop".mp OR "soup".mp OR "pollution".mp OR "overuse".mp OR "contamination".mp)) OR "Sustainable Development"/ OR "Sustainable Development".mp OR (("Plastic".mp OR "plastics".mp) AND "overuse".mp) OR ("hydrogen*".mp AND "moles".mp AND "equiv*".mp) OR ("Dichlorobenzen*".mp AND "equiv*".mp) OR ("2,4-D".mp AND "equiv*".mp) OR ("NOx".mp AND "equiv*".mp) OR ("ethane".mp AND "equiv*".mp) OR ("PO4".mp AND "equiv*".mp) OR ("DCB".mp AND "equiv*".mp) OR ("sustainability".mp AND ("environment*".mp OR "carbon".mp)) OR (("Carbon Dioxide"/ OR "Carbon Dioxide".mp OR "CO2".mp) AND ("pollution".mp OR "emission".mp OR "emissions".mp OR "waste".mp OR "environment".mp OR "environmental*".mp OR "footprint".mp OR "footprint*".mp OR "sustainable".mp OR "hazard".mp OR "hazard*".mp))) NOT (conference review or conference abstract).pt AND (2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022).yr) AND ((exp "meta analysis"/ OR exp "meta analysis (topic)"/ OR metaanaly*.ti,ab OR "meta analy*".ti,ab OR metanaly*.ti,ab OR "systematic review"/ OR "cochrane database of systematic reviews".jn OR prisma.ti,ab OR prospero.ti,ab OR (((systemati* OR scoping OR umbrella OR "structured literature") ADJ3 (review* OR overview*)).ti,ab) OR ((systemic* ADJ1 review*).ti,ab) OR (((systemati* OR literature OR database* OR "data base*") ADJ10 search*).ti,ab) OR (((structured OR comprehensive* OR systemic*) ADJ3 search*).ti,ab) OR (((literature ADJ3 review*).ti,ab) AND (search*.ti,ab OR database*.ti,ab OR "data base*".ti,ab)) OR (("data extraction".ti,ab OR "data source*".ti,ab) AND "study selection".ti,ab) OR ("search strategy".ti,ab AND "selection criteria".ti,ab) OR ("data source*".ti,ab AND "data synthesis".ti,ab) OR medline.ab OR pubmed.ab OR embase.ab OR cochrane.ab OR (((critical OR rapid) ADJ2 (review* OR overview* OR synthes*)).ti) OR ((((critical* OR rapid*) ADJ3 (review* OR overview* OR synthes*)).ab) AND (search*.ab OR database*.ab OR "data base*".ab)) OR metasynthes*.ti,ab OR "meta synthes*".ti,ab) OR (exp "clinical trial"/ OR exp "randomization"/ OR exp "single blind procedure"/ OR exp "double blind procedure"/ OR exp "crossover procedure"/ OR exp "placebo"/ OR exp "prospective study"/ OR rct.ti,ab OR random*.ti,ab OR "single blind".ti,ab OR "randomised controlled trial".ti,ab OR exp "randomized controlled trial"/ OR placebo*.ti,ab) OR (exp

"Comparative Study"/ OR "comparison".ti,ab OR "comparative".ti,ab OR "compar*".ti,ab OR "major clinical study"/ OR "clinical study"/ OR "case control study"/ OR "family study"/ OR "longitudinal study"/ OR "retrospective study"/ OR "prospective study"/ OR "cohort analysis"/ OR cohort*.ti,ab OR (("case control" ADJ1 (study OR studies)).ti,ab) OR (("follow up" ADJ1 (study OR studies)).ti,ab) OR (observational ADJ1 (study OR studies)) OR ((epidemiologic ADJ1 (study OR studies)).ti,ab) OR (("cross sectional" ADJ1 (study OR studies)).ti,ab)) OR ("life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "life cycle inventory".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp)**)**

Zoekverantwoording UV 2.2

Algemene informatie

Richtlijn: Duurzaamheid	
Uitgangsvraag: UV2.2 - Wat is het effect van het gebruik van reusable medische hulpmiddelen in vergelijking met disposable medische hulpmiddelen op duurzaamheidsaspecten?	
Database(s): Medline (PubMed), Embase (OVID), Web of Science, Cochrane Library, Emcare (OVID)	Datum: 7-12-2021
Periode: 2000-..	Talen: nvt
Literatuurspecialist: Jan W. Schoones	
BMI zoekblokken: voor verschillende opdrachten wordt (deels) gebruik gemaakt van de zoekblokken van BMI-Online https://blocks.bmi-online.nl/ Bij gebruikmaking van een volledig zoekblok zal naar de betreffende link op de website worden verwezen.	
Toelichting:	
Te gebruiken voor richtlijnen tekst: In de databases Medline (PubMed), Embase (OVID), Web of Science, Cochrane Library, en Emcare (OVID) is op 7-12-2021 met relevante zoektermen gezocht naar systematische reviews, RCTs, observationele studies, ander vergelijkend onderzoek (bijv. case control, cohort-onderzoek), en life cycle assessments (LCA's) over UV2.2 - Wat is het effect van het gebruik van reusable medische hulpmiddelen in vergelijking met disposable medische hulpmiddelen op duurzaamheidsaspecten? De literatuurzoekactie leverde 72 unieke treffers op.	

Zoekopbrengst

	MEDLINE (PubMed)	**Embase (OVID)**	**Web of Science**	**Cochrane Library**	**Emcare (OVID)**	**Ontdubbeld**
	21	49	22	2	16	72

Zoekstrategie

MEDLINE (PubMed)

(("reusable scissor"[tw] OR "reusable scissors"[tw] OR "reusable scope"[tw] OR "reusable scopes"[tw] OR "reusable specula"[tw] OR "reusable speculum"[tw] OR "reusable surgical kit"[tw] OR "reusable surgical kits"[tw] OR "reusable ureteroscope"[tw] OR "reusable ureteroscopes"[tw] OR "recyclable flexible optical scope"[tw] OR "recyclable flexible optical scopes"[tw] OR "recyclable scissor"[tw] OR "recyclable scissors"[tw] OR "recyclable scope"[tw] OR "recyclable scopes"[tw] OR "recyclable specula"[tw] OR "recyclable speculum"[tw] OR "recyclable surgical kit"[tw] OR "recyclable surgical kits"[tw] OR "recyclable ureteroscope"[tw] OR "recyclable ureteroscopes"[tw] OR (("Equipment Reuse"[mesh] OR "reusables"[tw] OR "reusable"[tw] OR "reusabl*"[tw] OR "reuse"[tw] OR "re usables"[tw] OR "re usable"[tw] OR "re usabl*"[tw] OR "re use"[tw] OR "recyclable"[tw] OR "recyclables"[tw] OR "recycl*"[tw] OR "re cyclable"[tw] OR "re cycl*"[tw] OR "Recycling"[Mesh] OR "reprocess"[tw] OR "reprocessing"[tw] OR "reprocess*"[tw]) AND ("flexible optical scope"[tw] OR "flexible optical scopes"[tw] OR "scissor"[tw] OR "scissors"[tw] OR "Endoscopes"[Mesh] OR "scopes"[tw] OR "Endoscopes"[tw] OR "Endoscope"[tw] OR "specula"[tw] OR "speculum"[tw] OR "Surgical Scissor"[tw] OR "Surgical Scissors"[tw] OR "Surgical Staplers"[tw] OR "Surgical Stapler"[tw] OR "Staplers"[tw] OR "Stapler"[tw] OR "Staples"[tw] OR "Staple"[tw] OR "Stapling"[tw] OR "Surgical Drill"[tw] OR "Surgical Drills"[tw] OR "Surgical Drilling"[tw] OR "Drill"[tw] OR "Drills"[tw] OR "Drilling"[tw] OR "surgical kit"[tw] OR "surgical kits"[tw] OR "surgery kit"[tw] OR "surgery kits"[tw] OR "Suture Anchors"[Mesh] OR "suture anchor"[tw] OR "suture anchors"[tw] OR "Bone Anchor"[tw] OR "Bone Anchors"[tw] OR "Ureteroscopes"[Mesh] OR "ureteroscope"[tw] OR "ureteroscopes"[tw] OR "kocher"[tw] OR "pincer"[tw] OR "pincers"[tw] OR "tweezer"[tw] OR "tweezers"[tw] OR "scalpel"[tw] OR "scalpels"[tw] OR "needle holder"[tw] OR "needle holders"[tw] OR "ligasure"[tw] OR "ligasur*"[tw] OR "harmonic"[tw] OR "harmonic*"[tw] OR "Angioscope"[tw] OR "Angioscopes"[tw] OR "Arthroscope"[tw] OR "Arthroscopes"[tw] OR "Bronchoscope"[tw] OR "Bronchoscopes"[tw] OR "Colonoscope"[tw] OR "Colonoscopes"[tw] OR "Colposcope"[tw] OR "Colposcopes"[tw] OR "Culdoscope"[tw] OR "Culdoscopes"[tw] OR "Cystoscope"[tw] OR "Cystoscopes"[tw] OR "Duodenoscope"[tw] OR "Duodenoscopes"[tw] OR "Esophagoscope"[tw] OR "Esophagoscopes"[tw] OR "Fetoscope"[tw] OR "Fetoscopes"[tw] OR "Gastroscope"[tw] OR "Gastroscopes"[tw] OR "Hysteroscope"[tw] OR "Hysteroscopes"[tw] OR "Laparoscope"[tw] OR "Laparoscopes"[tw] OR "Laryngoscope"[tw] OR "Laryngoscopes"[tw] OR "Mediastinoscope"[tw] OR "Mediastinoscopes"[tw] OR "Neuroendoscope"[tw] OR "Neuroendoscopes"[tw] OR "Proctoscope"[tw] OR "Proctoscopes"[tw] OR "Sigmoidoscope"[tw] OR "Sigmoidoscopes"[tw] OR "Thoracoscope"[tw] OR "Thoracoscopes"[tw] OR (("Menisci, Tibial"[mesh] OR "menisc*"[tw]) AND ("Suture Techniques"[tw] OR "sutur*"[tw]))))) AND ("disposable scissor"[tw] OR "disposable scissors"[tw] OR "disposable scope"[tw] OR "disposable scopes"[tw] OR "disposable specula"[tw] OR "disposable speculum"[tw] OR "single use scissor"[tw] OR "single use scissors"[tw] OR "single use scope"[tw] OR "single use scopes"[tw] OR (("Disposable Equipment"[Mesh] OR "disposable"[tw] OR "disposables"[tw] OR "dispos*"[tw] OR "single use"[tw] OR "single use*"[tw] OR "singleuse"[tw] OR "singleuse*"[tw] OR "single usage"[tw] OR "single usage*"[tw]) AND ("scissor"[tw] OR "scissors"[tw] OR "Endoscopes"[Mesh] OR "scopes"[tw] OR "Endoscopes"[tw] OR "Endoscope"[tw] OR "Surgical Scissor"[tw] OR

"Surgical Scissors"[tw] OR "Surgical Staplers"[tw] OR "Surgical Stapler"[tw] OR "Surgery Staplers"[tw] OR "Surgery Stapler"[tw] OR "Staplers"[tw] OR "Stapler"[tw] OR "Stapling"[tw] OR "Surgical Drill"[tw] OR "Surgical Drills"[tw] OR "Surgical Drilling"[tw] OR "Drill"[tw] OR "Drills"[tw] OR "Drilling"[tw] OR "kocher"[tw] OR "pincer"[tw] OR "pincers"[tw] OR "tweezer"[tw] OR "tweezers"[tw] OR "scalpel"[tw] OR "scalpels"[tw] OR "needle holder"[tw] OR "needle holders"[tw] OR "ligasure"[tw] OR "ligasur*"[tw] OR "harmonic"[tw] OR "harmonic*"[tw] OR "Angioscope"[tw] OR "Angioscopes"[tw] OR "Arthroscope"[tw] OR "Arthroscopes"[tw] OR "Bronchoscope"[tw] OR "Bronchoscopes"[tw] OR "Colonoscope"[tw] OR "Colonoscopes"[tw] OR "Colposcope"[tw] OR "Colposcopes"[tw] OR "Culdoscope"[tw] OR "Culdoscopes"[tw] OR "Cystoscope"[tw] OR "Cystoscopes"[tw] OR "Duodenoscope"[tw] OR "Duodenoscopes"[tw] OR "Esophagoscope"[tw] OR "Esophagoscopes"[tw] OR "Fetoscope"[tw] OR "Fetoscopes"[tw] OR "Gastroscope"[tw] OR 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"ecoefficien*"[tw] OR "eco-efficien*"[tw] OR "ecoefficiency"[tw] OR "eco-efficiency"[tw] OR "ecological footprint"[tw] OR "ecological footprint*"[tw] OR "ecological sustainability"[tw] OR "ecotoxic*"[tw] OR "ecotoxicity"[tw] OR "Emission reduction strategy"[tw] OR "Emission reduction"[tw] OR **"Environment"[Mesh:noexp]** OR "environmental impact"[tw] OR "environmental impact*"[tw] OR "environmental impacts"[tw] OR "environmental pollut*"[tw] OR "Environmental Pollution"[Mesh] OR "environmental pollution"[tw] OR "environmental protection"[tw] OR "environmental sustainab*"[tw] OR "environmental sustainability"[tw] OR **"Environmental*"[ti]** OR "EP in kg PO4 equivalent"[tw] OR "Eutrophication potential"[tw] OR "Eutrophication"[Mesh] OR "eutrophication"[tw] OR "FAETP in kg DCB equivalent"[tw] OR "Freshwater Aquatic Ecotoxicity Potential"[tw] OR "Global Warming"[mesh] OR "Global Warming"[tw] OR "Green deal"[tw] OR "Green surgery"[tw] OR "Greenhouse Effect"[mesh] OR "greenhouse effect*"[tw] OR "greenhouse effects"[tw] OR "greenhouse gas emission"[tw] OR "greenhouse gas emissions"[tw] OR "Greenhouse Gas"[tw] OR "Greenhouse Gases"[mesh] OR "Greenhouse Gases"[tw] OR "greening"[tw] OR "GWP in kg CO2 equivalents"[tw] OR "H+ moles equivalents"[tw] OR "hospital waste"[tw] OR "HTTP in kg Dichlorobenzene equivalent"[tw] OR "Human Toxicity Potential"[tw] OR "kg 2.4-D equivalents"[tw] OR "kg CFC-11 equivalent"[tw] OR "kg N equivalents"[tw] OR "kg NOx equivalents"[tw] OR "LCA"[tw] OR "LCAs"[tw] OR "life cycle analysis"[tw] OR "life cycle assess*"[tw] OR "life cycle assessment"[tw] OR "life cycle inventories"[tw] OR "life cycle inventory"[tw] OR "Medical Waste Disposal"[mesh] OR "Medical Waste"[mesh] OR "medical waste"[tw] OR "N equiv*"[tw] OR "Ozone Depletion"[Mesh] OR "ozone depletion"[tw] OR "Photochemical Ozone Depletion Potential"[tw] OR "Plastic overuse"[tw] OR "POCP in kg ethane equivalent"[tw] OR "preservation of natural resources"[tw] OR "Refuse Disposal"[Mesh] OR "Refuse Disposal"[tw] OR "Rising Sea Level"[tw] OR "Rising Sea Levels"[tw] OR "Sea Level Rise"[mesh] OR "Sea Level Rise"[tw] OR "Smog"[mesh] OR "smog"[tw] OR "SO2 equiv*"[tw] OR "sustainability"**[ti]** OR "Sustainable Development"[Mesh] OR "Sustainable Development"[tw] OR "Waste Disposal"[tw] OR "Waste Disposal, Fluid"[mesh] OR "Waste Management"[mesh] OR "Waste"[tw] OR "waste"[tw] OR "Waste Water"[Mesh] OR "Waste Water"[tw] OR "wastes"[tw] OR "Wastewater"[tw] OR "Water Purification"[Mesh] OR "Water Purification"[tw] OR (("plastic*"[tw] OR "microplastic*") AND ("soop"[tw] OR "soup"[tw] OR "pollution"[tw] OR "overuse"[tw] OR "contamination"[tw])) OR (("Plastic"[tw] OR "plastics"[tw]) AND "overuse"[tw]) OR ("hydrogen*"[tw] AND "moles"[tw] AND "equiv*"[tw]) OR ("Dichlorobenzen*"[tw] AND "equiv*"[tw]) OR ("2,4-D"[tw] AND "equiv*"[tw]) OR ("NOx"[tw] AND "equiv*"[tw]) OR ("ethane"[tw] AND "equiv*"[tw]) OR ("PO4"[tw] AND "equiv*"[tw]) OR ("DCB"[tw] AND "equiv*"[tw]) OR ("sustainability"[tw] AND ("environment*"[tw] OR "carbon"[tw])) OR (("Carbon Dioxide"[mesh] OR "Carbon Dioxide"[tw] OR "CO2"[tw]) AND ("pollution"[tw] OR "emission"[tw] OR "emissions"[tw] OR "waste"[tw] OR "environment"[tw] OR "environmental*"[tw] OR "footprint"[tw] OR "footprint*"[tw] OR "sustainable"[tw] OR "hazard"[tw] OR "hazard*"[tw]))) AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])) AND (("Meta-Analysis"[Publication Type] OR "Meta-Analysis as Topic"[Mesh] OR metaanaly*[tiab] OR meta-analy*[tiab] OR metanaly*[tiab] OR "Systematic Review"[Publication Type] OR systematic[sb] OR "Cochrane Database Syst Rev"[Journal] or prisma[tiab] OR preferred reporting items[tiab] OR prospero[tiab] OR ((systemati*[ti] OR scoping[ti] OR umbrella[ti] OR structured literature[ti]) AND (review*[ti] OR overview*[ti])) OR systematic review*[tiab] OR scoping review*[tiab] OR umbrella review*[tiab] OR structured literature review*[tiab] OR systematic qualitative review*[tiab] OR systematic quantitative review*[tiab] OR systematic search and review[tiab] OR systematized review[tiab] OR systematised review[tiab] OR systemic review[tiab] OR systematic literature review*[tiab] OR systematic integrative literature review*[tiab] OR systematically review*[tiab] OR scoping literature review*[tiab] OR systematic critical review[tiab] OR systematic integrative review*[tiab] OR systematic evidence review[tiab] OR Systematic integrative literature review*[tiab] OR Systematic mixed studies review*[tiab] OR Systematized literature review*[tiab] OR Systematic overview*[tiab] OR Systematic narrative review*[tiab] OR ((systemati*[tiab] OR literature[tiab] OR database*[tiab] OR data-base*[tiab] OR structured[tiab] OR comprehensive*[tiab] OR systemic*[tiab]) AND search*[tiab]) OR (Literature[ti] AND review[ti] AND (database*[tiab] OR data-base*[tiab] OR search*[tiab])) OR ((data extraction[tiab] OR data source*[tiab]) AND study selection[tiab]) OR (search strategy[tiab] AND selection criteria[tiab]) OR (data source*[tiab] AND data synthesis[tiab]) OR medline[tiab] OR pubmed[tiab] OR embase[tiab] OR Cochrane[tiab] OR ((critical[ti] OR rapid[ti]) AND (review*[ti] OR overview*[ti] OR synthes*[ti])) OR (((critical*[tiab] OR rapid*[tiab]) AND (review*[tiab] OR overview*[tiab] OR synthes*[tiab]) AND (search*[tiab] OR database*[tiab] OR data-base*[tiab]))) OR metasynthes*[tiab] OR meta-synthes*[tiab]) **OR** ("Randomized Controlled Trial"[Publication Type] OR random*[tiab] OR pragmatic clinical trial*[tiab] OR practical clinical trial*[tiab] OR non-inferiority trial*[tiab] OR noninferiority trial*[tiab] OR superiority trial*[tiab] OR equivalence clinical trial*[tiab]) NOT (("Animals"[Mesh]) OR "Models, Animal"[Mesh] NOT humans[mh]) NOT (letter[pt] OR comment[pt] OR editorial[pt])) **OR ("Comparative Study"[Publication Type] OR "comparison"[tiab] OR "comparative"[tiab] OR "compar*"[tiab] OR "Epidemiologic studies"[mesh:noexp] OR "case control studies"[mesh] OR "cohort studies"[mesh] OR "Controlled Before-After Studies"[mesh] OR "Case control"[tw] OR cohort*[tw] OR "Cohort analy*"[tw] OR "Follow up stud*"[tw] OR "observational stud*"[tw] OR Longitudinal[tw] OR Retrospective*[tw] OR prospective*[tw] OR consecutive*[tw] OR Cross**

sectional[tw] OR "Cross-sectional studies"[mesh] OR "historically controlled study"[mesh] OR "interrupted time series analysis"[mesh]) OR ("life cycle assess*"[tw] OR "life cycle assessment"[tw] OR "life cycle inventory"[tw] OR "LCA"[tw] OR "LCAs"[tw] OR "life cycle inventory"[tw] OR "life cycle inventories"[tw]))

Embase (OVID)

(("reusable scissor".mp OR "reusable scissors".mp OR "reusable scope".mp OR "reusable scopes".mp OR "reusable specula".mp OR "reusable speculum".mp OR "reusable surgical kit".mp OR "reusable surgical kits".mp OR "reusable ureteroscope".mp OR "reusable ureteroscopes".mp OR "recyclable flexible optical scope".mp OR "recyclable flexible optical scopes".mp OR "recyclable scissor".mp OR "recyclable scissors".mp OR "recyclable scope".mp OR "recyclable scopes".mp OR "recyclable specula".mp OR "recyclable speculum".mp OR "recyclable surgical kit".mp OR "recyclable surgical kits".mp OR "recyclable ureteroscope".mp OR "recyclable ureteroscopes".mp OR ((exp "Recycling"/ OR "reusables".mp OR "reusable".mp OR "reusabl*".mp OR "reuse".mp OR "re usables".mp OR "re usable".mp OR "re usabl*".mp OR "re use".mp OR "recyclable".mp OR "recyclables".mp OR "recycl*".mp OR "re cyclable".mp OR "re cycl*".mp OR "reprocess".mp OR "reprocessing".mp OR "reprocess*".mp) AND ("flexible optical scope".mp OR "flexible optical scopes".mp OR exp "Scissors"/ OR "scissor".mp OR "scissors".mp OR exp "Endoscope"/ OR "scopes".mp OR "Endoscopes".mp OR "Endoscope".mp OR "ophthalmic speculum"/ OR "nose speculum"/ OR "vaginal speculum"/ OR "rectal speculum"/ OR "gynecological and obstetric surgical equipment"/ OR "specula".mp OR "speculum".mp OR "Surgical Scissor".mp OR "Surgical Scissors".mp OR exp "Stapler"/ OR "Surgical Staplers".mp OR "Surgical Stapler".mp OR "Staplers".mp OR "Stapler".mp OR "Staples".mp OR "Staple".mp OR "Stapling".mp OR exp "Surgical Drill"/ OR "Surgical Drill".mp OR "Surgical Drills".mp OR "Surgical Drilling".mp OR exp "Drill"/ OR "Drill".mp OR "Drills".mp OR "Drilling".mp OR "surgical kit".mp OR "surgical kits".mp OR "surgery kit".mp OR "surgery kits".mp OR exp "Suture Anchor"/ OR "suture anchor".mp OR "suture anchors".mp OR "Bone Anchor".mp OR "Bone Anchors".mp OR exp "Ureteroscope"/ OR "ureteroscope".mp OR "ureteroscopes".mp OR "kocher".mp OR "pincer".mp OR "pincers".mp OR "tweezer".mp OR "tweezers".mp OR exp "Scalpel"/ OR "scalpel".mp OR "scalpels".mp OR exp "needle holder"/ OR "needle holder".mp OR "needle holders".mp OR exp "vessel sealing system "/ OR "ligasure".mp OR "ligasur*".mp OR "harmonic".mp OR "harmonic*".mp OR exp "Angioscope"/ OR "Angioscope".mp OR "Angioscopes".mp OR exp "Arthroscope"/ OR "Arthroscope".mp OR "Arthroscopes".mp OR exp "Bronchoscope"/ OR "Bronchoscope".mp OR "Bronchoscopes".mp OR exp "Colonoscope"/ OR "Colonoscope".mp OR "Colonoscopes".mp OR exp "Colposcope"/ OR "Colposcope".mp OR "Colposcopes".mp OR exp "Culdoscope"/ OR "Culdoscope".mp OR "Culdoscopes".mp OR exp "Cystoscope"/ OR "Cystoscope".mp OR "Cystoscopes".mp OR exp "Duodenoscope"/ OR "Duodenoscope".mp OR "Duodenoscopes".mp OR exp "Esophagoscope"/ OR "Esophagoscope".mp OR "Esophagoscopes".mp OR exp "Fetoscope"/ OR "Fetoscope".mp OR "Fetoscopes".mp OR exp "Gastroscope"/ OR "Gastroscope".mp OR "Gastroscopes".mp OR exp "Hysteroscope"/ OR "Hysteroscope".mp OR "Hysteroscopes".mp OR exp "Laparoscope"/ OR "Laparoscope".mp OR "Laparoscopes".mp OR exp "Laryngoscope"/ OR "Laryngoscope".mp OR "Laryngoscopes".mp OR exp "Mediastinoscope"/ OR "Mediastinoscope".mp OR "Mediastinoscopes".mp OR exp "Neuroendoscope"/ OR "Neuroendoscope".mp OR "Neuroendoscopes".mp OR exp "Proctoscope"/ OR "Proctoscope".mp OR "Proctoscopes".mp OR exp "Sigmoidoscope"/ OR "Sigmoidoscope".mp OR "Sigmoidoscopes".mp OR exp "Thoracoscope"/ OR "Thoracoscope".mp OR "Thoracoscopes".mp OR ((exp "Knee Meniscus"/ OR exp "Knee Meniscus Rupture"/ OR "menisc*".mp) AND (exp "Suturing Method"/ OR exp "Suture"/ OR "sutur*".mp))))) AND ("disposable scissor".mp OR "disposable scissors".mp OR "disposable scope".mp OR "disposable scopes".mp OR "disposable specula".mp OR "disposable speculum".mp OR "single use scissor".mp OR "single use scissors".mp OR "single use scope".mp OR "single use scopes".mp OR ((exp "Disposable Equipment"/ OR "disposable".mp OR "disposables".mp OR "dispos*".mp OR "single use".mp OR "single use*".mp OR "singleuse".mp OR "singleuse*".mp OR "single usage".mp OR "single usage*".mp) AND (exp "Scissors"/ OR "scissor".mp OR "scissors".mp OR exp "Endoscope"/ OR "scopes".mp OR "Endoscopes".mp OR "Endoscope".mp OR "Surgical Scissor".mp OR "Surgical Scissors".mp OR exp "Stapler"/ OR "Surgical Staplers".mp OR "Surgical Stapler".mp OR "Surgery Staplers".mp OR "Surgery Stapler".mp OR "Staplers".mp OR "Stapler".mp OR "Stapling".mp OR exp "Surgical Drill"/ OR exp "Drill"/ OR "Surgical Drill".mp OR "Surgical Drills".mp OR "Surgical Drilling".mp OR "Drill".mp OR "Drills".mp OR "Drilling".mp OR "kocher".mp OR "pincer".mp OR "pincers".mp OR "tweezer".mp OR "tweezers".mp OR exp "Scalpel"/ OR "scalpel".mp OR "scalpels".mp OR exp"Needle Holder"/ OR "needle holder".mp OR "needle holders".mp OR "ligasure".mp OR "ligasur*".mp OR "harmonic".mp OR "harmonic*".mp OR exp "Angioscope"/ OR "Angioscope".mp OR "Angioscopes".mp OR exp "Arthroscope"/ OR "Arthroscope".mp OR "Arthroscopes".mp OR exp "Bronchoscope"/ OR "Bronchoscope".mp OR "Bronchoscopes".mp OR exp "Colonoscope"/ OR "Colonoscope".mp OR "Colonoscopes".mp OR exp "Colposcope"/ OR "Colposcope".mp OR "Colposcopes".mp OR exp "Culdoscope"/ OR "Culdoscope".mp OR "Culdoscopes".mp OR exp "Cystoscope"/ OR "Cystoscope".mp OR "Cystoscopes".mp OR exp "Duodenoscope"/ OR "Duodenoscope".mp OR "Duodenoscopes".mp OR exp "Esophagoscope"/ OR "Esophagoscope".mp OR "Esophagoscopes".mp OR exp "Fetoscope"/ OR "Fetoscope".mp OR "Fetoscopes".mp OR exp "Gastroscope"/ OR "Gastroscope".mp OR "Gastroscopes".mp OR exp "Hysteroscope"/ OR "Hysteroscope".mp OR "Hysteroscopes".mp OR exp "Laparoscope"/ OR "Laparoscope".mp OR "Laparoscopes".mp OR exp "Laryngoscope"/ OR "Laryngoscope".mp OR "Laryngoscopes".mp OR exp "Mediastinoscope"/ OR "Mediastinoscope".mp OR "Mediastinoscopes".mp OR exp "Neuroendoscope"/ OR "Neuroendoscope".mp OR "Neuroendoscopes".mp OR exp "Proctoscope"/ OR "Proctoscope".mp OR "Proctoscopes".mp OR exp "Sigmoidoscope"/ OR "Sigmoidoscope".mp OR "Sigmoidoscopes".mp OR exp "Thoracoscope"/ OR "Thoracoscope".mp OR "Thoracoscopes".mp))) AND ("Carbon Footprint"/ OR "carbon footprint".mp OR "carbon footprint*".mp OR exp "Climate Change"/ OR "climate change".mp OR "CO2 emission".mp OR "CO2 emissions".mp OR "CO2 footprint".mp OR "CO2 footprint*".mp OR exp "environmental protection"/ OR "conservation of natural resources".mp OR "environmental protection".mp OR "ecological footprint".mp OR "ecological footprint*".mp OR "ecological sustainability".mp OR exp "environmental impact"/ OR "environmental impact".mp OR "environmental impact*".mp OR "environmental impacts".mp OR "environmental pollut*".mp OR exp "pollution"/ OR "environmental pollution".mp OR "environmental sustainab*".mp OR "environmental sustainability"/ OR "environmental sustainability".mp OR "Global Warming"/ OR "Global Warming".mp OR "Greenhouse Effect"/ OR "greenhouse effect*".mp OR "greenhouse effects".mp OR "greenhouse gas emission".mp OR "greenhouse gas emissions".mp OR "Greenhouse Gas"/ OR "greening".mp OR "hospital waste".mp OR "life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp OR exp "Waste Disposal"/ OR exp "Hospital Waste"/ OR "medical waste".mp OR "Rising Sea Level".mp OR "Rising Sea Levels".mp OR "Sea Level Rise"/ OR "Sea Level Rise".mp OR "sustainability".**mp** OR "Waste Disposal".mp OR "waste water recycling"/ OR exp "Waste Disposal"/ OR exp "Waste Management"/ OR "Plastic overuse".mp OR "Green surgery".mp OR "Emission reduction".mp OR "Emission reduction strategy".mp OR "air pollution control"/ OR "air pollution control".mp **OR "Environment"/ OR "Environmental*".mp** OR "acidification"/ OR "soil acidification"/ OR "ocean acidification"/ OR "acidification".mp OR "Acidification potential".mp OR "AP in kg SO2 equivalents".mp OR "eco-efficiency".mp OR "ecoefficiency".mp OR "eco-efficien*".mp OR "ecoefficien*".mp OR "ecotoxicity"/ OR "ecotoxicity".mp OR "ecotoxic*".mp OR "eco toxicity".mp OR "eco toxic*".mp OR "EP in kg PO4 equivalent".mp OR exp "Eutrophication"/ OR "eutrophication".mp OR "Eutrophication potential".mp OR "FAETP in kg DCB equivalent".mp OR "Freshwater Aquatic Ecotoxicity Potential".mp OR "GWP in kg CO2 equivalents".mp OR "H+ moles equivalents".mp OR "HTTP in kg Dichlorobenzene equivalent".mp OR "Human Toxicity Potential".mp OR "kg 2.4-D equivalents".mp OR "kg CFC-11 equivalent".mp OR "kg N equivalents".mp OR "kg NOx equivalents".mp OR "life cycle analysis".mp OR "ozone depletion".mp OR "Photochemical Ozone Depletion Potential".mp OR "POCP in kg ethane equivalent".mp OR "smog".mp OR exp "Waste"/ OR "waste".mp OR "wastes".mp OR "Ozone Depletion"/ OR "Smog"/ OR "Greenhouse Gases".mp OR "Greenhouse Gas".mp OR "SO2 equiv*".mp OR "CO2 equiva*".mp OR "CFC-11 equiv*".mp OR "N equiv*".mp OR exp "Biodiversity"/ OR "Biodiversity".mp OR "Climatic change".mp OR "Green deal".mp OR "preservation of natural resources".mp OR "Refuse Disposal".mp OR exp "Wastewater"/ OR "Waste Water".mp OR "Wastewater".mp OR exp "Water Management"/ OR "Water Purification".mp OR (("plastic*".mp OR "microplastic*") AND ("soop".mp OR "soup".mp OR "pollution".mp OR "overuse".mp OR "contamination".mp)) OR "Sustainable Development"/ OR "Sustainable Development".mp OR (("Plastic".mp OR "plastics".mp) AND "overuse".mp) OR ("hydrogen*".mp AND "moles".mp AND "equiv*".mp) OR ("Dichlorobenzen*".mp AND "equiv*".mp) OR ("2,4-D".mp AND "equiv*".mp) OR ("NOx".mp AND "equiv*".mp) OR ("ethane".mp AND "equiv*".mp) OR ("PO4".mp AND "equiv*".mp) OR ("DCB".mp AND "equiv*".mp) OR ("sustainability".mp AND ("environment*".mp OR "carbon".mp)) OR (("Carbon Dioxide"/ OR "Carbon Dioxide".mp OR "CO2".mp) AND ("pollution".mp OR "emission".mp OR "emissions".mp OR "waste".mp OR "environment".mp OR "environmental*".mp OR "footprint".mp OR "footprint*".mp OR "sustainable".mp OR "hazard".mp OR "hazard*".mp))) NOT (conference review or conference abstract).pt AND (2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022).yr) AND **(***(exp "meta analysis"/ OR exp "meta analysis (topic)"/ OR metaanaly*.ti,ab OR "meta analy*".ti,ab OR metanaly*.ti,ab OR "systematic review"/ OR "cochrane database of systematic reviews".jn OR prisma.ti,ab OR prospero.ti,ab OR (((systemati* OR scoping OR umbrella OR "structured literature") ADJ3 (review* OR overview*)).ti,ab) OR ((systemic* ADJ1 review*).ti,ab) OR (((systemati* OR literature OR database* OR "data base*") ADJ10 search*).ti,ab) OR (((structured OR comprehensive* OR systemic*) ADJ3 search*).ti,ab) OR (((literature ADJ3 review*).ti,ab) AND (search*.ti,ab OR database*.ti,ab OR "data base*".ti,ab)) OR (("data extraction".ti,ab OR "data source*".ti,ab) AND "study selection".ti,ab) OR ("search strategy".ti,ab AND "selection criteria".ti,ab) OR ("data source*".ti,ab AND "data synthesis".ti,ab) OR medline.ab OR pubmed.ab OR embase.ab OR cochrane.ab OR (((critical OR rapid) ADJ2 (review* OR overview* OR synthes*)).ti) OR ((((critical* OR rapid*) ADJ3 (review* OR overview* OR synthes*)).ab) AND (search*.ab OR database*.ab OR "data base*".ab)) OR metasynthes*.ti,ab OR "meta synthes*".ti,ab)* OR (exp "clinical trial"/ OR exp "randomization"/ OR exp "single blind procedure"/ OR exp "double blind procedure"/ OR exp "crossover procedure"/ OR exp "placebo"/ OR exp "prospective study"/ OR rct.ti,ab OR random*.ti,ab OR "single blind".ti,ab OR "randomised controlled trial".ti,ab OR exp "randomized controlled trial"/ OR placebo*.ti,ab) **OR (exp "Comparative Study"/ OR "comparison".ti,ab OR "comparative".ti,ab OR "compar*".ti,ab OR "major clinical study"/ OR "clinical study"/ OR "case control study"/ OR "family study"/ OR "longitudinal study"/ OR "retrospective study"/ OR "prospective study"/ OR "cohort analysis"/ OR cohort*.ti,ab OR (("case control" ADJ1 (study OR studies)).ti,ab) OR (("follow up" ADJ1 (study OR studies)).ti,ab) OR (observational ADJ1 (study OR studies)) OR ((epidemiologic ADJ1 (study OR studies)).ti,ab) OR (("cross sectional" ADJ1 (study OR studies)).ti,ab)) OR** ("life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "life cycle inventory".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp)**)**

Web of Science

(TS=("reusable scissor" OR "reusable scissors" OR "reusable scope" OR "reusable scopes" OR "reusable specula" OR "reusable speculum" OR "reusable surgical kit" OR "reusable surgical kits" OR "reusable ureteroscope" OR "reusable ureteroscopes" OR "recyclable flexible optical scope" OR "recyclable flexible optical scopes" OR "recyclable scissor" OR "recyclable scissors" OR "recyclable scope" OR "recyclable scopes" OR "recyclable specula" OR "recyclable speculum" OR "recyclable surgical kit" OR "recyclable surgical kits" OR "recyclable ureteroscope" OR "recyclable ureteroscopes" OR (("Equipment Reuse" OR "reusables" OR "reusable" OR "reusabl*" OR "reuse" OR "re usables" OR "re usable" OR "re usabl*" OR "re use" OR "recyclable" OR "recyclables" OR "recycl*" OR "re cyclable" OR "re cycl*" OR "Recycling" OR "reprocess" OR "reprocessing" OR "reprocess*") AND ("flexible optical scope" OR "flexible optical scopes" OR "scissor" OR "scissors" OR "Endoscopes" OR "Endoscopes" OR "Endoscope" OR "specula" OR "speculum" OR "scopes" OR "Surgical Scissor" OR "Surgical Scissors" OR "Surgical Staplers" OR "Surgical Stapler" OR "Staplers" OR "Stapler" OR "Staples" OR "Staple" OR "Stapling" OR "Surgical Drill" OR "Surgical Drills" OR "Surgical Drilling" OR "surgical kit" OR "surgical kits" OR "surgery kit" OR "surgery kits" OR "Suture Anchors" OR "suture anchor" OR "suture anchors" OR "Bone Anchor" OR "Bone Anchors" OR "Ureteroscopes" OR "ureteroscope" OR "ureteroscopes" OR "kocher" OR "pincer" OR "pincers" OR "tweezer" OR "tweezers" OR "scalpel" OR "scalpels" OR "needle holder" OR "needle holders" OR "ligasure" OR "ligasur*" OR "harmonic" OR "harmonic*" OR "Angioscope" OR "Angioscopes" OR "Arthroscope" OR "Arthroscopes" OR "Bronchoscope" OR "Bronchoscopes" OR "Colonoscope" OR "Colonoscopes" OR "Colposcope" OR "Colposcopes" OR "Culdoscope" OR "Culdoscopes" OR "Cystoscope" OR "Cystoscopes" OR "Duodenoscope" OR "Duodenoscopes" OR "Esophagoscope" OR "Esophagoscopes" OR "Fetoscope" OR "Fetoscopes" OR "Gastroscope" OR "Gastroscopes" OR "Hysteroscope" OR "Hysteroscopes" OR "Laparoscope" OR "Laparoscopes" OR "Laryngoscope" OR "Laryngoscopes" OR "Mediastinoscope" OR "Mediastinoscopes" OR "Neuroendoscope" OR "Neuroendoscopes" OR "Proctoscope" OR "Proctoscopes" OR "Sigmoidoscope" OR "Sigmoidoscopes" OR "Thoracoscope" OR "Thoracoscopes" OR

(("Menisci, Tibial" OR "menisc*") AND ("Suture Techniques" OR "sutur*"))))) AND TS=("disposable scissor" OR "disposable scissors" OR "disposable scope" OR "disposable scopes" OR "disposable specula" OR "disposable speculum" OR "single use scissor" OR "single use scissors" OR "single use scope" OR "single use scopes" OR (("Disposable Equipment" OR "disposable" OR "disposables" OR "dispos*" OR "single use" OR "single use*" OR "singleuse" OR "singleuse*" OR "single usage" OR "single usage*") AND ("scissor" OR "scissors" OR "Endoscopes" OR "Endoscopes" OR "Endoscope" OR "Surgical Scissor" OR "Surgical Scissors" OR "scopes" OR "Surgical Staplers" OR "Surgical Stapler" OR "Surgery Staplers" OR "Surgery Stapler" OR "Staplers" OR "Stapler" OR "Stapling" OR "Surgical Drill" OR "Surgical Drills" OR "Surgical Drilling" OR "kocher" OR "pincer" OR "pincers" OR "tweezer" OR "tweezers" OR "scalpel" OR "scalpels" OR "needle holder" OR "needle holders" OR "ligasure" OR "ligasur*" OR "harmonic" OR 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OR "Plastic overuse" OR "Green surgery" OR "Emission reduction" OR "Emission reduction strategy" OR "air pollution control" OR "air pollution control" OR "acidification" OR "soil acidification" OR "ocean acidification" OR "acidification" OR "Acidification potential" OR "AP in kg SO2 equivalents" OR "eco-efficiency" OR "ecoefficiency" OR "eco-efficien*" OR "ecoefficien*" OR "ecotoxicity" OR "ecotoxicity" OR "ecotoxic*" OR "eco toxicity" OR "eco toxic*" OR "EP in kg PO4 equivalent" OR "Eutrophication" OR "eutrophication" OR "Eutrophication potential" OR "FAETP in kg DCB equivalent" OR "Freshwater Aquatic Ecotoxicity Potential" OR "GWP in kg CO2 equivalents" OR "H+ moles equivalents" OR "HTTP in kg Dichlorobenzene equivalent" OR "Human Toxicity Potential" OR "kg 2.4-D equivalents" OR "kg CFC-11 equivalent" OR "kg N equivalents" OR "kg NOx equivalents" OR "life cycle analysis" OR "ozone depletion" OR "Photochemical Ozone Depletion Potential" OR "POCP in kg ethane equivalent" OR "smog" OR "Waste" OR "waste" OR "wastes" OR "Ozone Depletion" OR "Smog" OR "Greenhouse Gases" OR "Greenhouse Gas" OR "SO2 equiv*" OR "CO2 equiva*" OR "CFC-11 equiv*" OR "N equiv*" OR "Sustainable Development" OR "Sustainable Development" OR "Biodiversity" OR "Climatic change" OR "Green deal" OR "preservation of natural resources" OR "Refuse Disposal" OR "Waste Water" OR "Wastewater" OR "Water Purification" OR (("plastic*" OR "microplastic*") AND ("soop" OR "soup" OR "pollution" OR "overuse" OR "contamination")) OR (("Plastic" OR "plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))) OR TI=("environmental*" OR "sustainab*") OR AB=("environmental*" OR "sustainab*") OR AK=("environmental*" OR "sustainab*")) NOT DT=(meeting abstract) AND PY=(2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022)) AND (TI=(("Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR/4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR/4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR/4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR/4 ("review*" OR "overview*" OR "synthes*") NEAR/4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*") OR ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR/1 (study OR studies))) OR (("follow up" NEAR/1 (study OR studies))) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies))) OR (("cross sectional" NEAR/1 (study OR studies)))) OR ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")) OR AB=(("Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR/4 (review* OR overview*)) OR "systematic review*" OR _"scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR/4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR/4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR/4 ("review*" OR "overview*" OR "synthes*") NEAR/4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*")_ **OR** ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") **OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal 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Cochrane Library

("reusable scissor" OR "reusable scissors" OR "reusable scope" OR "reusable scopes" OR "reusable specula" OR "reusable speculum" OR "reusable surgical kit" OR "reusable surgical kits" OR "reusable ureteroscope" OR "reusable ureteroscopes" OR "recyclable flexible optical scope" OR "recyclable flexible optical scopes" OR "recyclable scissor" OR "recyclable scissors" OR "recyclable scope" OR "recyclable scopes" OR "recyclable specula" OR "recyclable speculum" OR "recyclable surgical kit" OR "recyclable surgical kits" OR "recyclable ureteroscope" OR "recyclable ureteroscopes" OR (("Equipment Reuse" OR "reusables" OR "reusable" OR "reusabl*" OR "reuse" OR "re usables" OR "re usable" OR "re usabl*" OR "re use" OR "recyclable" OR "recyclables" OR "recycl*" OR "re cyclable" OR "re cycl*" OR "Recycling" OR "reprocess" OR "reprocessing" OR "reprocess*") AND ("flexible optical scope" OR "flexible optical scopes" OR "scissor" OR "scissors" OR "Endoscopes" OR "scopes" OR "Endoscopes" OR "Endoscope" OR "specula" OR "speculum" OR "Surgical Scissor" OR "Surgical Scissors" OR "Surgical Staplers" OR "Surgical Stapler" OR "Staplers" OR "Stapler" OR "Staples" OR "Staple" OR "Stapling" OR "Surgical Drill" OR "Surgical Drills" OR "Surgical Drilling" OR "Drill" OR "Drills" OR "Drilling" OR "surgical kit" OR "surgical kits" OR "surgery kit" OR "surgery kits" OR "Suture Anchors" OR "suture anchor" OR "suture anchors" OR "Bone Anchor" OR "Bone Anchors" OR "Ureteroscopes" OR "ureteroscope" OR "ureteroscopes" OR "kocher" OR "pincer" OR "pincers" OR "tweezer" OR "tweezers" OR "scalpel" OR "scalpels" OR "needle holder" OR "needle holders" OR "ligasure" OR "ligasur*" OR "harmonic" OR "harmonic*" OR "Angioscope" OR "Angioscopes" OR "Arthroscope" OR "Arthroscopes" OR "Bronchoscope" OR "Bronchoscopes" OR "Colonoscope" OR "Colonoscopes" OR "Colposcope" OR "Colposcopes" OR "Culdoscope" OR "Culdoscopes" OR "Cystoscope" OR "Cystoscopes" OR "Duodenoscope" OR "Duodenoscopes" OR "Esophagoscope" OR "Esophagoscopes" OR "Fetoscope" OR "Fetoscopes" OR "Gastroscope" OR "Gastroscopes" OR "Hysteroscope" OR "Hysteroscopes" OR "Laparoscope" OR "Laparoscopes" OR "Laryngoscope" OR "Laryngoscopes" OR "Mediastinoscope" OR "Mediastinoscopes" OR "Neuroendoscope" OR "Neuroendoscopes" OR "Proctoscope" OR "Proctoscopes" OR "Sigmoidoscope" OR "Sigmoidoscopes" OR "Thoracoscope" OR "Thoracoscopes" OR (("Menisci, Tibial" OR "menisc*") AND ("Suture Techniques" OR "sutur*"))))):ti,ab,kw AND ("disposable scissor" OR "disposable scissors" OR "disposable scope" OR "disposable scopes" OR "disposable specula" OR "disposable speculum" OR "single use scissor" OR "single use scissors" OR "single use scope" OR "single use scopes" OR (("Disposable Equipment" OR "disposable" OR "disposables" OR "dispos*" OR "single use" OR "single use*" OR "singleuse" OR "singleuse*" OR "single usage" OR "single usage*") AND ("scissor" OR "scissors" OR "Endoscopes" OR "scopes" OR "Endoscopes" OR "Endoscope" OR "Surgical Scissor" OR "Surgical Scissors" OR "Surgical Staplers" OR "Surgical Stapler" OR "Surgery Staplers" OR "Surgery Stapler" OR "Staplers" OR "Stapler" OR "Stapling" OR "Surgical Drill" OR "Surgical Drills" OR "Surgical Drilling" OR "Drill" OR "Drills" OR "Drilling" OR "kocher" OR "pincer" OR "pincers" OR "tweezer" OR "tweezers" OR "scalpel" OR "scalpels" OR "needle holder" OR "needle holders" OR "ligasure" OR "ligasur*" OR "harmonic" OR "harmonic*" OR "Angioscope" OR "Angioscopes" OR "Arthroscope" OR "Arthroscopes" OR "Bronchoscope" OR "Bronchoscopes" OR "Colonoscope" OR "Colonoscopes" OR "Colposcope" OR "Colposcopes" OR "Culdoscope" OR "Culdoscopes" OR "Cystoscope" OR "Cystoscopes" OR "Duodenoscope" OR "Duodenoscopes" OR "Esophagoscope" OR "Esophagoscopes" OR "Fetoscope" OR "Fetoscopes" OR "Gastroscope" OR "Gastroscopes" OR "Hysteroscope" OR "Hysteroscopes" OR "Laparoscope" OR "Laparoscopes" OR "Laryngoscope" OR "Laryngoscopes" OR "Mediastinoscope" OR "Mediastinoscopes" OR "Neuroendoscope" OR "Neuroendoscopes" OR "Proctoscope" OR "Proctoscopes" OR "Sigmoidoscope" OR "Sigmoidoscopes" OR "Thoracoscope" OR "Thoracoscopes"))):ti,ab,kw AND
(("Carbon Footprint" OR "carbon footprint" OR "carbon footprint*" OR "Climate Change" OR "climate change" OR "CO2 emission" OR "CO2 emissions" OR "CO2 footprint" OR "CO2 footprint*" OR "environmental protection" OR "conservation of natural resources" OR "environmental protection" OR "ecological footprint" OR "ecological footprint*" OR "ecological sustainability" OR "environmental impact" OR "environmental impact" OR "environmental impact*" OR "environmental impacts" OR "environmental pollut*" OR "pollution" OR "environmental pollution" OR "environmental sustainab*" OR "environmental sustainability" OR "environmental sustainability" OR "Global Warming" OR "Global Warming" OR "Greenhouse Effect" OR "greenhouse effect*" OR "greenhouse effects" OR "greenhouse gas emission" OR "greenhouse gas emissions" OR "Greenhouse Gas" OR "greening" OR "hospital waste" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assess*" OR "life cycle assessment" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories" OR "Waste Disposal" OR "Hospital Waste" OR "medical waste" OR "Rising Sea Level" OR "Rising Sea Levels" OR "Sea Level Rise" OR "Sea Level Rise" OR "Waste Disposal" OR "waste water

recycling" OR "Equipment reuse" OR "Reusables" OR "reusable" OR "reuse" OR "reused" OR "reusing" OR "Waste Disposal" OR "Waste Management" OR "Plastic overuse" OR "Green surgery" OR "Emission reduction" OR "Emission reduction strategy" OR "air pollution control" OR "air pollution control" OR "acidification" OR "soil acidification" OR "ocean acidification" OR "acidification" OR "Acidification potential" OR "AP in kg SO2 equivalents" OR "eco-efficiency" OR "ecoefficiency" OR "eco-efficien*" OR "ecoefficien*" OR "ecotoxicity" OR "ecotoxicity" OR "ecotoxic*" OR "eco toxicity" OR "eco toxic*" OR "EP in kg PO4 equivalent" OR "Eutrophication" OR "eutrophication" OR "Eutrophication potential" OR "FAETP in kg DCB equivalent" OR "Freshwater Aquatic Ecotoxicity Potential" OR "GWP in kg CO2 equivalents" OR "H+ moles equivalents" OR "HTTP in kg Dichlorobenzene equivalent" OR "Human Toxicity Potential" OR "kg 2.4-D equivalents" OR "kg CFC-11 equivalent" OR "kg N equivalents" OR "kg NOx equivalents" OR "life cycle analysis" OR "ozone depletion" OR "Photochemical Ozone Depletion Potential" OR "POCP in kg ethane equivalent" OR "smog" OR "Waste" OR "waste" OR "wastes" OR "Ozone Depletion" OR "Smog" OR "Equipment reuse" OR "Greenhouse Gases" OR "Greenhouse Gas" OR "SO2 equiv*" OR "CO2 equiva*" OR "CFC-11 equiv*" OR "N equiv*" OR "Biodiversity" OR "Climatic change" OR "Green deal" OR "preservation of natural resources" OR "Refuse Disposal" OR "Waste Water" OR "Wastewater" OR "Water Purification" OR (("plastic*" OR "microplastic*") AND ("soap" OR "soup" OR "pollution" OR "overuse" OR "contamination")) OR "Sustainable Development" OR "Sustainable Development" OR (("Plastic" OR "plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))):ti,ab,kw OR **("environmental" OR "sustainability")**:ti,ab,kw)

Emcare (OVID)

(("reusable scissor".mp OR "reusable scissors".mp OR "reusable scope".mp OR "reusable scopes".mp OR "reusable specula".mp OR "reusable speculum".mp OR "reusable surgical kit".mp OR "reusable surgical kits".mp OR "reusable ureteroscope".mp OR "reusable ureteroscopes".mp OR "recyclable flexible optical scope".mp OR "recyclable flexible optical scopes".mp OR "recyclable scissor".mp OR "recyclable scissors".mp OR "recyclable scope".mp OR "recyclable scopes".mp OR "recyclable specula".mp OR "recyclable speculum".mp OR "recyclable surgical kit".mp OR "recyclable surgical kits".mp OR "recyclable ureteroscope".mp OR "recyclable ureteroscopes".mp OR ((exp "Recycling"/ OR "reusables".mp OR "reusable".mp OR "reusabl*".mp OR "reuse".mp OR "re usables".mp OR "re usable".mp OR "re usabl*".mp OR "re use".mp OR "recyclable".mp OR "recyclables".mp OR "recycl*".mp OR "re cyclable".mp OR "re cycl*".mp OR "reprocess".mp OR "reprocessing".mp OR "reprocess*".mp) AND ("flexible optical scope".mp OR "flexible 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equivalents".mp OR "H+ moles equivalents".mp OR "HTTP in kg Dichlorobenzene equivalent".mp OR "Human Toxicity Potential".mp OR "kg 2.4-D equivalents".mp OR "kg CFC-11 equivalent".mp OR "kg N equivalents".mp OR "kg NOx equivalents".mp OR "life cycle analysis".mp OR "ozone depletion".mp OR "Photochemical Ozone Depletion Potential".mp OR "POCP in kg ethane equivalent".mp OR "smog".mp OR exp "Waste"/ OR "waste".mp OR "wastes".mp OR "Ozone Depletion"/ OR "Smog"/ OR "Greenhouse Gases".mp OR "Greenhouse Gas".mp OR "SO2 equiv*".mp OR "CO2 equiva*".mp OR "CFC-11 equiv*".mp OR "N equiv*".mp OR exp "Biodiversity"/ OR "Biodiversity".mp OR "Climatic change".mp OR "Green deal".mp OR "preservation of natural resources".mp OR "Refuse Disposal".mp OR exp "Wastewater"/ OR "Waste Water".mp OR "Wastewater".mp OR exp "Water Management"/ OR "Water Purification".mp OR (("plastic*".mp OR "microplastic*") AND ("soop".mp OR "soup".mp OR "pollution".mp OR "overuse".mp OR "contamination".mp)) OR "Sustainable 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Module 3: Afdekmaterialen

Samenvatting

Uitgangsvraag

Wat is het effect op duurzaamheidsuitkomsten van het gebruik van materialen die in contact komen met de patiënt op de operatietafel? Welke materialen zijn het meest duurzaam in gebruik?

GRADE

Zeer laag

Overwegingen: focus op Refuse (R1), Reduce (R2), Redesign (R3), Reuse (R4)

Aanbevelingen

Evalueer of het gebruik van materialen die in contact komen met de patiënt (bijvoorbeeld warmtedekens, celstofmatten, afdekdoeken, tafellakens, disposable dekbedden) daadwerkelijk nodig is (R1-Refuse, R2-Reduce).

- Optimaliseer de bestaande protocollen en neem duurzaamheid hierin mee.
- Zoek hierbij samenwerking met infectiepreventie voor het maken van een risicoafweging waarbij de risico's op een infectie/besmetting worden afgezet tegen verduurzamingsmaatregelen.

Optimaliseer de circulariteit van materialen door herontwerp te stimuleren (R3-redesign) en circulariteit te implementeren in het ontwerp.

Verleng waar mogelijk de levensduur en hergebruik materialen (R4-Reuse). Dit vergt samenwerking met de industrie.

Uitgangsvraag module 3 'afdekmaterialen'
Wat is het effect op duurzaamheidsuitkomsten van het gebruik van materialen die in contact komen met de patiënt op de operatietafel? Welke materialen zijn het meest duurzaam in gebruik?

Inleiding

Zowel voor patiënten als zorgverleners is het belangrijk dat het risico op bacteriële en virale transmissie laag blijft tijdens een operatie. Vandaar dat gebruik wordt gemaakt van afdekmaterialen. Wanneer de patiënt op de operatietafel ligt, is naast contact met het afdekmateriaal ook contact met bijvoorbeeld een warmtedeken of celstofmatten. In de meeste gevallen worden deze materialen tijdens een operatie eenmalig gebruikt, waarna het vervolgens bij het afval belandt. Dit resulteert in veel afval en een flinke belasting op het milieu (Axelrod, 2017). Momenteel is onduidelijk welk effect het gebruik van materialen die in contact komen met de patiënt (bijvoorbeeld warmtedekens, celstofmatten, afdekdoeken, lakens, disposable dekbedden) op de operatietafel heeft op duurzaamheidsuitkomsten. In deze module worden de huidige alternatieven voor materialen die in contact komen met de patiënt op de operatietafel met elkaar vergeleken.

Search and select

A systematic review of the literature was performed to answer the following question: *What is the effect on environmental sustainability of sustainable materials (i.e. heat blankets, surgical drapes, disposable duvets, cellulose pads) in comparison with standard materials that are in contact with patients on the operating table?*

P: Patients on the operating table
I: Sustainable alternative for heat blanket (bair hugger), surgical drapes, disposable duvet and cellulose pads
C: Use of standard heat blanket (bair hugger), surgical drapes, disposable duvet and cellulose pads
O: Climate change (CO_2 footprint/Global Warming Potential), waste, water use, land use, energy use

Relevant outcome measures

Life cycle assessment (LCA) is a methodological tool used to quantitatively analyse the life cycle of products/activities within the context of environmental impact. The assessment comprises all stages needed to produce and use a product, from the initial development to the treatment of waste (the total life cycle). An LCA is mainly based on four phases: 1) goal and scope definition, 2) inventory analysis, 3) impact assessment, and 4) interpretation. The third phase is the life cycle impact assessment (LCIA), in which emissions and resource extractions are translated into a limited number of environmental impact scores by means of so-called characterisation factors. The ReCiPe model is a method for the impact assessment in an LCA (Huijbregts, 2016, Huijbregts, 2017). To determine the outcome measures regarding environmental impact, the ReCiPe model of the National Institute for Public Health and the Environment (in Dutch: Rijksinstituut voor Volksgezondheid en Milieu, RIVM) was used.

The outcomes determined by the working group are based on the ReCiPe model. The working group considered climate change (CO_2 footprint/Global Warming Potential) and waste as a *critical* outcome measure for decision making; and water use, land use, and energy use as an *important* outcome measure for decision making.

A priori, the working group did not define the outcome measures listed above but used the definitions used in the studies.
Outcomes focused on environmental life cycle assessment (LCA) impact categories are relatively new in healthcare. Given the variety in scopes and methods of performing and reporting LCAs, the working group did not a priori define the minimal important difference. Differences between the techniques were evaluated by the working group after data extraction.

A glossary including the outcome measures is found in Module 1 'operatietechnieken'.

Search and select (Methods)
The databases Pubmed (via NCBI), Embase (via OVID), Web of Science (via Webofscience), Cochrane (via Cochrane library) and Emcare (via OVID) were searched with relevant search terms from 1980 until 7 December 2021. The detailed search strategy is depicted under the tab Methods. The systematic literature search resulted in 461 hits. Studies for this module were selected based on the following criteria:

- Systematic reviews in which searches were performed in at least two databases, with a detailed search strategy, risk of bias assessment and results of individual studies available, randomized controlled trials, (observational) comparative studies, Life Cycle Assessments;
- Full-text English or Dutch language publication; and
- Studies according to the PICO. This included studies that compared sustainable alternatives for heat blanket (bair hugger), surgical drapes, disposable duvet and cellulose pads compared with the use of standard heat blanket (bair hugger), surgical drapes, disposable duvet and cellulose pads, and included at least one of the outcomes conform the PICO.

After reading the full text, one study was included in the literature summary of this module.

Results
One study was included in the analysis of the literature, the study was a systematic review. Important study characteristics and results are summarized in the evidence table (Appendix 1). The assessment of the systematic review is summarized in the quality appraisal table for systematic reviews (Appendix 2).

Summary of literature
Description of studies
Nowack (2012) performed a systematic review to analyze how environmental aspects can be derived from life cycle management instruments for procurement decisions of low-value products by using operating room textiles as the case. A comparison is made between disposable and reusable gowns and drapes (OR-textiles). Nowack (2012) identified eight LCAs in OR-textiles (Brune, 1988; Schorb, 1990; IFEU, 1996; Jäger, 1996; Dettenkofer, 1999; Schmidt, 2000; Eriksson, 2003; Ponder, 2009). Nowack (2012) included three LCAs in the analysis of OR textiles (Schmidt 2000; IFEU 1996; Ponder 2009). However, only two of these studies (IFEU, 1996; Ponder, 2009) included surgical drapes, as Schmidt (2000) only included surgical gowns. Therefore, we only include the outcomes of IFEU (1996) and Ponder (2009) in our results. Relevant outcome measures were climate change (CO_2 footprint/Global Warming Potential), waste, water use, and energy use.

Results

1. Climate Change

Nowack (2012) reported on climate change, based on two LCAs (IFEU, 1996; Ponder, 2009). IFEU (1996) defined climate change as CO_2 (g) of 30 use cycles (uc) and 75 uc of reusable and single-use drapes. There are three types of reusable drapes (cotton, blended fabric, microfiber) compared to single-use non-woven drapes. Results are presented in Table 1. The single-use non woven drape results in the lowest impact on climate change.
Ponder (2009) defined climate change as CO_2 (kg) of 75 uc of reusable drapes in comparison to 75 uc of single-use drapes. The CO_2 (kg) for the reusable drapes was 5.71 kg CO_2 compared to 20.50 kg CO_2 for the single-use drapes. The reusable drapes result in the lowest impact on climate change.

Table 1. Outcome climate change (CO_2 g): summary of results of IFEU (1996)

No. of use cycles	reusable cotton drape	reusable blended fabric drape	reusable microfiber drape	single-use non woven drape
30 uc	6,037 g CO_2	5,110 g CO_2	5,940 g CO_2	3,886 g CO_2
75 uc	5,075 g CO_2	4,154 g CO_2	4,716 g CO_2	3,886 g CO_2

2. Waste

Nowack (2012) reported on waste, based on one LCA (IFEU, 1996), which described waste as the waste in kg per 30 uc and 75 uc. Results are presented in Table 2. The single-use non woven drape results in lowest waste.

Table 2. Outcome waste (in g): summary of results of IFEU (1996)

No. of use cycles	reusable cotton drape	reusable blended fabric drape	reusable microfiber drape	single-use non woven drape
30 uc	6,163 g	5,830 g	7,057 g	3,735 g
75 uc	4,210 g	3,890 g	4,672 g	3,735 g

3. Water use

Nowack (2012) reported on water use, based on two LCAs (IFEU, 1996 and Ponder, 2009). IFEU (1996) describes the outome measure water consumption (L) of 30 uc and 75 uc of reusable and single-use drapes. Three tyes of reusable drapes (cotton, blended fabric and microfiber) were compared to single-use non woven drapes. Results are presented in Table 3. The single-use non woven drape results in lowest water usage.
Ponder (2009) describes the outcome measure water consumption (kg) of 75 uc of reusable drapes in comparison to 75 uc of single-use drapes. The water consumption (kg) for the reusable variant is 1,373 kg compared to 0.00 kg for the single-use drapes.

Table 3. Outcome water use (L): summary of results of IFEU (1996)

No. of use cycles	reusable cotton drape	reusable blended fabric drape	reusable microfiber drape	single-use non woven drape
30 uc	4,690L	2,891L	239.4L	22L
75 uc	1,965L	1,241L	1,92L	22L

4. Energy use

Nowack (2012) reported on energy use, based on two LCAs (IFEU, 1996; Ponder, 2009). IFEU (1996) defined energy use as energy consumption (MJ) of 30 use cycles (uc) and 75 uc of reusable and single-use drapes. Three types of reusable drapes (cotton, blended fabric, microfiber) were compared to single-use non-woven drapes. Results are presented in Table 4. The reusable blended fabric drape (30uc) results in lowest energy consumption. Ponder (2009) describes energy use as net energy input (input-recovery) in MJ of 75 uc of reusable (CO/PES) drapes in comparison to 75 uc of single-use (PP-SMS) drapes. The net energy input (input-recovery) for the reusable variant is 65.05 MJ compared to 225.95 MJ for the single-use drapes.

Table 4. Outcome energy use (MJ): summary of results of IFEU (1996)

No. of use cycles	**reusable cotton drape**	**reusable blended fabric drape**	**reusable microfiber drape**	**single-use non woven drape**
30 uc	99,314 MJ	94,174 MJ	111,616 MJ	96,428 MJ
75 uc	83,567 MJ	72,878 MJ	85,527 MJ	96,428 MJ

5. Land use
Outcome is not reported.

<u>Level of evidence of the literature</u>
The working group assessed the level of evidence of LCAs using GRADE and used the critical appraisal of LCAs (Drew, 2021) to provide an indication of the study quality. See module 1 'operatietechnieken' for more details. As the systematic review Nowack (2012) included LCAs (e.g. IFEU, 1996; Ponder, 2009), the level of evidence started at grade *high*.

The level of evidence of this outcome measure 'climate change' was downgraded with 3 levels to *very low* due to risk of bias (-1; lack of data sources and transparency), imprecision (-1; limited internal validity of data, outdated data), and indirectness (-1; large material diversity; different functional units which limits comparability).

The level of evidence of this outcome measure 'waste' was downgraded with 3 levels to *very low* due to risk of bias (-1; lack of data sources and transparency) and imprecision (-2; limited internal validity of data, outdated data).

The level of evidence of this outcome measure 'water use' was downgraded with 3 levels to *very low* due to risk of bias (-1; lack of data sources and transparency), imprecision (-1; limited internal validity of data, outdated data), and indirectness (-1; large material diversity; different functional units which limits comparability).

The level of evidence of this outcome measure 'energy use' was downgraded with 3 levels to *very low* due to risk of bias (-1; lack of data sources and transparency), imprecision (-1; limited internal validity of data, outdated data), and indirectness (-1; large material diversity; different functional units which limits comparability).

The outcome measure 'land use' was not reported, thus could not be graded.

Conclusions

1. Climate change (critical)

Very low GRADE	The evidence is very uncertain about the effect on climate change when sustainable materials are compared to standard materials that are in contact with patients on the operating table. *Sources: IFEU, 1996; Ponder, 2009*

2. Waste (critical)

Very low GRADE	The evidence is very uncertain about the effect on waste when sustainable materials are compared to standard materials that are in contact with patients on the operating table. *Sources: IFEU, 1996*

3. Water use (important)

Very low GRADE	The evidence is very uncertain about the effect on water usage when sustainable materials are compared to standard materials that are in contact with patients on the operating table. *Sources: IFEU, 1996; Ponder, 2009*

4. Energy use (important)

Very low GRADE	The evidence is very uncertain about the effect on energy use when sustainable materials are compared to standard materials that are in contact with patients on the operating table. *Sources: IFEU, 1996; Ponder, 2009*

5. Land use (important)

- GRADE	The outcome measure 'land use' was not reported. *Source: -*

Overwegingen – van bewijs naar aanbeveling

Voor- en nadelen van de interventie en de kwaliteit van het bewijs

Op basis van de literatuur is gekeken naar de milieu-impact van materialen die in contact komen met de patiënt op de operatiekamer. Er is één systematic review gevonden (Nomack 2012) waarin LCA's zijn geïncludeerd die de milieu-impact van steriele chirurgische afdekdoeken hebben onderzocht. Twee LCA's (*IFEU, 1996; Ponder, 2009)* voldeden aan de PICO en zijn geëvalueerd in deze module. Deze LCA's verschillen onder andere in methodiek (verschillende materialen, verschillende analyses), databases en aannames. Daarnaast zijn er enkele methodologische beperkingen (*risk of bias, imprecisie, indirectness*). De bewijskracht van de literatuur is daardoor *zeer laag* voor de cruciale uitkomstmaten 'climate change' en 'waste'. Derhalve kunnen er op basis van de literatuur geen sterke conclusies worden getrokken over de mate van milieu-impact van materialen die in contact komen met de patiënt op de operatiekamer.

De materialen die in contact komen met de patiënt en de gevonden 'hotspots' worden in deze module geëvalueerd middels het 'R-ladder (strategieën van circulariteit)' (zie figuur 1, gebaseerd op Cramer, 2014; Hanemaaijer; 2018; Potting, 2016; Reike, 2018). Deze R-ladder laat zien dat de hoogste prioriteit om duurzaam te werken ‘refuse’ is, oftewel, niet gebruiken. Hoe lager het grondstofgebruik, des te hoger op de R-ladder en hoe dichter je bent bij circulair werken.

Refuse (R1) en Reduce (R2)

Bij het gebruik van materialen die in contact komen met de patiënt (bijvoorbeeld warmtedekens, celstofmatten, afdekdoeken, lakens, disposable dekbedden) op en rond de operatietafel speelt R1-Refuse een grote rol. Daarnaast is het belangrijk om het gebruik te beperken (R2-Reduce). Gebruik materialen niet uit gewoonte, maar noodzaak moet leidend zijn om materialen gebruiken. Bijvoorbeeld:

- Moet elke operatie met maximale steriliteit worden verricht?
- Kan een celstofmat worden vervangen door een handdoek?
- Kan het aantal celstofmatten/afdekdoeken/warmtedekens worden verminderd?

De werkgroep verwacht dat bewustzijn bij beiden punten een belangrijke factor is. Zoek hierbij contact met deskundigen op het gebied van infectiepreventie, om na te gaan wat daadwerkelijk mogelijk en nodig is in dit kader. Pas protocollen aan waar nodig en neem duurzaamheid hierin mee.

Figuur 1. *Prioriteitsvolgorde circulariteit strategieën*

Redesign (R3)

Denk na of herontwerp (met de nadruk op circulariteit) mogelijk is. Produceer een product op een duurzame manier, bijvoorbeeld door het gebruik van gerecyclede materialen of door een duurzaam productieproces (bijv. duurzame energiebronnen).
Indien disposable materialen in en rondom het bed van de patiënt worden gebruikt, is het mogelijk een optie om deze te vervangen door reusable alternatieven. Als dit niet mogelijk is (bijv. de reusables bieden onvoldoende kwaliteit), kan worden ingezet op circulariteit van disposables. Zoek hierbij samenwerking met de industrie. Denk bijvoorbeeld aan afvalscheiding en hergebruik van de materialen. Herontwerp van producten, met als doel

circulariteit, moet daarbij voorop staan. Duurzaamheid moet dan ook als standaard worden meegenomen in productontwerp. Daarnaast is het mogelijk om disposables anders te ontwerpen, met als doen verminderen van het materiaalgebruik. Denk dan aan een klein gatdoek i.p.v. een groot afdekdoek.

Re-use (R4)
Nomack (2012) vergelijkt reusable en disposable steriele chirurgische afdekdoeken (IFEU, 1996; Ponder, 2009) op specifieke duurzaamheidsuitkomsten. De disposable afdekdoeken hebben een lagere milieu-impact volgens IFEU (1996), daarentegen toont Ponder (2009) dat reusable afdekdoeken een lagere impact hebben voor de uitkomstmaten climate change en energy use. Hierin moet rekening worden gehouden met mogelijke *bias*, feit is dat IFEU (1996) is gesponsord door de fabrikant van disposable textiel. Ponder (2009) is het meest recent en is volgens Nomack (2012) ook compleet. Het nadeel van Ponder (2009) is dat de data niet te achterhalen is.
Daarnaast is er indertijd gekozen voor disposable afdekdoeken vanwege vermeende partikel afgifte. De eis ten aanzien van partikels geldt alleen bij orthopedische implantaatchirurgie. Voor alle overige operaties is partikelafgifte niet meer relevant en komt dit argument te vervallen als motivatie voor het gebruik van disposable afdekdoeken (NVMM, 2022).

Repair (R5), Refurbish (R6), Remanufacture (R7)
Voordat een product wordt afgedankt, is het van belang om opnieuw te kijken of de levensduur nog verlengd kan worden. De werkgroep adviseert om het repareren of opknappen van producten standaard te overwegen.

Repurpose (R8), Recycling (R9), Recover (R10)
Indien een product niet meer gebruikt kan worden, kan worden gekeken naar een nieuw doeleinde (R8-Repurpose). Terugwinning van energie en materialen kan de milieu-impact van het productieproces verlagen (R9-Recycling, R10-Recover). Het is dus de moeite waard om in te zetten op recycling en recover van materialen en energie.

Waarden en voorkeuren van patiënten (en evt. hun verzorgers)
Duurzamere alternatieven in gebruik rondom een operatie zullen ook voor patiënten een indirect positief effect hebben. Zoals bekend, heeft klimaatverandering invloed op de gezondheid van de mens en met duurzamere alternatieven wordt hier op een positieve manier aan bijdragen (WHO, 2021).

Kosten (middelenbeslag)
De werkgroep verwacht dat in veel gevallen duurzaamheid zal resulteren in kostenbesparing. Indien wordt gekozen voor het hoogst haalbare op de ladder van circulariteit (R1-Refuse, R2-Reduce), zullen bijvoorbeeld bepaalde materialen niet of minder gebruikt worden.

Aanvaardbaarheid, haalbaarheid en implementatie
Het is van belang dat patiëntveiligheid voorop blijft staan, maar indien er gelijke uitkomsten zijn met betrekking tot o.a. infectierisico's, zal duurzaamheid een rol moeten spelen bij de beslissing voor de inzet van bepaalde afdekmaterialen. Voor de haalbaarheid en implementatie kan contact worden opgenomen met de deskundige infectiepreventie. Zie ook de handreiking 'Handreiking voor inhoudelijke afweging bij duurzaamheid initiatieven door deskundigen infectiepreventie' voor meer informatie (Green team VHIG, 2022). De werkgroep voorziet overigens geen grote haalbaarheid- of implementatiebarrières.

Aanbevelingen

Rationale van de aanbeveling: weging van argumenten voor en tegen de interventies

Op basis van de gevonden literatuur is de bewijskracht voor duurzaamheidsuitkomsten zeer laag. Overwegingen richten zich voornamelijk op R1-Refuse, R2-Reduce, R3-Redesign en R4-Reuse. De werkgroep acht het uiterst belangrijk om meer bewustwording van duurzaamheid te creëren op het gebied van afdekmaterialen.

> Evalueer of het gebruik van materialen die in contact komen met de patiënt (bijvoorbeeld warmtedekens, celstofmatten, afdekdoeken, tafellakens, disposable dekbedden) daadwerkelijk nodig is (R1-Refuse, R2-Reduce).
>
> - Optimaliseer de bestaande protocollen en neem duurzaamheid hierin mee.
> - Zoek hierbij samenwerking met infectiepreventie voor het maken van een risicoafweging waarbij de risico's op een infectie/besmetting worden afgezet tegen verduurzamingsmaatregelen.
>
> Optimaliseer de circulariteit van materialen door herontwerp te stimuleren (R3-redesign) en circulariteit te implementeren in het ontwerp.
>
> Verleng waar mogelijk de levensduur en hergebruik materialen (R4-Reuse). Dit vergt samenwerking met de industrie.

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Bijlagen bij module 3 'Afdekmaterialen'

Appendix 1. Evidence table

Study reference	Study characteristics	Product characteristics	Intervention (I)	Comparison / control (C)	Follow-up	Outcome measures and effect size	Comments
Nowack (2012)	SR of three life cycle assessments to identify environmental indicators for procurement decisions of low-value products. Literature search up to 2012 **A**: Schmidt, 2000 **B**: IFEU, 1996 **C**: Ponder, 2009 Study design: LCA Setting and Country: Germany Source of funding and conflicts of interest: Not stated.	Inclusion criteria SR: Sound methodology, verifiability, completeness and actuality. Exclusion criteria SR: Foreign language Three studies included Functional unit (as stated in the SR): **A**: 1 gown **B**: 1 operation **C**: 1 gown	Describe intervention: **A**: Reusable OR textiles (CO/PES PES) **B**: Reusable OR textiles (CO, CO/PES) **C**: Reusable OR textiles (CO/PES)	Describe control: **A**: Single-use OR textiles (Pulp/PES, pulp/PES/PE) **B**: Single-use OR textiles (Pulp/PE/PES) **C**: Single-use OR textiles (PP SMS)	End-point of follow-up: N/A For how many participants were no complete outcome data available? N/A	Climate change (CO_2 footprint/Global Warming Potential (GWP)) **A**: Schmidt (2000) describes only surgical gowns and no surgical drapes. Surgical gowns are not included in the research question of this module. Therefore this study is no longer included in the results. **B**: IFEU (1996) describes the outome measure CO_2 (g) of 30 use cycles (uc) and 75 uc of reusable and single-use drapes. There are three different kind of reusable drapes (cotton, blended fabric and microfiber) compared to single-use non woven drapes. The impact on CO_2 (g) for the reusable cotton drape is 6,037 g CO_2 for 30 uc and 5,075 g CO_2 for 75 uc. For the reusable blended fabric drape this results in 5,110 g CO_2 for 30 uc and 4,154 g CO_2 for 75 uc and for the reusable microfiber drape in 5,940 g CO_2 for 30 uc and 4,716 g CO_2 for 75 uc. The single-use non woven drape results in	Authors conclusion: This review on the existing LCAs available on OR textiles show it is not recommended to base the procurement decision on the existing LCAs. This is due to the variance of methodological strength, incompleteness of data, outdated data, variability of data and complexity. Interpretation of results: The study from IFEU 1996 is outdated, since OR textiles have developed over the years. Next to that, it is not clear how the data is gathered and what impact the different phases of the life cycle have (e.g. production phase, use phase, disposal etc.) and if all the phases are even taken into account. The most recent study from Ponder (2009) suggests the reusable drapes have a lower environmental impact compared to the disposable drape. However, it is still necessary to conduct more research since the authors state the data can

Study reference	Study characteristics	Product characteristics	Intervention (I)	Comparison / control (C)	Follow-up	Outcome measures and effect size	Comments
						an impact of 3,886 g CO_2 for 30 uc and 3,886 g CO_2 for 75 uc. **C**: Ponder (2009) describes the outcome measure CO_2 (kg) of 75 use cycles of reusable (CO/PES) drapes in comparison to 75 use cycles of single-use (PP-SMS) drapes. The CO_2 (kg) for the reusable variant is 5.71 kg CO_2 compared to 20.50 kg CO_2 for the single-use drapes. <u>Waste</u> **B**: IFEU (1996) describes the outome measure waste (g) of 30 use cycles (uc) and 75 uc of reusable and single-use drapes. There are three different kind of reusable drapes (cotton, blended fabric and microfiber) compared to single-use non woven drapes. The waste (g) from the reusable cotton drape is 6,163 g for 30 uc and 4,210 g for 75 uc. For the reusable blended fabric drape this results in 5,830 g for 30 uc and 3,890 g for 75 uc and for the reusable microfiber drape in 7,057 g for 30 uc and 4,672 g for 75 uc. The single-use non woven drape results in 3,735 g for 30 uc and 3,735 g for 75 uc.	substantially differ between countries. In contrast to IFEU (1996), Ponder has not included other scenarios (e.g. different uc or different energy mixes) in the analysis. It was unable to pool the data from the different studies included in the review, since they were not comparable. Low quality studies have been excluded based on a quality assessment, as shown in Table 1 of the review.

Study reference	Study characteristics	Product characteristics	Intervention (I)	Comparison / control (C)	Follow-up	Outcome measures and effect size	Comments
						C: Ponder (2009) describes no results on the outcome waste. Water use **B**: IFEU (1996) describes the outome measure water consumption (l) of 30 use cycles (uc) and 75 uc of reusable and single-use drapes. There are three different kind of reusable drapes (cotton, blended fabric and microfiber) compared to single-use non woven drapes. The water consumption (l) from the reusable cotton drape is 4,690 l for 30 uc and 1,965 l for 75 uc. For the reusable blended fabric drape this results in 2,891.30 l for 30 uc and 1,241.90 l for 75 uc and for the reusable microfiber drape in 239.4 l for 30 uc and 192.80 l for 75 uc. The single-use non woven drape results in 22.2 l for 30 uc and 22.2 l for 75 uc. **C**: Ponder (2009) describes the outcome measure water consumption (kg) of 75 use cycles of reusable (CO/PES) drapes in comparison to 75 use cycles of single-use (PP-SMS) drapes. The water consumption (kg) for the reusable variant is 1,373.83	

Study reference	Study characteristics	Product characteristics	Intervention (I)	Comparison / control (C)	Follow-up	Outcome measures and effect size	Comments
						kg compared to 0.00 kg for the single-use drapes. Energy use **B**: IFEU (1996) describes the outome measure energy use as energy consumption (MJ) of 30 use cycles (uc) and 75 uc of reusable and single-use drapes. There are three different kind of reusable drapes (cotton, blended fabric and microfiber) compared to single-use non woven drapes. The energy consumption (MJ) from the reusable cotton drape is 99,314 MJ for 30 uc and 83,567 MJ for 75 uc. For the reusable blended fabric drape this results in 94,174 MJ for 30 uc and 72,878 MJ for 75 uc and for the reusable microfiber drape in 111,616 MJ for 30 uc and 85,527 MJ for 75 uc. The single-use non woven drape results in 96,428 MJ for 30 uc and 96,428 MJ for 75 uc. **C**: Ponder (2009) describes the outcome measure energy use as net energy input (input-recovery) in MJ of 75 use cycles of reusable (CO/PES) drapes in comparison to 75 use cycles of single-use (PP-SMS) drapes. The net energy input (input-recovery) for the	

Study reference	Study characteristics	Product characteristics	Intervention (I)	Comparison / control (C)	Follow-up	Outcome measures and effect size	Comments
						reusable variant is 65.05 MJ compared to 225.95 MJ for the single-use drapes.	

Appendix 2. Table of quality assessment for systematic reviews of RCTs/LCAs and observational studies

Based on AMSTAR checklist (Shea et al.; 2007, BMC Methodol 7: 10; doi:10.1186/1471-2288-7-10) and PRISMA checklist (Moher et al 2009, PLoS Med 6: e1000097; doi:10.1371/journal.pmed1000097)

Study	Appropriate and clearly focused question?[1]	Comprehensive and systematic literature search?[2]	Description of included and excluded studies?[3]	Description of relevant characteristics of included studies?[4]	Appropriate adjustment for potential confounders in observational studies?[5]	Assessment of scientific quality of included studies?[6]	Enough similarities between studies to make combining them reasonable?[7]	Potential risk of publication bias taken into account?[8]	Potential conflicts of interest reported?[9]
Nowack 2012	Clearly focused question. How can environmental aspects be derived from life cycle management (LCM) Instruments for procurement decisions regarding low-value products such as operating room textiles (O.R. textiles)?	PICO is not clearly stated, only keywords and databases. Databases do not include Medline or EMBASE.	Included and excluded studies are described with reason.	Characteristics of the studies are relevant to the search.	N/A	Yes, studies have been critically evaluated for sound methodology, verifiability, completeness, and actuality.	No	No	No

Literature search strategy

Zoekverantwoording

Algemene informatie

Richtlijn: Duurzaamheid	
Uitgangsvraag: UV3 - Welke materialen die in contact komen met de patiënt op de operatietafel (warmtedeken (bair hugger), afdekdoeken, OK tafellaken, disposable dekbed en celstofmatjes) zijn het meest duurzaam? Als je warmtedekens, afdekdoeken, OK tafellakens, dekbedden en celstofmatjes gebruikt; welke moet je dan gebruiken om het meest duurzaam te werken? Zit er verschil in milieu-impact tussen disposable en reusable materialen?	
Database(s): Medline (PubMed), Embase (OVID), Web of Science, Cochrane Library, Emcare (OVID)	Datum: 7-12-2021
Periode: 1980-..	Talen: nvt
Literatuurspecialist: Jan W. Schoones	
BMI zoekblokken: voor verschillende opdrachten wordt (deels) gebruik gemaakt van de zoekblokken van BMI-Online https://blocks.bmi-online.nl/ Bij gebruikmaking van een volledig zoekblok zal naar de betreffende link op de website worden verwezen.	
Toelichting:	
Te gebruiken voor richtlijnen tekst: In de databases Medline (PubMed), Embase (OVID), Web of Science, Cochrane Library, en Emcare (OVID) is op 7-12-2021 met relevante zoektermen gezocht naar systematische reviews, RCTs, observationele studies, ander vergelijkend onderzoek (bijv. case control, cohort-onderzoek), en life cycle assessments (LCA's) over UV3 - Welke materialen die in contact komen met de patiënt op de operatietafel (warmtedeken (bair hugger), afdekdoeken, OK tafellaken, disposable dekbed en celstofmatjes) zijn het meest duurzaam? Als je warmtedekens, afdekdoeken, OK tafellakens, dekbedden en celstofmatjes gebruikt; welke moet je dan gebruiken om het meest duurzaam te werken? Zit er verschil in milieu-impact tussen disposable en reusable materialen? De literatuurzoekactie leverde 461 unieke treffers op.	

Zoekopbrengst

	MEDLINE (PubMed)	Embase (OVID)	Web of Science	Cochrane Library	Emcare (OVID)	Ontdubbeld
	255	253	111	73	111	461

Zoekstrategie

MEDLINE (PubMed)

(("Operating Tables"[Mesh] OR "Operating Tables"[tw] OR "Operating Table"[tw] OR "Operating Room Tables"[tw] OR "Operating Room Table"[tw] OR "Operation Tables"[tw] OR "Operation Table"[tw] OR "Operation Room Tables"[tw] OR "Operation Room Table"[tw] OR "Operating Rooms"[Mesh] OR "Operating Rooms"[tw] OR "Operating Room"[tw] OR "Operation Rooms"[tw] OR "Operation Room"[tw] OR "Operating Theatres"[tw] OR "Operating Theatre"[tw] OR "Operation Theatres"[tw] OR "Operation Theatre"[tw] OR "Operating Theaters"[tw] OR "Operating Theater"[tw] OR "Operation Theaters"[tw] OR "Operation Theater"[tw] OR "Perioperative Period"[Mesh] OR "Perioperative Care"[Mesh] OR "Perioperative Nursing"[Mesh] OR "Perioperative Medicine"[Mesh] OR "Perioperative"[tw] OR "Perioperativ*"[tw] OR "Peri operative"[tw] OR "Peri operativ*"[tw] OR "Intraoperative"[tw] OR "Operative"[tw] OR "Postoperative"[tw] OR "Preoperative"[tw] OR "Intra operative"[tw] OR "Post operative"[tw] OR "Pre operative"[tw] OR 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pads"[tw] OR "fibre pad"[tw] OR "fiberpads"[tw] OR "fiberpad"[tw] OR "fibrepads"[tw] OR "fibrepad"[tw] OR "fibermats"[tw] OR "fibermat"[tw] OR "fibremats"[tw] OR "fibremat"[tw] OR "coverlets"[tw] OR "coverlet"[tw] OR "cellulose pads"[tw] OR "cellulose pad"[tw] OR "cellulose mats"[tw] OR "cellulose mat"[tw] OR (("cellulose"[tw] OR "fibre"[tw] OR "fibres"[tw] OR "fiber"[tw] OR "fibers"[tw]) AND ("pad"[tw] OR "pads"[tw] OR "mat"[tw] OR "mats"[tw]))) AND ("Acidification potential"[tw] OR "acidification"[tw] OR "air pollution control"[tw] OR "AP in kg SO2 equivalents"[tw] OR "Biodiversity"[Mesh] OR "Biodiversity"[tw] OR "Carbon Footprint"[mesh] OR "carbon footprint"[tw] OR "carbon footprint*"[tw] OR "CFC-11 equiv*"[tw] OR "Climate Change"[Mesh] OR "climate change"[tw] OR "Climatic change"[tw] OR "CO2 emission"[tw] OR "CO2 emissions"[tw] OR "CO2 equiva*"[tw] OR "CO2 footprint"[tw] OR "CO2 footprint*"[tw] OR "conservation of natural resources"[mesh] OR "conservation of natural resources"[tw] OR "Disposable Equipment"[Mesh] OR "Disposable"[tw] OR "Disposables"[tw] OR "eco toxic*"[tw] OR "eco toxicity"[tw] OR "ecoefficien*"[tw] OR "eco-efficien*"[tw] OR "ecoefficiency"[tw] OR "eco-efficiency"[tw] OR "ecological footprint"[tw] OR "ecological footprint*"[tw] OR "ecological sustainability"[tw] OR "ecotoxic*"[tw] OR "ecotoxicity"[tw] OR "Emission reduction strategy"[tw] OR "Emission reduction"[tw] OR **"Environment"[Mesh:noexp]** OR "environmental impact"[tw] OR "environmental impact*"[tw] OR "environmental impacts"[tw] OR "environmental pollut*"[tw] OR "Environmental Pollution"[Mesh] OR "environmental pollution"[tw] OR "environmental protection"[tw] OR "environmental sustainab*"[tw] OR "environmental sustainability"[tw] OR **"Environmental*"[ti]** OR "EP in kg PO4 equivalent"[tw] OR "Equipment reuse"[mesh] OR "Equipment reuse"[tw] OR "Eutrophication potential"[tw] OR "Eutrophication"[Mesh] OR "eutrophication"[tw] OR "FAETP in kg DCB equivalent"[tw] OR "Freshwater Aquatic Ecotoxicity Potential"[tw] OR "Global Warming"[mesh] OR "Global Warming"[tw] OR "Green deal"[tw] OR "Green surgery"[tw] OR "Greenhouse Effect"[mesh] OR "greenhouse effect*"[tw] OR "greenhouse effects"[tw] OR "greenhouse gas emission"[tw] OR "greenhouse gas emissions"[tw] OR "Greenhouse Gas"[tw] OR "Greenhouse Gases"[mesh] OR "Greenhouse Gases"[tw] OR "greening"[tw] OR "GWP in kg CO2 equivalents"[tw] OR "H+ moles equivalents"[tw] OR "hospital waste"[tw] OR "HTTP in kg Dichlorobenzene equivalent"[tw] OR "Human Toxicity Potential"[tw] OR "kg 2.4-D equivalents"[tw] OR "kg CFC-11 equivalent"[tw] OR "kg N equivalents"[tw] OR "kg NOx equivalents"[tw] OR "LCA"[tw] OR "LCAs"[tw] OR "life cycle analysis"[tw] OR "life cycle assess*"[tw] OR "life cycle assessment"[tw] OR "life cycle inventories"[tw] OR "life cycle inventory"[tw] OR "Medical Waste Disposal"[mesh] OR "Medical Waste"[mesh] OR "medical waste"[tw] OR "N equiv*"[tw] OR "Ozone Depletion"[Mesh] OR "ozone depletion"[tw] OR "Photochemical Ozone Depletion Potential"[tw] OR "Plastic overuse"[tw] OR "POCP in kg ethane equivalent"[tw] OR "preservation of natural resources"[tw] OR "recycle*"[tw] OR "Recycling"[mesh] OR "recycling"[tw] OR "Refuse Disposal"[Mesh] OR "Refuse Disposal"[tw] OR "reusable"[tw] OR "Reusables"[tw] OR "reuse"[tw] OR "reused"[tw] OR "reusing"[tw] OR "Rising Sea Level"[tw] OR "Rising Sea Levels"[tw] OR "Sea Level Rise"[mesh] OR "Sea Level Rise"[tw] OR "Smog"[mesh] OR "smog"[tw] OR "SO2 equiv*"[tw] OR "sustainability"**[ti]** OR "Sustainable Development"[Mesh] OR "Sustainable Development"[tw] OR "Waste Disposal"[tw] OR "Waste Disposal, Fluid"[mesh] OR "Waste Management"[mesh] OR "Waste"[tw] OR "waste"[tw] OR "Waste Water"[Mesh] OR "Waste Water"[tw] OR "wastes"[tw] OR "Wastewater"[tw] OR "Water Purification"[Mesh] OR "Water Purification"[tw] OR (("plastic*"[tw] OR "microplastic*") AND ("soop"[tw] OR "soup"[tw] OR "pollution"[tw] OR "overuse"[tw] OR "contamination"[tw])) OR (("Plastic"[tw] OR 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(("Animals"[Mesh]) OR "Models, Animal"[Mesh] NOT humans[mh]) NOT (letter[pt] OR comment[pt] OR editorial[pt])) **OR ("Comparative Study"[Publication Type] OR "comparison"[tiab] OR "comparative"[tiab] OR "compar*"[tiab] OR "Epidemiologic studies"[mesh:noexp] OR "case control studies"[mesh] OR "cohort studies"[mesh] OR "Controlled Before-After Studies"[mesh] OR "Case control"[tw] OR cohort*[tw] OR "Cohort analy*"[tw] OR "Follow up stud*"[tw] OR "observational stud*"[tw] OR Longitudinal[tw] OR Retrospective*[tw] OR prospective*[tw] OR consecutive*[tw] OR Cross sectional[tw] OR "Cross-sectional studies"[mesh] OR "historically controlled study"[mesh] OR "interrupted time series analysis"[mesh]) OR** ("life cycle assess*"[tw] OR "life cycle assessment"[tw] OR "life cycle inventory"[tw] OR "LCA"[tw] OR "LCAs"[tw] OR "life cycle inventory"[tw] OR "life cycle inventories"[tw])**)**

Embase (OVID)

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"Intra operative".mp OR "Post operative".mp OR "Pre operative".mp OR "Intraoperativ*".mp OR "Operativ*".mp OR "Postoperativ*".mp OR "Preoperativ*".mp OR "Intra operativ*".mp OR "Post operativ*".mp OR "Pre operativ*".mp OR exp "Surgical Equipment"/ OR "surgery".fs OR "surgery".mp OR exp "Surgery"/ OR "surgical*".mp OR exp "Surgeon"/ OR "surgeon".mp OR "surgeons".mp) AND ("bair hugger".mp OR "bair hugger*".mp OR "forced-air warming system"/ OR exp "Textile"/ OR "Textiles".mp OR "Textile".mp OR "Bedlinen"/ OR "Bedding".mp OR "Beddings".mp OR "Linens".mp OR "Linen".mp OR "blanket".mp OR "blankets".mp OR exp "Surgical Drape"/ OR "Surgical Drapes".mp OR "Surgical Drape".mp OR "Drapes".mp OR "Drape".mp OR "cloth".mp OR "cloths".mp OR "tablecloth".mp OR "tablecloths".mp OR "bedsheets".mp OR "bedsheet".mp OR "bed sheets".mp OR "bed sheet".mp OR "fiber mats".mp OR "fiber mat".mp OR "fibre mats".mp OR "fibre mat".mp OR "fiber pads".mp OR "fiber pad".mp OR "fibre pads".mp OR "fibre pad".mp OR 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("hydrogen*".mp AND "moles".mp AND "equiv*".mp) OR ("Dichlorobenzen*".mp AND "equiv*".mp) OR ("2,4-D".mp AND "equiv*".mp) OR ("NOx".mp AND "equiv*".mp) OR ("ethane".mp AND "equiv*".mp) OR ("PO4".mp AND "equiv*".mp) OR ("DCB".mp AND "equiv*".mp) OR ("sustainability".mp AND ("environment*".mp OR "carbon".mp)) OR (("Carbon Dioxide"/ OR "Carbon Dioxide".mp OR "CO2".mp) AND ("pollution".mp OR "emission".mp OR "emissions".mp OR "waste".mp OR "environment".mp OR "environmental*".mp OR "footprint".mp OR "footprint*".mp OR "sustainable".mp OR "hazard".mp OR "hazard*".mp))) NOT (conference review or conference abstract).pt AND (1980 OR 1981 OR 1982 OR 1983 OR 1984 OR 1985 OR 1986 OR 1987 OR 1988 OR 1989 OR 1990 OR 1991 OR 1992 OR 1993 OR 1994 OR 1995 OR 1996 OR 1997 OR 1998 OR 1999 OR 2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022).yr) AND **(***(exp "meta analysis"/ OR exp "meta analysis (topic)"/ OR metaanaly*.ti,ab OR "meta analy*".ti,ab OR metanaly*.ti,ab OR "systematic review"/ OR "cochrane database of systematic reviews".jn OR prisma.ti,ab OR prospero.ti,ab OR (((systemati* OR scoping OR umbrella OR "structured literature") ADJ3 (review* OR overview*)).ti,ab) OR ((systemic* ADJ1 review*).ti,ab) OR (((systemati* OR literature OR database* OR "data base*") ADJ10 search*).ti,ab) OR (((structured OR comprehensive* OR systemic*) ADJ3 search*).ti,ab) OR (((literature ADJ3 review*).ti,ab) AND (search*.ti,ab OR database*.ti,ab OR "data base*".ti,ab)) OR (("data extraction".ti,ab OR "data source*".ti,ab) AND "study selection".ti,ab) OR ("search strategy".ti,ab AND "selection criteria".ti,ab) OR ("data source*".ti,ab AND "data synthesis".ti,ab) OR medline.ab OR pubmed.ab OR embase.ab OR cochrane.ab OR (((critical OR rapid) ADJ2 (review* OR overview* OR synthes*)).ti) OR ((((critical* OR rapid*) ADJ3 (review* OR overview* OR synthes*)).ab) AND (search*.ab OR database*.ab OR "data base*".ab)) OR metasynthes*.ti,ab OR "meta synthes*".ti,ab)* OR (exp "clinical trial"/ OR exp "randomization"/ OR exp "single blind procedure"/ OR exp "double blind procedure"/ OR exp "crossover procedure"/ OR exp "placebo"/ OR exp "prospective study"/ OR rct.ti,ab OR random*.ti,ab OR "single blind".ti,ab OR "randomised controlled trial".ti,ab OR exp "randomized controlled trial"/ OR placebo*.ti,ab) **OR (exp "Comparative Study"/ OR "comparison".ti,ab OR "comparative".ti,ab OR "compar*".ti,ab OR "major clinical study"/ OR "clinical study"/ OR "case control study"/ OR "family study"/ OR "longitudinal study"/ OR "retrospective study"/ OR "prospective study"/ OR "cohort analysis"/ OR cohort*.ti,ab OR (("case control" ADJ1 (study OR studies)).ti,ab) OR (("follow up" ADJ1 (study OR studies)).ti,ab) OR (observational ADJ1 (study OR studies)) OR ((epidemiologic ADJ1 (study OR studies)).ti,ab) OR (("cross sectional" ADJ1 (study OR studies)).ti,ab)) OR** ("life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "life cycle inventory".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp))**)**

Web of Science

(TS=("Operating Tables" OR "Operating Tables" OR "Operating Table" OR "Operating Room Tables" OR "Operating Room Table" OR "Operation Tables" OR "Operation Table" OR "Operation Room Tables" OR "Operation Room Table" OR "Operating Rooms" OR "Operating Rooms" OR "Operating Room" OR "Operation Rooms" OR "Operation Room" OR "Operating Theatres" OR "Operating Theatre" OR "Operation Theatres" OR "Operation Theatre" OR "Operating Theaters" OR "Operating Theater" OR "Operation Theaters" OR "Operation Theater" OR "Perioperative Period" OR "Perioperative Care" OR "Perioperative Nursing" OR "Perioperative Medicine" OR "Perioperative" OR "Perioperativ*" OR "Peri operative" OR "Peri operativ*" OR "Intraoperative" OR "Operative" OR "Postoperative" OR "Preoperative" OR "Intra operative" OR "Post operative" OR "Pre operative" OR "Intraoperativ*" OR "Operativ*" OR "Postoperativ*" OR "Preoperativ*" OR "Intra operativ*" OR "Post operativ*" OR "Pre operativ*" OR "Surgical Equipment" OR "surgery" OR 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"plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))) OR **TI=("environmental*" OR "sustainab*")**) NOT DT=(meeting abstract) AND PY=(1980 OR 1981 OR 1982 OR 1983 OR 1984 OR 1985 OR 1986 OR 1987 OR 1988 OR 1989 OR 1990 OR 1991 OR 1992 OR 1993 OR 1994 OR 1995 OR 1996 OR 1997 OR 1998 OR 1999 OR 2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022)) AND (TI=(*("Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR/4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR/4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR/4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR/4 ("review*" OR "overview*" OR "synthes*") NEAR/4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*")* **OR** ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") **OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal 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OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR/4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR/4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR/4 ("review*" OR "overview*" OR "synthes*") NEAR/4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*")* **OR** ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") **OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR/1 (study OR studies))) OR (("follow up" NEAR/1 (study OR studies))) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies))) OR (("cross sectional" NEAR/1 (study OR studies)))) OR** ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")**)**)

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Module 4: Anesthesie

Samenvatting

Uitgangsvragen

4.1 Wat is het effect op duurzaamheid van inhalatie-anesthetica in vergelijking met het gebruik van intraveneuze anesthesie?

4.2 Wat is het effect op duurzaamheid van inhalatie-anesthetica met het gebruik van Vapour Capture Technology in vergelijking met het gebruik van inhalatie-anesthetica zonder Vapour Capture Technology?

4.3 Wat is het effect op duurzaamheid van (loco)regionale en lokale anesthesie versus algehele anesthesie?

GRADE

Zeer laag tot Laag

Overwegingen: focus op Refuse (R1), Reduce (R2), Reuse (R4)

Aanbevelingen

Voor algehele anesthesie, gebruik intraveneuze anesthetica in plaats van inhalatie-anesthetica (R1-Refuse).

- Wees bewust dat inhalatie-anesthetica een grotere (negatieve) milieu-impact hebben in vergelijking met intraveneuze anesthesie (R1-Refuse).
- Indien het gebruik van inhalatie-anesthetica toch noodzakelijk wordt geacht, minimaliseer dan de hoeveelheid of vang het op (R2-reduce).
- Minimaliseer de verspilling van propofol door het medicijn op maat op te trekken (R2-reduce).

Indien het gebruik van inhalatie-anesthetica de voorkeur heeft, minimaliseer de hoeveelheid of vang het op. Kortom:

- Gebruik een lage flow (0,3-0,5 L/min) en een beademingsmachine met End-tidal functie om de milieu-impact van inhalatie-anesthetica te verlagen (R2-Reduce).
- Gebruik sevofluraan (R1-Refuse). Er is geen plaats meer voor desfluraan en isofluraan.
- Vermijd het gebruik van lachgas.
- Vang inhalatie-anesthetica die vrijkomen bij de patiënt op indien mogelijk, zodat het niet in de atmosfeer terecht komt (R2-Reduce, R4-Reuse).

Uitgangsvraag module 4 'Anesthesie'

4.1 Wat is het effect op duurzaamheid van inhalatie-anesthetica in vergelijking met het gebruik van intraveneuze anesthetica?

4.2 Wat is het effect op duurzaamheid van inhalatie-anesthetica met het gebruik van Vapour Capture Technology in vergelijking met het gebruik van inhalatie-anesthetica zonder Vapour Capture Technology?

4.3 Wat is het effect op duurzaamheid van (loco)regionale en lokale anesthesie versus algehele anesthesie?

Inleiding

Wanneer patiënten een operatie onder narcose ondergaan, kan de narcose worden onderhouden met inhalatie-anesthetica of intraveneuze anesthesie. De middelen die voor inhalatie-anesthetica worden gebruikt, fungeren als broeikasgassen. Het gebruik van inhalatie-anesthetica lijkt slechter voor het milieu dan het gebruik van intraveneuze anesthetica. Er zijn daarnaast meerdere methoden van anesthesie mogelijk, namelijk (loco)regionale of lokale anesthesie. In deze module worden de effecten op duurzaamheid van de verschillende soorten anesthesie geëvalueerd.

Search and select

A systematic review of the literature was performed to answer the following questions:

PICO1: *What is the effect on environmental sustainability of inhalation anaesthetics compared with the use of intravenous anaesthesia in patients undergoing surgery?*

P = patients who underwent a surgical procedure under general anaesthesia
I = inhalation anaesthetics
C = intravenous anaesthetics
O = climate change (CO_2 footprint/GWP), waste, medicine residue in water, human toxicity, ozone depletion

PICO2: *What is the effect on environmental sustainability of inhalation anaesthetics while using Vapour Capture Technology compared with the use of inhalation anaesthetics while not using Vapour Capture Technology in patients undergoing surgery?*

P = patients who underwent a surgical procedure under anaesthesia
I = inhalation anaesthetics with use of Vapour Capture Technology
C = inhalation anaesthetics without use of Vapour Capture Technology
O = climate change (CO_2 footprint/GWP), waste, medicine residue in water, human toxicity, ozone depletion

PICO3: *What is the effect on environmental sustainability of (loco)regional anaesthesia and local anaesthesia compared with the use of general anaesthesia in patients undergoing surgery?*

P = patients who underwent a surgical procedure under anaesthesia
I = (loco)regional anaesthesia and local anaesthesia
C = general anaesthesia
O = climate change (CO_2 footprint/GWP), waste, medicine residue in water, human toxicity, ozone depletion

<u>Relevant outcome measures</u>

Life cycle assessment (LCA) is a methodological tool used to quantitatively analyse the life cycle of products/activities within the context of environmental impact. The assessment comprises all stages needed to produce and use a product, from the initial development to the treatment of waste (the total life cycle). An LCA is mainly based on four phases: 1) goal and scope definition, 2) inventory analysis, 3) impact assessment, and 4) interpretation. The third phase is the life cycle impact assessment (LCIA), in which emissions and resource extractions are translated into a limited number of environmental impact scores by means of so-called characterisation factors. The ReCiPe model is a method for the impact assessment in an LCA (Huijbregts, 2016, Huijbregts, 2017). To determine the outcome measures regarding environmental impact, the ReCiPe model of the National Institute for Public Health and the Environment (in Dutch: Rijksinstituut voor Volksgezondheid en Milieu, RIVM) was used.

The outcomes determined by the working group are based on the ReCiPe model. The working group considered climate change (CO_2 footprint/Global Warming Potential) and waste as a *critical* outcome measure for decision making; and medicine residue in water, human toxicity and ozone depletion as an *important* outcome measure for decision making.

A priori, the working group did not define the outcome measures listed above but used the definitions used in the studies.

Outcomes focused on environmental life cycle assessment (LCA) impact categories are relatively new in healthcare. Given the variety in scopes and methods of performing and reporting LCAs, the working group did not a priori define the minimal important difference. Differences between the techniques were evaluated by the working group after data extraction.

A glossary including the outcome measures is found in Module 1 'operatietechnieken'.

Search and select (Methods)

The databases Pubmed (via NCBI), Embase (via OVID), Web of Science (via Webofscience), Cochrane (via Cochrane library) and Emcare (via OVID) were searched with relevant search terms from 2000 until 22 February 2022. The detailed search strategy is depicted under the tab Methods. The systematic literature search resulted in 798 hits in total. Studies for this module were selected based on the following criteria:

- Systematic reviews (searched in at least two databases, with a detailed search strategy, risk of bias assessment and results of individual studies available), randomized controlled trials, (observational) comparative studies, life cycle assessments, CO_2 footprint studies and environmental impact studies;
- Full-text English language publication; and
- Studies according to the PICO. Studies that compared different types of anaesthesia related and included at least one of the following outcomes conform the PICO.

After reading the full text, four studies were included in the literature summary of this module.

Results

Four studies were included in the analysis of the literature. Two studies were allocated to sub question 4.1 (Sherman, 2012; Thiel, 2018), one study to sub question 4.2 (Hu, 2021), and one study to sub question 4.3 (McGain, 2021). Important study characteristics and results are summarized in the evidence table. The assessment of the life cycle assessment (LCA) studies is summarized in the quality appraisal table. Important study characteristics and results are summarized in Appendix 1 'Evidence table of LCAs'. The quality assessment of the studies is summarized in Appendix 2 'Critical appraisal of LCAs'.

Summary of literature – Sub question 4.1

Description of studies

Sherman (2012) conducted an LCA to compared five types of anaesthetic drugs (sevoflurane, desflurane, isoflurane, N_2O, propofol) to inform clinician drug selection on the environmental impact of the drugs. The functional unit was 1 Minimum Alveolar Concentration (MAC), or MAC-equivalent for propofol, for maintenance anaesthesia for an average 70 kg adult patient for 1 hour (1 MAC-h). Included stages in the life cycle of the drug were raw material extraction, production, transport (to health care facilities), drug delivery (to the patient), and disposal. Additionally, the waste gas of the agent in the atmosphere and N_2O release were considered. Data on transport, drug transportation, energy requirements, and disposal were collected from to the Yale-New Haven Hospital. EcoInvent was used as primary data source. When data regarding the drugs was unavailable in EcoInvent, proxies that best matched the production characteristics of the drug were used. The outcome measure was climate change.

Thiel (2018) conducted a hybrid LCA to examine the efficacy of sustainable interventions to reduce Greenhouse Gas (GHG) emissions in the operating room (OR). Baseline emissions for a laparoscopic hysterectomy were calculated based on an average of 17 hysterectomies extracted from a previous study in the USA (Thiel, 2017). Further data was obtained from EIO-LCA and EcoInvent. Life cycle GHGs were calculated for interventions regarding anaesthetics, surgical materials, and energy. To model anaesthetic interventions, an average anaesthetic duration of 150 minutes was assumed. The outcome measure was climate change.

Summary of literature – Sub question 4.2

Description of studies

Hu (2021) used a Life Cycle Inventory Analysis (LCI) to calculate the carbon footprint of general anaesthetics. Thereby the potential impact of Vapour Capture Technology was provided. The functional unit for the anaesthetics was 1 Minimum Alveolar Concentration hour (MAC-h), or MAC-h equivalent for propofol. Raw material extraction, manufacturing, packaging, use, and waste of anaesthetic gases were included in the analysis. Since information on synthesizing general anaesthetics was not publicly available, two methods were modelled for the manufacturing process of the drugs: Method A (relatively older manufacturing processes) and Method B (newer manufacturing processes). Synthesis of propofol liquid was included. Transportation, energy consumption for using general anaesthetics in the OR, use of disposables, and propofol end of life waste was excluded from the analysis. For the Vapour Capture Technology effect, it was assumed that inhalational anaesthetic gases (IAG) can only be recycled once. Three scenarios are compared with different gas flow rates. Within these scenarios, for sevoflurane both US and UK situations are modelled.

Summary of literature – Sub question 4.3

Description of studies

McGain (2021) conducted an LCA to examine the CO_2 equivalent emissions associated with 1) general anaesthesia (either volatile gas anaesthetics or total intravenous anaesthesia), 2) spinal anaesthesia, and 3) combined (general and spinal) anaesthesia during total knee replacement. The functional unit was all anaesthesia for a total knee replacement. Anaesthesia data were obtained from 30 patients undergoing total knee replacement in an Australian hospital. Data from literature and databases such as EcoInvent and Australian Life Cycle Inventory were used. The outcome measures were climate change and waste.

Results

Sub question 4.1 inhalation anaesthetics versus intravenous anaesthetics

1.1 Climate Change

Two studies reported on climate change. Sherman (2012) showed outcomes only graphically (Figure 1 in the article), so we read values from this figure. Authors defined climate change as GHG-emissions (in CO_2 equivalents).

Considering the N_2O/O_2 admixture, desflurane has the biggest impact with approximately 56,000 g CO_2eq, followed by sevoflurane with 46,000 g CO_2eq, and isoflurane 24,000 g CO_2eq. The emissions of propofol could not be depicted from the figure (too small). The biggest hotspot was the N_2O release.

Considering the O_2/air admixture, desflurane has the greatest impact followed by isoflurane and sevoflurane. This change in impact between isoflurane and sevoflurane is attributable to the higher GWP for isoflurane (using O_2/air leads to a higher impact for isoflurane) and conversely the higher gas flow requirements for sevoflurane when using N_2O/O_2 (more N_2O usage).

Considering the life cycle, desflurane has the biggest impact (700 g CO_2eq), followed by sevoflurane (430 g CO_2eq), isoflurane (200 g CO_2eq), and propofol (25 g CO_2eq). For desflurane the largest hotspot is agent manufacturing, followed by delivery of the drug to the patient (electricity required for volatilization), and N_2O manufacturing. Sevoflurane and isoflurane have similar profiles, including the largest hotspot of N_2O manufacturing, followed by agent manufacturing, and packaging.

Thiel (2018) reported a baseline case including an average of 17 laparoscopic hysterectomies, with inclusion or exclusion of anaesthesia. The baseline case including and excluding anaesthesia resulted in 562 kg CO_2eq and 402 kg CO_2eq, respectively. Using desflurane only resulted in the largest emission of 762 kg CO_2eq, followed by desflurane with NO_2 (757 kg CO_2eq), sevoflurane with NO_2 (416 kg CO_2eq), sevoflurane only (410 kg CO_2eq), and propofol only (402 kg CO_2eq).

1.2 Waste, 1.3. Medicine residue in water, 1.4 *Human toxicity, 1.5 Ozone depletion*

Outcomes were not reported.

Sub question 4.2 with vs. without use of Vapour Capture Technology

2.1. Climate Change

Hu (2021) reported on the outcome climate change. The results on climate change are graphically shown in Figure 2-4 (Hu, 2021). Three different scenarios are studied:

1. Fresh gas flow of 1L (UK) or 2L (US)/min, % gas flow O_2/N_2O = 40/60
2. Fresh gas flow of 1L (UK) or 2L (US)/min, % gas flow O_2/N_2O = 100/0
3. Fresh gas flow of 0.5L/min, % gas flow O_2/N_2O = 100/0

Desflurane has the highest carbon footprint in all scenarios and propofol the lowest carbon footprint. Eliminating NO_2 leads to lower carbon footprints. Low fresh gas flow (scenario 3) resulted in the lowest the carbon footprint for all IAGs. The biggest hotspot for desflurane and isoflurane was the waste IAG, for sevoflurane the manufacturing process, and for propofol the drug administration.

Regarding manufacturing method (A vs. B), for all three anaesthetic gases (desflurane, Propofol, sevoflurane), method A (relatively older manufacturing processes) resulted in a larger carbon footprint when compared to method B (newer manufacturing processes). Reduction of the carbon footprint for the production of sevoflurane can be achieved by

avoiding the use of tetrafluoroethylene (84% reduction). The US method leads to a higher impact. Using Vapour Capture Technology results in lower carbon footprints for all anaesthetic gases.
When using a fresh gas flow rate of 0.5L/min, with method-B as the manufacturing process, the carbon footprint of sevoflurane is comparable to propofol. However, when the manufacturer of propofol uses renewable energy the carbon footprint can be cut by half.

*2.2 Waste, 2.3. Medicine residue in water, 2.*4 *Human toxicity, 2.5 Ozone depletion*
Outcomes were not reported.

Sub question 4.3 (loco)regional anaesthesia and local anaesthesia vs. general anaesthesia
3.1. Climate Change
McGain (2021) reported on the outcome climate change. Three hours of propofol (700 mg/h) will result in less than 50 g CO_2eq. The total emissions and mean anaesthesia duration times were:

- General anaesthesia: 14.9 kg CO_2eq (95%CI 9.7 to 22.5), 161 min (95%CI 113 to 193)
- Spinal anaesthesia: 16.9 kg CO_2eq (95%CI 13.2 to 20.5), 200 min (95%CI 168 to 288)
- Combination anaesthesia: 18.5 kg CO_2eq (95%CI 12.5 to 27.3), 189 min (95%CI 128 to 241)

Electricity for the patient air warmer was responsible for at least 2.46 kg CO_2eq for all approaches. Total single-use plastics and glass were responsible for 3.5 CO_2eq (general), 3.4 CO_2eq (spinal), and 4.3 CO_2eq (combination).
Pharmaceuticals beyond gases were responsible for 1.2 to 1.3 CO_2eq (7 to 8%). For general anaesthesia, sevoflurane was responsible for 4.7 kg CO_2eq (95%CI 2.7 to 8.6). Patients who received propofol represented the minimum of 8.4 kg CO_2eq in the general anaesthesia group. In the combination group, sevoflurane contributed for 3.1 kg CO_2eq (95%CI 0.6 to 10).
International comparisons were made by changing energy sources. Australia and China are more coal reliant, where the EU and UK are more dependent on nuclear and hydro/wind/solar sources. In the EU, spinal anaesthesia has a lower carbon footprint (Australia: 16.9 kg CO_2eq; EU: 9.9 kg CO_2eq) than Australia. This is due to high carbon intensity electricity that is required to clean reusable anaesthesia equipment. The carbon footprint of general anaesthesia in Australia was less than the EU average (Australia: 8.4 kg CO_2eq; EU: 11.9 kg CO_2eq).

3.2. Waste
McGain (2021) reported on the outcome waste. The total waste of single-use equipment were:

- General anaesthesia: mean 996 g (IQR 873 to 1,033; min-max 725 to 1,392);
- Spinal anaesthesia: mean 997 g (IQR 934 to 1,076; min-max 885 to 1,184); and
- Combination anaesthesia: mean 1,237 g (IQR 1,100 to 1,285; min-max 1,009 to 1,678).

The majority of the waste was caused by total plastics: average for general anaesthesia 783 g (78%), spinal 729 g (73%), and combination 932 (75%).

3.3. Medicine residue in water, 3.4 *Human toxicity, 3.5 Ozone depletion*
Outcomes were not reported.

Level of evidence of the literature

The working group assessed the level of evidence of LCAs using GRADE and used the critical appraisal of LCAs (Drew, 2021) to provide an indication of the study quality. See module 1 'operatietechnieken' for more details. As the four included studies contained LCAs (Sherman, 2012; Thiel, 2018; Hu, 2021; McGain, 2021), the level of evidence started at grade *high*.

Sub-question 4.1 inhalation anaesthetics vs. intravenous anaesthetics

1.1. Climate Change

Two studies (Sherman, 2012; Thiel, 2018) reported on 'climate change'. The level of evidence of this outcome measure was downgraded with 3 levels to *very low* due to risk of bias (-1; methods were not clearly stated, assumptions and measurements are not clearly described) and imprecision (-2; uncertainty due to limited or lack of LCA data, limited generalizability as evidence base lacks geographic and institutional diversity, sensitivity- or uncertainty analysis are lacking).

1.2 Waste, 1.3. Medicine residue in water, 1.4 Human toxicity, 1.5 Ozone depletion

Outcomes were not reported thus could not be graded.

Sub-question 4.2 with vs. without use of Vapour Capture Technology

2.1. Climate Change

One study (Hu, 2021) reported on 'climate change'. The level of evidence of this outcome measure was downgraded with 3 levels to *very low* due to risk of bias (-1; assumptions are not clearly described) and imprecision (-2; calculations are based on proxys as inventory data was unavailable, limited generalizability as evidence base lacks geographic and institutional diversity, uncertainty analysis was lacking).

2.2 Waste, 2.3. Medicine residue in water, 2.4 Human toxicity, 2.5 Ozone depletion

Outcomes were not reported, thus could not be graded.

Sub-question 4.3 (loco)regional anaesthesia and local anaesthesia vs. general anaesthesia

3.1. Climate Change

One study (McGain, 2021) reported on 'climate change'. The level of evidence of this outcome measure was downgraded with 3 levels to *very low* due to risk of bias (-1; functional unit was very broad defined, analysis lack other anaesthetics) and imprecision (-2; limited generalizability as evidence base lacks geographic and institutional diversity, data were only collected from one study including only 30 patients, uncertainty analysis was lacking).

3.2. Waste

One study (McGain, 2021) reported on 'waste'. The level of evidence of this outcome measure was downgraded with 3 levels to *very low* due to risk of bias (-1; functional unit was very broad defined, analysis lack other anaesthetics) and imprecision (-2; limited generalizability as evidence base lacks geographic and institutional diversity, data were only collected from one study including only 30 patients, uncertainty analysis was lacking).

3.3. Medicine residue in water, 3.4 Human toxicity, 3.5 Ozone depletion

Outcomes were not reported, thus could not be graded.

Conclusions

Sub-question 4.1 inhalation anaesthetics vs. intravenous anaesthetics

1.1 Climate Change (critical)

Very low GRADE	The evidence is very uncertain about the effect on climate change when inhalation anaesthetics is compared to intravenous anaesthetics in patients who underwent a surgical procedure under general anaesthesia. *Sources: Sherman, 2012; Thiel, 2018*

1.2 Waste (critical), 1.3. Medicine residue in water (important), 1.4 Human toxicity (important), 1.5 Ozone depletion (important)

- GRADE	Outcome measures 'waste', 'medicine residue in water', 'human toxicity' and 'ozone depletion' were not graded. *Sources: -*

Sub-question 4.2 with vs. without Vapour Capture Technology

2.1 Climate Change (critical)

Very low GRADE	The evidence is very uncertain about the effect on climate change when inhalation anaesthetics with Vapour Capture Technology is compared to inhalation anaesthetics without Vapour Capture Technology in patients who underwent a surgical procedure under general anaesthesia. *Sources: Hu, 2021*

2.2 Waste (critical), 2.3. Medicine residue in water (important), 2.4 Human toxicity (important), 2.5 Ozone depletion (important)

- GRADE	Outcome measures 'waste', 'medicine residue in water', 'human toxicity' and 'ozone depletion' were not graded. *Sources: -*

Sub-question 4.3 (loco)regional anaesthesia and local anaesthesia vs. general anaesthesia

3.1 Climate Change (critical)

Very low GRADE	The evidence is very uncertain about the effect on climate change when (loco)regional anaesthesia and local anaesthesia is compared to general anaesthesia in patients who underwent a surgical procedure. *Sources: Hu, 2021*

3.2 Waste (critical)

Very low GRADE	The evidence is very uncertain about the effect on waste when (loco)regional anaesthesia and local anaesthesia is compared to general anaesthesia in patients who underwent a surgical procedure. *Sources: Hu, 2021*

3.3. Medicine residue in water (important), 3.4 Human toxicity (important), 3.5 Ozone depletion (important)

- GRADE	Outcome measures 'medicine residue in water', 'human toxicity' and 'ozone depletion' were not graded. *Sources: -*

Overwegingen – van bewijs naar aanbeveling

<u>Voor- en nadelen van de interventie en de kwaliteit van het bewijs</u>

In deze module evalueert de werkgroep de milieu-impact van verschillende soorten anesthesietechnieken. Er werden in totaal vier studies gevonden. Twee LCA's vallen onder PICO1 (intraveneuze anesthetica versus inhalatie anesthetica), één LCA onder PICO2 (inhalatie-anesthetica met en zonder Vapour Capture Technology) en één LCA onder PICO3 (locoregionaal/lokaal versus algehele anesthesie). Omdat er geen uniforme en standaard GRADE methodiek specifiek is ontwikkeld voor LCA's (Morgan, 2016; Morgan, 2019), is ervoor gekozen om GRADE pragmatisch toe te passen. De bewijskracht voor de cruciale uitkomstmaten 'climate change' en 'waste' komt uit op *zeer laag*. Derhalve kunnen er op basis van de literatuur geen sterke conclusies worden getrokken over de mate van milieu-impact van de verschillende anesthesietechnieken.

De geïncludeerde LCA's zijn kritisch beoordeeld volgens Drew (2021), zie de bijlage 2 'Critical appraisal of LCAs'. McGain (2021) scoort met 89% het hoogst in vergelijking met Hu (2021; 84%), Sherman (2012; 83%) en Thiel (2018; 77%).
De verschillende soorten anesthesie en de geïdentificeerde hotspots uit de studies worden geëvalueerd middels het 'R-ladder (strategieën van circulariteit)' (zie figuur 1, gebaseerd op Cramer, 2014; Hanemaaijer; 2018; Potting, 2016; Reike, 2018). Deze R-ladder laat zien dat de hoogste prioriteit om duurzaam te werken 'refuse' is, oftewel, niet gebruiken. Hoe lager het grondstofgebruik, des te hoger op de R-ladder en hoe dichter je bent bij circulair werken.

Figuur 1. *Prioriteitsvolgorde circulariteit strategieën*

Refuse (R1) en Reduce (R2)

Drie LCA's (Sherman, 2012; Thiel, 2018; Hu, 2021) beschrijven algehele anesthesie en McGain (2021) beschrijft het gebruik van neuraxiale anesthesie. De studies impliceren dat algehele anesthesie met inhalatie-anesthetica resulteert in een grotere milieu-impact in vergelijking met intraveneuze anesthesie. Het vervangen van inhalatie-anesthetica met intraveneuze anesthetica zal dan ook leiden tot milieuwinst (R1-Refuse).

Spinale anesthesie

Opvallend is dat McGain (2021) laat zien dat spinale anesthesie een grotere negatieve milieu-impact heeft, in vergelijking met zowel algehele als gecombineerde anesthesie. Dit is voornamelijk te wijten aan het energieverbruik van de ‘air warmer’ van de patiënt en het zuurstof opvang systeem, het gebruik van disposables en het verbruik van energie voor het reinigings-, desinfectie- en sterilisatieproces. De hogere flow rate die wordt beschreven voor toediening van zuurstof (spinale anesthesie: 6-10 l/min, algehele anesthesie: 0.5-3 l/min) wordt gezien als belangrijke oorzaak voor de bijdrage in milieu-impact. De hogere flow in combinatie met de langere operatietijd (spinale anesthesie: 200 min, algehele anesthesie: 161 min, gecombineerde anesthesie: 189 min) vraagt een groter energieverbruik en hiermee een grotere negatieve milieu-impact (McGain, 2021). In Nederland is deze langere operatietijd bij spinale anesthesie ongebruikelijk. In tegenstelling tot McGain (2021), wordt uit recente literatuur geconcludeerd dat spinale anesthesie op basis van medicatiegebruik een lagere CO_2-footprint heeft dan algehele anesthesie (Whang, 2022). Al met al moeten deze resultaten voorzichtig worden geïnterpreteerd wegens methodologische beperkingen is de studies. Daarnaast zijn de resultaten mogelijk niet generaliseerbaar naar de Nederlandse setting.

Algehele anesthesie

Algehele anesthesie kan worden onderhouden met inhalatie-anesthetica en/of intraveneuze anesthetica. Hu (2021) laat zien dat het gebruik van Vapour Capture Technology (VCT) bij inhalatie-anesthetica de milieu-impact verlaagt (R2-Reduce). Op het moment dat VCT wordt gebruikt, resulteert dit dan ook in een vergelijkbare milieu-impact als intraveneuze anesthesie. Echter, wordt VCT nog niet als standaard in de praktijk toegepast. De werkgroep adviseert dan ook zoveel mogelijk met intraveneuze anesthesie te werken en inhalatie-anesthetica niet te gebruiken (R1-Refuse). Bij het gebruik van intraveneuze anesthesie, is het van belang om een goede inschatting te maken van de hoeveelheid propofol die nodig is per operatie. Bij een korte operatie is het mogelijk om minder te gebruiken (Reduce-R2). Omdat geneesmiddelen voor 18% bijdragen aan de CO_2-voetafdruk van de gezondheidszorg, dient men verspilling tegen te gaan (Gupta Strategists, 2019). Trek daarom de kleinst benodigde hoeveelheid propofol op in een spuit.

Indien het gebruik van inhalatie-anesthetica toch noodzakelijk wordt geacht, houdt dan het verbruik zo laag mogelijk door middel van een lage flow (0,3-0,5L/min), maak gebruik van een beademingsmachine met End tidal functie en kies voor inhalatie-anesthetica met een lage impact (sevofluraan: 130 GWP, desfluraan: 2540 GWP) (R2-Reduce). De Nederlandse Vereniging voor Anesthesiologie geeft verschillende adviezen hoe te verduurzamen op de operatiekamer (NVA, 2021).

Sherman (2012) toont dat isofluraan een lagere milieu-impact heeft dan sevofluraan. Ondanks dat isofluraan een sterker broeikasgas (GWP_{100} 510) is, heeft de gehele levenscyclus van sevofluraan (GWP_{100} 130) een grote milieu-impact wegens het productieproces (Sherman, 2012). Dit is mogelijk te verklaren doordat meer sevofluraan (8.0 mL) voor 1-MAC/hour dan isofluraan (2.0 mL) gebruikt wordt, waardoor er meer sevofluraan geproduceerd moet worden. Het gebruik van sevofluraan in een lage flow (0,3-0,5L/min) leidt ertoe dat minder gebruik en productie van sevofluraan nodig is, waardoor sevofluraan weer voordeliger kan uitkomen betreffende de milieu-impact. Wees daarnaast bewust dat lachgas (310 GWP) ook als broeikasgas werkt en een negatieve impact heeft op het milieu.

Redesign (R3)
Met betrekking tot R3-Redesign zijn er geen specifieke overwegingen met betrekking tot deze studies.

Re-use (R4)
Veelal wordt bij anesthesie gebruik gemaakt van disposables, daarom kunnen reusables een goede oplossing zijn om de milieu-impact te verlagen (zie module 2: Reusables versus disposables). McGain (2021) laat zien dat reusables een grote impact hebben in Australië en China, maar dat in de EU en het VK het milieuvriendelijker is om disposables te vervangen voor reusables. Dit verschil wordt veroorzaakt door het type energiebron die wordt gebruikt voor het reinigings- en sterilisatieproces. Zo gebruikt de EU minder steenkool en leunt ze meer op duurzame energiebronnen.

Wat betreft spinale anesthesie, draagt de hotspot 'elektriciteit voor het reinigen en steriliseren voor reusables, plastics en operatiejassen' voor een groot deel (27%) bij aan de milieu impact (McGain, 2021). In de meeste Nederlandse klinieken worden geen operatiejassen meer gebruikt bij spinale anesthesie en in plaats van reusable materialen worden veelal disposables gebruikt. De impact van deze categorie op spinale anesthesie zal in Nederland dus tot een ander resultaat kunnen leiden.
Daarnaast leidt het elektriciteitsverbruik in Australië tot een grotere negatieve milieu-impact dan in Nederland, omdat Nederland meer leunt op duurzame energiebronnen. In Australië hebben reusables dan ook een grotere negatieve milieu-impact dan disposables (McGain, 2021), wat daardoor ook de milieu impact van spinale anesthesie in Australië beïnvloedt.

Repair (R5), Refurbish (R6), Remanufacture (R7)
Met betrekking tot R5-Repair, R6-Refurbisch en R7-Manufacture zijn er geen specifieke overwegingen met betrekking tot deze studies.

Repurpose (R8), Recycling (R9), Recover (R10)
Vapour Capture Technology is nog volop in ontwikkeling en wordt momenteel nog beperkt toegepast in Nederland. In Nederland vindt het recyclen en verwerken van de inhalatie-anesthetica nog niet plaats, waardoor transport van de opgevangen anesthetica nodig is. Daarnaast is het wettelijk nu (nog) niet toegestaan om gerecyclede anesthetica toe te dienen aan patiënten. Hu (2021) laat zien dat als 70% wordt opgevangen en Vapour Capture Technology gebruikt wordt, de milieu-impact van sevofluraan lager kan zijn dan die van propofol. Ook kan de huidige technologie momenteel nog maar een beperkt deel van inhalatie-anesthetica opvangen. Hinterberg (2022) mat een recapture rate van 25% desfluraan.

<u>Waarden en voorkeuren van patiënten (en evt. hun verzorgers)</u>
Voor de patiënt en zorgverlener is het van belang dat de vorm van anesthesie veilig en effectief is en passend bij het type operatie. Desfluraan heeft de grootste impact op het milieu en moet worden vermeden. De werkgroep vindt het van belang om de milieu-impact mee te nemen in de keuze voor onderhoudsmedicatie van algehele anesthesie.

<u>Kosten (middelenbeslag)</u>
De werkgroep verwacht dat duurzaamheid in veel gevallen zal resulteren in kostenbesparing. Kosten spelen naar verwachting een rol in de keuze voor het type anesthesie. Desfluraan is duurder dan sevofluraan en propofol, de laatste twee zijn

nagenoeg gelijk qua kosten. Daarnaast spelen patiënt gerelateerde factoren (zoals kapinleiding bij kinderen) een rol in de overweging voor medicijnkeuze. De werkgroep is van mening dat ook duurzaamheid in deze beslissing moet worden meegenomen.

<u>Aanvaardbaarheid, haalbaarheid en implementatie</u>
De keuze van de vorm van anesthesie ligt bij de zorgverlener en wordt bepaald door veel verschillende factoren (e.g. effectiviteit, veiligheid, patiëntkarakteristieken, gebruiksgemak). De werkgroep vermoedt dat duurzaamheid met betrekking tot de keuze in anesthesie nog niet als doorslaggevende factor beschouwd wordt. Het vergt voornamelijk meer bewustwording over de milieu-impact van de verschillende interventies en hun hotspots om duurzaamheid mee te kunnen laten wegen in een beslissing. De werkgroep verwacht dat bestaande initiatieven de bewustwording onder zorgverleners zal vergroten.

Aanbevelingen

<u>Rationale van de aanbeveling: weging van argumenten voor en tegen de interventies</u>
De keuze voor de vorm van anesthesie ligt bij de zorgverlener, welke wordt bepaald door verschillende factoren (e.g. effectiviteit, veiligheid, patiëntkarakteristieken, gebruiksgemak). Indien de zorgverlener over deze kennis beschikt kan duurzaamheid een rol spelen in de keuze voor anesthesie. De werkgroep kiest, ondanks de zeer lage bewijskracht, voor een sterke aanbeveling met betrekking tot de aandacht voor duurzaamheidsuitkomsten.

Voor algehele anesthesie, gebruik intraveneuze anesthetica in plaats van inhalatie-anesthetica (R1-Refuse).

- Wees bewust dat inhalatie-anesthetica een grotere (negatieve) milieu-impact hebben in vergelijking met intraveneuze anesthesie (R1-Refuse).
- Indien het gebruik van inhalatie-anesthetica toch noodzakelijk wordt geacht, minimaliseer dan de hoeveelheid of vang het op (R2-reduce).
- Minimaliseer de verspilling van propofol door het medicijn op maat op te trekken (R2-reduce).

Indien het gebruik van inhalatie-anesthetica de voorkeur heeft, minimaliseer de hoeveelheid of vang het op.
Kortom:

- Gebruik een lage flow (0,3-0,5 L/min) en een beademingsmachine met End-tidal functie om de milieu-impact van inhalatie-anesthetica te verlagen (R2-Reduce).
- Gebruik sevofluraan (R1-Refuse). Er is geen plaats meer voor desfluraan en isofluraan.
- Vermijd het gebruik van lachgas.
- Vang inhalatie-anesthetica die vrijkomen bij de patiënt op indien mogelijk, zodat het niet in de atmosfeer terecht komt (R2-Reduce, R4-Reuse).

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Bijlagen bij module 4 'Anesthesie'

Appendix 1. Evidence table for LCA studies

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
Sherman (2012)	Anesthesia & Analgesia Journal information The "The Global Standard in Anesthesiology," provides practice-oriented, clinical research you need to keep current and provide optimal care to your patients. Brings peer reviewed articles on the latest advances in drugs, preoperative preparation, patient monitoring, pain management, pathophysiology, and many other timely topics. Critical review: Peer reviewed, not a specific LCA journal.	Type of study: LCA Objective: To perform an initial life cycle assessment on 5 anesthetic drugs – sevoflurane, desflurane, isoflurane, N_2O and propofol – to inform clinician drug selection on this basis. LCA-method: Attributional LCA Setting and country: Hospital in the US Facility: Yale-New Haven Hospital Years of data collection: - Surgical discipline(s): Anaesthesia Funding and conflict of interest: No funding mentioned. The authors state no conflicts of interest.	Goal and scope[1]: To compare the environmental impacts of 5 anaesthetic drugs to inform clinicians in drug selection. Functional unit(s)[2]: 1 minimum alveolar concentration (MAC), or MAC-equivalent for propofol, for maintenance anesthesia for an average 70 kg adult patient for 1 hour (1 MAC-h) System boundaries: Cradle to grave Included stages: Raw material extraction, production, transport, drug delivery, disposal Stated excluded components: Baseline energy requirement for the anaesthesia machine (considered to be constant for all drugs), basic disposables (such as: endotracheal tubes, circuits, CO_2 absorbents)	An LCA was conducted to compare the environmental impact of 5 types of anaesthetic drugs – sevoflurane, desflurane, isoflurane, N_2O and propofol – to inform clinician drug selection on this basis. The functional unit was 1 minimum alveolar concentration (MAC), or MAC-equivalent for propofol, for maintenance anesthesia for an average 70 kg adult patient for 1 hour (1 MAC-h). Included stages in the life cycle of the drug were raw material extraction, production, transport (to health care facilities), drug delivery (to the patient) and disposal. Besides that, the waste gas of the agent in the atmosphere and N_2O release were considered (O_2/air admixture and N_2O/O_2 admixture for administration were considered). Data collection on transport, drug transportation, energy requirements and disposal was specific to the Yale-New Haven Hospital. EcoInvent was used as primary data source. When data regarding	1. Climate Change The results on climate change are only graphically reported in Figure 1 (Sherman, 2012). The figure shows two graphs, whereas panel A shows the results on the life cycle (as mentioned before) of the drug, agent release and N_2O release and panel B shows nonwasted anaesthetic gas emissions (life cycle) from drug manufacturing, transport, drug delivery and disposal. Considering the N_2O/O_2 admixture, desflurane has the biggest impact with approximately 56,000 g CO_2e including agent release and N_2O release, followed by sevoflurane with 46,000 g CO_2e, isoflurane 24,000 g CO_2e and propofol. The emissions of propofol can not be depicted from the figure (too small). When choosing for the O_2/air admixture, desflurane has the greatest impact followed by isoflurane and sevoflurane.	Overall desflurane has the greatest impact on the outcome climate change. Propofol is the best choice considering this outcome. The admixture of O_2/air instead of NO_2/O_2 is the better environmental choice. The biggest hotspot of the GHG emissions is the N_2O release, followed by agent release and lastly the life cycle of the agent. When choosing for the O_2/air admixture, desflurane has the greatest impact followed by isoflurane and sevoflurane. The change in impact between isoflurane and sevoflurane when using the O_2/air mixture instead of NO_2/O_2 is attributable to the higher GWP for isoflurane and conversely the higher gas flow requirements for sevoflurane when using N_2O/O_2 (more N_2O is used). Considering the lifecycle of the agents, for desflurane the greatest hotspot is the agent manufacturing, followed by delivery of the drug to the patient (electricity required for volatilization) and N_2O	Authors conclusion The results reiterate previous published data, while providing the life cycle data on the anaesthetic drugs. Clinicians should consider the full environmental and human health impacts from anaesthetic use. Limitations study There is uncertainty regarding the synthesis of propofol and the volatile drugs and results should be carefully interpreted. It is not clear whether the manufacturing process of the disposables used for propofol administration is included in the analysis.

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
			were considered to be equivalent. <u>Inventory database:</u> EcoInvent <u>Allocation</u>: No <u>Normalization & Weighting</u>: No <u>Impacts reported</u>: Yes <u>Contribution analysis</u>: Yes <u>Scenario analysis</u>: Yes <u>Comparative analysis</u>: Yes <u>Sensitivity analysis</u>: No <u>Uncertainty analysis</u>: No <u>Variance analysis</u>: No	the drugs was unavailable in EcoInvent, proxies that best matched the production characteristics of the drug were used. <u>Characterization methods:</u> Sulbaeck et al. 2010, IPCC	Regarding the life cycle, desflurane has the biggest impact of 700 g CO_2e, followed by sevoflurane (430 g CO_2e), isoflurane (200 g CO_2e) and propofol (25 g CO_2e). <u>2. Waste</u> No results in this study. <u>3. Medicine residue in water</u> No results in this study. <u>4. Human toxicity</u> No results in this study. <u>5. Ozone Depletion</u> No results in this study.	manufacturing. Sevoflurane and isoflurane have more similar profiles, with the greatest hotspot being N_2O manufacturing, followed by agent manufacturing and packaging. GHG impacts of propofol are comparatively quite small and most of it is attributable to the drug delivery to the patient (energy needed to operate the syringe pump) and waste management.	
Thiel (2018)	American Journal of Public Health (AJPH) <u>Journal information</u> The American Journal of Public Health is a peer-reviewed public health journal published by the American Public Health Association that covers health policy and public health. The journals' stated mission is "to advance public health research, policy, practice, and education". <u>Critical review:</u> Peer reviewed, not a specific LCA journal.	<u>Type of study:</u> LCA <u>Objective:</u> To determine the carbon footprint of various sustainability interventions used for laparoscopic hysterectomy. <u>LCA-method:</u> Hybrid-LCA <u>Setting and country:</u> Hospital USA <u>Facility</u>: Magee-Womens Hospital of the University of Pittsburgh Medical Center (UPMC)	<u>Goal and scope</u>[1]: To examine the efficacy of interventions to reduce GHG emissions in the OR with the goal to improve the emission rate of the healthcare sector and thereby human health. <u>Functional unit(s)</u>[2]: One laparoscopic hysterectomy <u>System boundaries:</u> Cradle to grave, intraoperative period <u>Included stages:</u> Production, transport, energy use, pharmaceuticals, reuse, disposal	A hybrid LCA was conducted to examine the efficacy of sustainable interventions to reduce GHG emissions in the OR. Baseline emissions for laparoscopic hysterectomy were calculated from an average of 17 hysterectomies extracted from a previous study in the USA (Thiel, 2017). Further data was obtained from EIO-LCA and EcoInvent. Life cycle GHGs were calculated for interventions regarding anaesthetics (type of anaesthetic), surgical materials and energy. To model anaesthetic interventions, an average anaesthetic duration of 150 minutes was assumed. The	<u>1 Climate Change</u> The baseline case is an average of the combination of anaesthetic approaches used in each of the 17 laparoscopic hysterectomies. This resulted with anaesthesia in 562 kg CO_2e and without anaesthesia in 402 kg CO_2e. Using desflurane only, resulted in an emission of 762 kg CO_2e, desflurane with NO_2 in 757 kg CO_2e, sevoflurane with NO_2 in 416 kg CO_2e, sevoflurane only in 410 kg CO_2e and propofol only in 402 kg CO_2e. <u>2. Waste</u> No results in this study. <u>3. Medicine residue in water</u> No results in this study.	Volatile anaesthetics have a greater environmental impact compared to intravenous anaesthetics. The use of N_2O increases this impact and should be avoided if possible. If a volatile anaesthetic should be used, sevoflurane seems to be the most environmentally sound choice.	<u>Authors conclusion</u> Available interventions can be used with promising results to reduce the carbon footprint. <u>Limitations study</u> Uncertainty due to limited or lack of LCA data in healthcare. One location included in calculations, poor generalizability. More interventions possible than studied.

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
		Years of data collection: 2016 Surgical discipline(s): Obstetrics & Gynaecology, Anaesthesiology Funding and conflict of interest: None stated.	Stated excluded components: Infrastructure including machines and building; chemical manufacturing and cleaning of products; hot water use Inventory database: EcoInvent, USLCI Allocation: Impacts of resuable materials and equipment were apportioned based on estimated lifespan/number of uses. Normalization & Weighting: No Impacts reported: Yes Contribution analysis: Yes Scenario analysis: Yes Comparative analysis: Yes Sensitivity analysis*:* No Uncertainty analysis: No Variance analysis: No	outcome measure was climate change. Characterization methods: TRACI	4. Human toxicity No results in this study. 5. Ozone Depletion No results in this study.		
McGain (2021)	Anesthesiology Journal information ANESTHESIOLOGY is the official journal of the American Society of Anesthesiologists. Their mission is promoting scientific discovery and knowledge in perioperative, critical care and pain medicine to advance patient care.	Type of study: LCA Objective: To examine the carbon dioxide equivalent emissions associated with general anaesthesia, spinal anaesthesia and combined (general and spinal) anaesthesia during total knee replacement. LCA-method:	Goal and scope[1]: To aim to quantify the carbon dioxide equivalent emissions of general and spinal and combined anaesthesia to reduce GHG production and reduce the threat of climate change in healthcare. Functional unit(s)[2]: All anaesthesia for a total knee replacement.	An LCA was conducted to examine the carbon dioxide equivalent emissions associated with general anaesthesia (propofol and sevoflurane), spinal anaesthesia and combined (general and spinal) anaesthesia during total knee replacement. The functional unit was all anaesthesia for a total knee replacement. Anaesthesia data were obtained from 30 patients	1. Climate Change Three hours of propofol at 700 mg/h will result in less than 50 g CO_2e. The average/mean duration of spinal and combined anaesthesia were approximately 40 and 30 minutes more than general. This leads to increased energy use (0.8 and 0.6 kg CO_2e) and oxygen use (0.6 kg CO_2e). Spinal anaesthetic	The study shows total intravenous anaesthesia has the lowest environmental impact compared to general anaesthesia with sevoflurane, spinal anaesthesia and the two combined. The latter are comparable. Great contributors are the agent itself, single-use products and energy-use. International comparisons show reusables are a good alternative for single-use products when using a	Authors conclusion Carbon footprints for knee replacement anaesthesia (general, spinal, combined) were similar, with significant overlap between the CIs. Limitations study Small study with 30 samples, however possibly not more needed. One centre, difficult to generalize results. Lack of other anaesthetics (e.g. desflurane,

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
	Critical review: Peer reviewed, not a specific LCA journal.	Attributional LCA Setting and country: Hospital Australia Facility: Williamstown Hospital, Western Health, Melbourne, Australia Years of data collection: 2019 Surgical discipline(s): Anaesthesia Funding and conflict of interest: In-kind support (no cash funding) was provided solely from Western Health Anaesthesia Department sources (Melbourne, Australia). The authors declare no conflict of interest.	System boundaries: Cradle to grave Included stages: Raw material extraction, production, transport, drug usage phase, disposal Stated excluded components: HVAC and surgical equipment data. Inventory database: EcoInvent, the Australian Life Cycle Inventory Allocation: No Normalization & Weighting: No Impacts reported: Yes Contribution analysis: Yes Scenario analysis: No Comparative analysis: Yes Sensitivity analysis: Yes Uncertainty analysis: Yes, Monte Carlo analysis Variance analysis: No	undergoing total knee replacement in an Australian hospital. Data from literature and databases such as EcoInvent and Australian Life Cycle Inventory were used. The outcome measures were climate change and waste. Characterization methods: -	of shorter duration will result in a decrease of 1.4 kg CO_2e. The total emissions of general anaesthesia were 14.9 kg CO_2e (95% CI, 9.7 to 22.5); spinal anaesthesia 16.9 kg CO_2e (95% CI, 13.2 to 20.5); and combination anaesthesia 18.5 kg CO_2e (95% CI, 12.5 to 27.3). The average anaesthesia duration times were: general 161 (113 to 193) min, spinal 200 (168 to 288) min, combination 189 (128 to 241) min. Electricity for the patient air warmer was responsible for at least 2.46 kg CO_2e for all approaches. Total single-use plastics, glass and so forth were responsible for 3.5 (general), 3.4 (spinal) and 4.3 (combination) CO_2e. The majority was from single-use plastics. Pharmaceuticals beyond gases were responsible for 1.2 to 1.3 CO_2e (7 to 8%). For general anaesthesia, sevoflurane was responsible for an average of 4.7 kg CO_2e (32%), range 2.7 to 8.6 kg CO_2e. The patient who received propofol represented the minimum	renewable energy sources (e.g. nuclear/wind/solar energy).	intravenous anaesthesia separately).

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					of 8.4 kg CO_2e in the general anaesthesia group. In the combination group sevoflurane contributed for 3.1 kg CO_2e (17%), range 0.6 to 10 kg CO_2e. Fro spinal and combination anesthesia, washing an sterilizing reusable gowns, plastic spinal trays and so forth contributed for 4.5 kg and 4.0 kgCO_2e, respectively. Oxygen use was important for spinal, resulting in 2.8 kg CO_2e (16%) with flow rates from 6 to 10 l/min (compared to 0.5 to 3.1 l/min for general and combination). International comparisons were made by changing energy sources. Australia and China are more coal reliant, where the European Union (and UK) are more dependent on nuclear and hydro/wind/solar sources. This modelling changed the CO_2e for washing and sterilizing reusable equipment and electricity for patient warming. In the EU spinal anaesthesia has a carbon footprint of approximately 60% (9.9/16.9 CO_2e) of that in Australia. The general anaesthesia in Australia		

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					(total intravenous) is less than the EU average (8.4 kg vs. 11.9 kg CO_2e). The minimum for spinal anaesthesia in Australia is higher than the EU average (14.7 vs 9.9 kg CO_2e), due to high carbon intensity electricity required to clean reusable anaesthesia equipment. <u>2. Waste</u> The total masses of single-use equipment were: general anaesthesia (mean 996 g; interquartile range 873 to 1,033 g; range 725 to 1,392 g), spinal anaesthesia (mean 997 g; interquartile range 934 to 1,076 g; range 885 to 1,184 g) and combination anaesthesia (mean 1,237g; interquartile range 1,100 to 1,285 g; range 1,009 to 1,678 g). The majority of the waste was from total plastics: average for general anaesthesia 783/996 g (78%); spinal 729/997 g (73%); and combination 932/1,237 (75%). Glass was the next most discarded material. <u>3. Medicine residue in water</u> No results in this study. <u>4. Human toxicity</u> No results in this study.		

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					5. Ozone Depletion No results in this study.		
Hu (2021)	Resources, conservation & recycling Journal information Contributions from research, which consider sustainable management and conservation of resources. The journal emphasizes the transformation processes involved in a transition toward more sustainable production and consumption systems. Emphasis is upon technological, economic, institutional and policy aspects of specific resource management practices. Critical review: Peer reviewed article, LCA mentioned in scope of journal.	Type of study: LCA Objective: To estimate the carbon footprint of sevoflurane, isoflurane, desflurane and intravenous propofol and to provide evidence of the potential impact of Vapour Capture Technology. LCA-method: Attributional LCA Setting and country: UK Facility: - Years of data collection: 2018 Surgical discipline(s): Anaesthesia Funding and conflict of interest: HX, TT and MK were funded from the Innovate UK to the University of Exeter and SageTech Medical Equipment Ltd. The study was conducted independently and	Goal and scope[1]: The carbon footprint of general anaesthetics at the national level is presented to inform policy. Functional unit(s)[2]: 1 minimum alveolar concentration hour (MAC-h), or MAC-h equivalent for propofol. System boundaries: Cradle to grave Included stages: Raw material extraction, manufacturing, packaging, use, waste gases Stated excluded components: Transport, energy consumptions of using general anaesthetics in the OR, disposables from inhalational anaesthetic gases (IAG) use (assumed to be equal). Waste from propofol use. Inventory database: EcoInvent	A life cycle inventory was conducted to calculate the carbon footprint of general anaesthetics. Thereby the potential impact of Vapour Capture Technology was provided. The functional unit for the general anaesthetics in the LCI analysis was 1 minimum alveolar concentration hour (MAC-h), or MAC-h equivalent for propofol. Values of 2.2%, 1.2% and 6.7% respectively for sevoflurane, isoflurane and desflurane were used as basis of the modelling. Raw material extraction, manufacturing, packaging, transport, use and disposal were included in the analysis. Ecoinvent was used as an inventory database. Since information on synthesizing general anaesthesic agents was not publicly available, two methods were modelled for the manufacturing process of the drugs. Method 'A': relatively older processes and method 'B': newer processes in manufacturing. Synthesis	1. Climate Change The results on climate change are graphically shown in figure 2-4 (Hu, 2021). Three different scenarios are studied: 1. Fresh gas flow of 1L (UK) or 2L (US)/min, % gas flow O_2/N_2O = 40/60 2. Fresh gas flow of 1L (UK) or 2L (US)/min, % gas flow O_2/N_2O = 100/0 3. Fresh gas flow of 0.5L/min, % gas flow O_2/N_2O = 100/0 Desflurane has the highest carbon footprint in all scenarios, however sevoflurane is close in scenario 1. Propofol has the lowest carbon footprint, half of this is due to energy used to manufacturing the syringes. Scenario 2 (eliminating NO_2) leads to lower carbon footprints for isoflurane and sevoflurane compared to scenario 1, however desflurane increases due to the high GWP. In scenario 3 the carbon footprint is lowest for all IAGs. The manufacturing process with	Propofol use results in a low carbon footprint. It can be reduced by using renewable energy in the manufacturing process. Influence from propofol drug waste (e.g. urine excretion in sewerage water) has not been studied. Desflurane has the highest GWP and leads to a high carbon footprint compared to isoflurane and sevoflurane. Using low fresh gas flow rates, avoid using tetrafluoroethylene as raw material to synthesize IAGs and to avoid using NO_2 for isoflurane and sevoflurane leads to a lower carbon footprint. Sevoflurane has a lower carbon footprint compared to isoflurane when using method-B for the manufacturing process (avoid using tetrafluoroethylene) and using low fresh gas flow rates (0.5 or 1 L/min).	Authors conclusion Both isoflurane and sevoflurane have a smaller life-cycle carbon footprint compared to desflurane in all scenarios. It is optimal to use a low fresh gas flow rate, avoid using tetrafluoroethylene as raw material to synthesize IAGs and to avoid using NO_2 when using isoflurane or sevoflurane. VCT reduces carbon footprint of IAGs. Limitations study Not all inventory data was available, so assumptions has been made and data should be interpreted with caution.

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
		without the intervention of SageTech Medical Equipment Ltd.	 Allocation: No Normalization & Weighting: No Impacts reported: Yes Contribution analysis: Yes Scenario analysis: Yes Comparative analysis: Yes Sensitivity analysis: No Uncertainty analysis: No Variance analysis: No	of propofol liquid was included. Transportation was assumed to be similar, and therefore excluded from the analysis, as was energy consumption for using general anaesthetics in the OR, the use of disposables and propofol end of life waste. For the Vapour Capture Technology effect, it was assumed that IAG can only be recycled once. Two stages were employed: 1) IAG is used for 1 MAC-h, 70% is recycled and 2) recycled drug with manufactured drug is used for another MAC-h. Results are shown for US and UK scenarios; general scenario where NO_2 is used as a carrier gas and two scenarios were it is not used. The outcome measure was climate change. Characterization methods: -	method-B (lower impact) has a lower carbon footprint compared to method-A (higher impact) for all three anaesthetic gases. Reduction of the carbon footprint for the production of sevoflurane can be achieved by avoiding the use of tetrafluoroethylene (84% reduction). For isoflurane and desflurane these differences are smaller. For sevoflurane and isoflurane scenario 3, with method-B results in the lowest carbon footprint. Using method-A in all scenarios leads to a higher carbon footprint for sevoflurane compared to isoflurane, which is attributable to the manufacturing process. The US method (fresh gas flow of 2L/min), leads to a higher impact for sevoflurane compared to isoflurane. When changing this to 1L/min or 0.5L/min, combined with method-B, the carbon footprint of sevoflurane is lower than that of isoflurane. Using Vapour Capture Technology (VCT) results in lower carbon footprints for all anaesthetic gases. When using a fresh gas flow rate of		

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
					0.5L/min, with method-B as the manufacturing process, the carbon footprint is comparable to that of propofol. However, when the manufacturer of propofol uses renewable energy the carbon footprint can be cut by half. Overall, the biggest hotspot for desflurane and isoflurane is the waste IAG, for sevoflurane the manufacturing process and for propofol drug administration. 2. Waste No results in this study. 3. Medicine residue in water No results in this study. 4. Human toxicity No results in this study. 5. Ozone Depletion No results in this study.		

[1]Goals and scope: 'Phase of life cycle assessment in which the aim of the study, and in relation to that, the breadth and depth of the study is established'
[2]Functional unit: Quantified description of the function of a product or process that serves as the reference basis for all calculations regarding impact assessment.

Appendix 2. Critical appraisal of LCAs (based on Drew, 2021)

Drew (2021) developed a critical appraisal *pro forma*, based on Weidema's guidelines for critical review of LCA (Weidema, 1997). This scoring system consists of 16 appraisal criteria, which are divided between the different phases of an LCA. It addresses a range of study quality indicators, such as internal validity, external validity, consistency, transparency, and bias. The percentage score provides an indication of the overall study quality. A higher score indicates a higher overall study quality. The points that can be obtained are displayed in the column labeled "appraisal criteria".

Appraisal criteria	**Indicator(s)**	**Key effect modifiers**	**Sherman (2012)**	**Thiel (2018)**	**Hu (2021)**	**McGain (2021)**
Phase 1: Goal & Scope (13 points)						
Study goal is clearly stated, including the study's rationale (1), intended application (1), and intended audience (1)	Transparency		3	3	3	3
Lifecycle assessment method is clearly stated (1)	Transparency	Process-based life-cycle assessment, which is well suited to product-level analysis, may underestimate environmental impacts (i.e. from truncation error); economic input-output lifecycle assessment (EIO-LCA), which uses aggregate data and is well-suited to sector-level analysis, may overestimate environmental impacts	0	1	1	1
Functional unit is clearly defined and measurable (1), justified (1), and consistent with the study's intended application (1)	Consistency		3	3	3	2
The system to be studied is adequately described with clearly stated system boundaries (1), lifecycle stages (1), and appropriate justification of any omitted stages (1)	Transparency; Bias	Assessments with narrow system boundaries that exclude a number of lifecycle stages are prone to underestimating life-cycle environmental impacts	3	2	3	3
The system covers production (1), use/reuse (1) and disposal (1) of materials and energy (half mark if only for energy and vice versa)	Internal Validity, Completeness		3	3	2	3
Phase 2: Inventory analysis (7 points)						
The data collection process is clearly explained, including the source(s) of foreground material weights and energy values (1); the source(s) of reference data (e.g. inventory database; 1); and what data are included (e.g. production and disposal of unit processes; 1)	Transparency, Internal Validity		3	3	3	3
Representativeness of the data is discussed (1), differences in electricity generating mix are accounted for (1), and the potential significance of exclusions or assumptions is addressed (1)	Internal validity; External validity		2	2	2	3
Allocation procedures, where necessary, are described and appropriately justified (1; mark given if no allocation used)	Transparency; Bias		1	1	1	1
Phase 3: Impact assessment (6 points)						
Impact categories (1), characterization method (1), and software used (1) are documented transparently	Transparency		3	2	3	2
Results are clearly reported in the context of the functional unit (1) (0.5 if graphically, 0 if only normalized results reported)	Consistency; Transparency		1	1	0.5	1

A contribution analysis is performed and clearly reported (1), and hotspots are identified (1)			2	2	2	2
Phase 4: Interpretation (9 points)						
Conclusions are consistent with the goal and scope (1) and supported by the impact assessment results (1)	Internal validity; Consistency		2	2	2	2
Results are contextualized through the use of sensitivity analysis (1) and uncertainty analysis (1)	Internal validity		0	0	1	2
Limitations are adequately discussed (1), and the potential impact of omissions or assumptions on the study's outcomes are described (1)	Bias		1	1	1	1
The assessment has been critically appraised (i.e. peer review if journal article or independent, external critical review if report/thesis; 1)	Bias		1	1	1	1
Source(s) of funding and any potential conflict(s) of interest are disclosed (1), and are unlikely to be a source of bias (1)	Bias		1	0	1	1
		Total (/35)	29	27	29.5	31
		Percentage score	**83%**	**77%**	**84%**	**89%**

Literature search strategy

Zoekverantwoording

Algemene informatie

<table>
<tr><td colspan="2">Richtlijn: Duurzaamheid</td></tr>
<tr><td colspan="2">Uitgangsvraag: UV4 -
1) Wat is het effect op duurzaamheid van inhalatie-anesthetica in vergelijking met het gebruik van intraveneuze anesthesie?
2) Wat is het effect op duurzaamheid van inhalatie-anesthetica met het gebruik van een dampopvanger in vergelijking met het gebruik van inhalatie-anesthetica zonder een dampopvanger?
3) Wat is het effect op duurzaamheid van (loco)regionale en lokale anesthesie versus algehele anesthesie?</td></tr>
<tr><td>Database(s): Medline (PubMed), Embase (OVID), Web of Science, Cochrane Library, Emcare (OVID)</td><td>Datum: 22-2-2022</td></tr>
<tr><td>Periode: 2000-..</td><td>Talen: nvt</td></tr>
<tr><td colspan="2">Literatuurspecialist: Jan W. Schoones</td></tr>
<tr><td colspan="2">BMI zoekblokken: voor verschillende opdrachten wordt (deels) gebruik gemaakt van de zoekblokken van BMI-Online https://blocks.bmi-online.nl/ Bij gebruikmaking van een volledig zoekblok zal naar de betreffende link op de website worden verwezen.</td></tr>
<tr><td colspan="2">In de databases Medline (PubMed), Embase (OVID), Web of Science, Cochrane Library, en Emcare (OVID) is op 22-2-2022 met relevante zoektermen gezocht naar systematische reviews, RCTs, observationele studies, ander vergelijkend onderzoek (bijv. case control, cohort-onderzoek), en life cycle assessments (LCA's) over UV4:
1) Wat is het effect op duurzaamheid van inhalatie-anesthetica in vergelijking met het gebruik van intraveneuze anesthesie?
2) Wat is het effect op duurzaamheid van inhalatie-anesthetica met het gebruik van een dampopvanger in vergelijking met het gebruik van inhalatie-anesthetica zonder een dampopvanger?
3) Wat is het effect op duurzaamheid van (loco)regionale en lokale anesthesie versus algehele anesthesie?</td></tr>
</table>

Zoekopbrengst

	MEDLINE (PubMed)	Embase (OVID)	Web of Science	Cochrane Library	Emcare (OVID)	Ontdubbeld
UV4.1	409	183	64	65	97	614
UV4.2	45	47	23	11	25	31
UV4.3	44	121	27	41	68	153
UV4.1-3	498	351	114	117	190	798

Zoekstrategie

MEDLINE (PubMed)

UV4.1

(((("Anesthetics, Inhalation"[Mesh] OR "Anesthetics, Inhalation"[pharmacological action] OR "Anesthesia, Inhalation"[Mesh] OR "Closed-Circuit Anesthesia"[tw] OR "Endotracheal Anesthesia"[tw] OR "Closed-Circuit Anaesthesia"[tw] OR "Endotracheal Anaesthesia"[tw] OR "Halothane"[mesh] OR "Isoflurane"[mesh] OR "Methoxyflurane"[mesh] OR "Sevoflurane"[mesh] OR "Anaesthetic gas"[tw] OR "Anaesthetic gases"[tw] OR "Anesthetic gas"[tw] OR "Anesthetic gases"[tw] OR "Desflurane"[tw] OR "Enflurane"[tw] OR "Flurane"[tw] OR "Fluranes"[tw] OR "Gaseous anaesthesia"[tw] OR "Gaseous anaesthetic"[tw] OR "Gaseous anaesthetics"[tw] OR "Gaseous anesthesia"[tw] OR "Gaseous anesthetic"[tw] OR "Gaseous anesthetics"[tw] OR "Halothane"[tw] OR "Inhalation anaesthesia"[tw] OR "inhalation anaesthetic"[tw] OR "inhalation anaesthetics"[tw] OR "Inhalation anesthesia"[tw] OR "inhalation anesthetic"[tw] OR "inhalation anesthetics"[tw] OR "Inhalational agents"[tw] OR "Inhalational anaesthesia"[tw] OR "Inhalational 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inventories"[tw])))

UV4.2

(("Anesthesia, Inhalation"[Mesh] OR "Anesthetics, Inhalation"[Mesh] OR "Anesthetics, Inhalation"[pharmacological action] OR "Closed-Circuit Anesthesia"[tw] OR "Endotracheal Anesthesia"[tw] OR "Closed-Circuit Anaesthesia"[tw] OR "Endotracheal Anaesthesia"[tw] OR "Halothane"[mesh] OR "Isoflurane"[mesh] OR "Methoxyflurane"[mesh] OR "Sevoflurane"[mesh] OR "Anaesthetic gas"[tw] OR "Anaesthetic gases"[tw] OR "Anesthetic gas"[tw] OR "Anesthetic gases"[tw] OR "Desflurane"[tw] OR "Enflurane"[tw] OR "Flurane"[tw] OR "Fluranes"[tw] OR "Gaseous anaesthesia"[tw] OR "Gaseous anaesthetic"[tw] OR "Gaseous anaesthetics"[tw] OR "Gaseous anesthesia"[tw] OR "Gaseous anesthetic"[tw] OR "Gaseous anesthetics"[tw] OR "Halothane"[tw] OR "Inhalation anaesthesia"[tw] OR "inhalation anaesthetic"[tw] OR "inhalation anaesthetics"[tw] OR "Inhalation anesthesia"[tw] OR "inhalation anesthetic"[tw] OR "inhalation anesthetics"[tw] OR "Inhalational agents"[tw] OR "Inhalational anaesthesia"[tw] OR "Inhalational anaesthetic"[tw] OR "Inhalational anaesthetic agent"[tw] OR "Inhalational anaesthetic agents"[tw] OR "Inhalational anaesthetics"[tw] OR "Inhalational anesthesia"[tw] OR "Inhalational anesthetic"[tw] OR "Inhalational anesthetic agent"[tw] OR "Inhalational anesthetic agents"[tw] OR "Inhalational anesthetics"[tw] OR "Inhaled anaesthetic"[tw] OR "Inhaled anaesthetic agent"[tw] OR "Inhaled anaesthetic agents"[tw] OR "Inhaled anaesthetics"[tw] OR "Inhaled anesthetic"[tw] OR "Inhaled anesthetic agents"[tw] OR "Inhaled anesthetics"[tw] OR "insufflation anaesthesia"[tw] OR "insufflation anaesthetic"[tw] OR "insufflation anaesthetics"[tw] OR "insufflation anesthesia"[tw] OR "insufflation anesthetic"[tw] OR "insufflation anesthetics"[tw] OR "Isoflurane"[tw] OR "Methoxyflurane"[tw] OR "Sevoflurane"[tw] OR "Vapor anaesthesia"[tw] OR "Vapor anaesthetic"[tw] OR "Vapor anaesthetics"[tw] OR "Vapor anesthesia"[tw] OR "Vapor anesthetic"[tw] OR "Vapor anesthetics"[tw] OR "Volatile agent"[tw] OR "Volatile 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"vapour captur*"[tw] OR "vapour capture"[tw] OR "Vapour Capture Technology"[tw] OR "vapour recycl*"[tw] OR "vapour recycling technology"[tw] OR "vapour recycling"[tw]) AND ("Acidification potential"[tw] OR "acidification"[tw] OR "air pollution control"[tw] OR "AP in kg SO2 equivalents"[tw] OR "Biodiversity"[Mesh] OR "Biodiversity"[tw] OR "Carbon Footprint"[mesh] OR "carbon footprint"[tw] OR "carbon footprint*"[tw] OR "CFC-11 equi"[tw] OR "Climate Change"[Mesh] OR "climate change"[tw] OR "Climatic change"[tw] OR "CO2 emission"[tw] OR "CO2 emissions"[tw] OR "CO2 equiva*"[tw] OR "CO2 footprint"[tw] OR "CO2 footprint*"[tw] OR "conservation of natural resources"[mesh] OR "conservation of natural resources"[tw] OR "Disposable Equipment"[Mesh] OR "Disposable"[tw] OR "Disposables"[tw] OR "eco toxic*"[tw] OR "eco toxicity"[tw] OR "ecoefficien*"[tw] OR "eco-efficien*"[tw] OR "ecoefficiency"[tw] OR "eco-efficiency"[tw] OR "ecological footprint"[tw] OR "ecological footprint*"[tw] OR "ecological 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OR "Greenhouse Gases"[mesh] OR "Greenhouse Gases"[tw] OR "greening"[tw] OR "GWP in kg CO2 equivalents"[tw] OR "H+ moles equivalents"[tw] OR "hospital waste"[tw] OR "HTTP in kg Dichlorobenzene equivalent"[tw] OR "Human Toxicity Potential"[tw] OR "kg 2.4-D equivalents"[tw] OR "kg CFC-11 equivalent"[tw] OR "kg N equivalents"[tw] OR "kg NOx equivalents"[tw] OR "LCA"[tw] OR "LCAs"[tw] OR "life cycle analysis"[tw] OR "life cycle assess*"[tw] OR "life cycle assessment"[tw] OR "life cycle inventories"[tw] OR "life cycle inventory"[tw] OR "Medical Waste Disposal"[mesh] OR "Medical Waste"[mesh] OR "medical waste"[tw] OR "N equiv*"[tw] OR "Ozone Depletion"[Mesh] OR "ozone depletion"[tw] OR "Photochemical Ozone Depletion Potential"[tw] OR "Plastic overuse"[tw] OR "POCP in kg ethane equivalent"[tw] OR "preservation of natural resources"[tw] OR "recycle*"[tw] OR "Recycling"[mesh] OR "recycling"[tw] OR "Refuse Disposal"[Mesh] OR "Refuse Disposal"[tw] OR "reusable"[tw] OR "Reusables"[tw] OR "reuse"[tw] OR "reused"[tw] OR "reusing"[tw] OR "Rising Sea Level"[tw] OR "Rising Sea Levels"[tw] OR "Sea Level Rise"[mesh] OR "Sea Level Rise"[tw] OR "Smog"[mesh] OR "smog"[tw] OR "SO2 equiv*"[tw] OR "sustainability"[ti] OR "Sustainable Development"[Mesh] OR "Sustainable Development"[tw] OR "Waste Disposal"[tw] OR "Waste Disposal, Fluid"[mesh] OR "Waste Management"[mesh] OR "Waste"[tw] OR "waste"[tw] OR "Waste Water"[Mesh] OR "Waste Water"[tw] OR "wastes"[tw] OR "Wastewater"[tw] OR "Water Purification"[Mesh] OR "Water Purification"[tw] OR (("plastic*"[tw] OR "microplastic*") AND ("soup"[tw] OR "pollution"[tw] OR "overuse"[tw] OR "contamination"[tw])) OR (("Plastic"[tw] OR "plastics"[tw]) AND "overuse"[tw]) OR ("hydrogen*"[tw] AND "moles"[tw] AND "equiv*"[tw]) OR ("Dichlorobenzen*"[tw] AND "equiv*"[tw]) OR ("2,4-D"[tw] AND "equiv*"[tw]) OR ("NOx"[tw] AND "equiv*"[tw]) OR ("ethane"[tw] AND "equiv*"[tw]) OR ("PO4"[tw] AND "equiv*"[tw]) OR ("DCB"[tw] AND "equiv*"[tw]) OR ("sustainability"[tw] AND ("environment*"[tw] OR "carbon"[tw])) OR (("Carbon Dioxide"[mesh] OR "Carbon Dioxide"[tw] OR "CO2"[tw]) AND ("pollution"[tw] OR "emission"[tw] OR "emissions"[tw] OR "waste"[tw] OR "environment"[tw] OR "environmental*"[tw] OR "footprint"[tw] OR "footprint*"[tw] OR "sustainable"[tw] OR "hazard"[tw] OR "hazard*"[tw]))) AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])) AND (("Meta-Analysis"[Publication Type] OR "Meta-Analysis as Topic"[Mesh] OR metaanaly*[tiab] OR meta-analy*[tiab] or metanaly*[tiab] OR "Systematic Review"[Publication Type] OR systematic[sb] OR "Cochrane Database Syst Rev"[Journal] or prisma[tiab] OR preferred reporting items[tiab] OR prospero[tiab] OR ((systemati*[ti] OR scoping[ti] OR umbrella[ti] OR structured literature[ti]) AND (review*[ti] OR overview*[ti])) OR systematic review*[tiab] OR scoping review*[tiab] OR umbrella review*[tiab] OR structured literature review*[tiab] OR systematic qualitative review*[tiab] OR systematic quantitative review*[tiab] OR systematic search and review[tiab] OR systematized review[tiab] OR systematised review[tiab] OR systemic review[tiab] OR systematic literature review*[tiab] OR systematic integrative literature review*[tiab] OR systematically review*[tiab] OR scoping literature review*[tiab] OR systematic critical review[tiab] OR systematic integrative review*[tiab] OR systematic evidence review[tiab] OR Systematic integrative literature review*[tiab] OR Systematic mixed studies review*[tiab] OR Systematized literature review*[tiab] OR Systematic overview*[tiab] OR Systematic narrative review*[tiab] OR ((systemati*[tiab] OR literature[tiab] OR database*[tiab] OR data-base*[tiab] OR structured[tiab] OR comprehensive*[tiab] OR systemic*[tiab]) AND search*[tiab]) OR (Literature[ti] AND review[ti] AND (database*[tiab] OR data-base*[tiab] OR search*[tiab])) OR ((data extraction[tiab] OR data source*[tiab]) AND study selection[tiab]) OR (search strategy[tiab] AND selection criteria[tiab]) OR (data source*[tiab] AND data synthesis[tiab]) OR medline[tiab] OR pubmed[tiab] OR embase[tiab] OR Cochrane[tiab] OR ((critical[ti] OR rapid[ti]) AND (review*[ti] OR overview*[ti] OR synthes*[ti])) OR (((critical*[tiab] OR rapid*[tiab]) AND (review*[tiab] OR overview*[tiab] OR synthes*[tiab]) AND (search*[tiab] OR database*[tiab] OR data-base*[tiab]))) OR metasynthes*[tiab] OR meta-synthes*[tiab]) OR ("Randomized Controlled Trial"[Publication Type] OR random*[tiab] OR pragmatic clinical trial*[tiab] OR practical clinical trial*[tiab] OR non-inferiority trial*[tiab] OR noninferiority trial*[tiab] OR superiority trial*[tiab] OR equivalence clinical trial*[tiab]) NOT (("Animals"[Mesh]) OR "Models, Animal"[Mesh] NOT humans[mh]) NOT (letter[pt] OR comment[pt] OR editorial[pt])) OR ("Comparative Study"[Publication Type] OR "comparison"[tiab] OR "comparative"[tiab] OR "compar*"[tiab] OR "Epidemiologic studies"[mesh:noexp] OR "case control studies"[mesh] OR "cohort studies"[mesh] OR "Controlled Before-After Studies"[mesh] OR "Case control"[tw] OR cohort*[tw] OR "Cohort analy*"[tw] OR "Follow up stud*"[tw] OR "observational stud*"[tw] OR Longitudinal[tw] OR Retrospective*[tw] OR prospective*[tw] OR consecutive*[tw] OR Cross sectional[tw] OR "Cross-sectional studies"[mesh] OR "historically controlled study"[mesh] OR "interrupted time series analysis"[mesh]) OR ("life cycle assess*"[tw] OR "life cycle assessment"[tw] OR "life cycle inventory"[tw] OR "LCA"[tw] OR "LCAs"[tw] OR "life cycle inventory"[tw] OR "life cycle inventories"[tw]))

UV4.3

(("Anesthesia, Local"[Mesh] OR "Local Anesthesia"[tw] OR "Local Anaesthesia"[tw] OR "Locoregional Anesthesia"[tw] OR "Locoregional Anaesthesia"[tw] OR "Local Anesthetics"[tw] OR "Local Anaesthetics"[tw] OR "Locoregional Anesthetics"[tw] OR "Locoregional Anaesthetics"[tw] OR "Local Anesthetic"[tw] OR "Local Anaesthetic"[tw] OR "Locoregional Anesthetic"[tw] OR "Locoregional Anaesthetic"[tw] OR "axillary block"[tw] OR "axillary block*"[tw] OR "Bier block"[tw] OR "Bier block*"[tw] OR "Bier's block"[tw] OR "Bier's block*"[tw] OR "brachial plexus block"[tw] OR "brachial plexus block*"[tw] OR "combined spinal epidural"[tw] OR "combined spinal epidural block"[tw] OR "combined spinal epidural block*"[tw] OR "epidural anaesthesia"[tw] OR "epidural anesthesia"[tw] OR "intravenous regional anesthaesia"[tw] OR "intravenous regional anesthesia"[tw] OR "ischiadic block"[tw] OR "ischiadic block*"[tw] OR "local infiltration"[tw] OR "lower extremity block"[tw] OR "lower extremity block*"[tw] OR "nerve block"[tw] OR "nerve block"[tw] OR "nerve block*"[tw] OR "nerve block*"[tw] OR "neuraxial anaesthesia"[tw] OR "neuraxial anesthesia"[tw] OR "neuraxial block"[tw] OR "neuraxial block*"[tw] OR "neuraxial technique"[tw] OR "neuraxial techniques"[tw] OR "peripheral nerve block"[tw] OR "peripheral nerve block*"[tw] OR "plexus block"[tw] OR "plexus block*"[tw] OR "plexus nerve block"[tw] OR "plexus nerve block*"[tw] OR "popliteal block"[tw] OR "popliteal block*"[tw] OR "regional anaesthesia"[tw] OR "regional anesthesia"[tw] OR "spinal anaesthesia"[tw] OR "spinal anaesthetic block"[tw] OR "spinal anaesthetic block*"[tw] OR "spinal anesthesia"[tw] OR "spinal anesthetic block"[tw] OR "spinal anesthetic block*"[tw] OR "supraclavicular block"[tw] OR "supraclavicular block*"[tw] OR "upper extremity block"[tw] OR "upper extremity block*"[tw]) AND ("Anesthesia, General"[Mesh] OR "general anesthesia"[tw] OR "general anaesthesia"[tw] OR "general anesthe*"[tw] OR "general anaesthe*"[tw] OR "Anesthesia, Inhalation"[Mesh] OR "Closed-Circuit Anesthesia"[tw] OR "Endotracheal Anesthesia"[tw] OR "Closed-Circuit Anaesthesia"[tw] OR "Endotracheal Anaesthesia"[tw] OR "Halothane"[mesh] OR "Isoflurane"[mesh] OR "Methoxyflurane"[mesh] OR "Sevoflurane"[mesh] OR "Anaesthetic gas"[tw] OR "Anaesthetic gases"[tw] OR "Anesthetic gas"[tw] OR "Anesthetic gases"[tw] OR "Desflurane"[tw] OR "Enflurane"[tw] OR "Flurane"[tw] OR "Fluranes"[tw] OR "Gaseous anaesthesia"[tw] OR "Gaseous anaesthetic"[tw] OR "Gaseous anaesthetics"[tw] OR "Gaseous anesthesia"[tw] OR "Gaseous anesthetic"[tw] OR "Gaseous anesthetics"[tw] OR "Halothane"[tw] OR "Inhalation anaesthesia"[tw] OR "inhalation anaesthetic"[tw] OR "inhalation anaesthetics"[tw] OR "Inhalation anesthesia"[tw] OR "inhalation anesthetic"[tw] OR "inhalation anesthetics"[tw] OR "Inhalational agents"[tw] OR "Inhalational anaesthesia"[tw] OR "Inhalational anaesthetic"[tw] OR "Inhalational anaesthetic agent"[tw] OR "Inhalational anaesthetic agents"[tw] OR 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OR "Volatile anesthetics"[tw] OR "Volatile drug"[tw] OR "Volatile drugs"[tw] OR "Volatile fluorinated liquid"[tw] OR "Volatile fluorinated liquids"[tw] OR "Volatile gas"[tw] OR "Volatile gases"[tw] OR "Volatile liquid agent"[tw] OR "Volatile liquid agents"[tw] OR "Anesthetics, Inhalation"[Mesh] OR "Anesthetic Gas"[tw] OR "Anesthetic Gases"[tw] OR "Inhalation Anaesthetic"[tw] OR "Inhalation Anaesthetics"[tw] OR "Inhalation Anesthetic"[tw] OR "Inhalation Anesthetics"[tw] OR "Anesthesia, Intravenous"[Mesh] OR "Anesthetics, Intravenous"[Mesh] OR "Anesthetics, Intravenous"[Pharmacological Action] OR "Intravenous Anesthetics"[tw] OR "Intravenous Anaesthetics"[tw] OR "Intravenous Anesthetic"[tw] OR "Intravenous Anaesthetic"[tw] OR "Intravenous Anesthesia"[tw] OR "Intravenous Anaesthesia"[tw] OR "Dissociative Anesthetics"[tw] OR "Dissociative Anaesthetics"[tw] OR "Dissociative Anesthetic"[tw] OR "Dissociative Anaesthetic"[tw] OR "Dissociative Anesthesia"[tw] OR "Dissociative Anaesthesia"[tw] OR "2-(3-methoxyphenyl)-2-(ethylamino)cyclohexanone"[Supplementary Concept] OR "2-Oxo-PCE"[Supplementary Concept] OR "Alfentanil"[mesh] OR "Chloralose"[mesh] OR "Diazepam"[mesh] OR "Etomidate"[mesh] OR "Fentanyl"[mesh] OR "Ketamine"[mesh] OR "Methohexital"[mesh] OR "Midazolam"[mesh] OR "Propanidid"[mesh] OR "Propofol"[mesh] OR "Sodium Oxybate"[mesh] OR "Sufentanil"[mesh] OR "Thiamylal"[mesh] OR "Thiopental"[mesh] OR "Tiletamine"[mesh] OR "Urethane"[mesh] OR "2-(3-methoxyphenyl)-2-(ethylamino)cyclohexanone"[tw] OR "2-Oxo-PCE"[tw] OR "Alfentanil"[tw] OR "Chloralose"[tw] OR "Diazepam"[tw] OR "Etomidate"[tw] OR "Fentanyl"[tw] OR "intravenous anaesthesia"[tw] OR "intravenous anaesthesias"[tw] OR "Intravenous anaesthetic"[tw] OR "Intravenous anaesthetic agent"[tw] OR "Intravenous anaesthetic agents"[tw] OR "Intravenous anaesthetic drug"[tw] OR "Intravenous anaesthetic drugs"[tw] OR "Intravenous anaesthetics"[tw] OR "intravenous anesthesia"[tw] OR "intravenous anesthesias"[tw] OR "intravenous 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change"[tw] OR "CO2 emission"[tw] OR "CO2 emissions"[tw] OR "CO2 equiva*"[tw] OR "CO2 footprint"[tw] OR "CO2 footprint*"[tw] OR "conservation of natural resources"[mesh] OR "conservation of natural resources"[tw] OR "Disposable Equipment"[Mesh] OR "Disposable"[tw] OR "Disposables"[tw] OR "eco toxic*"[tw] OR "eco toxicity"[tw] OR "ecoefficien*"[tw] OR "eco-efficien*"[tw] OR "ecoefficiency"[tw] OR "eco-efficiency"[tw] OR "ecological footprint"[tw] OR "ecological footprint*"[tw] OR "ecological sustainability"[tw] OR "ecotoxic*"[tw] OR "ecotoxicity"[tw] OR "Emission reduction strategy"[tw] OR "Emission reduction"[tw] OR "Environment"[Mesh:noexp] OR "environmental impact"[tw] OR "environmental impact*"[tw] OR "environmental impacts"[tw] OR "environmental pollut*"[tw] OR "Environmental Pollution"[Mesh] OR "environmental pollution"[tw] OR "environmental protection"[tw] OR "environmental sustainab*"[tw] OR "environmental sustainability"[tw] OR "Environmental*"[ti] OR "EP in kg PO4 equivalent"[tw] OR "Equipment reuse"[mesh] OR "Equipment reuse"[tw] OR "Eutrophication potential"[tw] OR "Eutrophication"[Mesh] OR "eutrophication"[tw] OR "FAETP in kg DCB equivalent"[tw] OR "Freshwater Aquatic Ecotoxicity Potential"[tw] OR "Global Warming"[mesh] OR "Global Warming"[tw] OR "Green deal"[tw] OR "Green surgery"[tw] OR "Greenhouse Effect"[mesh] OR "greenhouse effect*"[tw] OR "greenhouse effects"[tw] OR "greenhouse gas emission"[tw] OR "greenhouse gas emissions"[tw] OR "Greenhouse Gas"[tw] OR "Greenhouse Gases"[mesh] OR "Greenhouse Gases"[tw] OR "greening"[tw] OR "GWP in kg CO2 equivalents"[tw] OR "H+ moles equivalents"[tw] OR "hospital waste"[tw] OR "HTTP in kg Dichlorobenzene equivalent"[tw] OR "Human Toxicity Potential"[tw] OR "kg 2.4-D equivalents"[tw] OR "kg CFC-11 equivalent"[tw] OR "kg N equivalents"[tw] OR "kg NOx equivalents"[tw] OR "LCA"[tw] OR "LCAs"[tw] OR "life cycle analysis"[tw] OR "life cycle assess*"[tw] OR "life cycle assessment"[tw] OR "life cycle inventories"[tw] OR "life cycle inventory"[tw] OR "Medical Waste Disposal"[mesh] OR "Medical Waste"[mesh] OR "medical waste"[tw] OR "N equiv*"[tw] OR "Ozone Depletion"[Mesh] OR "ozone depletion"[tw] OR "Photochemical Ozone Depletion Potential"[tw] OR "Plastic overuse"[tw] OR "POCP in kg ethane equivalent"[tw] OR "preservation of natural resources"[tw] OR "recycle*"[tw] OR "Recycling"[mesh] OR "recycling"[tw] OR "Refuse Disposal"[Mesh] OR "Refuse Disposal"[tw] OR "reusable"[tw] OR "Reusables"[tw] OR "reuse"[tw] OR "reused"[tw] OR "reusing"[tw] OR "Rising Sea Level"[tw] OR "Rising Sea Levels"[tw] OR "Sea Level Rise"[mesh] OR "Sea Level Rise"[tw] OR "Smog"[mesh] OR "smog"[tw] OR "SO2 equiv*"[tw] OR "sustainability"[ti] OR "Sustainable Development"[Mesh] OR "Sustainable Development"[tw] OR "Waste Disposal"[tw] OR "Waste Disposal, Fluid"[mesh] OR "Waste Management"[mesh] OR "Waste"[tw] OR "waste"[tw] OR "Waste Water"[Mesh] OR "Waste Water"[tw] OR "wastes"[tw] OR "Wastewater"[tw] OR "Water Purification"[Mesh] OR "Water Purification"[tw] OR (("plastic*"[tw] OR "microplastic*") AND ("soup"[tw] OR "pollution"[tw] OR "overuse"[tw] OR "contamination"[tw])) OR (("Plastic"[tw] OR "plastics"[tw]) AND "overuse"[tw]) OR ("hydrogen*"[tw] AND "moles"[tw] AND "equiv*"[tw]) OR ("Dichlorobenzen*"[tw] AND "equiv*"[tw]) OR ("2,4-D"[tw] AND "equiv*"[tw]) OR ("NOx"[tw] AND "equiv*"[tw]) OR ("ethane"[tw] AND "equiv*"[tw]) OR ("PO4"[tw] AND "equiv*"[tw]) OR ("DCB"[tw] AND "equiv*"[tw]) OR ("sustainability"[tw] AND ("environment*"[tw] OR "carbon"[tw])) OR (("Carbon Dioxide"[mesh] OR "Carbon Dioxide"[tw] OR "CO2"[tw]) AND ("pollution"[tw] OR "emission"[tw] OR "emissions"[tw] OR "waste"[tw] OR "environment"[tw] OR "environmental*"[tw] OR "footprint"[tw] OR "footprint*"[tw] OR "sustainable"[tw] OR "hazard"[tw] OR "hazard*"[tw]))) AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])) AND ((*"Meta-Analysis"[Publication Type] OR "Meta-Analysis as Topic"[Mesh] OR metaanaly*[tiab] OR meta-analy*[tiab] or metanaly*[tiab] OR "Systematic Review"[Publication Type] OR systematic[sb] OR "Cochrane Database Syst Rev"[Journal] or prisma[tiab] OR preferred reporting items[tiab] OR prospero[tiab] OR ((systemati*[ti] OR scoping[ti] OR umbrella[ti] OR structured literature[ti]) AND (review*[ti] OR overview*[ti])) OR systematic review*[tiab] OR scoping review*[tiab] OR umbrella review*[tiab] OR structured literature review*[tiab] OR systematic qualitative review*[tiab] OR systematic quantitative review*[tiab] OR systematic search and review[tiab] OR systematized review[tiab] OR systematised review[tiab] OR systemic review[tiab] OR systematic literature review*[tiab] OR systematic integrative literature review*[tiab] OR systematically review*[tiab] OR scoping literature review*[tiab] OR systematic critical review[tiab] OR systematic integrative review*[tiab] OR systematic evidence review[tiab] OR Systematic integrative literature review*[tiab] OR Systematic mixed studies review*[tiab] OR Systematized literature review*[tiab] OR Systematic overview*[tiab] OR Systematic narrative review*[tiab] OR ((systemati*[tiab] OR literature[tiab] OR database*[tiab] OR data-base*[tiab] OR structured[tiab] OR comprehensive*[tiab] OR systemic*[tiab]) AND search*[tiab]) OR (Literature[ti] AND review[ti] AND (database*[tiab] OR data-base*[tiab] OR search*[tiab])) OR ((data extraction[tiab] OR data source*[tiab]) AND study selection[tiab]) OR (search strategy[tiab] AND selection criteria[tiab]) OR (data source*[tiab] AND data synthesis[tiab]) OR medline[tiab] OR pubmed[tiab] OR embase[tiab] OR Cochrane[tiab] OR ((critical[ti] OR rapid[ti]) AND (review*[ti] OR overview*[ti] OR synthes*[ti])) OR (((critical*[tiab] OR rapid*[tiab]) AND (review*[tiab] OR overview*[tiab] OR synthes*[tiab]) AND (search*[tiab] OR database*[tiab] OR data-base*[tiab]))) OR metasynthes*[tiab] OR meta-synthes*[tiab])* OR ("Randomized Controlled Trial"[Publication Type] OR random*[tiab] OR pragmatic clinical trial*[tiab] OR practical clinical trial*[tiab] OR non-inferiority trial*[tiab] OR noninferiority trial*[tiab] OR superiority trial*[tiab] OR equivalence clinical trial*[tiab]) NOT (("Animals"[Mesh]) OR "Models, Animal"[Mesh] NOT humans[mh]) NOT (letter[pt] OR comment[pt] OR editorial[pt]) OR ("Comparative Study"[Publication Type] OR "comparison"[tiab] OR "comparative"[tiab] OR "compar*"[tiab] OR "Epidemiologic studies"[mesh:noexp] OR "case control studies"[mesh] OR "cohort studies"[mesh] OR "Controlled Before-After Studies"[mesh] OR "Case control"[tw] OR cohort*[tw] OR "Cohort analy*"[tw] OR "Follow up stud*"[tw] OR "observational stud*"[tw] OR Longitudinal[tw] OR Retrospective*[tw] OR prospective*[tw] OR consecutive*[tw] OR Cross sectional[tw] OR "Cross-sectional studies"[mesh] OR "historically controlled study"[mesh] OR "interrupted time series analysis"[mesh]) OR ("life cycle assess*"[tw] OR "life cycle assessment"[tw] OR "life cycle inventory"[tw] OR "LCA"[tw] OR "LCAs"[tw] OR "life cycle inventory"[tw] OR "life cycle inventories"[tw]))

Embase (OVID)
UV4.1

((exp "inhalation anesthetic agent"/ OR exp "inhalation anesthesia"/ OR "Closed-Circuit Anesthesia".mp OR "Endotracheal Anesthesia".mp OR "Closed-Circuit Anaesthesia".mp OR "Endotracheal Anaesthesia".mp OR "Halothane"/ OR "Isoflurane"/ OR "Methoxyflurane"/ OR "Sevoflurane"/ OR "Anaesthetic gas".mp OR "Anaesthetic gases".mp OR "Anesthetic gas".mp OR "Anesthetic gases".mp OR "Desflurane".mp OR "Enflurane".mp OR "Flurane".mp OR "Fluranes".mp OR "Gaseous anaesthesia".mp OR "Gaseous anaesthetic".mp OR "Gaseous anaesthetics".mp OR "Gaseous anesthesia".mp OR "Gaseous anesthetic".mp OR "Gaseous anesthetics".mp OR "Halothane".mp OR "Inhalation anaesthesia".mp OR "inhalation anaesthetic".mp OR "inhalation anaesthetics".mp OR "Inhalation anesthesia".mp OR "inhalation anesthetic".mp OR "inhalation anesthetics".mp OR "Inhalational agents".mp OR "Inhalational anaesthesia".mp OR "Inhalational anaesthetic".mp OR "Inhalational anaesthetic agent".mp OR "Inhalational anaesthetic agents".mp OR "Inhalational anaesthetics".mp OR "Inhalational anesthesia".mp OR "Inhalational anesthetic".mp OR "Inhalational anesthetic agent".mp OR "Inhalational anesthetic agents".mp OR "Inhalational anesthetics".mp OR "Inhaled anaesthetic".mp OR "Inhaled anaesthetic agent".mp OR "Inhaled anaesthetic agents".mp OR "Inhaled anaesthetics".mp OR "Inhaled anesthetic".mp OR "Inhaled anesthetic agents".mp OR "Inhaled anesthetics".mp OR "insufflation anaesthesia".mp OR "insufflation anaesthetic".mp OR "insufflation anaesthetics".mp OR "insufflation anesthesia".mp OR "insufflation anesthetic".mp OR "insufflation anesthetics".mp OR "Isoflurane".mp OR "Methoxyflurane".mp OR "Sevoflurane".mp OR "Vapor anaesthesia".mp OR "Vapor anaesthetic".mp OR "Vapor anaesthetics".mp OR "Vapor anesthesia".mp OR "Vapor anesthetic".mp OR "Vapor anesthetics".mp OR "Volatile agent".mp OR "Volatile agents".mp OR "Volatile Anaesthetic".mp OR "Volatile Anaesthetics".mp OR "Volatile anesthetic".mp OR "Volatile anesthetics".mp OR "Volatile drug".mp OR "Volatile drugs".mp OR "Volatile fluorinated liquid".mp OR "Volatile fluorinated liquids".mp OR "Volatile gas".mp OR "Volatile gases".mp OR "Volatile liquid agent".mp OR "Volatile liquid agents".mp OR "Anesthetic Gas".mp OR "Anesthetic Gases".mp OR "Inhalation Anaesthetic".mp OR "Inhalation Anaesthetics".mp OR "Inhalation Anesthetic".mp OR "Inhalation Anesthetics".mp) AND (exp "intravenous anesthetic agent"/ OR exp "Intravenous Anesthesia"/ OR "Intravenous Anesthetics".mp OR "Intravenous Anaesthetics".mp OR "Intravenous Anesthetic".mp OR "Intravenous Anaesthetic".mp OR "Intravenous Anesthesia".mp OR "Intravenous Anaesthesia".mp OR "Dissociative Anesthetics".mp OR "Dissociative Anaesthetics".mp OR "Dissociative Anesthetic".mp OR "Dissociative Anaesthetic".mp OR "Dissociative Anesthesia".mp OR "Dissociative Anaesthesia".mp OR "2-(3-methoxyphenyl)-2-(ethylamino)cyclohexanone"/ OR "2-Oxo-PCE"/ OR "Alfentanil"/ OR "Chloralose"/ OR "Diazepam"/ OR "Etomidate"/ OR "Fentanyl"/ OR "Ketamine"/ OR "Methohexital"/ OR "Midazolam"/ OR "Propanidid"/ OR "Propofol"/ OR "Sodium Oxybate"/ OR "Sufentanil"/ OR "Thiamylal"/ OR "Thiopental"/ OR "Tiletamine"/ OR "Urethane"/ OR "2-(3-methoxyphenyl)-2-(ethylamino)cyclohexanone".mp OR "2-Oxo-PCE".mp OR "Alfentanil".mp OR "Chloralose".mp OR "Diazepam".mp OR "Etomidate".mp OR "Fentanyl".mp OR "intravenous anaesthesia".mp OR "intravenous anaesthesias".mp OR "Intravenous anaesthetic".mp OR "Intravenous anaesthetic agent".mp OR "Intravenous anaesthetic agents".mp OR "Intravenous anaesthetic drug".mp OR "Intravenous anaesthetic drugs".mp OR "Intravenous anaesthetics".mp OR "intravenous anesthesia".mp OR "intravenous anesthesias".mp OR "intravenous anesthetic".mp OR "Intravenous anesthetic agents".mp OR "Intravenous anesthetic agents".mp OR "Intravenous anesthetic drug".mp OR "Intravenous anesthetic drugs".mp OR "intravenous anesthetics".mp OR "IV anaesthesia".mp OR "IV anaesthetics".mp OR "IV anaesthetics".mp OR "IV anesthesia".mp OR "IV anesthetic".mp OR "IV anesthetics".mp OR "Ketamine".mp OR "Methohexital".mp OR "Midazolam".mp OR "Propanidid".mp OR "Propofol".mp OR "Sodium Oxybate".mp OR "Sufentanil".mp OR "Thiamylal".mp OR "Thiopental".mp OR "Tiletamine".mp OR "TIVA".mp OR "Total intravenous anaesthesia".mp OR "Total Intravenous anesthesia".mp OR "Urethane".mp)) AND ("Carbon Footprint"/ OR "carbon footprint".mp OR "carbon footprint*".mp OR exp "Climate Change"/ OR "climate change".mp OR "CO2 emission".mp OR "CO2 emissions".mp OR "CO2 footprint".mp OR "CO2 footprint*".mp OR exp "environmental protection"/ OR "conservation of natural resources".mp OR "environmental protection".mp OR "Disposable Equipment"/ OR "Disposables".mp OR "Disposable".mp OR "ecological footprint".mp OR "ecological footprint*".mp OR "ecological sustainability".mp OR exp "environmental impact"/ OR "environmental impact".mp OR "environmental impact*".mp OR "environmental impacts".mp OR "environmental pollut*".mp OR exp "pollution"/ OR "environmental pollution".mp OR "environmental sustainab*".mp OR "environmental sustainability"/ OR "environmental sustainability".mp OR "Global Warming"/ OR "Global Warming".mp OR "Greenhouse Effect"/ OR "greenhouse effect*".mp OR "greenhouse effects".mp OR "greenhouse gas emission".mp OR "greenhouse gas emissions".mp OR "Greenhouse Gas"/ OR "greening".mp OR "hospital waste".mp OR "life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp OR exp "Waste Disposal"/ OR exp "Hospital Waste"/ OR "medical waste".mp OR "Rising Sea Level".mp OR "Rising Sea Levels".mp OR "Sea Level Rise"/ OR "Sea Level Rise".mp OR "sustainability".ti OR "Waste Disposal".mp OR "waste water recycling"/ OR "Recycling"/ OR "recycling".mp OR "recycle*".mp OR "Equipment reuse".mp OR "Reusables".mp OR "reusable".mp OR "reuse".mp OR "reused".mp OR "reusing".mp OR exp "Waste Disposal"/ OR exp "Waste Management"/ OR "Plastic overuse".mp OR "Green surgery".mp OR "Emission reduction".mp OR "Emission reduction strategy".mp OR "air pollution control"/ OR "air pollution control".mp OR "Environment"/ OR "Environmental*".ti OR "acidification"/ OR "soil acidification"/ OR "ocean acidification"/ OR "acidification".mp OR "Acidification potential".mp OR "AP in kg SO2 equivalents".mp OR "eco-efficiency".mp OR "ecoefficiency".mp OR "eco-efficien*".mp OR "ecoefficien*".mp OR "ecotoxicity"/ OR "ecotoxicity".mp OR "ecotoxic*".mp OR "eco toxicity".mp OR "eco toxic*".mp OR "EP in kg PO4 equivalent".mp OR exp "Eutrophication"/ OR "eutrophication".mp OR "Eutrophication potential".mp OR "FAETP in kg DCB equivalent".mp OR "Freshwater Aquatic Ecotoxicity Potential".mp OR "GWP in kg CO2 equivalents".mp OR "H+ moles equivalents".mp OR "HTTP in kg Dichlorobenzene equivalent".mp OR "Human Toxicity Potential".mp OR "kg 2.4-D equivalents".mp OR "kg CFC-11 equivalent".mp OR "kg N equivalents".mp OR "kg NOx equivalents".mp OR "life cycle analysis".mp OR "ozone depletion".mp OR "Photochemical Ozone Depletion Potential".mp OR "POCP in kg ethane equivalent".mp OR "smog".mp OR exp "Waste"/ OR "waste".mp OR "wastes".mp OR "Ozone Depletion"/ OR "Smog"/ OR "Equipment reuse".mp OR "Greenhouse Gases".mp OR "Greenhouse Gas".mp OR "SO2 equiv*".mp OR "CO2 equiva*".mp OR "CFC-11 equiv*".mp OR "N equiv*".mp OR exp "Biodiversity"/ OR "Biodiversity".mp OR "Climatic change".mp OR "Green deal".mp OR "preservation of natural resources".mp OR "Refuse Disposal".mp OR exp "Wastewater"/ OR "Waste Water".mp OR "Wastewater".mp OR exp "Water Management"/ OR "Water Purification".mp OR (("plastic*".mp OR "microplastic*".mp) AND ("soup".mp OR "pollution".mp OR "overuse".mp OR "contamination".mp)) OR "Sustainable Development"/ OR "Sustainable Development".mp OR (("Plastic".mp OR "plastics".mp) AND "overuse".mp) OR ("hydrogen*".mp AND "moles".mp AND "equiv*".mp) OR ("Dichlorobenzen*".mp AND "equiv*".mp) OR ("2,4-D".mp AND "equiv*".mp) OR ("NOx".mp AND "equiv*".mp) OR ("ethane".mp AND "equiv*".mp) OR ("PO4".mp AND "equiv*".mp) OR ("DCB".mp AND "equiv*".mp) OR ("sustainability".mp AND ("environment*".mp OR "carbon".mp)) OR (("Carbon Dioxide"/ OR "Carbon Dioxide".mp OR "CO2".mp) AND ("pollution".mp OR "emission".mp OR "emissions".mp OR "waste".mp OR "environment".mp OR "environmental*".mp OR "footprint".mp OR "footprint*".mp OR "sustainable".mp OR "hazard".mp OR "hazard*".mp))) NOT (conference review or conference abstract).pt AND (2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022).yr AND (*(exp "meta analysis"/ OR exp "meta analysis (topic)"/ OR metaanaly*.ti,ab OR "meta analy*".ti,ab OR metanaly*.ti,ab OR "systematic review"/ OR "cochrane database of systematic reviews".jn OR prisma.ti,ab OR prospero.ti,ab OR (((systemati* OR scoping OR umbrella OR "structured literature") ADJ3 (review* OR overview*)).ti,ab) OR ((systemic* ADJ1 review*).ti,ab) OR (((systemati* OR literature OR database* OR "data base*") ADJ10 search*).ti,ab) OR (((structured OR comprehensive* OR systemic*) ADJ3 search*).ti,ab) OR (((literature ADJ3 review*).ti,ab) AND (search*.ti,ab OR database*.ti,ab OR "data base*".ti,ab)) OR (("data extraction".ti,ab OR "data source*".ti,ab) AND "study selection".ti,ab) OR ("search* *strategy".ti,ab AND "selection criteria".ti,ab) OR ("data source*".ti,ab AND "data synthesis".ti,ab) OR medline.ab OR pubmed.ab OR embase.ab OR cochrane.ab OR (((critical OR rapid) ADJ2 (review* OR overview* OR synthes*)).ti) OR ((((critical* OR rapid*) ADJ3 (review* OR overview* OR synthes*)).ab) AND (search*.ab OR database*.ab OR "data base*".ab)) OR metasynthes*.ti,ab OR "meta synthes*".ti,ab)* OR (exp "clinical trial"/ OR exp "randomization"/ OR exp "single blind procedure"/ OR exp "double blind procedure"/ OR exp "crossover procedure"/ OR exp "placebo"/ OR exp "prospective study"/ OR rct.ti,ab OR random*.ti,ab OR "single blind".ti,ab OR "randomised controlled trial".ti,ab OR exp "randomized controlled trial"/ OR placebo*.ti,ab) OR (exp "Comparative Study"/ OR "comparison".ti,ab OR "comparative".ti,ab OR "compar*".ti,ab OR "major clinical study"/ OR "clinical study"/ OR "case control study"/ OR "family study"/ OR "longitudinal study"/ OR "retrospective study"/ OR "prospective study"/ OR "cohort analysis"/ OR cohort*.ti,ab OR (("case control" ADJ1 (study OR studies)).ti,ab) OR (("follow up" ADJ1 (study OR studies)).ti,ab) OR (observational ADJ1 (study OR studies)).ti,ab OR ((epidemiologic ADJ1 (study OR studies)).ti,ab) OR (("cross sectional" ADJ1 (study OR studies)).ti,ab)) OR ("life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "life cycle inventory".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp))

UV4.2

((exp "inhalation anesthetic agent"/ OR exp "inhalation anesthesia"/ OR "Closed-Circuit Anesthesia".mp OR "Endotracheal Anesthesia".mp OR "Closed-Circuit Anaesthesia".mp OR "Endotracheal Anaesthesia".mp OR "Halothane"/ OR "Isoflurane"/ OR "Methoxyflurane"/ OR "Sevoflurane"/ OR "Anaesthetic gas".mp OR "Anaesthetic gases".mp OR "Anesthetic gas".mp OR "Anesthetic gases".mp OR "Desflurane".mp OR "Enflurane".mp OR "Flurane".mp OR "Fluranes".mp OR "Gaseous anaesthesia".mp OR "Gaseous anaesthetic".mp OR "Gaseous anaesthetics".mp OR "Gaseous anesthesia".mp OR "Gaseous anesthetic".mp OR "Gaseous anesthetics".mp OR "Halothane".mp OR "Inhalation anaesthesia".mp OR "inhalation anaesthetic".mp OR "inhalation anaesthetics".mp OR "Inhalation anesthesia".mp OR "inhalation anesthetic".mp OR "inhalation anesthetics".mp OR "Inhalational agents".mp OR "Inhalational anaesthesia".mp OR "Inhalational anaesthetic".mp OR "Inhalational anaesthetic agent".mp OR "Inhalational anaesthetic agents".mp OR "Inhalational anaesthetics".mp OR "Inhalational anesthesia".mp OR "Inhalational anesthetic".mp OR "Inhalational anesthetic agent".mp OR "Inhalational anesthetic agents".mp OR "Inhalational anesthetics".mp OR "Inhaled anaesthetic".mp OR "Inhaled anaesthetic agent".mp OR "Inhaled anaesthetic agents".mp OR "Inhaled anaesthetics".mp OR "Inhaled anesthetic".mp OR "Inhaled anesthetic agents".mp OR "Inhaled anesthetics".mp OR "insufflation anaesthesia".mp OR "insufflation anaesthetic".mp OR "insufflation anaesthetics".mp OR "insufflation anesthesia".mp OR "insufflation anesthetic".mp OR "insufflation anesthetics".mp OR "Isoflurane".mp OR "Methoxyflurane".mp OR "Sevoflurane".mp OR "Vapor anaesthesia".mp OR "Vapor anaesthetic".mp OR "Vapor anaesthetics".mp OR "Vapor anesthesia".mp OR "Vapor anesthetic".mp OR "Vapor anesthetics".mp OR "Volatile agent".mp OR "Volatile agents".mp OR "Volatile Anaesthetic".mp OR "Volatile Anaesthetics".mp OR "Volatile anesthetic".mp OR "Volatile anesthetics".mp OR "Volatile drug".mp OR "Volatile drugs".mp OR "Volatile fluorinated liquid".mp OR "Volatile fluorinated liquids".mp OR "Volatile gas".mp OR "Volatile gases".mp OR "Volatile liquid agent".mp OR "Volatile liquid agents".mp OR "Anesthetic Gas".mp OR "Anesthetic Gases".mp OR "Inhalation Anaesthetic".mp OR "Inhalation Anaesthetics".mp OR "Inhalation Anesthetic".mp OR "Inhalation Anesthetics".mp) AND ("scavenging system"/ OR "anaesthetic gas scavenging system".mp OR "anesthetic gas scavenging system".mp OR "Contrafluran".mp OR "gas extract*".mp OR "gas extraction".mp OR "gas extraction system".mp OR "gas extraction systems".mp OR "gas scaveng*".mp OR "gas scavenger".mp OR "gas scavengers".mp OR "gas scavenging ".mp OR "scavenging device".mp OR "scavenging device".mp OR "scavenging devices".mp OR "scavenging system".mp OR "scavenging systems".mp OR "vapour captur*".mp OR "vapour capture".mp OR "Vapour Capture Technology".mp OR "vapour recycl*".mp OR "vapour recycling technology".mp OR "vapour recycling".mp)) AND ("Carbon Footprint"/ OR "carbon footprint".mp OR "carbon footprint*".mp OR exp "Climate Change"/ OR "climate change".mp OR "CO2 emission".mp OR "CO2 emissions".mp OR "CO2 footprint".mp OR "CO2 footprint*".mp OR exp "environmental protection"/ OR "conservation of natural resources".mp OR "environmental protection".mp OR "Disposable Equipment"/ OR "Disposables".mp OR "Disposable".mp OR "ecological footprint".mp OR "ecological footprint*".mp OR "ecological sustainability".mp OR exp "environmental impact"/ OR "environmental impact".mp OR "environmental impact*".mp OR "environmental impacts".mp OR "environmental pollut*".mp OR exp "pollution"/ OR "environmental pollution".mp OR "environmental sustainab*".mp OR "environmental sustainability"/ OR "environmental sustainability".mp OR "Global Warming"/ OR "Global Warming".mp OR "Greenhouse Effect"/ OR "greenhouse effect*".mp OR "greenhouse effects".mp OR "greenhouse gas emission".mp OR "greenhouse gas emissions".mp OR "Greenhouse Gas"/ OR "greening".mp OR "hospital waste".mp OR "life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp OR exp "Waste Disposal"/ OR exp "Hospital Waste"/ OR "medical waste".mp OR "Rising Sea Level".mp OR "Rising Sea Levels".mp OR "Sea Level Rise"/ OR "Sea Level Rise".mp OR "sustainability".ti OR "Waste Disposal".mp OR "waste water recycling"/ OR "Recycling"/ OR "recycling".mp OR "recycle*".mp OR "Equipment reuse".mp OR "Reusables".mp OR "reusable".mp OR "reuse".mp OR "reused".mp OR "reusing".mp OR exp "Waste Disposal"/ OR exp "Waste Management"/ OR "Plastic overuse".mp OR "Green surgery".mp OR "Emission reduction".mp OR "Emission reduction strategy".mp OR "air pollution control"/ OR "air pollution control".mp OR "Environment"/ OR "Environmental*".ti OR "acidification"/ OR "soil acidification"/ OR "ocean acidification"/ OR "acidification".mp OR "Acidification potential".mp OR "AP in kg SO2 equivalents".mp OR "eco-efficiency".mp OR "ecoefficiency".mp OR "eco-efficien*".mp OR "ecoefficien*".mp OR "ecotoxicity"/ OR "ecotoxicity".mp OR "ecotoxic*".mp OR "eco toxicity".mp OR "eco toxic*".mp OR "EP in kg PO4 equivalent".mp OR exp "Eutrophication"/ OR "eutrophication".mp OR "Eutrophication potential".mp OR "FAETP in kg DCB equivalent".mp OR "Freshwater Aquatic Ecotoxicity Potential".mp OR "GWP in kg CO2 equivalents".mp OR "H+ moles equivalents".mp OR "HTTP in kg Dichlorobenzene equivalent".mp OR "Human Toxicity Potential".mp OR "kg 2.4-D equivalents".mp OR "kg CFC-11 equivalent".mp OR "kg N equivalents".mp OR "kg NOx equivalents".mp OR "life cycle analysis".mp OR "ozone depletion".mp OR "Photochemical Ozone Depletion Potential".mp OR "POCP in kg ethane equivalent".mp OR "smog".mp OR exp "Waste"/ OR "waste".mp OR "wastes".mp OR "Ozone Depletion"/ OR "Smog"/ OR "Equipment reuse".mp OR "Greenhouse Gases".mp OR "Greenhouse Gas".mp OR "SO2 equiv*".mp OR "CO2 equiva*".mp OR "CFC-11 equiv*".mp OR "N equiv*".mp OR exp "Biodiversity"/ OR "Biodiversity".mp OR "Climatic change".mp OR "Green deal".mp OR "preservation of natural resources".mp OR "Refuse Disposal".mp OR exp "Wastewater"/ OR "Waste

Water".mp OR "Wastewater".mp OR exp "Water Management"/ OR "Water Purification".mp OR (("plastic*".mp OR "microplastic*".mp) AND ("soup".mp OR "pollution".mp OR "overuse".mp OR "contamination".mp)) OR "Sustainable Development"/ OR "Sustainable Development".mp OR (("Plastic".mp OR "plastics".mp) AND "overuse".mp) OR ("hydrogen*".mp AND "moles".mp AND "equiv*".mp) OR ("Dichlorobenzen*".mp AND "equiv*".mp) OR ("2,4-D".mp AND "equiv*".mp) OR ("NOx".mp AND "equiv*".mp) OR ("ethane".mp AND "equiv*".mp) OR ("PO4".mp AND "equiv*".mp) OR ("DCB".mp AND "equiv*".mp) OR ("sustainability".mp AND ("environment*".mp OR "carbon".mp)) OR (("Carbon Dioxide"/ OR "Carbon Dioxide".mp OR "CO2".mp) AND ("pollution".mp OR "emission".mp OR "emissions".mp OR "waste".mp OR "environment".mp OR "environmental*".mp OR "footprint".mp OR "footprint*".mp OR "sustainable".mp OR "hazard".mp OR "hazard*".mp))) NOT (conference review or conference abstract).pt AND (2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022).yr AND (*(exp "meta analysis"/ OR exp "meta analysis (topic)"/ OR metaanaly*.ti,ab OR "meta analy*".ti,ab OR metanaly*.ti,ab OR "systematic review"/ OR "cochrane database of systematic reviews".jn OR prisma.ti,ab OR prospero.ti,ab OR (((systemati* OR scoping OR umbrella OR "structured literature") ADJ3 (review* OR overview*)).ti,ab) OR ((systemic* ADJ1 review*).ti,ab) OR (((systemati* OR literature OR database* OR "data base*") ADJ10 search*).ti,ab) OR (((structured OR comprehensive* OR systemic*) ADJ3 search*).ti,ab) OR (((literature ADJ3 review*).ti,ab) AND (search*.ti,ab OR database*.ti,ab OR "data base*".ti,ab)) OR (("data extraction".ti,ab OR "data source*".ti,ab) AND "study selection".ti,ab) OR ("search strategy".ti,ab AND "selection criteria".ti,ab) OR ("data source*".ti,ab AND "data synthesis".ti,ab) OR medline.ab OR pubmed.ab OR embase.ab OR cochrane.ab OR (((critical OR rapid) ADJ2 (review* OR overview* OR synthes*)).ti) OR ((((critical* OR rapid*) ADJ3 (review* OR overview* OR synthes*)).ab) AND (search*.ab OR database*.ab OR "data base*".ab)) OR metasynthes*.ti,ab OR "meta synthes*".ti,ab)* OR (exp "clinical trial"/ OR exp "randomization"/ OR exp "single blind procedure"/ OR exp "double blind procedure"/ OR exp "crossover procedure"/ OR exp "placebo"/ OR exp "prospective study"/ OR rct.ti,ab OR random*.ti,ab OR "single blind".ti,ab OR "randomised controlled trial".ti,ab OR exp "randomized controlled trial"/ OR placebo*.ti,ab) OR (exp "Comparative Study"/ OR "comparison".ti,ab OR "comparative".ti,ab OR "compar*".ti,ab OR "major clinical study"/ OR "clinical study"/ OR "case control study"/ OR "family study"/ OR "longitudinal study"/ OR "retrospective study"/ OR "prospective study"/ OR "cohort analysis"/ OR cohort*.ti,ab OR (("case control" ADJ1 (study OR studies)).ti,ab) OR (("follow up" ADJ1 (study OR studies)).ti,ab) OR (observational ADJ1 (study OR studies)).ti,ab OR ((epidemiologic ADJ1 (study OR studies)).ti,ab) OR (("cross sectional" ADJ1 (study OR studies)).ti,ab)) OR ("life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "life cycle inventory".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp))

UV4.3

((exp "Local Anesthesia"/ OR exp *"local anesthetic agent"/ OR "Local Anesthesia".mp OR "Local Anaesthesia".mp OR "Locoregional Anesthesia".mp OR "Locoregional Anaesthesia".mp OR "Local Anesthetics".mp OR "Local Anaesthetics".mp OR "Locoregional Anesthetics".mp OR "Locoregional Anaesthetics".mp OR "Local Anesthetic".mp OR "Local Anaesthetic".mp OR "Locoregional Anesthetic".mp OR "Locoregional Anaesthetic".mp OR "axillary block".mp OR "axillary block*".mp OR "Bier block".mp OR "Bier block*".mp OR "Bier's block".mp OR "Bier's block*".mp OR "brachial plexus block".mp OR "brachial plexus block*".mp OR "combined spinal epidural".mp OR "combined spinal epidural block".mp OR "combined spinal epidural block*".mp OR "epidural anaesthesia".mp OR "epidural anesthesia".mp OR "intravenous regional anesthaesia".mp OR "intravenous regional anesthesia".mp OR "ischiadic block".mp OR "ischiadic block*".mp OR "local infiltration".mp OR "lower extremity block".mp OR "lower extremity block*".mp OR "nerve block".mp OR "nerve block".mp OR "nerve block*".mp OR "nerve block*".mp OR "neuraxial anaesthesia".mp OR "neuraxial anesthesia".mp OR "neuraxial block".mp OR "neuraxial block*".mp OR "neuraxial technique".mp OR "neuraxial techniques".mp OR "peripheral nerve block".mp OR "peripheral nerve block*".mp OR "plexus block".mp OR "plexus block*".mp OR "plexus nerve block".mp OR "plexus nerve block*".mp OR "popliteal block".mp OR "popliteal block*".mp OR "regional anaesthesia".mp OR "regional anesthesia".mp OR "spinal anaesthesia".mp OR "spinal anaesthetic block".mp OR "spinal anaesthetic block*".mp OR "spinal anesthesia".mp OR "spinal anesthetic block".mp OR "spinal anesthetic block*".mp OR "supraclavicular block".mp OR "supraclavicular block*".mp OR "upper extremity block".mp OR "upper extremity block*".mp) AND (exp "General Anesthesia"/ OR "general anesthesia".mp OR "general anaesthesia".mp OR "general anesthe*".mp OR "general anaesthe*".mp OR exp "inhalation anesthetic agent"/ OR exp "inhalation anesthesia"/ OR "Closed-Circuit Anesthesia".mp OR "Endotracheal Anesthesia".mp OR "Closed-Circuit Anaesthesia".mp OR "Endotracheal Anaesthesia".mp OR "Halothane"/ OR "Isoflurane"/ OR "Methoxyflurane"/ OR "Sevoflurane"/ OR "Anaesthetic gas".mp OR "Anaesthetic gases".mp OR "Anesthetic gas".mp OR "Anesthetic gases".mp OR "Desflurane".mp OR "Enflurane".mp OR "Flurane".mp OR "Fluranes".mp OR "Gaseous anaesthesia".mp OR "Gaseous anaesthetic".mp OR "Gaseous anaesthetics".mp OR "Gaseous anesthesia".mp OR "Gaseous anesthetic".mp OR "Gaseous anesthetics".mp OR "Halothane".mp OR "Inhalation anaesthesia".mp OR "inhalation anaesthetic".mp OR "inhalation anaesthetics".mp OR "Inhalation anesthesia".mp OR "inhalation anesthetic".mp OR "inhalation anesthetics".mp OR "Inhalational agents".mp OR "Inhalational anaesthesia".mp OR "Inhalational anaesthetic".mp OR "Inhalational anaesthetic agent".mp OR "Inhalational anaesthetic agents".mp OR "Inhalational anaesthetics".mp OR "Inhalational anesthesia".mp OR "Inhalational anesthetic".mp OR "Inhalational anesthetic agent".mp OR "Inhalational anesthetic agents".mp OR "Inhalational anesthetics".mp OR "Inhaled anaesthetic".mp OR "Inhaled anaesthetic agent".mp OR "Inhaled anaesthetic agents".mp OR "Inhaled anaesthetics".mp OR "Inhaled anesthetic".mp OR "Inhaled anesthetic agents".mp OR "Inhaled anesthetics".mp OR "insufflation anaesthesia".mp OR "insufflation anaesthetic".mp OR "insufflation anaesthetics".mp OR "insufflation anesthesia".mp OR "insufflation anesthetic".mp OR "insufflation anesthetics".mp OR "Isoflurane".mp OR "Methoxyflurane".mp OR "Sevoflurane".mp OR "Vapor anaesthesia".mp OR "Vapor anaesthetic".mp OR "Vapor anaesthetics".mp OR "Vapor anesthesia".mp OR "Vapor anesthetic".mp OR "Vapor anesthetics".mp OR "Volatile agent".mp OR "Volatile agents".mp OR "Volatile Anaesthetic".mp OR "Volatile Anaesthetics".mp OR "Volatile anesthetic".mp OR "Volatile anesthetics".mp OR "Volatile drug".mp OR "Volatile drugs".mp OR "Volatile fluorinated liquid".mp OR "Volatile fluorinated liquids".mp OR "Volatile gas".mp OR "Volatile gases".mp OR "Volatile liquid agent".mp OR "Volatile liquid agents".mp OR "Anesthetic Gas".mp OR "Anesthetic Gases".mp OR "Inhalation Anaesthetic".mp OR "Inhalation Anaesthetics".mp OR "Inhalation Anesthetic".mp OR "Inhalation

Anesthetics".mp OR exp "intravenous anesthetic agent"/ OR exp "Intravenous Anesthesia"/ OR "Intravenous Anesthetics".mp OR "Intravenous Anaesthetics".mp OR "Intravenous Anesthetic".mp OR "Intravenous Anaesthetic".mp OR "Intravenous Anesthesia".mp OR "Intravenous Anaesthesia".mp OR "Dissociative Anesthetics".mp OR "Dissociative Anaesthetics".mp OR "Dissociative Anesthetic".mp OR "Dissociative Anaesthetic".mp OR "Dissociative Anesthesia".mp OR "Dissociative Anaesthesia".mp OR "2-(3-methoxyphenyl)-2-(ethylamino)cyclohexanone"/ OR "2-Oxo-PCE"/ OR "Alfentanil"/ OR "Chloralose"/ OR "Diazepam"/ OR "Etomidate"/ OR "Fentanyl"/ OR "Ketamine"/ OR "Methohexital"/ OR "Midazolam"/ OR "Propanidid"/ OR "Propofol"/ OR "Sodium Oxybate"/ OR "Sufentanil"/ OR "Thiamylal"/ OR "Thiopental"/ OR "Tiletamine"/ OR "Urethane"/ OR "2-(3-methoxyphenyl)-2-(ethylamino)cyclohexanone".mp OR "2-Oxo-PCE".mp OR "Alfentanil".mp OR "Chloralose".mp OR "Diazepam".mp OR "Etomidate".mp OR "Fentanyl".mp OR "intravenous 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waste".mp OR "life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp OR exp "Waste Disposal"/ OR exp "Hospital Waste"/ OR "medical waste".mp OR "Rising Sea Level".mp OR "Rising Sea Levels".mp OR "Sea Level Rise"/ OR "Sea Level Rise".mp OR "sustainability".ti OR "Waste Disposal".mp OR "waste water recycling"/ OR "Recycling"/ OR "recycling".mp OR "recycle*".mp OR "Equipment reuse".mp OR "Reusables".mp OR "reusable".mp OR "reuse".mp OR "reused".mp OR "reusing".mp OR exp "Waste Disposal"/ OR exp "Waste Management"/ OR "Plastic overuse".mp OR "Green surgery".mp OR "Emission reduction".mp OR "Emission reduction strategy".mp OR "air pollution control"/ OR "air pollution control".mp OR "Environment"/ OR "Environmental*".ti OR "acidification"/ OR "soil acidification"/ OR "ocean acidification"/ OR "acidification".mp OR "Acidification potential".mp OR "AP in kg SO2 equivalents".mp OR "eco-efficiency".mp OR "ecoefficiency".mp OR "eco-efficien*".mp OR "ecoefficien*".mp OR "ecotoxicity"/ OR "ecotoxicity".mp OR "ecotoxic*".mp OR "eco toxicity".mp OR "eco toxic*".mp OR "EP in kg PO4 equivalent".mp OR exp "Eutrophication"/ OR "eutrophication".mp OR "Eutrophication potential".mp OR "FAETP in kg DCB equivalent".mp OR "Freshwater Aquatic Ecotoxicity Potential".mp OR "GWP in kg CO2 equivalents".mp OR "H+ moles equivalents".mp OR "HTTP in kg Dichlorobenzene equivalent".mp OR "Human Toxicity Potential".mp OR "kg 2.4-D equivalents".mp OR "kg CFC-11 equivalent".mp OR "kg N equivalents".mp OR "kg NOx equivalents".mp OR "life cycle analysis".mp OR "ozone depletion".mp OR "Photochemical Ozone Depletion Potential".mp OR "POCP in kg ethane equivalent".mp OR "smog".mp OR exp "Waste"/ OR "waste".mp OR "wastes".mp OR "Ozone Depletion"/ OR "Smog"/ OR "Equipment reuse".mp OR "Greenhouse Gases".mp OR "Greenhouse Gas".mp OR "SO2 equiv*".mp OR "CO2 equiva*".mp OR "CFC-11 equiv*".mp OR "N equiv*".mp OR exp "Biodiversity"/ OR "Biodiversity".mp OR "Climatic change".mp OR "Green deal".mp OR "preservation of natural resources".mp OR "Refuse Disposal".mp OR exp "Wastewater"/ OR "Waste Water".mp OR "Wastewater".mp OR exp "Water Management"/ OR "Water Purification".mp OR (("plastic*".mp OR "microplastic*".mp) AND ("soup".mp OR "pollution".mp OR "overuse".mp OR "contamination".mp)) OR "Sustainable Development"/ OR "Sustainable Development".mp OR (("Plastic".mp OR "plastics".mp) AND "overuse".mp) OR ("hydrogen*".mp AND "moles".mp AND "equiv*".mp) OR ("Dichlorobenzen*".mp AND "equiv*".mp) OR ("2,4-D".mp AND "equiv*".mp) OR ("NOx".mp AND "equiv*".mp) OR ("ethane".mp AND "equiv*".mp) OR ("PO4".mp AND "equiv*".mp) OR ("DCB".mp AND "equiv*".mp) OR ("sustainability".mp AND ("environment*".mp OR "carbon".mp)) OR (("Carbon Dioxide"/ OR "Carbon Dioxide".mp OR "CO2".mp) AND ("pollution".mp OR "emission".mp OR "emissions".mp OR "waste".mp OR "environment".mp OR "environmental*".mp OR "footprint".mp OR "footprint*".mp OR "sustainable".mp OR "hazard".mp OR "hazard*".mp))) NOT (conference review or conference abstract).pt AND (2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022).yr AND ((exp "meta analysis"/ OR exp "meta analysis (topic)"/ OR metaanaly*.ti,ab OR "meta analy*".ti,ab OR metanaly*.ti,ab OR "systematic review"/ OR "cochrane database of systematic reviews".jn OR prisma.ti,ab OR prospero.ti,ab OR (((systemati* OR scoping OR umbrella OR "structured literature") ADJ3 (review* OR overview*)).ti,ab) OR ((systemic* ADJ1 review*).ti,ab) OR (((systemati* OR literature OR database* OR "data base*") ADJ10 search*).ti,ab) OR (((structured OR comprehensive* OR systemic*) ADJ3 search*).ti,ab) OR (((literature ADJ3 review*).ti,ab) AND (search*.ti,ab OR database*.ti,ab OR "data base*".ti,ab)) OR (("data extraction".ti,ab OR "data source*".ti,ab) AND "study selection".ti,ab) OR ("search strategy".ti,ab AND "selection criteria".ti,ab) OR ("data source*".ti,ab AND "data synthesis".ti,ab) OR medline.ab OR pubmed.ab OR embase.ab OR cochrane.ab OR (((critical OR rapid) ADJ2 (review* OR overview* OR synthes*)).ti) OR ((((critical* OR rapid*) ADJ3 (review* OR overview* OR synthes*)).ab) AND (search*.ab OR database*.ab OR "data base*".ab)) OR metasynthes*.ti,ab OR "meta synthes*".ti,ab) OR (exp "clinical trial"/ OR exp "randomization"/ OR exp "single blind procedure"/ OR exp "double blind procedure"/ OR exp "crossover procedure"/ OR exp "placebo"/ OR exp "prospective study"/ OR rct.ti,ab OR random*.ti,ab OR "single blind".ti,ab OR "randomised controlled trial".ti,ab OR exp "randomized controlled trial"/ OR placebo*.ti,ab) OR (exp "Comparative Study"/ OR "comparison".ti,ab OR "comparative".ti,ab OR "compar*".ti,ab OR "major clinical study"/ OR "clinical study"/ OR "case control study"/ OR "family study"/ OR "longitudinal study"/ OR "retrospective study"/ OR "prospective study"/ OR "cohort analysis"/ OR cohort*.ti,ab OR (("case control" ADJ1 (study OR studies)).ti,ab) OR (("follow up" ADJ1 (study OR studies)).ti,ab) OR (observational ADJ1 (study OR studies)).ti,ab OR ((epidemiologic ADJ1 (study OR studies)).ti,ab) OR (("cross sectional" ADJ1 (study OR studies)).ti,ab)) OR ("life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "life cycle inventory".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp))

Web of Science
UV4.1
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Gases" OR "Inhalation Anaesthetic" OR "Inhalation Anaesthetics" OR "Inhalation Anesthetic" OR "Inhalation Anesthetics") AND TS=("Anesthesia, Intravenous" OR "Anesthetics, Intravenous" OR "Anesthetics, Intravenous" OR "Intravenous Anesthetics" OR "Intravenous Anaesthetics" OR "Intravenous Anesthetic" OR "Intravenous Anaesthetic" OR "Intravenous Anesthesia" OR "Intravenous Anaesthesia" OR "Dissociative Anesthetics" OR "Dissociative Anaesthetics" OR "Dissociative Anesthetic" OR "Dissociative Anaesthetic" OR "Dissociative Anesthesia" OR "Dissociative Anaesthesia" OR "2-(3-methoxyphenyl)-2-(ethylamino)cyclohexanone"OR "2-Oxo-PCE"OR "Alfentanil" OR "Chloralose" OR "Diazepam" OR "Etomidate" OR "Fentanyl" OR "Ketamine" OR "Methohexital" OR "Midazolam" OR "Propanidid" OR "Propofol" OR "Sodium Oxybate" OR "Sufentanil" OR "Thiamylal" OR "Thiopental" OR "Tiletamine" OR "Urethane" OR "2-(3-methoxyphenyl)-2-(ethylamino)cyclohexanone" OR "2-Oxo-PCE" OR "Alfentanil" OR "Chloralose" OR "Diazepam" OR 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("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))) OR TI=("environmental*" OR "sustainab*")) NOT DT=(meeting abstract) AND (PY=(2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022)) AND (TI=((*"Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR/4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR/4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR/4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR/4 ("review*" OR "overview*" OR "synthes*") NEAR/4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*")* OR ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR/1 (study OR studies))) OR (("follow up" NEAR/1 (study OR studies))) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies))) OR (("cross sectional" NEAR/1 (study OR studies)))) OR ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")) OR AB=((*"Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR/4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR/4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR/4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR/4 ("review*" OR "overview*" OR "synthes*") NEAR/4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*")* OR ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR/1 (study OR studies))) OR (("follow up" NEAR/1 (study OR studies))) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies))) OR (("cross sectional" NEAR/1 (study OR studies)))) OR ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")))

UV4.2

(TS=("Closed-Circuit Anesthesia" OR "Endotracheal Anesthesia" OR "Closed-Circuit Anaesthesia" OR "Endotracheal Anaesthesia" OR "Halothane" OR "Isoflurane" OR "Methoxyflurane" OR "Sevoflurane" OR "Anaesthetic gas" OR "Anaesthetic gases" OR "Anesthetic gas" OR "Anesthetic gases" OR "Desflurane" OR "Enflurane" OR "Flurane" OR "Fluranes" OR "Gaseous anaesthesia" OR "Gaseous anaesthetic" OR "Gaseous anaesthetics" OR "Gaseous anesthesia" OR "Gaseous anesthetic" OR "Gaseous anesthetics" OR "Halothane" OR "Inhalation anaesthesia" OR "inhalation anaesthetic" OR "inhalation anaesthetics" OR "Inhalation anesthesia" OR "inhalation anesthetic" OR "inhalation anesthetics" OR "Inhalational agents" OR "Inhalational anaesthesia" OR "Inhalational anaesthetic" OR "Inhalational anaesthetic agent" OR "Inhalational anaesthetic agents" OR "Inhalational anaesthetics" OR "Inhalational anesthesia" OR "Inhalational anesthetic" OR "Inhalational anesthetic agent" OR "Inhalational anesthetic agents" OR "Inhalational anesthetics" OR "Inhaled anaesthetic" OR "Inhaled anaesthetic agent" OR "Inhaled anaesthetic agents" OR "Inhaled anaesthetics" OR "Inhaled anesthetic" OR "Inhaled anesthetic agents" OR "Inhaled anesthetics" OR "insufflation anaesthesia" OR "insufflation anaesthetic" OR "insufflation anaesthetics" OR "insufflation anesthesia" OR "insufflation anesthetic" OR "insufflation anesthetics" OR "Isoflurane" OR "Methoxyflurane" OR "Sevoflurane" OR "Vapor anaesthesia" OR "Vapor anaesthetic" OR "Vapor anaesthetics" OR "Vapor anesthesia" OR "Vapor anesthetic" OR "Vapor anesthetics" OR "Volatile agent" OR "Volatile agents" OR "Volatile Anaesthetic" OR "Volatile Anaesthetics" OR "Volatile anesthetic" OR "Volatile anesthetics" OR "Volatile drug" OR "Volatile drugs" OR "Volatile fluorinated liquid" OR "Volatile fluorinated liquids" OR "Volatile gas" OR "Volatile gases" OR "Volatile liquid agent" OR "Volatile liquid agents" OR "Anesthetics, Inhalation" OR "Anesthetic Gas" OR "Anesthetic Gases" OR "Inhalation Anaesthetic" OR "Inhalation Anaesthetics" OR "Inhalation Anesthetic" OR "Inhalation Anesthetics") AND TS=("scavenging system" OR "anaesthetic gas scavenging system" OR "anesthetic gas scavenging system" OR "Contrafluran" OR "gas extract*" OR "gas extraction" OR "gas extraction system" OR "gas extraction systems" OR "gas scaveng*" OR "gas scavenger" OR "gas scavengers" OR "gas scavenging " OR "scavenging device" OR "scavenging device" OR "scavenging devices" OR "scavenging system" OR "scavenging systems" OR "vapour captur*" OR "vapour capture" OR "Vapour Capture Technology" OR "vapour recycl*" OR "vapour recycling technology" OR "vapour recycling")) AND (TS=("Carbon Footprint" OR "carbon footprint" OR "carbon footprint*" OR "Climate Change" OR "climate change" OR "CO2 emission" OR "CO2 emissions" OR "CO2 footprint" OR "CO2 footprint*" OR "environmental protection" OR "conservation of natural resources" OR "environmental protection" OR "Disposable Equipment" OR "Disposables" OR "Disposable" OR "ecological footprint" OR "ecological footprint*" OR "ecological sustainability" OR "environmental impact" OR "environmental impact" OR "environmental impact*" OR "environmental impacts" OR "environmental pollut*" OR "pollution" OR "environmental pollution" OR "environmental sustainab*" OR "environmental sustainability" OR "environmental sustainability" OR "Global Warming" OR "Global Warming" OR "Greenhouse Effect" OR "greenhouse effect*" OR "greenhouse effects" OR "greenhouse gas emission" OR "greenhouse gas emissions" OR "Greenhouse Gas" OR "greening" OR "hospital waste" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assess*" OR "life cycle assessment" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories" OR "Waste Disposal" OR "Hospital Waste" OR "medical waste" OR "Rising Sea Level" OR "Rising Sea Levels" OR "Sea Level Rise" OR "Sea Level Rise" OR "Waste Disposal" OR "waste water recycling" OR "Recycling" OR "recycling" OR "recycle*" OR "Equipment reuse" OR "Reusables" OR "reusable" OR "reuse" OR "reused" OR "reusing" OR "Waste Disposal" OR "Waste Management" OR "Plastic overuse" OR "Green surgery" OR "Emission reduction" OR "Emission reduction strategy" OR "air pollution control" OR "air pollution control" OR "acidification" OR "soil acidification" OR "ocean acidification" OR "acidification" OR "Acidification potential" OR "AP in kg SO2 equivalents" OR "eco-efficiency" OR "ecoefficiency" OR "eco-efficien*" OR "ecoefficien*" OR "ecotoxicity" OR "ecotoxicity" OR "ecotoxic*" OR "eco toxicity" OR "eco toxic*" OR "EP in kg PO4 equivalent" OR "Eutrophication" OR "eutrophication" OR "Eutrophication potential" OR "FAETP in kg DCB equivalent" OR "Freshwater Aquatic Ecotoxicity Potential" OR "GWP in kg CO2 equivalents" OR "H+ moles equivalents" OR "HTTP in kg Dichlorobenzene equivalent" OR "Human Toxicity Potential" OR "kg 2.4-D equivalents" OR "kg CFC-11 equivalent" OR "kg N equivalents" OR "kg NOx equivalents" OR "life cycle analysis" OR "ozone depletion" OR "Photochemical Ozone Depletion Potential" OR "POCP in kg ethane equivalent" OR "smog" OR "Waste" OR "waste" OR "wastes" OR "Ozone Depletion" OR "Smog" OR "Equipment reuse" OR "Greenhouse Gases" OR "Greenhouse Gas" OR "SO2 equiv*" OR "CO2 equiva*" OR "CFC-11 equiv*" OR "N equiv*" OR "Sustainable Development" OR "Sustainable Development" OR "Biodiversity" OR "Climatic change" OR "Green deal" OR "preservation of natural resources" OR "Refuse Disposal" OR "Waste Water" OR "Wastewater" OR "Water Purification" OR (("plastic*" OR "microplastic*") AND ("soup" OR "pollution" OR "overuse" OR "contamination")) OR (("Plastic" OR "plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))) OR TI=("environmental*" OR "sustainab*")) NOT DT=(meeting abstract) AND (PY=(2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022)) AND (TI=((*"Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR4 ("review*" OR "overview*" OR "synthes*") NEAR4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*")* OR ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR1 (study OR studies))) OR (("follow up" NEAR1 (study OR studies))) OR (observational NEAR1 (study OR studies)) OR ((epidemiologic NEAR1 (study OR studies))) OR (("cross sectional" NEAR1 (study OR studies)))) OR ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")) OR AB=((*"Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR4 ("review*" OR "overview*" OR "synthes*") NEAR4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*")* OR ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*"

OR "superiority trial*" OR "equivalence clinical trial*") OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR1 (study OR studies))) OR (("follow up" NEAR1 (study OR studies))) OR (observational NEAR1 (study OR studies)) OR ((epidemiologic NEAR1 (study OR studies))) OR (("cross sectional" NEAR1 (study OR studies)))) OR ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")))

UV4.3

TS=(("Local Anesthesia" OR "local anesthetic agent" OR "Nerve Block" OR "Local Anesthesia" OR "Local Anaesthesia" OR "Locoregional Anesthesia" OR "Locoregional Anaesthesia" OR "Local Anesthetics" OR "Local Anaesthetics" OR "Locoregional Anesthetics" OR "Locoregional Anaesthetics" OR "Local Anesthetic" OR "Local Anaesthetic" OR "Locoregional Anesthetic" OR "Locoregional Anaesthetic" OR "axillary block" OR "axillary block*" OR "Bier block" OR "Bier block*" OR "Bier's block" OR "Bier's block*" OR "brachial plexus block" OR "brachial plexus block*" OR "combined spinal epidural" OR "combined spinal epidural block" OR "combined spinal epidural block*" OR "epidural anaesthesia" OR "epidural anesthesia" OR "intravenous regional anesthaesia" OR "intravenous regional anesthesia" OR "ischiadic block" OR "ischiadic block*" OR "local infiltration" OR "lower extremity block" OR "lower extremity block*" OR "nerve block" OR "nerve block" OR "nerve block*" OR "nerve block*" OR "neuraxial anaesthesia" OR "neuraxial anesthesia" OR "neuraxial block" OR "neuraxial block*" OR "neuraxial technique" OR "neuraxial techniques" OR "peripheral nerve block" OR "peripheral nerve block*" OR "plexus block" OR "plexus block*" OR "plexus nerve block" OR "plexus nerve block*" OR "popliteal block" OR "popliteal block*" OR "regional anaesthesia" OR "regional anesthesia" OR "spinal anaesthesia" OR "spinal anaesthetic block" OR "spinal anaesthetic block*" OR "spinal anesthesia" OR "spinal anesthetic block" OR "spinal anesthetic block*" OR "supraclavicular block" OR "supraclavicular block*" OR "upper extremity block" OR "upper extremity block*") AND ("General Anesthesia" OR "general anesthesia" OR "general anaesthesia" OR "general anesthe*" OR "general anaesthe*" OR "inhalation anesthetic agent" OR "inhalation anesthesia" OR "Closed Circuit Anesthesia" OR "Endotracheal Anesthesia" OR "Closed Circuit Anaesthesia" OR "Endotracheal Anaesthesia" OR "Halothane" OR "Isoflurane" OR "Methoxyflurane" OR "Sevoflurane" OR "Anaesthetic gas" OR "Anaesthetic gases" OR "Anesthetic gas" OR "Anesthetic gases" OR "Desflurane" OR "Enflurane" OR "Flurane" OR "Fluranes" OR "Gaseous anaesthesia" OR "Gaseous anaesthetic" OR "Gaseous anaesthetics" OR "Gaseous anesthesia" OR "Gaseous anesthetic" OR "Gaseous anesthetics" OR "Halothane" OR "Inhalation anaesthesia" OR "inhalation anaesthetic" OR "inhalation anaesthetics" OR "Inhalation anesthesia" OR "inhalation anesthetic" OR "inhalation anesthetics" OR "Inhalational agents" OR "Inhalational anaesthesia" OR "Inhalational anaesthetic" OR "Inhalational anaesthetic agent" OR "Inhalational anaesthetic agents" OR "Inhalational anaesthetics" OR "Inhalational anesthesia" OR "Inhalational anesthetic" OR "Inhalational anesthetic agent" OR "Inhalational anesthetic agents" OR "Inhalational anesthetics" OR "Inhaled anaesthetic" OR "Inhaled anaesthetic agent" OR "Inhaled anaesthetic agents" OR "Inhaled anaesthetics" OR "Inhaled anesthetic" OR "Inhaled anesthetic agents" OR "Inhaled anesthetics" OR "insufflation anaesthesia" OR "insufflation anaesthetic" OR "insufflation anaesthetics" OR "insufflation anesthesia" OR "insufflation anesthetic" OR "insufflation anesthetics" OR "Isoflurane" OR "Methoxyflurane" OR "Sevoflurane" OR "Vapor anaesthesia" OR "Vapor anaesthetic" OR "Vapor anaesthetics" OR "Vapor anesthesia" OR "Vapor anesthetic" OR "Vapor anesthetics" OR "Volatile agent" OR "Volatile agents" OR "Volatile Anaesthetic" OR "Volatile Anaesthetics" OR "Volatile anesthetic" OR "Volatile anesthetics" OR "Volatile drug" OR "Volatile drugs" OR "Volatile fluorinated liquid" OR "Volatile fluorinated liquids" OR "Volatile gas" OR "Volatile gases" OR "Volatile liquid agent" OR "Volatile liquid agents" OR "Anesthetic Gas" OR "Anesthetic Gases" OR "Inhalation Anaesthetic" OR "Inhalation Anaesthetics" OR "Inhalation Anesthetic" OR "Inhalation Anesthetics" OR "intravenous anesthetic agent" OR "Intravenous Anesthesia" OR "Intravenous Anesthetics" OR "Intravenous Anaesthetics" OR "Intravenous Anesthetic" OR "Intravenous Anaesthetic" OR "Intravenous Anesthesia" OR "Intravenous Anaesthesia" OR "Dissociative Anesthetics" OR "Dissociative Anaesthetics" OR "Dissociative Anesthetic" OR "Dissociative Anaesthetic" OR "Dissociative Anesthesia" OR "Dissociative Anaesthesia" OR "2 (3 methoxyphenyl) 2 (ethylamino)cyclohexanone" OR "2 Oxo PCE" OR "Alfentanil" OR "Chloralose" OR "Diazepam" OR "Etomidate" OR "Fentanyl" OR "Ketamine" OR "Methohexital" OR "Midazolam" OR "Propanidid" OR "Propofol" OR "Sodium Oxybate" OR "Sufentanil" OR "Thiamylal" OR "Thiopental" OR "Tiletamine" OR "Urethane" OR "2 (3 methoxyphenyl) 2 (ethylamino)cyclohexanone" OR "2 Oxo PCE" OR "Alfentanil" OR "Chloralose" OR "Diazepam" OR "Etomidate" OR "Fentanyl" OR "intravenous anaesthesia" OR "intravenous anaesthesias" OR "Intravenous anaesthetic" OR "Intravenous anaesthetic agent" OR "Intravenous anaesthetic agents" OR "Intravenous anaesthetic drug" OR "Intravenous anaesthetic drugs" OR "Intravenous anaesthetics" OR "intravenous anesthesia" OR "intravenous anesthesias" OR "intravenous anesthetic" OR "Intravenous anesthetic agents" OR "Intravenous anesthetic agents" OR "Intravenous anesthetic drug" OR "Intravenous anesthetic drugs" OR "intravenous anesthetics" OR "IV anaesthesia" OR "IV anaesthetics" OR "IV anaesthetics" OR "IV anesthesia" OR "IV anesthetic" OR "IV anesthetics" OR "Ketamine" OR "Methohexital" OR "Midazolam" OR "Propanidid" OR "Propofol" OR "Sodium Oxybate" OR "Sufentanil" OR "Thiamylal" OR "Thiopental" OR "Tiletamine" OR "TIVA" OR "Total intravenous anaesthesia" OR "Total Intravenous anesthesia" OR "Urethane")) AND (TS=("Carbon Footprint" OR "carbon footprint" OR "carbon footprint*" OR "Climate Change" OR "climate change" OR "CO2 emission" OR "CO2 emissions" OR "CO2 footprint" OR "CO2 footprint*" OR "environmental protection" OR "conservation of natural resources" OR "environmental protection" OR "Disposable Equipment" OR "Disposables" OR "Disposable" OR "ecological footprint" OR "ecological footprint*" OR "ecological sustainability" OR "environmental impact" OR "environmental impact" OR "environmental impact*" OR "environmental impacts" OR "environmental pollut*" OR "pollution" OR "environmental pollution" OR "environmental sustainab*" OR "environmental sustainability" OR "environmental sustainability" OR "Global Warming" OR "Global Warming" OR "Greenhouse Effect" OR "greenhouse effect*" OR "greenhouse effects" OR "greenhouse gas emission" OR "greenhouse gas emissions" OR "Greenhouse Gas" OR "greening" OR "hospital waste" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assess*" OR "life cycle assessment" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories" OR "Waste Disposal" OR "Hospital Waste" OR "medical waste" OR "Rising Sea Level" OR "Rising Sea Levels" OR "Sea Level Rise" OR "Sea Level Rise" OR "Waste Disposal" OR "waste water recycling" OR "Recycling" OR "recycling" OR "recycle*" OR "Equipment reuse" OR "Reusables" OR "reusable" OR "reuse" OR "reused" OR "reusing" OR "Waste Disposal" OR "Waste Management" OR "Plastic overuse" OR "Green surgery" OR "Emission reduction" OR "Emission reduction strategy" OR "air pollution control" OR "air pollution control" OR "acidification"

OR "soil acidification" OR "ocean acidification" OR "acidification" OR "Acidification potential" OR "AP in kg SO2 equivalents" OR "eco-efficiency" OR "ecoefficiency" OR "eco-efficien*" OR "ecoefficien*" OR "ecotoxicity" OR "ecotoxicity" OR "ecotoxic*" OR "eco toxicity" OR "eco toxic*" OR "EP in kg PO4 equivalent" OR "Eutrophication" OR "eutrophication" OR "Eutrophication potential" OR "FAETP in kg DCB equivalent" OR "Freshwater Aquatic Ecotoxicity Potential" OR "GWP in kg CO2 equivalents" OR "H+ moles equivalents" OR "HTTP in kg Dichlorobenzene equivalent" OR "Human Toxicity Potential" OR "kg 2.4-D equivalents" OR "kg CFC-11 equivalent" OR "kg N equivalents" OR "kg NOx equivalents" OR "life cycle analysis" OR "ozone depletion" OR "Photochemical Ozone Depletion Potential" OR "POCP in kg ethane equivalent" OR "smog" OR "Waste" OR "waste" OR "wastes" OR "Ozone Depletion" OR "Smog" OR "Equipment reuse" OR "Greenhouse Gases" OR "Greenhouse Gas" OR "SO2 equiv*" OR "CO2 equiva*" OR "CFC-11 equiv*" OR "N equiv*" OR "Sustainable Development" OR "Sustainable Development" OR "Biodiversity" OR "Climatic change" OR "Green deal" OR "preservation of natural resources" OR "Refuse Disposal" OR "Waste Water" OR "Wastewater" OR "Water Purification" OR (("plastic*" OR "microplastic*") AND ("soup" OR "pollution" OR "overuse" OR "contamination")) OR (("Plastic" OR "plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))) OR TI=("environmental*" OR "sustainab*")) NOT DT=(meeting abstract) AND (PY=(2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022)) AND (TI=(("Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR4 ("review*" OR "overview*" OR "synthes*") NEAR4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*") OR ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR1 (study OR studies))) OR (("follow up" NEAR1 (study OR studies))) OR (observational NEAR1 (study OR studies)) OR ((epidemiologic NEAR1 (study OR studies))) OR (("cross sectional" NEAR1 (study OR studies)))) OR ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")) OR AB=(("Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR4 ("review*" OR "overview*" OR "synthes*") NEAR4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*") OR ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR1 (study OR studies))) OR (("follow up" NEAR1 (study OR studies))) OR (observational NEAR1 (study OR studies)) OR ((epidemiologic NEAR1 (study OR studies))) OR (("cross sectional" NEAR1 (study OR studies)))) OR ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")))

Cochrane
UV4.1
(("inhalation anesthetic agent" OR "inhalation anesthesia" OR "Closed Circuit Anesthesia" OR "Endotracheal Anesthesia" OR "Closed Circuit Anaesthesia" OR "Endotracheal Anaesthesia" OR "Halothane" OR "Isoflurane" OR "Methoxyflurane" OR "Sevoflurane" OR "Anaesthetic gas" OR "Anaesthetic gases" OR "Anesthetic gas" OR "Anesthetic gases" OR "Desflurane" OR "Enflurane" OR "Flurane" OR "Fluranes" OR "Gaseous anaesthesia" OR "Gaseous anaesthetic" OR "Gaseous anaesthetics" OR "Gaseous anesthesia" OR "Gaseous anesthetic" OR "Gaseous anesthetics" OR "Halothane" OR "Inhalation anaesthesia" OR "inhalation anaesthetic" OR "inhalation anaesthetics" OR "Inhalation anesthesia" OR "inhalation anesthetic" OR "inhalation

anesthetics" OR "Inhalational agents" OR "Inhalational anaesthesia" OR "Inhalational anaesthetic" OR "Inhalational anaesthetic agent" OR "Inhalational anaesthetic agents" OR "Inhalational anaesthetics" OR "Inhalational anesthesia" OR "Inhalational anesthetic" OR "Inhalational anesthetic agent" OR "Inhalational anesthetic agents" OR "Inhalational anesthetics" OR "Inhaled anaesthetic" OR "Inhaled anaesthetic agent" OR "Inhaled anaesthetic agents" OR "Inhaled anaesthetics" OR "Inhaled anesthetic" OR "Inhaled anesthetic agents" OR "Inhaled anesthetics" OR "insufflation anaesthesia" OR "insufflation anaesthetic" OR "insufflation anaesthetics" OR "insufflation anesthesia" OR "insufflation anesthetic" OR "insufflation anesthetics" OR "Isoflurane" OR "Methoxyflurane" OR "Sevoflurane" OR "Vapor anaesthesia" OR "Vapor anaesthetic" OR "Vapor anaesthetics" OR "Vapor anesthesia" OR "Vapor anesthetic" OR "Vapor anesthetics" OR "Volatile agent" OR "Volatile agents" OR "Volatile Anaesthetic" OR "Volatile Anaesthetics" OR "Volatile anesthetic" OR "Volatile anesthetics" OR "Volatile drug" OR "Volatile drugs" OR "Volatile fluorinated liquid" OR "Volatile fluorinated liquids" OR "Volatile gas" OR "Volatile gases" OR "Volatile liquid agent" OR "Volatile liquid agents" OR "Anesthetic Gas" OR "Anesthetic Gases" OR "Inhalation Anaesthetic" OR "Inhalation Anaesthetics" OR "Inhalation Anesthetic" OR "Inhalation Anesthetics") AND ("intravenous anesthetic agent" OR "Intravenous Anesthesia" OR "Intravenous Anesthetics" OR "Intravenous Anaesthetics" OR "Intravenous Anesthetic" OR "Intravenous Anaesthetic" OR "Intravenous Anesthesia" OR "Intravenous Anaesthesia" OR "Dissociative Anesthetics" OR "Dissociative Anaesthetics" OR "Dissociative Anesthetic" OR "Dissociative Anaesthetic" OR "Dissociative Anesthesia" OR "Dissociative Anaesthesia" OR "2 (3 methoxyphenyl) 2 (ethylamino)cyclohexanone" OR "2 Oxo PCE" OR "Alfentanil" OR "Chloralose" OR "Diazepam" OR "Etomidate" OR "Fentanyl" OR "Ketamine" OR "Methohexital" OR "Midazolam" OR "Propanidid" OR "Propofol" OR "Sodium Oxybate" OR "Sufentanil" OR "Thiamylal" OR "Thiopental" OR "Tiletamine" OR "Urethane" OR "2 (3 methoxyphenyl) 2 (ethylamino)cyclohexanone" OR "2 Oxo PCE" OR "Alfentanil" OR "Chloralose" OR "Diazepam" OR "Etomidate" OR "Fentanyl" OR "intravenous anaesthesia" OR "intravenous anaesthesias" OR "Intravenous anaesthetic" OR "Intravenous anaesthetic agent" OR "Intravenous anaesthetic agents" OR "Intravenous anaesthetic drug" OR "Intravenous anaesthetic drugs" OR "Intravenous anaesthetics" OR "intravenous anesthesia" OR "intravenous anesthesias" OR "intravenous anesthetic" OR "Intravenous anesthetic agents" OR "Intravenous anesthetic agents" OR "Intravenous anesthetic drug" OR "Intravenous anesthetic drugs" OR "intravenous anesthetics" OR "IV anaesthesia" OR "IV anaesthetics" OR "IV anaesthetics" OR "IV anesthesia" OR "IV anesthetic" OR "IV anesthetics" OR "Ketamine" OR "Methohexital" OR "Midazolam" OR "Propanidid" OR "Propofol" OR "Sodium Oxybate" OR "Sufentanil" OR "Thiamylal" OR "Thiopental" OR "Tiletamine" OR "TIVA" OR "Total intravenous anaesthesia" OR "Total Intravenous anesthesia" OR "Urethane")):ti,ab,kw AND (("Carbon Footprint" OR "carbon footprint" OR "carbon footprint*" OR "Climate Change" OR "climate change" OR "CO2 emission" OR "CO2 emissions" OR "CO2 footprint" OR "CO2 footprint*" OR "environmental protection" OR "conservation of natural resources" OR "environmental protection" OR "Disposable Equipment" OR "Disposables" OR "Disposable" OR "ecological footprint" OR "ecological footprint*" OR "ecological sustainability" OR "environmental impact" OR "environmental impact" OR "environmental impact*" OR "environmental impacts" OR "environmental pollut*" OR "pollution" OR "environmental pollution" OR "environmental sustainab*" OR "environmental sustainability" OR "environmental sustainability" OR "Global Warming" OR "Global Warming" OR "Greenhouse Effect" OR "greenhouse effect*" OR "greenhouse effects" OR "greenhouse gas emission" OR "greenhouse gas emissions" OR "Greenhouse Gas" OR "greening" OR "hospital waste" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assess*" OR "life cycle assessment" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories" OR "Waste Disposal" OR "Hospital Waste" OR "medical waste" OR "Rising Sea Level" OR "Rising Sea Levels" OR "Sea Level Rise" OR "Sea Level Rise" OR "Waste Disposal" OR "waste water recycling" OR "Recycling" OR "recycling" OR "recycle*" OR "Equipment reuse" OR "Reusables" OR "reusable" OR "reuse" OR "reused" OR "reusing" OR "Waste Disposal" OR "Waste Management" OR "Plastic overuse" OR "Green surgery" OR "Emission reduction" OR "Emission reduction strategy" OR "air pollution control" OR "air pollution control" OR "acidification" OR "soil acidification" OR "ocean acidification" OR "acidification" OR "Acidification potential" OR "AP in kg SO2 equivalents" OR "eco-efficiency" OR "ecoefficiency" OR "eco-efficien*" OR "ecoefficien*" OR "ecotoxicity" OR "ecotoxicity" OR "ecotoxic*" OR "eco toxicity" OR "eco toxic*" OR "EP in kg PO4 equivalent" OR "Eutrophication" OR "eutrophication" OR "Eutrophication potential" OR "FAETP in kg DCB equivalent" OR "Freshwater Aquatic Ecotoxicity Potential" OR "GWP in kg CO2 equivalents" OR "H+ moles equivalents" OR "HTTP in kg Dichlorobenzene equivalent" OR "Human Toxicity Potential" OR "kg 2.4-D equivalents" OR "kg CFC-11 equivalent" OR "kg N equivalents" OR "kg NOx equivalents" OR "life cycle analysis" OR "ozone depletion" OR "Photochemical Ozone Depletion Potential" OR "POCP in kg ethane equivalent" OR "smog" OR "Waste" OR "waste" OR "wastes" OR "Ozone Depletion" OR "Smog" OR "Equipment reuse" OR "Greenhouse Gases" OR "Greenhouse Gas" OR "SO2 equiv*" OR "CO2 equiva*" OR "CFC-11 equiv*" OR "N equiv*" OR "Biodiversity" OR "Climatic change" OR "Green deal" OR "preservation of natural resources" OR "Refuse Disposal" OR "Waste Water" OR "Wastewater" OR "Water Purification" OR (("plastic*" OR "microplastic*") AND ("soup" OR "pollution" OR "overuse" OR "contamination")) OR "Sustainable Development" OR "Sustainable Development" OR (("Plastic" OR "plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))):ti,ab,kw OR ("environmental" OR "sustainability"):ti)

UV4.2

(("inhalation anesthetic agent" OR "inhalation anesthesia" OR "Closed Circuit Anesthesia" OR "Endotracheal Anesthesia" OR "Closed Circuit Anaesthesia" OR "Endotracheal Anaesthesia" OR "Halothane" OR "Isoflurane" OR "Methoxyflurane" OR "Sevoflurane" OR "Anaesthetic gas" OR "Anaesthetic gases" OR "Anesthetic gas" OR "Anesthetic gases" OR "Desflurane" OR "Enflurane" OR "Flurane" OR "Fluranes" OR "Gaseous anaesthesia" OR "Gaseous anaesthetic" OR "Gaseous anaesthetics" OR "Gaseous anesthesia" OR "Gaseous anesthetic" OR "Gaseous anesthetics" OR "Halothane" OR "Inhalation anaesthesia" OR "inhalation anaesthetic" OR "inhalation anaesthetics" OR "Inhalation anesthesia" OR "inhalation anesthetic" OR "inhalation anesthetics" OR "Inhalational agents" OR "Inhalational anaesthesia" OR "Inhalational anaesthetic" OR "Inhalational anaesthetic agent" OR "Inhalational anaesthetic agents" OR "Inhalational anaesthetics" OR "Inhalational anesthesia" OR "Inhalational anesthetic" OR "Inhalational anesthetic agent" OR "Inhalational anesthetic agents" OR "Inhalational anesthetics" OR "Inhaled anaesthetic" OR "Inhaled anaesthetic agent" OR "Inhaled anaesthetic agents" OR "Inhaled anaesthetics" OR "Inhaled anesthetic" OR "Inhaled anesthetic agents" OR "Inhaled anesthetics" OR "insufflation anaesthesia" OR "insufflation anaesthetic" OR "insufflation anaesthetics" OR "insufflation anesthesia" OR "insufflation anesthetic" OR "insufflation anesthetics" OR "Isoflurane" OR "Methoxyflurane" OR "Sevoflurane" OR "Vapor anaesthesia" OR "Vapor anaesthetic" OR "Vapor anaesthetics" OR "Vapor anesthesia" OR "Vapor anesthetic" OR "Vapor anesthetics" OR "Volatile agent" OR "Volatile agents" OR "Volatile Anaesthetic" OR "Volatile Anaesthetics" OR "Volatile anesthetic" OR "Volatile anesthetics" OR "Volatile drug" OR "Volatile drugs" OR "Volatile fluorinated liquid" OR "Volatile fluorinated liquids" OR "Volatile gas" OR "Volatile gases" OR "Volatile liquid agent" OR "Volatile liquid agents" OR "Anesthetic Gas" OR "Anesthetic Gases" OR "Inhalation Anaesthetic" OR "Inhalation Anaesthetics" OR "Inhalation Anesthetic" OR "Inhalation Anesthetics") AND ("scavenging system" OR "anaesthetic gas scavenging system" OR "anesthetic gas scavenging system" OR "Contrafluran" OR "gas extract*" OR "gas extraction" OR "gas extraction system" OR "gas extraction systems" OR "gas scaveng*" OR "gas scavenger" OR "gas scavengers" OR "gas scavenging " OR "scavenging device" OR "scavenging device" OR "scavenging devices" OR "scavenging system" OR "scavenging systems" OR "vapour captur*" OR "vapour capture" OR "Vapour Capture Technology" OR "vapour recycl*" OR "vapour recycling technology" OR "vapour recycling")):ti,ab,kw **AND** (("Carbon Footprint" OR "carbon footprint" OR "carbon footprint*" OR "Climate Change" OR "climate change" OR "CO2 emission" OR "CO2 emissions" OR "CO2 footprint" OR "CO2 footprint*" OR "environmental protection" OR "conservation of natural resources" OR "environmental protection" OR "Disposable Equipment" OR "Disposables" OR "Disposable" OR "ecological footprint" OR "ecological footprint*" OR "ecological sustainability" OR "environmental impact" OR "environmental impact" OR "environmental impact*" OR "environmental impacts" OR "environmental pollut*" OR "pollution" OR "environmental pollution" OR "environmental sustainab*" OR "environmental sustainability" OR "environmental sustainability" OR "Global Warming" OR "Global Warming" OR "Greenhouse Effect" OR "greenhouse effect*" OR "greenhouse effects" OR "greenhouse gas emission" OR "greenhouse gas emissions" OR "Greenhouse Gas" OR "greening" OR "hospital waste" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assess*" OR "life cycle assessment" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories" OR "Waste Disposal" OR "Hospital Waste" OR "medical waste" OR "Rising Sea Level" OR "Rising Sea Levels" OR "Sea Level Rise" OR "Sea Level Rise" OR "Waste Disposal" OR "waste water recycling" OR "Recycling" OR "recycling" OR "recycle*" OR "Equipment reuse" OR "Reusables" OR "reusable" OR "reuse" OR "reused" OR "reusing" OR "Waste Disposal" OR "Waste Management" OR "Plastic overuse" OR "Green surgery" OR "Emission reduction" OR "Emission reduction strategy" OR "air pollution control" OR "air pollution control" OR "acidification" OR "soil acidification" OR "ocean acidification" OR "acidification" OR "Acidification potential" OR "AP in kg SO2 equivalents" OR "eco-efficiency" OR "ecoefficiency" OR "eco-efficien*" OR "ecoefficien*" OR "ecotoxicity" OR "ecotoxicity" OR "ecotoxic*" OR "eco toxicity" OR "eco toxic*" OR "EP in kg PO4 equivalent" OR "Eutrophication" OR "eutrophication" OR "Eutrophication potential" OR "FAETP in kg DCB equivalent" OR "Freshwater Aquatic Ecotoxicity Potential" OR "GWP in kg CO2 equivalents" OR "H+ moles equivalents" OR "HTTP in kg Dichlorobenzene equivalent" OR "Human Toxicity Potential" OR "kg 2.4-D equivalents" OR "kg CFC-11 equivalent" OR "kg N equivalents" OR "kg NOx equivalents" OR "life cycle analysis" OR "ozone depletion" OR "Photochemical Ozone Depletion Potential" OR "POCP in kg ethane equivalent" OR "smog" OR "Waste" OR "waste" OR "wastes" OR "Ozone Depletion" OR "Smog" OR "Equipment reuse" OR "Greenhouse Gases" OR "Greenhouse Gas" OR "SO2 equiv*" OR "CO2 equiva*" OR "CFC-11 equiv*" OR "N equiv*" OR "Biodiversity" OR "Climatic change" OR "Green deal" OR "preservation of natural resources" OR "Refuse Disposal" OR "Waste Water" OR "Wastewater" OR "Water Purification" OR (("plastic*" OR "microplastic*") AND ("soup" OR "pollution" OR "overuse" OR "contamination")) OR "Sustainable Development" OR "Sustainable Development" OR (("Plastic" OR "plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))):ti,ab,kw OR ("environmental" OR "sustainability"):ti)

UV4.3

(("Local Anesthesia" OR "local anesthetic agent" OR "Nerve Block" OR "Local Anesthesia" OR "Local Anaesthesia" OR "Locoregional Anesthesia" OR "Locoregional Anaesthesia" OR "Local Anesthetics" OR "Local Anaesthetics" OR "Locoregional Anesthetics" OR "Locoregional Anaesthetics" OR "Local Anesthetic" OR "Local Anaesthetic" OR "Locoregional Anesthetic" OR "Locoregional Anaesthetic" OR "axillary block" OR "axillary block*" OR "Bier block" OR "Bier block*" OR "Bier's block" OR "Bier's block*" OR "brachial plexus block" OR "brachial plexus block*" OR "combined spinal epidural" OR "combined spinal epidural block" OR "combined spinal epidural block*" OR "epidural anaesthesia" OR "epidural anesthesia" OR "intravenous regional anesthaesia" OR "intravenous regional anesthesia" OR "ischiadic block" OR "ischiadic block*" OR "local infiltration" OR "lower extremity block" OR "lower extremity block*" OR "nerve block" OR "nerve block" OR "nerve block*" OR "nerve block*" OR "neuraxial anaesthesia" OR "neuraxial anesthesia" OR "neuraxial block" OR "neuraxial block*" OR "neuraxial technique" OR "neuraxial techniques" OR "peripheral nerve block" OR "peripheral nerve block*" OR "plexus block" OR "plexus block*" OR "plexus nerve block" OR "plexus nerve block*" OR "popliteal block" OR "popliteal block*" OR "regional anaesthesia" OR "regional anesthesia" OR "spinal anaesthesia" OR "spinal anaesthetic block" OR "spinal anaesthetic block*" OR "spinal anesthesia" OR "spinal anesthetic block" OR "spinal anesthetic block*" OR "supraclavicular block" OR "supraclavicular block*" OR "upper extremity block" OR "upper extremity block*") AND ("General Anesthesia" OR "general anesthesia" OR "general anaesthesia" OR "general anesthe*" OR "general anaesthe*" OR "inhalation anesthetic agent" OR "inhalation anesthesia" OR "Closed Circuit Anesthesia" OR "Endotracheal Anesthesia" OR "Closed Circuit Anaesthesia" OR "Endotracheal Anaesthesia" OR "Halothane" OR "Isoflurane" OR "Methoxyflurane" OR "Sevoflurane" OR "Anaesthetic gas" OR "Anaesthetic gases" OR "Anesthetic gas" OR "Anesthetic gases" OR "Desflurane" OR "Enflurane" OR "Flurane" OR "Fluranes" OR "Gaseous anaesthesia" OR "Gaseous anaesthetic" OR "Gaseous anaesthetics" OR "Gaseous anesthesia" OR "Gaseous anesthetic" OR "Gaseous anesthetics" OR "Halothane" OR "Inhalation anaesthesia" OR "inhalation anaesthetic" OR "inhalation anaesthetics" OR "Inhalation anesthesia" OR "inhalation anesthetic" OR "inhalation anesthetics" OR "Inhalational agents" OR "Inhalational anaesthesia" OR "Inhalational anaesthetic" OR "Inhalational anaesthetic agent" OR "Inhalational anaesthetic agents" OR "Inhalational anaesthetics" OR "Inhalational anesthesia" OR "Inhalational anesthetic" OR "Inhalational anesthetic agent" OR

"Inhalational anesthetic agents" OR "Inhalational anesthetics" OR "Inhaled anaesthetic" OR "Inhaled anaesthetic agent" OR "Inhaled anaesthetic agents" OR "Inhaled anaesthetics" OR "Inhaled anesthetic" OR "Inhaled anesthetic agents" OR "Inhaled anesthetics" OR "insufflation anaesthesia" OR "insufflation anaesthetic" OR "insufflation anaesthetics" OR "insufflation anesthesia" OR "insufflation anesthetic" OR "insufflation anesthetics" OR "Isoflurane" OR "Methoxyflurane" OR "Sevoflurane" OR "Vapor anaesthesia" OR "Vapor anaesthetic" OR "Vapor anaesthetics" OR "Vapor anesthesia" OR "Vapor anesthetic" OR "Vapor anesthetics" OR "Volatile agent" OR "Volatile agents" OR "Volatile Anaesthetic" OR "Volatile Anaesthetics" OR "Volatile anesthetic" OR "Volatile anesthetics" OR "Volatile drug" OR "Volatile drugs" OR "Volatile fluorinated liquid" OR "Volatile fluorinated liquids" OR "Volatile gas" OR "Volatile gases" OR "Volatile liquid agent" OR "Volatile liquid agents" OR "Anesthetic Gas" OR "Anesthetic Gases" OR "Inhalation Anaesthetic" OR "Inhalation Anaesthetics" OR "Inhalation Anesthetic" OR "Inhalation Anesthetics" OR "intravenous anesthetic agent" OR "Intravenous Anesthesia" OR "Intravenous Anesthetics" OR "Intravenous Anaesthetics" OR "Intravenous Anesthetic" OR "Intravenous Anaesthetic" OR "Intravenous Anesthesia" OR "Intravenous Anaesthesia" OR "Dissociative Anesthetics" OR "Dissociative Anaesthetics" OR "Dissociative Anesthetic" OR "Dissociative Anaesthetic" OR "Dissociative Anesthesia" OR "Dissociative Anaesthesia" OR "2 (3 methoxyphenyl) 2 (ethylamino)cyclohexanone" OR "2 Oxo PCE" OR "Alfentanil" OR "Chloralose" OR "Diazepam" OR "Etomidate" OR "Fentanyl" OR "Ketamine" OR "Methohexital" OR "Midazolam" OR "Propanidid" OR "Propofol" OR "Sodium Oxybate" OR "Sufentanil" OR "Thiamylal" OR "Thiopental" OR "Tiletamine" OR "Urethane" OR "2 (3 methoxyphenyl) 2 (ethylamino)cyclohexanone" OR "2 Oxo PCE" OR "Alfentanil" OR "Chloralose" OR "Diazepam" OR "Etomidate" OR "Fentanyl" OR "intravenous anaesthesia" OR "intravenous anaesthesias" OR "Intravenous anaesthetic" OR "Intravenous anaesthetic agent" OR "Intravenous anaesthetic agents" OR "Intravenous anaesthetic drug" OR "Intravenous anaesthetic drugs" OR "Intravenous anaesthetics" OR "intravenous anesthesia" OR "intravenous anesthesias" OR "intravenous anesthetic" OR "Intravenous anesthetic agents" OR "Intravenous anesthetic agents" OR "Intravenous anesthetic drug" OR "Intravenous anesthetic drugs" OR "intravenous anesthetics" OR "IV anaesthesia" OR "IV anaesthetics" OR "IV anaesthetics" OR "IV anesthesia" OR "IV anesthetic" OR "IV anesthetics" OR "Ketamine" OR "Methohexital" OR "Midazolam" OR "Propanidid" OR "Propofol" OR "Sodium Oxybate" OR "Sufentanil" OR "Thiamylal" OR "Thiopental" OR "Tiletamine" OR "TIVA" OR "Total intravenous anaesthesia" OR "Total Intravenous anesthesia" OR "Urethane")):ti,ab,kw AND (("Carbon Footprint" OR "carbon footprint" OR "carbon footprint*" OR "Climate Change" OR "climate change" OR "CO2 emission" OR "CO2 emissions" OR "CO2 footprint" OR "CO2 footprint*" OR "environmental protection" OR "conservation of natural resources" OR "environmental protection" OR "Disposable Equipment" OR "Disposables" OR "Disposable" OR "ecological footprint" OR "ecological footprint*" OR "ecological sustainability" OR "environmental impact" OR "environmental impact" OR "environmental impact*" OR "environmental impacts" OR "environmental pollut*" OR "pollution" OR "environmental pollution" OR "environmental sustainab*" OR "environmental sustainability" OR "environmental sustainability" OR "Global Warming" OR "Global Warming" OR "Greenhouse Effect" OR "greenhouse effect*" OR "greenhouse effects" OR "greenhouse gas emission" OR "greenhouse gas emissions" OR "Greenhouse Gas" OR "greening" OR "hospital waste" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assess*" OR "life cycle assessment" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories" OR "Waste Disposal" OR "Hospital Waste" OR "medical waste" OR "Rising Sea Level" OR "Rising Sea Levels" OR "Sea Level Rise" OR "Sea Level Rise" OR "Waste Disposal" OR "waste water recycling" OR "Recycling" OR "recycling" OR "recycle*" OR "Equipment reuse" OR "Reusables" OR "reusable" OR "reuse" OR "reused" OR "reusing" OR "Waste Disposal" OR "Waste Management" OR "Plastic overuse" OR "Green surgery" OR "Emission reduction" OR "Emission reduction strategy" OR "air pollution control" OR "air pollution control" OR "acidification" OR "soil acidification" OR "ocean acidification" OR "acidification" OR "Acidification potential" OR "AP in kg SO2 equivalents" OR "eco-efficiency" OR "ecoefficiency" OR "eco-efficien*" OR "ecoefficien*" OR "ecotoxicity" OR "ecotoxicity" OR "ecotoxic*" OR "eco toxicity" OR "eco toxic*" OR "EP in kg PO4 equivalent" OR "Eutrophication" OR "eutrophication" OR "Eutrophication potential" OR "FAETP in kg DCB equivalent" OR "Freshwater Aquatic Ecotoxicity Potential" OR "GWP in kg CO2 equivalents" OR "H+ moles equivalents" OR "HTTP in kg Dichlorobenzene equivalent" OR "Human Toxicity Potential" OR "kg 2.4-D equivalents" OR "kg CFC-11 equivalent" OR "kg N equivalents" OR "kg NOx equivalents" OR "life cycle analysis" OR "ozone depletion" OR "Photochemical Ozone Depletion Potential" OR "POCP in kg ethane equivalent" OR "smog" OR "Waste" OR "waste" OR "wastes" OR "Ozone Depletion" OR "Smog" OR "Equipment reuse" OR "Greenhouse Gases" OR "Greenhouse Gas" OR "SO2 equiv*" OR "CO2 equiva*" OR "CFC-11 equiv*" OR "N equiv*" OR "Biodiversity" OR "Climatic change" OR "Green deal" OR "preservation of natural resources" OR "Refuse Disposal" OR "Waste Water" OR "Wastewater" OR "Water Purification" OR (("plastic*" OR "microplastic*") AND ("soup" OR "pollution" OR "overuse" OR "contamination")) OR "Sustainable Development" OR "Sustainable Development" OR (("Plastic" OR "plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))):ti,ab,kw OR ("environmental" OR "sustainability"):ti)

Emcare (OVID)
UV4.1
((exp "inhalation anesthetic agent"/ OR exp "inhalation anesthesia"/ OR "Closed-Circuit Anesthesia".mp OR "Endotracheal Anesthesia".mp OR "Closed-Circuit Anaesthesia".mp OR "Endotracheal Anaesthesia".mp OR "Halothane"/ OR "Isoflurane"/ OR "Methoxyflurane"/ OR "Sevoflurane"/ OR "Anaesthetic gas".mp OR "Anaesthetic gases".mp OR "Anesthetic gas".mp OR "Anesthetic gases".mp OR "Desflurane".mp OR "Enflurane".mp OR "Flurane".mp OR "Fluranes".mp OR "Gaseous anaesthesia".mp OR "Gaseous anaesthetic".mp OR "Gaseous anaesthetics".mp OR "Gaseous anesthesia".mp OR "Gaseous anesthetic".mp OR "Gaseous anesthetics".mp OR "Halothane".mp OR "Inhalation anaesthesia".mp OR "inhalation anaesthetic".mp OR "inhalation anaesthetics".mp OR "Inhalation anesthesia".mp OR "inhalation anesthetic".mp OR "inhalation anesthetics".mp OR "Inhalational agents".mp OR "Inhalational anaesthesia".mp OR "Inhalational anaesthetic".mp OR "Inhalational anaesthetic agent".mp OR "Inhalational anaesthetic agents".mp OR "Inhalational anaesthetics".mp OR "Inhalational anesthesia".mp OR "Inhalational anesthetic".mp OR "Inhalational anesthetic agent".mp OR "Inhalational anesthetic agents".mp OR "Inhalational anesthetics".mp OR "Inhaled anaesthetic".mp OR "Inhaled anaesthetic agent".mp OR

"Inhaled anaesthetic agents".mp OR "Inhaled anaesthetics".mp OR "Inhaled anesthetic".mp OR "Inhaled anesthetic agents".mp OR "Inhaled anesthetics".mp OR "insufflation anaesthesia".mp OR "insufflation anaesthetic".mp OR "insufflation anaesthetics".mp OR "insufflation anesthesia".mp OR "insufflation anesthetic".mp OR "insufflation anesthetics".mp OR "Isoflurane".mp OR "Methoxyflurane".mp OR "Sevoflurane".mp OR "Vapor anaesthesia".mp OR "Vapor anaesthetic".mp OR "Vapor anaesthetics".mp OR "Vapor anesthesia".mp OR "Vapor anesthetic".mp OR "Vapor anesthetics".mp OR "Volatile agent".mp OR "Volatile agents".mp OR "Volatile Anaesthetic".mp OR "Volatile Anaesthetics".mp OR "Volatile anesthetic".mp OR "Volatile anesthetics".mp OR "Volatile drug".mp OR "Volatile drugs".mp OR "Volatile fluorinated liquid".mp OR "Volatile fluorinated liquids".mp OR "Volatile gas".mp OR "Volatile gases".mp OR "Volatile liquid agent".mp OR "Volatile liquid agents".mp OR "Anesthetic Gas".mp OR "Anesthetic Gases".mp OR "Inhalation Anaesthetic".mp OR "Inhalation Anaesthetics".mp OR "Inhalation Anesthetic".mp OR "Inhalation Anesthetics".mp) AND (exp "intravenous anesthetic agent"/ OR exp "Intravenous Anesthesia"/ OR "Intravenous Anesthetics".mp OR "Intravenous Anaesthetics".mp OR "Intravenous Anesthetic".mp OR "Intravenous Anaesthetic".mp OR "Intravenous Anesthesia".mp OR "Intravenous Anaesthesia".mp OR "Dissociative Anesthetics".mp OR "Dissociative Anaesthetics".mp OR "Dissociative Anesthetic".mp OR "Dissociative Anaesthetic".mp OR "Dissociative Anesthesia".mp OR "Dissociative Anaesthesia".mp OR "2-(3-methoxyphenyl)-2-(ethylamino)cyclohexanone"/ OR "2-Oxo-PCE"/ OR "Alfentanil"/ OR "Chloralose"/ OR "Diazepam"/ OR "Etomidate"/ OR "Fentanyl"/ OR "Ketamine"/ OR "Methohexital"/ OR "Midazolam"/ OR "Propanidid"/ OR "Propofol"/ OR "Sodium Oxybate"/ OR "Sufentanil"/ OR "Thiamylal"/ OR "Thiopental"/ OR "Tiletamine"/ OR "Urethane"/ OR "2-(3-methoxyphenyl)-2-(ethylamino)cyclohexanone".mp OR "2-Oxo-PCE".mp OR "Alfentanil".mp OR "Chloralose".mp OR "Diazepam".mp OR "Etomidate".mp OR "Fentanyl".mp OR "intravenous anaesthesia".mp OR "intravenous anaesthesias".mp OR "Intravenous anaesthetic".mp OR "Intravenous anaesthetic agent".mp OR "Intravenous anaesthetic agents".mp OR "Intravenous anaesthetic drug".mp OR "Intravenous anaesthetic drugs".mp OR "Intravenous anaesthetics".mp OR "intravenous anesthesia".mp OR "intravenous anesthesias".mp OR "intravenous anesthetic".mp OR "Intravenous anesthetic agents".mp OR "Intravenous anesthetic agents".mp OR "Intravenous anesthetic drug".mp OR "Intravenous anesthetic drugs".mp OR "intravenous anesthetics".mp OR "IV anaesthesia".mp OR "IV anaesthetics".mp OR "IV anaesthetics".mp OR "IV anesthesia".mp OR "IV anesthetic".mp OR "IV anesthetics".mp OR "Ketamine".mp OR "Methohexital".mp OR "Midazolam".mp OR "Propanidid".mp OR "Propofol".mp OR "Sodium Oxybate".mp OR "Sufentanil".mp OR "Thiamylal".mp OR "Thiopental".mp OR "Tiletamine".mp OR "TIVA".mp OR "Total intravenous anaesthesia".mp OR "Total Intravenous anesthesia".mp OR "Urethane".mp)) AND ("Carbon Footprint"/ OR "carbon footprint".mp OR "carbon footprint*".mp OR exp "Climate Change"/ OR "climate change".mp OR "CO2 emission".mp OR "CO2 emissions".mp OR "CO2 footprint".mp OR "CO2 footprint*".mp OR exp "environmental protection"/ OR "conservation of natural resources".mp OR "environmental protection".mp OR "Disposable Equipment"/ OR "Disposables".mp OR "Disposable".mp OR "ecological footprint".mp OR "ecological footprint*".mp OR "ecological sustainability".mp OR exp "environmental impact"/ OR "environmental impact".mp OR "environmental impact*".mp OR "environmental impacts".mp OR "environmental pollut*".mp OR exp "pollution"/ OR "environmental pollution".mp OR "environmental sustainab*".mp OR "environmental sustainability"/ OR "environmental sustainability".mp OR "Global Warming"/ OR "Global Warming".mp OR "Greenhouse Effect"/ OR "greenhouse effect*".mp OR "greenhouse effects".mp OR "greenhouse gas emission".mp OR "greenhouse gas emissions".mp OR "Greenhouse Gas"/ OR "greening".mp OR "hospital waste".mp OR "life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp OR exp "Waste Disposal"/ OR exp "Hospital Waste"/ OR "medical waste".mp OR "Rising Sea Level".mp OR "Rising Sea Levels".mp OR "Sea Level Rise"/ OR "Sea Level Rise".mp OR "sustainability".ti OR "Waste Disposal".mp OR "waste water recycling"/ OR "Recycling"/ OR "recycling".mp OR "recycle*".mp OR "Equipment reuse".mp OR "Reusables".mp OR "reusable".mp OR "reuse".mp OR "reused".mp OR "reusing".mp OR exp "Waste Disposal"/ OR exp "Waste Management"/ OR "Plastic overuse".mp OR "Green surgery".mp OR "Emission reduction".mp OR "Emission reduction strategy".mp OR "air pollution control"/ OR "air pollution control".mp OR "Environment"/ OR "Environmental*".ti OR "acidification"/ OR "soil acidification"/ OR "ocean acidification"/ OR "acidification".mp OR "Acidification potential".mp OR "AP in kg SO2 equivalents".mp OR "eco-efficiency".mp OR "ecoefficiency".mp OR "eco-efficien*".mp OR "ecoefficien*".mp OR "ecotoxicity"/ OR "ecotoxicity".mp OR "ecotoxic*".mp OR "eco toxicity".mp OR "eco toxic*".mp OR "EP in kg PO4 equivalent".mp OR exp "Eutrophication"/ OR "eutrophication".mp OR "Eutrophication potential".mp OR "FAETP in kg DCB equivalent".mp OR "Freshwater Aquatic Ecotoxicity Potential".mp OR "GWP in kg CO2 equivalents".mp OR "H+ moles equivalents".mp OR "HTTP in kg Dichlorobenzene equivalent".mp OR "Human Toxicity Potential".mp OR "kg 2.4-D equivalents".mp OR "kg CFC-11 equivalent".mp OR "kg N equivalents".mp OR "kg NOx equivalents".mp OR "life cycle analysis".mp OR "ozone depletion".mp OR "Photochemical Ozone Depletion Potential".mp OR "POCP in kg ethane equivalent".mp OR "smog".mp OR exp "Waste"/ OR "waste".mp OR "wastes".mp OR "Ozone Depletion"/ OR "Smog"/ OR "Equipment reuse".mp OR "Greenhouse Gases".mp OR "Greenhouse Gas".mp OR "SO2 equiv*".mp OR "CO2 equiva*".mp OR "CFC-11 equiv*".mp OR "N equiv*".mp OR exp "Biodiversity"/ OR "Biodiversity".mp OR "Climatic change".mp OR "Green deal".mp OR "preservation of natural resources".mp OR "Refuse Disposal".mp OR exp "Wastewater"/ OR "Waste Water".mp OR "Wastewater".mp OR exp "Water Management"/ OR "Water Purification".mp OR (("plastic*".mp OR "microplastic*".mp) AND ("soup".mp OR "pollution".mp OR "overuse".mp OR "contamination".mp)) OR "Sustainable Development"/ OR "Sustainable Development".mp OR (("Plastic".mp OR "plastics".mp) AND "overuse".mp) OR ("hydrogen*".mp AND "moles".mp AND "equiv*".mp) OR ("Dichlorobenzen*".mp AND "equiv*".mp) OR ("2,4-D".mp AND "equiv*".mp) OR ("NOx".mp AND "equiv*".mp) OR ("ethane".mp AND "equiv*".mp) OR ("PO4".mp AND "equiv*".mp) OR ("DCB".mp AND "equiv*".mp) OR ("sustainability".mp AND ("environment*".mp OR "carbon".mp)) OR (("Carbon Dioxide"/ OR "Carbon Dioxide".mp OR "CO2".mp) AND ("pollution".mp OR "emission".mp OR "emissions".mp OR "waste".mp OR "environment".mp OR "environmental*".mp OR "footprint".mp OR "footprint*".mp OR "sustainable".mp OR "hazard".mp OR "hazard*".mp))) NOT (conference review or conference abstract).pt AND (2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022).yr AND (*(exp "meta analysis"/ OR exp "meta analysis (topic)"/ OR metaanaly*.ti,ab OR "meta analy*".ti,ab OR metanaly*.ti,ab OR "systematic review"/ OR "cochrane database of systematic reviews".jn OR prisma.ti,ab OR prospero.ti,ab OR (((systemati* OR scoping OR umbrella OR "structured literature") ADJ3 (review* OR overview*)).ti,ab) OR ((systemic* ADJ1 review*).ti,ab) OR (((systemati* OR literature OR database* OR "data base*") ADJ10 search*).ti,ab) OR (((structured OR* *comprehensive* OR systemic*) ADJ3 search*).ti,ab) OR (((literature ADJ3 review*).ti,ab) AND (search*.ti,ab OR database*.ti,ab OR "data base*".ti,ab)) OR (("data extraction".ti,ab OR "data source*".ti,ab) AND "study selection".ti,ab) OR ("search strategy".ti,ab AND "selection criteria".ti,ab) OR ("data source*".ti,ab AND "data synthesis".ti,ab) OR medline.ab OR pubmed.ab OR embase.ab OR cochrane.ab OR (((critical OR rapid) ADJ2 (review* OR overview* OR synthes*)).ti) OR ((((critical* OR rapid*) ADJ3 (review* OR overview* OR synthes*)).ab) AND (search*.ab OR database*.ab OR "data base*".ab)) OR metasynthes*.ti,ab OR "meta synthes*".ti,ab)* OR (exp "clinical trial"/ OR exp "randomization"/ OR exp "single blind procedure"/ OR exp "double blind procedure"/ OR exp "crossover procedure"/ OR exp "placebo"/ OR exp "prospective study"/ OR rct.ti,ab OR random*.ti,ab OR "single blind".ti,ab OR "randomised controlled trial".ti,ab OR exp "randomized controlled trial"/ OR placebo*.ti,ab) OR (exp "Comparative Study"/ OR "comparison".ti,ab OR "comparative".ti,ab OR "compar*".ti,ab OR "major clinical study"/ OR "clinical study"/ OR "case control study"/ OR "family study"/ OR "longitudinal study"/ OR "retrospective study"/ OR "prospective study"/ OR "cohort analysis"/ OR cohort*.ti,ab OR (("case control" ADJ1 (study OR studies)).ti,ab) OR (("follow up" ADJ1 (study OR studies)).ti,ab) OR (observational ADJ1 (study OR studies)).ti,ab OR ((epidemiologic ADJ1 (study OR studies)).ti,ab) OR (("cross sectional" ADJ1 (study OR studies)).ti,ab)) OR ("life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "life cycle inventory".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp))

UV4.2

(TS=("Closed-Circuit Anesthesia" OR "Endotracheal Anesthesia" OR "Closed-Circuit Anaesthesia" OR "Endotracheal Anaesthesia" OR "Halothane" OR "Isoflurane" OR "Methoxyflurane" OR "Sevoflurane" OR "Anaesthetic gas" OR "Anaesthetic gases" OR "Anesthetic gas" OR "Anesthetic gases" OR "Desflurane" OR "Enflurane" OR "Flurane" OR "Fluranes" OR "Gaseous anaesthesia" OR "Gaseous anaesthetic" OR "Gaseous anaesthetics" OR "Gaseous anesthesia" OR "Gaseous anesthetic" OR "Gaseous anesthetics" OR "Halothane" OR "Inhalation anaesthesia" OR "inhalation anaesthetic" OR "inhalation anaesthetics" OR "Inhalation anesthesia" OR "inhalation anesthetic" OR "inhalation anesthetics" OR "Inhalational agents" OR "Inhalational anaesthesia" OR "Inhalational anaesthetic" OR "Inhalational anaesthetic agent" OR "Inhalational anaesthetic agents" OR "Inhalational anaesthetics" OR "Inhalational anesthesia" OR "Inhalational anesthetic" OR "Inhalational anesthetic agent" OR "Inhalational anesthetic agents" OR "Inhalational anesthetics" OR "Inhaled anaesthetic" OR "Inhaled anaesthetic agent" OR "Inhaled anaesthetic agents" OR "Inhaled anaesthetics" OR "Inhaled anesthetic" OR "Inhaled anesthetic agents" OR "Inhaled anesthetics" OR "insufflation anaesthesia" OR "insufflation anaesthetic" OR "insufflation anaesthetics" OR "insufflation anesthesia" OR "insufflation anesthetic" OR "insufflation anesthetics" OR "Isoflurane" OR "Methoxyflurane" OR "Sevoflurane" OR "Vapor anaesthesia" OR "Vapor anaesthetic" OR "Vapor anaesthetics" OR "Vapor anesthesia" OR "Vapor anesthetic" OR "Vapor anesthetics" OR "Volatile agent" OR "Volatile agents" OR "Volatile Anaesthetic" OR "Volatile Anaesthetics" OR "Volatile anesthetic" OR "Volatile anesthetics" OR "Volatile drug" OR "Volatile drugs" OR "Volatile fluorinated liquid" OR "Volatile fluorinated liquids" OR "Volatile gas" OR "Volatile gases" OR "Volatile liquid agent" OR "Volatile liquid agents" OR "Anesthetics, Inhalation" OR "Anesthetic Gas" OR "Anesthetic Gases" OR "Inhalation Anaesthetic" OR "Inhalation Anaesthetics" OR "Inhalation Anesthetic" OR "Inhalation Anesthetics") AND TS=("scavenging system" OR "anaesthetic gas scavenging system" OR "anesthetic gas scavenging system" OR "Contrafluran" OR "gas extract*" OR "gas extraction" OR "gas extraction system" OR "gas extraction systems" OR "gas scaveng*" OR "gas scavenger" OR "gas scavengers" OR "gas scavenging " OR "scavenging device" OR "scavenging device" OR "scavenging devices" OR "scavenging system" OR "scavenging systems" OR "vapour captur*" OR "vapour capture" OR "Vapour Capture Technology" OR "vapour recycl*" OR "vapour recycling technology" OR "vapour recycling")) AND (TS=("Carbon Footprint" OR "carbon footprint" OR "carbon footprint*" OR "Climate Change" OR "climate change" OR "CO2 emission" OR "CO2 emissions" OR "CO2 footprint" OR "CO2 footprint*" OR "environmental protection" OR "conservation of natural resources" OR "environmental protection" OR "Disposable Equipment" OR "Disposables" OR "Disposable" OR "ecological footprint" OR "ecological footprint*" OR "ecological sustainability" OR "environmental impact" OR "environmental impact" OR "environmental impact*" OR "environmental impacts" OR "environmental pollut*" OR "pollution" OR "environmental pollution" OR "environmental sustainab*" OR "environmental sustainability" OR "environmental sustainability" OR "Global Warming" OR "Global Warming" OR "Greenhouse Effect" OR "greenhouse effect*" OR "greenhouse effects" OR "greenhouse gas emission" OR "greenhouse gas emissions" OR "Greenhouse Gas" OR "greening" OR "hospital waste" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assess*" OR "life cycle assessment" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories" OR "Waste Disposal" OR "Hospital Waste" OR "medical waste" OR "Rising Sea Level" OR "Rising Sea Levels" OR "Sea Level Rise" OR "Sea Level Rise" OR "Waste Disposal" OR "waste water recycling" OR "Recycling" OR "recycling" OR "recycle*" OR "Equipment reuse" OR "Reusables" OR "reusable" OR "reuse" OR "reused" OR "reusing" OR "Waste Disposal" OR "Waste Management" OR "Plastic overuse" OR "Green surgery" OR "Emission reduction" OR "Emission reduction strategy" OR "air pollution control" OR "air pollution control" OR "acidification" OR "soil acidification" OR "ocean acidification" OR "acidification" OR "Acidification potential" OR "AP in kg SO2 equivalents" OR "eco-efficiency" OR "ecoefficiency" OR "eco-efficien*" OR "ecoefficien*" OR "ecotoxicity" OR "ecotoxicity" OR "ecotoxic*" OR "eco toxicity" OR "eco toxic*" OR "EP in kg PO4 equivalent" OR "Eutrophication" OR "eutrophication" OR "Eutrophication potential" OR "FAETP in kg DCB equivalent" OR "Freshwater Aquatic Ecotoxicity Potential" OR "GWP in kg CO2 equivalents" OR "H+ moles equivalents" OR "HTTP in kg Dichlorobenzene equivalent" OR "Human Toxicity Potential" OR "kg 2.4-D equivalents" OR "kg CFC-11 equivalent" OR "kg N equivalents" OR "kg NOx equivalents" OR "life cycle analysis" OR "ozone depletion" OR "Photochemical Ozone Depletion Potential" OR "POCP in kg ethane equivalent" OR "smog" OR "Waste" OR "waste" OR "wastes" OR "Ozone Depletion" OR "Smog" OR "Equipment reuse" OR "Greenhouse Gases" OR "Greenhouse Gas" OR "SO2 equiv*" OR "CO2 equiva*" OR "CFC-11 equiv*" OR "N equiv*" OR "Sustainable Development" OR "Sustainable Development" OR "Biodiversity" OR "Climatic change" OR "Green deal" OR "preservation of natural resources" OR "Refuse Disposal" OR "Waste Water" OR "Wastewater" OR "Water Purification" OR (("plastic*" OR "microplastic*") AND ("soup" OR "pollution" OR "overuse" OR "contamination")) OR (("Plastic" OR "plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))) OR TI=("environmental*" OR "sustainab*")) NOT DT=(meeting abstract) AND (PY=(2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022)) AND (TI=(("Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR4 ("review*" OR "overview*" OR "synthes*") NEAR4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*") OR ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR1 (study OR studies))) OR (("follow up" NEAR1 (study OR studies))) OR (observational NEAR1 (study OR studies)) OR ((epidemiologic NEAR1 (study OR studies))) OR (("cross sectional" NEAR1 (study OR studies)))) OR ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")) OR AB=(("Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR4 ("review*" OR "overview*" OR "synthes*") NEAR4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*") OR ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR1 (study OR studies))) OR (("follow up" NEAR1 (study OR studies))) OR (observational NEAR1 (study OR studies)) OR ((epidemiologic NEAR1 (study OR studies))) OR (("cross sectional" NEAR1 (study OR studies)))) OR ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")))

UV4.3

((exp "Local Anesthesia"/ OR exp "local anesthetic agent"/ OR exp "Nerve Block"/ OR "Local Anesthesia".mp OR "Local Anaesthesia".mp OR "Locoregional Anesthesia".mp OR "Locoregional Anaesthesia".mp OR "Local Anesthetics".mp OR "Local Anaesthetics".mp OR "Locoregional Anesthetics".mp OR "Locoregional Anaesthetics".mp OR "Local Anesthetic".mp OR "Local Anaesthetic".mp OR "Locoregional Anesthetic".mp OR "Locoregional Anaesthetic".mp OR "axillary block".mp OR "axillary block*".mp OR "Bier block".mp OR "Bier block*".mp OR "Bier's block".mp OR "Bier's block*".mp OR "brachial plexus block".mp OR "brachial plexus block*".mp OR "combined spinal epidural".mp OR "combined spinal epidural block".mp OR "combined spinal epidural block*".mp OR "epidural anaesthesia".mp OR "epidural anesthesia".mp OR "intravenous regional anesthaesia".mp OR "intravenous regional anesthesia".mp OR "ischiadic block".mp OR "ischiadic block*".mp OR "local infiltration".mp OR "lower extremity block".mp OR "lower extremity block*".mp OR "nerve block".mp OR "nerve block".mp OR "nerve block*".mp OR "nerve block*".mp OR "neuraxial anaesthesia".mp OR "neuraxial anesthesia".mp OR "neuraxial block".mp OR "neuraxial block*".mp OR "neuraxial technique".mp OR "neuraxial techniques".mp OR "peripheral nerve block".mp OR "peripheral nerve block*".mp OR "plexus block".mp OR "plexus block*".mp OR "plexus nerve block".mp OR "plexus nerve block*".mp OR "popliteal block".mp OR "popliteal block*".mp OR "regional anaesthesia".mp OR "regional anesthesia".mp OR "spinal anaesthesia".mp OR "spinal anaesthetic block".mp OR "spinal anaesthetic block*".mp OR "spinal anesthesia".mp OR "spinal anesthetic block".mp OR "spinal anesthetic block*".mp OR "supraclavicular block".mp OR "supraclavicular block*".mp OR "upper extremity block".mp OR "upper extremity block*".mp) AND (exp "General Anesthesia"/ OR "general anesthesia".mp OR "general anaesthesia".mp OR "general anesthe*".mp OR "general anaesthe*".mp OR exp "inhalation anesthetic agent"/ OR exp "inhalation anesthesia"/ OR "Closed-Circuit Anesthesia".mp OR "Endotracheal Anesthesia".mp OR "Closed-Circuit Anaesthesia".mp OR "Endotracheal Anaesthesia".mp OR "Halothane"/ OR "Isoflurane"/ OR "Methoxyflurane"/ OR "Sevoflurane"/ OR "Anaesthetic gas".mp OR "Anaesthetic gases".mp OR "Anesthetic gas".mp OR "Anesthetic gases".mp OR "Desflurane".mp OR "Enflurane".mp OR "Flurane".mp OR "Fluranes".mp OR "Gaseous anaesthesia".mp OR "Gaseous anaesthetic".mp OR "Gaseous anaesthetics".mp OR "Gaseous anesthesia".mp OR "Gaseous anesthetic".mp OR "Gaseous anesthetics".mp OR "Halothane".mp OR "Inhalation anaesthesia".mp OR "inhalation anaesthetic".mp OR "inhalation anaesthetics".mp OR "Inhalation anesthesia".mp OR "inhalation anesthetic".mp OR "inhalation anesthetics".mp OR "Inhalational agents".mp OR "Inhalational anaesthesia".mp OR "Inhalational anaesthetic".mp OR "Inhalational anaesthetic agent".mp OR "Inhalational anaesthetic agents".mp OR "Inhalational anaesthetics".mp OR 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"Methohexital"/ OR "Midazolam"/ OR "Propanidid"/ OR "Propofol"/ OR "Sodium Oxybate"/ OR "Sufentanil"/ OR "Thiamylal"/ OR "Thiopental"/ OR "Tiletamine"/ OR "Urethane"/ OR "2-(3-methoxyphenyl)-2-(ethylamino)cyclohexanone".mp OR "2-Oxo-PCE".mp OR "Alfentanil".mp OR "Chloralose".mp OR "Diazepam".mp OR "Etomidate".mp OR "Fentanyl".mp OR "intravenous anaesthesia".mp OR "intravenous anaesthesias".mp OR "Intravenous anaesthetic".mp OR "Intravenous anaesthetic agent".mp OR "Intravenous anaesthetic agents".mp OR "Intravenous anaesthetic drug".mp OR "Intravenous anaesthetic drugs".mp OR "Intravenous anaesthetics".mp OR "intravenous anesthesia".mp OR "intravenous anesthesias".mp OR "intravenous anesthetic".mp OR "Intravenous anesthetic agents".mp OR "Intravenous anesthetic agents".mp OR "Intravenous anesthetic drug".mp OR "Intravenous anesthetic drugs".mp OR "intravenous anesthetics".mp OR "IV anaesthesia".mp OR "IV anaesthetics".mp OR "IV anaesthetics".mp OR "IV anesthesia".mp OR "IV 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equivalents".mp OR "kg NOx equivalents".mp OR "life cycle analysis".mp OR "ozone depletion".mp OR "Photochemical Ozone Depletion Potential".mp OR "POCP in kg ethane equivalent".mp OR "smog".mp OR exp "Waste"/ OR "waste".mp OR "wastes".mp OR "Ozone Depletion"/ OR "Smog"/ OR "Equipment reuse".mp OR "Greenhouse Gases".mp OR "Greenhouse Gas".mp OR "SO2 equiv*".mp OR "CO2 equiva*".mp OR "CFC-11 equiv*".mp OR "N equiv*".mp OR exp "Biodiversity"/ OR "Biodiversity".mp OR "Climatic change".mp OR "Green deal".mp OR "preservation of natural resources".mp OR "Refuse Disposal".mp OR exp "Wastewater"/ OR "Waste Water".mp OR "Wastewater".mp OR exp "Water Management"/ OR "Water Purification".mp OR (("plastic*".mp OR "microplastic*".mp) AND ("soup".mp OR "pollution".mp OR "overuse".mp OR "contamination".mp)) OR "Sustainable Development"/ OR "Sustainable Development".mp OR (("Plastic".mp OR "plastics".mp) AND "overuse".mp) OR ("hydrogen*".mp AND "moles".mp AND "equiv*".mp) OR ("Dichlorobenzen*".mp AND "equiv*".mp) OR ("2,4-D".mp AND "equiv*".mp) OR ("NOx".mp AND "equiv*".mp) OR ("ethane".mp AND "equiv*".mp) OR ("PO4".mp AND "equiv*".mp) OR ("DCB".mp AND "equiv*".mp) OR ("sustainability".mp AND ("environment*".mp OR "carbon".mp)) OR (("Carbon Dioxide"/ OR "Carbon Dioxide".mp OR "CO2".mp) AND ("pollution".mp OR "emission".mp OR "emissions".mp OR "waste".mp OR "environment".mp OR "environmental*".mp OR "footprint".mp OR "footprint*".mp OR "sustainable".mp OR "hazard".mp OR "hazard*".mp))) NOT (conference review or conference abstract).pt AND (2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR

2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022).yr AND (*(exp "meta analysis"/ OR exp "meta analysis (topic)"/ OR metaanaly*.ti,ab OR "meta analy*".ti,ab OR metanaly*.ti,ab OR "systematic review"/ OR "cochrane database of systematic reviews".jn OR prisma.ti,ab OR prospero.ti,ab OR (((systemati* OR scoping OR umbrella OR "structured literature") ADJ3 (review* OR overview*)).ti,ab) OR ((systemic* ADJ1 review*).ti,ab) OR (((systemati* OR literature OR database* OR "data base*") ADJ10 search*).ti,ab) OR (((structured OR comprehensive* OR systemic*) ADJ3 search*).ti,ab) OR (((literature ADJ3 review*).ti,ab) AND (search*.ti,ab OR database*.ti,ab OR "data base*".ti,ab)) OR (("data extraction".ti,ab OR "data source*".ti,ab) AND "study selection".ti,ab) OR ("search strategy".ti,ab AND "selection criteria".ti,ab) OR ("data source*".ti,ab AND "data synthesis".ti,ab) OR medline.ab OR pubmed.ab OR embase.ab OR cochrane.ab OR (((critical OR rapid) ADJ2 (review* OR overview* OR synthes*)).ti) OR ((((critical* OR rapid*) ADJ3 (review* OR overview* OR synthes*)).ab) AND (search*.ab OR database*.ab OR "data base*".ab)) OR metasynthes*.ti,ab OR "meta synthes*".ti,ab)* OR (exp "clinical trial"/ OR exp "randomization"/ OR exp "single blind procedure"/ OR exp "double blind procedure"/ OR exp "crossover procedure"/ OR exp "placebo"/ OR exp "prospective study"/ OR rct.ti,ab OR random*.ti,ab OR "single blind".ti,ab OR "randomised controlled trial".ti,ab OR exp "randomized controlled trial"/ OR placebo*.ti,ab) OR (exp "Comparative Study"/ OR "comparison".ti,ab OR "comparative".ti,ab OR "compar*".ti,ab OR "major clinical study"/ OR "clinical study"/ OR "case control study"/ OR "family study"/ OR "longitudinal study"/ OR "retrospective study"/ OR "prospective study"/ OR "cohort analysis"/ OR cohort*.ti,ab OR (("case control" ADJ1 (study OR studies)).ti,ab) OR (("follow up" ADJ1 (study OR studies)).ti,ab) OR (observational ADJ1 (study OR studies)).ti,ab OR ((epidemiologic ADJ1 (study OR studies)).ti,ab) OR (("cross sectional" ADJ1 (study OR studies)).ti,ab)) OR ("life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "life cycle inventory".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp))

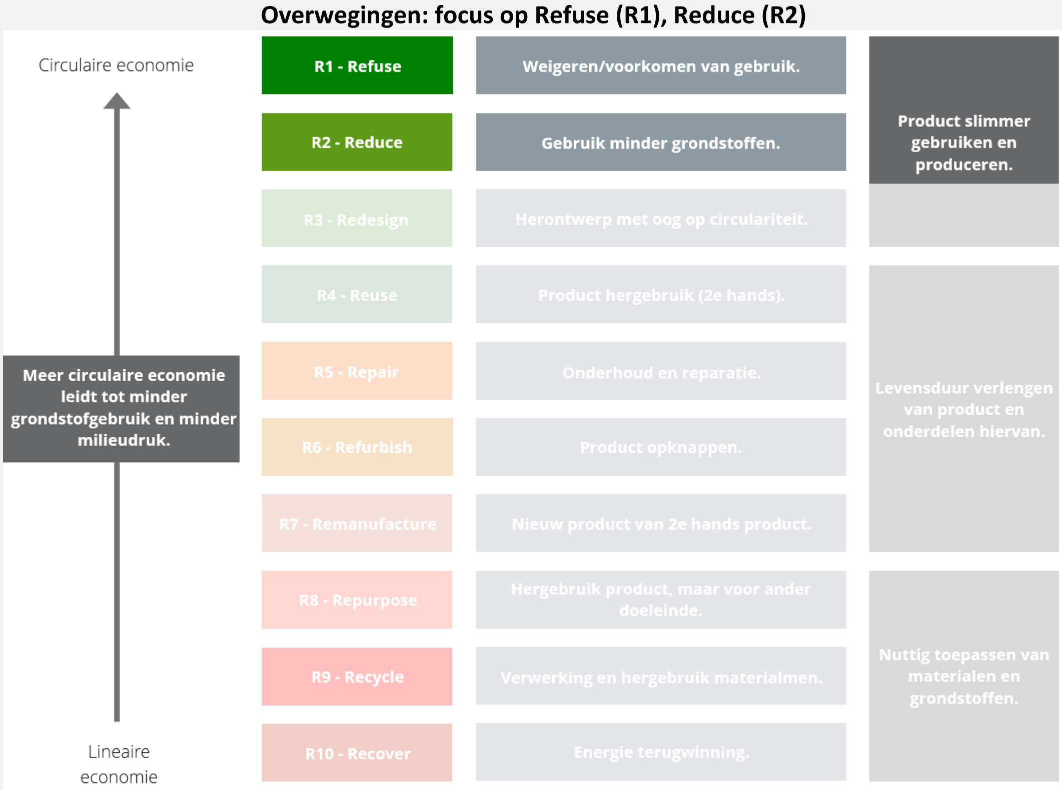
Module 5: Luchtbehandeling

Samenvatting

Uitgangsvraag
5.1 Wat is het effect op duurzaamheid van verschillende klassen luchtbehandeling op een operatiecomplex in een ziekenhuis?
5.2 Wat is het effect op duurzaamheid (in de gehele levenscyclus) van de verschillende typen luchtbehandelingssystemen bij een operatiecomplex in een ziekenhuis?

GRADE
Zeer laag

Overwegingen: focus op Refuse (R1), Reduce (R2)



Aanbevelingen

Inventariseer voor welke operatie indicatie welke klasse luchtbehandeling nodig is.

- Pas richtlijnen hier landelijk op aan.
- Opereer op een operatiekamer met de juiste klasse luchtbehandeling geschikt voor het type operatie (R1-Refuse, R2-Reduce). Klasse 1+ vergt de meeste energie, gevolgd door klasse 1 en klasse 2. Houd bij de planning van operaties rekening met verschillende OK-klassen.
- Overweeg het gebruik van de zelfstandige behandelkamer indien de operatie indicatie het toelaat.

Op instellingsniveau, ga na of de luchtbehandeling juist is ingesteld.

- Minimaliseer het gebruik van luchtbehandeling (R1-Refuse, R2-Reduce). Zorg voor sequentieel gebruik, zet aan waar nodig en zet uit waar kan.
- Denk hierbij aan het aantal luchtwisselingen/uur, luchtbevochtiging, de temperatuur en de relatieve vochtigheid (R2-Reduce). Een gelijke basistemperatuur op het gehele OK-complex vermindert het energieverbruik.

Zoek samenwerking met de OK-manager, deskundige infectiepreventie en het hoofd technische dienst, om de mogelijkheden tot verduurzaming van luchtbehandeling te bespreken en door te voeren.

5

Uitgangsvraag

5.1 Wat is het effect op duurzaamheid van verschillende klassen luchtbehandeling op een operatiecomplex in een ziekenhuis?

5.2 Wat is het effect op duurzaamheid (in de gehele levenscyclus) van de verschillende typen luchtbehandelingssystemen bij een operatiecomplex in een ziekenhuis?

Inleiding

Om het infectierisico bij een operatie of behandeling te verlagen wordt gebruik gemaakt van luchtbehandeling. Voor de luchtbehandeling van een operatiekamer zijn verschillende klassen en systemen beschikbaar. Operatiecomplexen in Nederland voldeden voorheen aan klasse 1 of klasse 2 luchtbehandeling, waarbij in klasse 1 onderscheid werd gemaakt tussen prestatieniveau 1 en prestatieniveau 2 (Richtlijn OK luchtbeheersing, WIP 2014). Recent wordt onderscheid gemaakt tussen operatiekamer klasse 1+, klasse 1 en klasse 2 (NVMM, 2022; Richtlijn 'Luchtbehandeling in operatiekamers en behandelkamers'). Daarnaast is het ook mogelijk om behandelingen te verrichten op een zelfstandige behandelkamer.
De twee meest toegepaste luchtinblaassystemen zijn: (1) een mengend luchtinblaassysteem of (2) een uni-directioneel of verdringend luchtinblaassysteem. Een mengend luchtinblaassysteem verdunt de contaminatie in de ruimte door het toevoegen van schone lucht aan de al bestaande lucht (menging met gefilterde schone lucht). Daarentegen wordt bij een uni-directioneel of verdringend luchtinblaassysteem de verontreiniging van lucht verminderd door middel van het 'verdringen' van de lucht uit het gebied en wordt het binnendringen van lucht uit de omgeving voorkomen. De lucht heeft dan ook een stroomrichting die turbulentie arm is ('unidirectional flow'). Voor meer informatie waaraan operatiekamers moeten voldoen, verwijst de werkgroep naar de richtlijn 'Luchtbehandeling in operatiekamers en behandelkamers' (NVMM, 2022).
Omdat het grootste energieverbruik op de operatiekamer kan worden toegewezen aan luchtbehandeling (MacNeill, 2017), valt hier naar verwachting duurzaamheidswinst te behalen. Echter is het momenteel onduidelijk wat de impact op duurzaamheid is als men een klasse 1 gebruikt in plaats van een klasse 2. Om de impact op duurzaamheid goed te kunnen evalueren, is deze module opgesplitst in twee deelvragen.

Search and select

A systematic review of the literature was performed to answer the following questions:
PICO1: *What is the difference in environmental sustainability outcomes between the different operating room ventilation systems (class 1: performance level 1, class 1: performance level 2, class 2) during surgical procedures?*

P = surgical procedures
I = air treatment class 1: performance level 1 or class 1: performance level 2
C = air treatment class 2
O = climate change (CO_2 footprint/Global Warming Potential), energy use

PICO2: *What is the difference in environmental sustainability outcomes across the entire life cycle of the a mixed air handling system in comparison to suppressing semi-suppressing air handling system in surgical procedures??*

P = surgical procedures
I = mixed air handling system (e.g. inlet grilles)
C = suppressing or semi-suppressing air handling system (e.g. unidirectional laminar downflow/plenum, opragon, halton)
O = climate change (CO_2 footprint/Global Warming Potential), energy use

Relevant outcome measures
Life cycle assessment (LCA) is a methodological tool used to quantitatively analyse the life cycle of products/activities within the context of environmental impact. The assessment comprises all stages needed to produce and use a product, from the initial development to the treatment of waste (the total life cycle). An LCA is mainly based on four phases: 1) goal and scope definition, 2) inventory analysis, 3) impact assessment, and 4) interpretation. The third phase is the life cycle impact assessment (LCIA), in which emissions and resource extractions are translated into a limited number of environmental impact scores by means of so-called characterisation factors. The ReCiPe model is a method for the impact assessment in an LCA (Huijbregts, 2016, Huijbregts, 2017). To determine the outcome measures regarding environmental impact, the ReCiPe model of the National Institute for Public Health and the Environment (in Dutch: Rijksinstituut voor Volksgezondheid en Milieu, RIVM) was used.

The outcomes determined by the working group are based on the ReCiPe model. The working group considered climate change (CO_2 footprint/Global Warming Potential) and energy use both as *critical* outcome measures for decision making.

A priori, the working group did not define the outcome measures listed above but used the definitions used in the studies.

Outcomes focused on environmental life cycle assessment (LCA) impact categories are relatively new in healthcare. Given the variety in scopes and methods of performing and reporting LCAs, the working group did not a priori define the minimal important difference. Differences between the techniques were evaluated by the working group after data extraction.

A glossary including the outcome measures is found in Module 1 'operatietechnieken'.

Search and select (Methods)
The databases Pubmed (via NCBI), Embase (via OVID), Web of Science (via Webofscience), Cochrane (via Cochrane library) and Emcare (via OVID) were searched with relevant search terms from 1980 until 10 May 2022. The detailed search strategy is depicted under the tab Methods. The systematic literature search resulted in 364 hits. Studies for this module were selected based on the following criteria:

- Systematic reviews in which searches were performed in at least two databases, with a detailed search strategy, risk of bias assessment and results of individual studies available, randomized controlled trials, (observational) comparative studies, Life Cycle Assessments;
- Full-text English or Dutch language publication; and
- Studies according to the PICO. The included studies that compared different air treatment systems and included at least one of the following outcomes: Climate change (CO_2 footprint/GWP) or energy use.

After reading the full text, two studies were included in the literature summary of this module.

Results
In total two studies were included in the analysis of the literature. No studies were found for sub question 5.1, but both studies were allocated to sub question 5.2. Important study

characteristics and results are summarized in Appendix 1 'Evidence table'. The quality assessment of the studies is summarized in Appendix 2 'Risk of Bias'.

Summary of literature

Description of studies

Alsved (2018) evaluated in a comparative study three types of ventilation systems for Operating Rooms (ORs) with respect to air cleanliness, energy consumption, and comfort of working environment as reported by surgical team members. Vertical laminar airflow (LAF) and turbulent mixed airflow (TMA) were compared with temperature-controlled airflow (TAF). Colony-forming unit (cfu) concentrations were measured at three OR locations during 45 orthopaedic procedures: 1) close to the wound (<40 cm), 2) at the instrument table, and 3) peripherally in the room. The relevant outcome measure was energy use.

Marsault (2021) describes in a comparative study the comparison between laminar airflow (LAF) and turbulent airflow (TAF) during total hip arthroplasty surgery. Thirty-two mock-up operations were completed. Primary outcomes were comparison of particle counts, colony-forming unit (cfu), and energy use between LAF and TAF at 100% fresh air influx. Additionally, same parameters were evaluated but with different comparisons: LAF_{100} vs. LAF_{50}, TAF_{100} vs. TAF_{50}, LAF_{50} vs. TAF_{100}. Measurements were taken at two ORs between October 2014 and January 2015 at two identical full-size operating theatres. One was equipped with a large, high volume LAF system and the other with TAF ventilation. Total 32 hip arthroplasty surgery-simulations were included. LAF uses 2 HEPA filters, airflow rate of fresh air is 2760 m^3/h, and recirculated air is 7075 m^3/h. TAF uses 1 HEPA filter and airflow rate is 2533 m^3/h, which is all outside air. Outcome measure was energy use.

Results

1. Climate Change

No results.

2. Energy use

Both studies reported on energy use. Alsved (2018) defined energy use for ventilation power per type of airflow was expressed in kW. For LAF, TAF, and TMA this resulted in 8.0kW, 5.7kW, and 2.8kW, respectively. Thus, LAF had the greatest energy use. To reduce the energy use, airflow using a lower energy setting can be used. Alsved (2018) demonstrates that TAF is more energy efficient than LAF, and still provides high air cleanliness. Marsault (2021) described that when reducing air influx from 100% to 50%, LAF energy use was reduced with 41% (from 1.85 kWh and 1.12 kWh). When reducing air influx from 100% to 50%, TAF energy use was reduced with 51% (from 1.54 kWh to 0.75 kWh).

Level of evidence of the literature

No studies were found for sub question 5.1, bot studies were allocated to sub question 5.2. The included studies are all comparative observational studies, the level of evidence starts at GRADE low.

1. Climate Change

Outcome was not reported, thus could not be graded.

2. Energy use

The level of evidence regarding the outcome measure 'energy use' was downgraded to *very low* due to lack of adequate adjustment for confounders (risk of bias, -1) and lacking information on data distribution, limited generalizability, use of dummy variables and surrogate endpoints (imprecision, -1).

Conclusions

1. Climate change (critical)

- GRADE	Outcome measures 'climate change' was not graded. *Sources: -*

2. Energy use (critical)

Very low GRADE	The evidence is very uncertain about the effect on energy use when a mixed air handling system is compared to suppressing or semi-suppressing air handling system in surgical procedures. *Source: Alsved, 2018; Marsault, 2021*

Overwegingen – van bewijs naar aanbeveling

<u>Voor- en nadelen van de interventie en de kwaliteit van het bewijs</u>

Op basis van de beschikbare literatuur is gekeken naar de invloed van verschillende soorten luchtbehandeling op duurzaamheidsaspecten. Voor subvraag 5.1 (verschillende klassen luchtbehandeling) zijn geen studies gevonden. Voor subvraag 5.2 (verschillende typen luchtbehandelingssystemen) zijn twee studies gevonden (Alsved, 2018; Marsault, 2021). De uitkomstmaat 'climate change' is niet gerapporteerd. De bewijskracht voor de cruciale uitkomstmaat 'energy use' komt uit op zeer laag (risk of bias, imprecisie). Wegens de zeer lage bewijskracht kunnen er op basis van de literatuur geen harde conclusies geformuleerd worden.

De 'hotspot' voor luchtbehandeling is de energie consumptie, hierin zit de grootste verbeterruimte. Er is geen LCA verricht om verdere impact categorieën of hotspots te identificeren. De uitkomsten van de studies en de expert opinie over luchtbehandeling wordt geëvalueerd middels de 'R-ladder (strategieën van circulariteit)' (zie figuur 1, gebaseerd op Cramer, 2014; Hanemaaijer; 2018; Potting, 2016; Reike, 2018). Deze R-ladder laat zien dat de hoogste prioriteit om duurzaam te werken 'refuse' is, oftewel, niet gebruiken. Hoe lager het grondstofgebruik, des te hoger op de R-ladder en hoe dichter je bent bij circulair werken.

Figuur 1. *Prioriteitsvolgorde circulariteit strategieën*

Refuse (R1) en Reduce (R2)

Allereerst is het van belang te opereren op een operatiekamer met de juiste klasse luchtbehandeling geschikt voor het type operatie (R1-Refuse). Niet elke type operatie heeft een klasse 1+ of 1 nodig, maar kan bijvoorbeeld in een klasse 2 of zelfstandige behandelkamer plaatsvinden. Voor bepaalde operatie indicaties is veel duurzaamheidswinst te behalen om niet op een klasse 1+ OK te opereren. Zo kan er bijvoorbeeld onderscheid worden gemaakt tussen minimaal invasieve chirurgie (MIC), open chirurgie en implantaatchirurgie. Vanwege het lage infectierisico bij MIC is het te overwegen om op een OK klasse 2 te opereren. Het is al technisch mogelijk om op één operatiekamer verschillende klassen te gebruiken, echter is het logistiek gezien nog een uitdaging om tussen de operaties door te wisselen van klasse. De werkgroep adviseert dan ook om deze mogelijkheden verder te exploreren en uit te voeren.

Daarnaast zijn er nog andere mogelijkheden om de milieu-impact te verlagen. Marsault (2021) laat zien dat indien de hoeveelheid ingeblazen verse lucht wordt gehalveerd, de energieconsumptie ook nagenoeg halveert. Gebruik van een mengend systeem leidt dan ook tot minder energieverbruik, omdat de hoeveelheid ingeblazen lucht lager is. Indien een operatiekamer niet wordt gebruikt, is het onnodig om de luchtbehandeling te laten draaien met dezelfde intensiteit als wanneer een patiënt wordt geopereerd. Het is belangrijk dat ziekenhuizen inventariseren hoeveel acute operatiekamers operationeel moeten blijven. Indien een unidirectioneel systeem gedurende nachten en weekenden wordt uitgezet, kan dit 70% van het totale energieverbruik besparen (Traversari, 2017). Na 30 minuten opstarttijd kan de operatiekamer weer veilig worden gebruikt (Traversari, 2017; Dettenkofer, 2003).

Daarnaast moet onderzocht worden of het mogelijk is om de luchtbehandeling in een lage stand te zetten tijdens bepaalde operaties (R2-Reduce). Op basis van expert opinion vergt klasse 1+ de meeste energie en is klasse 2 het meest energiezuinig. Ook kan nagedacht

worden over optimalisatie van het OK-programma, zodat operaties die een 1+ kamer nodig hebben achter elkaar gepland worden.
Voor een OK klasse 1+ is het temperatuurverschil een belangrijke parameter voor goed functioneren. Dit kost relatief veel energie en het uitzetten hiervan draagt bij aan vermindering van energie. De werkgroep acht het belangrijk dat de luchtbehandeling juist is ingesteld. Denk aan het juiste aantal luchtwisselingen/uur, de temperatuur en de relatieve vochtigheid. Het handhaven van temperatuur en relatieve vochtigheid als kritische parameter is niet meer aan de orde voor klasse 1 (NVMM, 2022). Dit kan in het kader van duurzaamheid dus worden verlaten. Daarnaast draaien ook opdek plenums vaak 24 uur per dag. Realiseer dat deze plenums alleen aan gaan bij gebruik. Ook de verlichting van de plenums kost energie en uitschakelen hiervan leidt dan ook tot energiewinst.
Meer over de juiste criteria per klasse is te vinden in de Richtlijn 'Luchtbehandeling in operatiekamers en behandelkamers' (NVMM, 2022).

Redesign (R3)
Ontwikkelaars van luchtbehandeling systemen zullen energiezuinige systemen moeten ontwikkelen (R3-Redesign). Daarnaast moet, zoals eerder benoemd, de luchtbehandeling aangepast worden aan het type operatie dat plaats gaat vinden. Het is hierbij van belang om in het proces aanpassingen te doen, zodat dit logistiek ook mogelijk wordt gemaakt. Denk hierbij bijvoorbeeld aan het standaardiseren van het wisselen van OK-klasse in de time-out na de operatie en het zoveel mogelijk plannen van dezelfde type operaties op één dag en op één operatiekamer. De werkgroep adviseert om hier rekening mee te houden en te streven naar minimaal energieverbruik.

Re-use (R4)
Hergebruik is een lastige kwestie, gezien de meeste systemen lang mee gaan. Wanneer de systemen worden vervangen, zijn deze veelal niet meer geschikt voor hergebruik.

Repair (R5), Refurbish (R6), Remanufacture (R7)
Herstel van luchtbehandeling systemen, indien er iets kapot gaat, wordt in de praktijk al verricht.

Repurpose (R8), Recycling (R9), Recover (R10)
Wat betreft Repurpose (R8) is een herindeling naar een lager geclassificeerde ruimte mogelijk (NVMM, 2022). Momenteel is er nog geen tot weinig sprake van recycling en circulair verwerken betreffende luchtbehandeling (R9-Recycling). Bepaalde onderdelen worden wel gerecycled, al wordt dit met name door de lokale afvalverwerker van het ziekenhuis zo georganiseerd (bijv. de metalen rand rondom een luchtfilter wordt jaarlijks vervangen). Luchtbehandelingssystemen zijn vaak gedateerd voordat zij worden vervangen. Het vervoeren en vervolgens hergebruiken is een uitdaging.

<u>Waarden en voorkeuren van patiënten (en evt. hun verzorgers)</u>
Duurzamer werken rondom een operatie zal ook op de volksgezondheid een positief effect hebben. Patiëntveiligheid moet te alle tijden gewaarborgd worden als veranderingen plaatsvinden in de luchtbehandeling op de operatiekamer.

<u>Kosten (middelenbeslag)</u>
Op dit gebied zijn geen kosten-effectiviteitsstudies bekend bij de werkgroep. De werkgroep verwacht dat duurzamer werken m.b.t. luchtbehandeling, bijvoorbeeld bij verlaging van energieverbruik, zal resulteren in kostenbesparing. Indien wordt gekozen voor het hoogst

haalbare op de ladder van circulariteit (R1-Refuse, R2-Reduce), kan de luchtbehandeling worden uitgezet of deels worden uitgezet/verlaagd. Het zal initieel een investering vragen van ziekenhuizen om over te stappen naar een luchtbehandelingssysteem dat aan- en uitgezet kan worden (of in standen kan wisselen), maar op lange termijn zal dit een positieve impact hebben op de volksgezondheid in algemene zin. Daarnaast gebruiken ziekenhuizen een groot deel van het energienetwerk in Nederland. Ziekenhuizen hebben een verantwoordelijkheid tegenover de burger dat dit netwerk niet onnodig wordt overbelast.

Aanvaardbaarheid, haalbaarheid en implementatie

Het is van belang dat patiëntveiligheid voorop blijft staan, maar er kan op een veilige manier energie bespaard worden op luchtbehandeling. De werkgroep vermoedt dat men bewust is van de invloed op energieverbruik van luchtbehandeling, maar dat nog te weinig acties worden ondernomen. Gewoonweg omdat het nog niet is geadresseerd in de dagelijkse routine van de ziekenhuizen. Om verbeteringen door te voeren is het van belang dat een deskundige infectiepreventie, de manager van de OK en het hoofd technische dienst met elkaar om de tafel gaan om de verduurzaming van het systeem te verkennen en aanpassingen door te voeren.

Aanbevelingen

Rationale van de aanbeveling: weging van argumenten voor en tegen de interventies

Op basis van de gevonden literatuur is de bewijskracht voor duurzaamheidsuitkomsten laag tot zeer laag. Overwegingen richten zich voornamelijk op R1-Refuse en R2-Reduce. De werkgroep kiest, ondanks de zeer lage bewijskracht, voor een sterke aanbeveling met betrekking tot de aandacht voor duurzaamheidsaspecten.

Inventariseer voor welke operatie indicatie welke klasse luchtbehandeling nodig is.

- Pas richtlijnen hier landelijk op aan.
- Opereer op een operatiekamer met de juiste klasse luchtbehandeling geschikt voor het type operatie (R1-Refuse, R2-Reduce). Klasse 1+ vergt de meeste energie, gevolgd door klasse 1 en klasse 2. Houd bij de planning van operaties rekening met verschillende OK-klassen.
- Overweeg het gebruik van de zelfstandige behandelkamer indien de operatie indicatie het toelaat.

Op instellingsniveau, ga na of de luchtbehandeling juist is ingesteld.

- Minimaliseer het gebruik van luchtbehandeling (R1-Refuse, R2-Reduce). Zorg voor sequentieel gebruik, zet aan waar nodig en zet uit waar kan.
- Denk hierbij aan het aantal luchtwisselingen/uur, luchtbevochtiging, de temperatuur en de relatieve vochtigheid (R2-Reduce). Een gelijke basistemperatuur op het gehele OK-complex vermindert het energieverbruik.

Literatuur

Acero, 2015. Greendelta, LCIA methods: Impact assessment methods in Life Cycle Assessment and their impact categories. Version: 1.5.4. Date: 16 March 2015. Accessed at: https://www.openlca.org/wp-content/uploads/2015/11/LCIA-METHODS-v.1.5.4.pdf

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Bijlagen bij module 5 'Luchtbehandeling'

Appendix 1. Evidence tables

Study reference	Journal	Study characteristics	Methods	Data collection	Outcomes	Interpretation	Comments
Alsved (2018)	Journal of Hospital Infection Journal information The Journal of Hospital Infection is the editorially independent scientific publication of the Healthcare Infection Society. The aim of the Journal is to publish high quality research and information relating to infection prevention and control that is relevant to an international audience. Critical review: Peer reviewed article. Not in specific LCA journal.	Type of study: Comparative study Objective: To evaluate three types of ventilation systems for ORs with respect to air cleanliness, energy consumption and comfort of working environment as reported by surgical team members. LCA-method: N/A Setting and country: Three different ORs in a hospital in Sweden. Facility: Helsingborg General Hospital, Helsingborg, Sweden Years of data collection: 2015-2016 Surgical discipline(s): Orthopedics Funding and conflict of interest: -	Comparison: a) Vertical laminar airflow (LAF) and turbulent mixed airflow (TMA) b) Temperature-controlled airflow (T_cAF) Cfu concentrations were measured at three locations in an OR during 45 orthopaedic procedures: 1. Close to the wound (<40 cm) 2. At the instrument table 3. Peripherally in the room A questionnaire answered by the OR team evaluated the comfort of the working environment. Energy consumption was evaluated.	Measurements were taken at three ORs between January 2015 and February 2016 at the ortophaedic surgery department. Total 45 operations were included. Different airflows of the three OR ventilation systems were modelled. For specifications of the ventilations systems see table 1 (Alsved, 2018). Characterization: -	1. Climate Change No results. 2. Energy use Energy use for ventilation power per type of airflow was expressed in kW. For TMA this resulted in 2.8 kW, LAF in 8.0 kW and T_cAF in 5.7 kW.	LAF lead to the greatest energy use, followed by T_cAF and TMA. To reduce the energy use, and thereby environmental impact, airflow using a lower energy setting can be used. T_cAF is more energy efficient than LAF, and still provides high air cleanliness.	Authors conclusion Comparison of three ventilation systems in three identical ORs showed that LAF and T_cAF provide high air cleanliness. Cfu levels of TMA are too high. T_cAF is more energy efficient and comfortable to work in than LAF, and still provides high air cleanliness. Limitations study Many designs exist for TMA and LAF ventilations (e.g. higher/lower airflows). Many other versions are available and not included in the study.
Marsault (2021)	Journal information The Journal of Hospital Infection is the editorially independent scientific publication of the	Type of study: Comparative study Objective:	Comparison of: a) Laminar airflow (LAF) b) Turbulent mixed airflow (TMA)	Measurements were taken at two ORs between October 2014 and January 2015 at two identical full-size operating theatres.	1. Climate Change No results reported. 2. Energy use	Decreasing air influx leads to lower energy consumption. Next to that, TAF has a lower energy consumption	Authors conclusion Lowering air influx by 50% in LAF did not significantly affect cfu or particles, but

	Healthcare Infection Society. The aim of the Journal is to publish high quality research and information relating to infection prevention and control that is relevant to an international audience. Critical review: Peer reviewed article.	To compare how large, high volume, laminar airflow (LAF) and turbulent airflow (TAF) ventilation systems perform during standardized simulated total hip arthroplasty (THA). LCA-method: N/A Setting and country: Operating room, Denmark. Facility: Genthofte Hospital's Department of Orthopaedic Surgery Years of data collection: 2014-2015 Surgical discipline(s): Orthopedics Funding and conflict of interest: -	During total hip arthroplasty surgery (THA). 32 THA mock-up operations were completed. Primary outcomes were comparison of particle counts, cfu, and energy consumption between LAF and TAF at 100% fresh air influx. Secondary, same parameters were evaluated but with different comparisons: LAF_{100} and LAF_{50}, TAF_{100} and TAF_{50}, LAF_{50} and TAF_{100}.	One was equipped with a large, high volume LAF system and the oteher with TAF ventilation. Total 32 simulations were included. LAF uses 2 HEPA filters, airflow rate of fresh air is 2760 m^3/h and recirculated air is 7075 m^3/h. TAF ventilation uses 1 HEPA filter and airflow rate is 2533 m^3/h, which is all outside air. Characterization: -	When decreasing air influx from 100% to 50% using LAF, energy consumption was reduced by 41% ($P = 0.0007$) (Table V, Marsault, 2021). For TAF energy consumption was reduced by 51% ($P = 0.0007$) when reducing air influx from 100% to 50%.	compared to LAF, however it is a small difference.	reduced energy consumption. Limitations study A heated dummy was used instead of a patient, as a result there was no bleeding or moisture what could have influenced results on e.g. particle count.

[1]Goals and scope: 'Phase of life cycle assessment in which the aim of the study, and in relation to that, the breadth and depth of the study is established'
[2]Functional unit: Quantified description of the function of a product or process that serves as the reference basis for all calculations regarding impact assessment.

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Appendix 2. Risk of bias table for interventions studies (cohort studies based on risk of bias tool by the CLARITY Group at McMaster University)

Author, year	**Selection of participants** **Was selection of exposed and non-exposed cohorts drawn from the same population?**	**Exposure** **Can we be confident in the assessment of exposure?**	**Outcome of interest** **Can we be confident that the outcome of interest was not present at start of study?**	**Confounding-assessment** **Can we be confident in the assessment of confounding factors?**	**Confounding-analysis** **Did the study match exposed and unexposed for all variables that are associated with the outcome of interest or did the statistical analysis adjust for these confounding variables?**	**Assessment of outcome** **Can we be confident in the assessment of outcome?**	**Follow up** **Was the follow up of cohorts adequate? In particular, was outcome data complete or imputed?**	**Co-interventions** **Were co-interventions similar between groups?**	**Overall Risk of bias**
Alsved (2018)	Definitely no	Probably yes	Definitely yes	Definitely no	Definitely no	Probably yes	Probably yes	No information	**Some concerns**
Marsault (2021)	Definitely no	Probably no	Probably no	Definitely no	Definitely no	Probably yes	Probably yes	No information	**High**

Literature search strategy

Zoekverantwoording

Algemene informatie

Richtlijn: Duurzaamheid	
Uitgangsvraag: UV5 1) Wat is het verschil in duurzaamheidsuitkomsten tussen de verschillende klassen luchtbehandeling (klasse 1 – prestatieniveau 1, klasse 1 – prestatieniveau 2 en klasse 2) op een operatiecomplex? 2) Wat is het verschil in duurzaamheidsuitkomsten in de gehele levenscyclus van de verschillende luchtbehandelingssystemen (bijvoorbeeld een mengend (inblaasroosters), verdringend (unidirectionele laminaire downflow/plenum) of semi-verdringend (opragon of halton) luchtbehandelingssysteem)?	
Database(s): Medline (PubMed), Embase (OVID), Web of Science, Cochrane Library, Emcare (OVID)	Datum: 10-5-2022
Periode: 1980-..	Talen: nvt
Literatuurspecialist: Jan W. Schoones	
BMI zoekblokken: voor verschillende opdrachten wordt (deels) gebruik gemaakt van de zoekblokken van BMI-Online https://blocks.bmi-online.nl/ Bij gebruikmaking van een volledig zoekblok zal naar de betreffende link op de website worden verwezen.	
Toelichting:	
In de databases Medline (PubMed), Embase (OVID), Web of Science, Cochrane Library, en Emcare (OVID) is op 10-5-2022 met relevante zoektermen gezocht naar systematische reviews, RCTs, observationele studies, ander vergelijkend onderzoek (bijv. case control, cohort-onderzoek), en life cycle assessments (LCA's) over UV5: 1) Wat is het verschil in duurzaamheidsuitkomsten tussen de verschillende klassen luchtbehandeling (klasse 1 – prestatieniveau 1, klasse 1 – prestatieniveau 2 en klasse 2) op een operatiecomplex? 2) Wat is het verschil in duurzaamheidsuitkomsten in de gehele levenscyclus van de verschillende luchtbehandelingssystemen (bijvoorbeeld een mengend (inblaasroosters), verdringend (unidirectionele laminaire downflow/plenum) of semi-verdringend (opragon of halton) luchtbehandelingssysteem)?	

Zoekopbrengst

	MEDLINE (PubMed)	Embase (OVID)	Web of Science	Cochrane Library	Emcare (OVID)	Ontdubbeld
UV5	192	231	88	22	117	364

Zoekstrategie

PubMed

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"observational stud*"[tw] OR Longitudinal[tw] OR Retrospective*[tw] OR prospective*[tw] OR consecutive*[tw] OR Cross sectional[tw] OR "Cross-sectional studies"[mesh] OR "historically controlled study"[mesh] OR "interrupted time series analysis"[mesh]) OR ("life cycle assess*"[tw] OR "life cycle assessment"[tw] OR "life cycle inventory"[tw] OR "LCA"[tw] OR "LCAs"[tw] OR "life cycle inventory"[tw] OR "life cycle inventories"[tw]))

Embase

(exp "Operating Room"/ OR "operating room".mp OR "operating rooms".mp OR "operation room".mp OR "operation rooms".mp OR "operating theatre".mp OR "operating theatres".mp OR "operation theatre".mp OR "operation theatres".mp OR "operating theater".mp OR "operating theaters".mp OR "operation theater".mp OR "operation theaters".mp OR "surgery room".mp OR "surgery rooms".mp OR "operation room".mp OR "operation rooms".mp OR "surgery theatre".mp OR "surgery theatres".mp OR "operation theatre".mp OR "operation theatres".mp OR "surgery theater".mp OR "surgery theaters".mp OR "operation theater".mp OR "operation theaters".mp OR "surgical room".mp OR "surgical rooms".mp OR "operation room".mp OR "operation rooms".mp OR "surgical theatre".mp OR "surgical theatres".mp OR "operation theatre".mp OR "operation theatres".mp OR "surgical theater".mp OR "surgical theaters".mp OR "operation theater".mp OR "operation theaters".mp OR "operating department".mp OR "operating departments".mp OR ("operation".ti 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"uni directional down flow".mp OR "laminair downflow".mp OR "laminair down flow".mp OR "laminar downflow".mp OR "laminar down flow".mp OR "plenum".mp OR "opragon".mp OR "halton".mp OR "3 zones".mp OR "three zones".mp OR "3 zone".mp OR "three zone".mp OR "Temperature 18-23 degrees Celsius".mp OR ((exp "Temperature"/ OR "temperature".mp OR "temperatures".mp) AND ("18".mp OR "19".mp OR "20".mp OR "21".mp OR "22".mp OR "23".mp) AND ("celsius".mp OR "degree c".mp OR "degrees c".mp)) OR exp "Humidity"/ OR "humidity".mp OR "humid".mp OR "recovery time".mp OR "recovery times".mp OR "NEN 14644-3".mp OR "ISO 14644-3".mp OR "14644-3".mp OR "air change".mp OR "air changes".mp OR "air quality ISO 7".mp OR "air quality".mp OR "ISO 7".mp OR "NEN 14644-1".mp OR "ISO 14644-1".mp OR "14644-1".mp OR "146441".mp OR "2 zones".mp OR "2 zone".mp OR "two zones".mp OR "two zone".mp OR "mixing ventilation airflow".mp OR "MAF".mp OR "Mixing ventilation air flow".mp OR "mixing ventilation".mp OR 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flow".mp OR "partial uni directional flow".mp OR "P-UDAF".mp OR "PUDAF".mp OR "unidirectional airflow".mp OR "uni directional airflow".mp OR "unidirectional airflow*".mp OR "uni directional airflow*".mp OR "unidirectional air*".mp OR "uni directional air*".mp OR "unidirectional flow*".mp OR "uni directional flow*".mp OR "displacement ventilation".mp OR "plenum ventilated".mp OR "plenum-ventilated".mp OR "plenum ventilation".mp OR "horizontal ventilation".mp OR "vertical ventilation".mp) AND ("Carbon Footprint"/ OR "carbon footprint".mp OR "carbon footprint*".mp OR exp "Climate Change"/ OR "climate change".mp OR "CO2 emission".mp OR "CO2 emissions".mp OR "CO2 footprint".mp OR "CO2 footprint*".mp OR exp "environmental protection"/ OR "conservation of natural resources".mp OR "environmental protection".mp OR "Disposable Equipment"/ OR "Disposables".mp OR "Disposable".mp OR "ecological footprint".mp OR "ecological footprint*".mp OR "ecological sustainability".mp OR exp "environmental 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"recycling".mp OR "recycle*".mp OR "Equipment reuse".mp OR "Reusables".mp OR "reusable".mp OR "reuse".mp OR "reused".mp OR "reusing".mp OR exp "Waste Disposal"/ OR exp "Waste Management"/ OR "Plastic overuse".mp OR "Green surgery".mp OR "Emission reduction".mp OR "Emission reduction strategy".mp OR "air pollution control"/ OR "air pollution control".mp OR "Environment"/ OR "Environmental*".ti OR "acidification"/ OR "soil acidification"/ OR "ocean acidification"/ OR "acidification".mp OR "Acidification potential".mp OR "AP in kg SO2 equivalents".mp OR "eco-efficiency".mp OR "ecoefficiency".mp OR "eco-efficien*".mp OR "ecoefficien*".mp OR "ecotoxicity"/ OR "ecotoxicity".mp OR "ecotoxic*".mp OR "eco toxicity".mp OR "eco toxic*".mp OR "EP in kg PO4 equivalent".mp OR exp "Eutrophication"/ OR "eutrophication".mp OR "Eutrophication potential".mp OR "FAETP in kg DCB equivalent".mp OR "Freshwater Aquatic Ecotoxicity Potential".mp OR "GWP in kg CO2 equivalents".mp OR "H+ moles equivalents".mp OR 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"Sustainable Development".mp OR (("Plastic".mp OR "plastics".mp) AND "overuse".mp) OR ("hydrogen*".mp AND "moles".mp AND "equiv*".mp) OR ("Dichlorobenzen*".mp AND "equiv*".mp) OR ("2,4-D".mp AND "equiv*".mp) OR ("NOx".mp AND "equiv*".mp) OR ("ethane".mp AND "equiv*".mp) OR ("PO4".mp AND "equiv*".mp) OR ("DCB".mp AND "equiv*".mp) OR ("sustainability".mp AND ("environment*".mp OR "carbon".mp)) OR (("Carbon Dioxide"/ OR "Carbon Dioxide".mp OR "CO2".mp) AND ("pollution".mp OR "emission".mp OR "emissions".mp OR "waste".mp OR "environment".mp OR "environmental*".mp OR "footprint".mp OR "footprint*".mp OR "sustainable".mp OR "hazard".mp OR "hazard*".mp))) NOT (conference review or conference abstract).pt AND 1980:2023.(sa_year) AND (*(exp "meta analysis"/ OR exp "meta analysis (topic)"/ OR metaanaly*.ti,ab OR "meta analy*".ti,ab OR metanaly*.ti,ab OR "systematic review"/ OR "cochrane database of systematic reviews".jn OR prisma.ti,ab OR prospero.ti,ab OR (((systemati* OR scoping OR umbrella OR "structured literature") ADJ3 (review* OR overview*)).ti,ab) OR ((systemic* ADJ1 review*).ti,ab) OR (((systemati* OR literature OR database* OR "data base*") ADJ10 search*).ti,ab) OR (((structured OR comprehensive* OR systemic*) ADJ3 search*).ti,ab) OR (((literature ADJ3 review*).ti,ab) AND (search*.ti,ab OR database*.ti,ab OR "data base*".ti,ab)) OR (("data extraction".ti,ab OR "data source*".ti,ab) AND "study selection".ti,ab) OR ("search strategy".ti,ab AND "selection criteria".ti,ab) OR ("data source*".ti,ab AND "data synthesis".ti,ab) OR medline.ab OR pubmed.ab OR embase.ab OR cochrane.ab OR (((critical OR rapid) ADJ2 (review* OR overview* OR synthes*)).ti) OR ((((critical* OR rapid*) ADJ3 (review* OR overview* OR synthes*)).ab) AND (search*.ab OR database*.ab OR "data base*".ab)) OR metasynthes*.ti,ab OR "meta synthes*".ti,ab)* OR (exp "clinical trial"/ OR exp "randomization"/ OR exp "single blind procedure"/ OR exp "double blind procedure"/ OR exp "crossover procedure"/ OR exp "placebo"/ OR exp "prospective study"/ OR rct.ti,ab OR random*.ti,ab OR "single blind".ti,ab OR "randomised controlled trial".ti,ab OR exp "randomized controlled trial"/ OR placebo*.ti,ab) OR (exp "Comparative Study"/ OR "comparison".ti,ab OR "comparative".ti,ab OR "compar*".ti,ab OR "major clinical study"/ OR "clinical study"/ OR "case control study"/ OR "family study"/ OR "longitudinal study"/ OR "retrospective study"/ OR "prospective study"/ OR "cohort analysis"/ OR cohort*.ti,ab OR (("case control" ADJ1 (study OR studies)).ti,ab) OR (("follow up" ADJ1 (study OR studies)).ti,ab) OR (observational ADJ1 (study OR studies)).ti,ab OR ((epidemiologic ADJ1 (study OR studies)).ti,ab) OR (("cross sectional" ADJ1 (study OR studies)).ti,ab)) OR ("life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "life cycle inventory".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp))

Web of Science

TS=(("Operating Rooms" OR "operating room" OR "operating rooms" OR "operation room" OR "operation rooms" OR "operating theatre" OR "operating theatres" OR "operation theatre" OR "operation theatres" OR "operating theater" OR "operating theaters" OR "operation theater" OR "operation theaters" OR "surgery room" OR "surgery rooms" OR "operation room" OR "operation rooms" OR "surgery theatre" OR "surgery theatres" OR "operation theatre" OR "operation theatres" OR "surgery theater" OR "surgery theaters" OR "operation theater" OR "operation theaters" OR "surgical room" OR "surgical rooms" OR "operation room" OR "operation rooms" OR "surgical theatre" OR "surgical theatres" OR "operation theatre" OR "operation theatres" OR "surgical theater" OR "surgical theaters" OR "operation theater" OR "operation theaters" OR "operating department" OR "operating departments" OR "operationg department" OR "operation departments" OR "surgical suite" OR "surgical suites" OR "surgery suite" OR "surgery suites" OR "operation suite" OR "operation suites" OR "operating suite" OR "operating suites") AND ("Ventilation" OR "ventilation" OR "ventilat*" OR "ventilation system" OR "ventilation systems" OR "air system" OR "air systems" OR "Air Conditioning" OR "Air Conditioning" OR "Air Condition*" OR "HVAC" OR "Heating Ventilation and Air-Conditioning" OR "Heating, Ventilation and Air-Conditioning" OR "hepa-filter" OR "hepafilter" OR "hepa filters" OR "hepafilters" OR "hepa filtration" OR "hepafiltration" OR "high efficiency particulate air" OR "unidirectional downflow system" OR "unidirectional downflow" OR "unidirectional down flow" OR "uni directional down flow" OR "laminair downflow" OR "laminair down flow" OR "laminar downflow" OR "laminar down flow" OR "plenum" OR "opragon" OR "halton" OR "3 zones" OR "three zones" OR "3 zone" OR "three zone" OR "Temperature 18-23 degrees Celsius" OR (("Temperature" OR "temperature" OR "temperatures") AND ("18" OR "19" OR "20" OR "21" OR "22" OR "23") AND ("celsius" OR "degree c" OR "degrees c")) OR "Humidity" OR "humidity" OR "humid" OR "recovery time" OR "recovery times" OR "NEN 14644-3" OR "ISO 14644-3" OR "14644-3" OR "air change" OR "air changes" OR "air quality ISO 7" OR "air quality" OR "ISO 7" OR "NEN 14644-1" OR "ISO 14644-1" OR "14644-1" OR "146441" OR "2 zones" OR "2 zone" OR "two zones" OR "two zone" OR "mixing ventilation airflow" OR "MAF" OR "Mixing ventilation air flow" OR "mixing ventilation" OR (("ventilation" OR "ventilat*" OR "airflow" OR "air flow") AND ("mixed" OR "mixing" OR "turbulent")) OR "conventional airflow" OR "conventional air flow" OR "ceiling diffusers" OR "ceiling diffuser" OR "ceiling diffus*" OR "circulatory system" OR "circulatory systems" OR "laminar flow" OR "unidirectional flow" OR "laminar-air-flow" OR "laminar airflow" OR "laminar flow*" OR "unidirectional flow*" OR "laminar-air-flow*" OR "laminar airflow*" OR "laminar air" OR "conventional ventilation" OR "ultraclean ventilation" OR "ultraclean air" OR "clean-airflow" OR "conventional ventilat*" OR "ultraclean ventilation" OR "ultraclean air" OR "ultra clean ventilation" OR "ultra clean air" OR "ultraclean ventilat*" OR "ultraclean air*" OR "ultra clean ventilat*" OR "ultra clean air*" OR "clean-airflow" OR "clean-airflow*" OR "opragon" OR "halton" OR "partial unidirectional airflow" OR "partial uni directional airflow" OR "partial unidirectional flow" OR "partial uni directional flow" OR "P-UDAF" OR "PUDAF" OR "unidirectional airflow" OR "uni directional airflow" OR "unidirectional airflow*" OR "uni directional airflow*" OR "unidirectional air*" OR "uni directional air*" OR "unidirectional flow*" OR "uni directional flow*" OR "displacement ventilation" OR "plenum ventilated" OR "plenum-ventilated" OR "plenum ventilation" OR "horizontal ventilation" OR "vertical ventilation" OR "plenum" OR "halton")) AND (TS=("Carbon Footprint" OR "carbon footprint" OR "carbon footprint*" OR "Climate Change" OR "climate change" OR "CO2 emission" OR "CO2 emissions" OR "CO2 footprint" OR "CO2 footprint*" OR "environmental protection" OR "conservation of natural resources" OR "environmental protection" OR "Disposable Equipment" OR "Disposables" OR "Disposable" OR "ecological footprint" OR "ecological footprint*" OR "ecological sustainability" OR "environmental impact" OR "environmental impact" OR "environmental impact*" OR "environmental impacts" OR "environmental pollut*" OR "pollution" OR "environmental pollution" OR "environmental sustainab*" OR "environmental sustainability" OR "environmental sustainability" OR "Global Warming" OR "Global Warming" OR "Greenhouse Effect" OR "greenhouse effect*" OR "greenhouse effects" OR "greenhouse gas emission" OR "greenhouse gas emissions" OR "Greenhouse Gas" OR "greening" OR "hospital waste" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assess*" OR "life cycle assessment" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle 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Potential" OR "GWP in kg CO2 equivalents" OR "H+ moles equivalents" OR "HTTP in kg Dichlorobenzene equivalent" OR "Human Toxicity Potential" OR "kg 2.4-D equivalents" OR "kg CFC-11 equivalent" OR "kg N equivalents" OR "kg NOx equivalents" OR "life cycle analysis" OR "ozone depletion" OR "Photochemical Ozone Depletion Potential" OR "POCP in kg ethane equivalent" OR "smog" OR "Waste" OR "waste" OR "wastes" OR "Ozone Depletion" OR "Smog" OR "Equipment reuse" OR "Greenhouse Gases" OR "Greenhouse Gas" OR "SO2 equiv*" OR "CO2 equiva*" OR "CFC-11 equiv*" OR "N equiv*" OR "Sustainable Development" OR "Sustainable Development" OR "Biodiversity" OR "Climatic change" OR "Green deal" OR "preservation of natural resources" OR "Refuse Disposal" OR "Waste Water" OR "Wastewater" OR "Water Purification" OR (("plastic*" OR "microplastic*") AND ("soop" OR "soup" OR "pollution" OR "overuse" OR "contamination")) OR (("Plastic" OR "plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))) OR TI=("environmental*" OR "sustainab*")) NOT DT=(meeting abstract) AND (PY=(1980 OR 1981 OR 1982 OR 1983 OR 1984 OR 1985 OR 1986 OR 1987 OR 1988 OR 1989 OR 1990 OR 1991 OR 1992 OR 1993 OR 1994 OR 1995 OR 1996 OR 1997 OR 1998 OR 1999 OR 2000 OR 2001 OR 2002 OR 2003 OR 2004 OR 2005 OR 2006 OR 2007 OR 2008 OR 2009 OR 2010 OR 2011 OR 2012 OR 2013 OR 2014 OR 2015 OR 2016 OR 2017 OR 2018 OR 2019 OR 2020 OR 2021 OR 2022)) AND (TI=(("Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR/4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR/4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR/4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR/4 ("review*" OR "overview*" OR "synthes*") NEAR/4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*") OR ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR/1 (study OR studies))) OR (("follow up" NEAR/1 (study OR studies))) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies))) OR (("cross sectional" NEAR/1 (study OR studies)))) OR ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")) OR AB=(("Meta-Analysis" OR metaanaly* OR "meta-analy*" or metanaly* OR "Systematic Review" OR "Cochrane Database Syst Rev" OR "prisma" OR "preferred reporting items" OR "prospero" OR ((systemati* OR scoping OR umbrella OR "structured literature") NEAR/4 (review* OR overview*)) OR "systematic review*" OR "scoping review*" OR "umbrella review*" OR "structured literature review*" OR "systematic qualitative review*" OR "systematic quantitative review*" OR "systematic search and review" OR "systematized review" OR "systematised review" OR "systemic review" OR "systematic literature review*" OR "systematic integrative literature review*" OR "systematically review*" OR "scoping literature review*" OR "systematic critical review" OR "systematic integrative review*" OR "systematic evidence review" OR "Systematic integrative literature review*" OR "Systematic mixed studies review*" OR "Systematized literature review*" OR "Systematic overview*" OR "Systematic narrative review*" OR (("systemati*" OR "literature" OR "database*" OR "data-base*" OR "structured" OR "comprehensive*" OR "systemic*") NEAR/4 "search*") OR ("Literature" AND "review" AND ("database*" OR "data-base*" OR "search*")) OR (("data extraction" OR "data source*") AND "study selection") OR ("search strategy" AND "selection criteria") OR ("data source*" AND "data synthesis") OR "medline" OR "pubmed" OR "embase" OR "Cochrane" OR (("critical" OR "rapid") NEAR/4 ("review*" OR "overview*" OR "synthes*")) OR ((("critical*" OR "rapid*") NEAR/4 ("review*" OR "overview*" OR "synthes*") NEAR/4 ("search*" OR "database*" OR "data-base*"))) OR metasynthes* OR "meta-synthes*") OR ("Randomized Controlled Trial" OR random* OR "RCT"OR "RCTs" OR "pragmatic clinical trial*" OR "practical clinical trial*" OR "non-inferiority trial*" OR "noninferiority trial*" OR "superiority trial*" OR "equivalence clinical trial*") OR ("Comparative Study" OR "comparison" OR "comparative" OR "compar*" OR "major clinical study" OR "clinical study" OR "case control study" OR "family study" OR "longitudinal study" OR "retrospective study" OR "prospective study" OR "cohort analysis" OR cohort* OR (("case control" NEAR/1 (study OR studies))) OR (("follow up" NEAR/1 (study OR studies))) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies))) OR (("cross sectional" NEAR/1 (study OR studies))))

OR ("life cycle assess*" OR "life cycle assessment" OR "life cycle inventory" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories")))

Cochrane Library

(("Operating Rooms" OR "operating room" OR "operating rooms" OR "operation room" OR "operation rooms" OR "operating theatre" OR "operating theatres" OR "operation theatre" OR "operation theatres" OR "operating theater" OR "operating theaters" OR "operation theater" OR "operation theaters" OR "surgery room" OR "surgery rooms" OR "operation room" OR "operation rooms" OR "surgery theatre" OR "surgery theatres" OR "operation theatre" OR "operation theatres" OR "surgery theater" OR "surgery theaters" OR "operation theater" OR "operation theaters" OR "surgical room" OR "surgical rooms" OR "operation room" OR "operation rooms" OR "surgical theatre" OR "surgical theatres" OR "operation theatre" OR "operation theatres" OR "surgical theater" OR "surgical theaters" OR "operation theater" OR "operation theaters" OR "operating department" OR "operating departments" OR "operationg department" OR "operation departments" OR "surgical suite" OR "surgical suites" OR "surgery suite" OR "surgery suites" OR "operation suite" OR "operation suites" OR "operating suite" OR "operating suites") AND ("Ventilation" OR "ventilation" OR "ventilation system" OR "ventilation systems" OR "air system" OR "air systems" OR "Air Conditioning" OR "Air Conditioning" OR "HVAC" OR "Heating Ventilation and Air Conditioning" OR "Heating, Ventilation and Air Conditioning" OR "hepa filter" OR "hepafilter" OR "hepa filters" OR "hepafilters" OR "hepa filtration" OR "hepafiltration" OR "high efficiency particulate air" OR "unidirectional downflow system" OR "unidirectional downflow" OR "unidirectional down flow" OR "uni directional down flow" OR "laminair downflow" OR "laminair down flow" OR "laminar downflow" OR "laminar down flow" OR "plenum" OR "opragon" OR "halton" OR "3 zones" OR "three zones" OR "3 zone" OR "three zone" OR "Temperature 18 23 degrees Celsius" OR (("Temperature" OR "temperature" OR "temperatures") NEAR/4 ("18" OR "19" OR "20" OR "21" OR "22" OR "23") AND ("celsius" OR "degree c" OR "degrees c")) OR "Humidity" OR "humidity" OR "humid" OR "recovery time" OR "recovery times" OR "NEN 14644 3" OR "ISO 14644 3" OR "14644 3" OR "air change" OR "air changes" OR "air quality ISO 7" OR "air quality" OR "ISO 7" OR "NEN 14644 1" OR "ISO 14644 1" OR "14644 1" OR "146441" OR "2 zones" OR "2 zone" OR "two zones" OR "two zone" OR "mixing ventilation airflow" OR "MAF" OR "Mixing ventilation air flow" OR "mixing ventilation" OR (("ventilation" OR "airflow" OR "air flow") NEAR/4 ("mixed" OR "mixing" OR "turbulent")) OR "conventional airflow" OR "conventional air flow" OR "ceiling diffusers" OR "ceiling diffuser" OR "circulatory system" OR "circulatory systems" OR "laminar flow" OR "unidirectional flow" OR "laminar air flow" OR "laminar airflow" OR "laminar air" OR "conventional ventilation" OR "ultraclean ventilation" OR "ultraclean air" OR "clean airflow" OR "ultraclean ventilation" OR "ultraclean air" OR "ultra clean ventilation" OR "ultra clean air" OR "clean airflow" OR "opragon" OR "halton" OR "partial unidirectional airflow" OR "partial uni directional airflow" OR "partial unidirectional flow" OR "partial uni directional flow" OR "P UDAF" OR "PUDAF" OR "unidirectional airflow" OR "uni directional airflow" OR "displacement ventilation" OR "plenum ventilated" OR "plenum ventilated" OR "plenum ventilation" OR "horizontal ventilation" OR "vertical ventilation" OR "plenum" OR "halton")):ti,ab,kw AND
(("Carbon Footprint" OR "carbon footprint" OR "carbon footprint*" OR "Climate Change" OR "climate change" OR "CO2 emission" OR "CO2 emissions" OR "CO2 footprint" OR "CO2 footprint*" OR "environmental protection" OR "conservation of natural resources" OR "environmental protection" OR "Disposable Equipment" OR "Disposables" OR "Disposable" OR "ecological footprint" OR "ecological footprint*" OR "ecological sustainability" OR "environmental impact" OR "environmental impact" OR "environmental impact*" OR "environmental impacts" OR "environmental pollut*" OR "pollution" OR "environmental pollution" OR "environmental sustainab*" OR "environmental sustainability" OR "environmental sustainability" OR "Global Warming" OR "Global Warming" OR "Greenhouse Effect" OR "greenhouse effect*" OR "greenhouse effects" OR "greenhouse gas emission" OR "greenhouse gas emissions" OR "Greenhouse Gas" OR "greening" OR "hospital waste" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assessment" OR "environmental impact assessment" OR "life cycle assess*" OR "life cycle assessment" OR "LCA" OR "LCAs" OR "life cycle inventory" OR "life cycle inventories" OR "Waste Disposal" OR "Hospital Waste" OR "medical waste" OR "Rising Sea Level" OR "Rising Sea Levels" OR "Sea Level Rise" OR "Sea Level Rise" OR "Waste Disposal" OR "waste water recycling" OR "Recycling" OR "recycling" OR "recycle*" OR "Equipment reuse" OR "Reusables" OR "reusable" OR "reuse" OR "reused" OR "reusing" OR "Waste Disposal" OR "Waste Management" OR "Plastic overuse" OR "Green surgery" OR "Emission reduction" OR "Emission reduction strategy" OR "air pollution control" OR "air pollution control" OR "acidification" OR "soil acidification" OR "ocean acidification" OR "acidification" OR "Acidification potential" OR "AP in kg SO2 equivalents" OR "eco-efficiency" OR "ecoefficiency" OR "eco-efficien*" OR "ecoefficien*" OR "ecotoxicity" OR "ecotoxicity" OR "ecotoxic*" OR "eco toxicity" OR "eco toxic*" OR "EP in kg PO4 equivalent" OR "Eutrophication" OR "eutrophication" OR "Eutrophication potential" OR "FAETP in kg DCB equivalent" OR "Freshwater Aquatic Ecotoxicity Potential" OR "GWP in kg CO2 equivalents" OR "H+ moles equivalents" OR "HTTP in kg Dichlorobenzene equivalent" OR "Human Toxicity Potential" OR "kg 2.4-D equivalents" OR "kg CFC-11 equivalent" OR "kg N equivalents" OR "kg NOx equivalents" OR "life cycle analysis" OR "ozone depletion" OR "Photochemical Ozone Depletion Potential" OR "POCP in kg ethane equivalent" OR "smog" OR "Waste" OR "waste" OR "wastes" OR "Ozone Depletion" OR "Smog" OR "Equipment reuse" OR "Greenhouse Gases" OR "Greenhouse Gas" OR "SO2 equiv*" OR "CO2 equiva*" OR "CFC-11 equiv*" OR "N equiv*" OR "Biodiversity" OR "Climatic change" OR "Green deal" OR "preservation of natural resources" OR "Refuse Disposal" OR "Waste Water" OR "Wastewater" OR "Water Purification" OR (("plastic*" OR "microplastic*") AND ("soop" OR "soup" OR "pollution" OR "overuse" OR "contamination")) OR "Sustainable Development" OR "Sustainable Development" OR (("Plastic" OR "plastics") AND "overuse") OR ("hydrogen*" AND "moles" AND "equiv*") OR ("Dichlorobenzen*" AND "equiv*") OR ("2,4-D" AND "equiv*") OR ("NOx" AND "equiv*") OR ("ethane" AND "equiv*") OR ("PO4" AND "equiv*") OR ("DCB" AND "equiv*") OR ("sustainability" AND ("environment*" OR "carbon")) OR (("Carbon Dioxide" OR "Carbon Dioxide" OR "CO2") AND ("pollution" OR "emission" OR "emissions" OR "waste" OR "environment" OR "environmental*" OR "footprint" OR "footprint*" OR "sustainable" OR "hazard" OR "hazard*"))):ti,ab,kw OR ("environmental" OR "sustainability"):ti)
NOT DT=(meeting abstract)

Emcare

(exp "Operating Room"/ OR "operating room".mp OR "operating rooms".mp OR "operation room".mp OR "operation rooms".mp OR "operating theatre".mp OR "operating theatres".mp OR "operation theatre".mp OR "operation theatres".mp OR "operating theater".mp OR "operating theaters".mp OR "operation theater".mp OR "operation theaters".mp OR "surgery room".mp OR "surgery rooms".mp OR "operation room".mp OR "operation rooms".mp OR "surgery theatre".mp OR "surgery theatres".mp OR "operation theatre".mp OR "operation theatres".mp OR "surgery theater".mp OR "surgery theaters".mp OR "operation theater".mp OR "operation theaters".mp OR "surgical room".mp OR "surgical rooms".mp OR "operation room".mp OR "operation rooms".mp OR "surgical theatre".mp OR "surgical theatres".mp OR "operation theatre".mp OR "operation theatres".mp OR "surgical theater".mp OR "surgical theaters".mp OR "operation theater".mp OR "operation theaters".mp OR "operating department".mp OR "operating departments".mp OR ("operation".ti AND ("department".ti OR "departments".ti)) OR "surgical suite".mp OR "surgical suites".mp OR "surgery suite".mp OR "surgery suites".mp OR "operation suite".mp OR "operation suites".mp OR "operating suite".mp OR "operating suites".mp) AND ("room ventilation"/ OR "air conditioning"/ OR exp "ventilator"/ OR "ventilation".mp OR "ventilat*".mp OR "ventilation system".mp OR "ventilation systems".mp OR "air system".mp OR "air systems".mp OR "Air Conditioning".mp OR "Air Condition*".mp OR "HVAC".mp OR "Heating Ventilation and Air-Conditioning".mp OR "Heating, Ventilation and Air-Conditioning".mp OR "hepa-filter".mp OR "hepafilter".mp OR "hepa filters".mp OR "hepafilters".mp OR "hepa filtration".mp OR "hepafiltration".mp OR "high efficiency particulate air".mp OR exp "air filter"/ OR "Air Filters".mp OR "Air Filter".mp OR "Airfilters".mp OR "Airfilter".mp OR "Air Filt*".mp OR "Airfilt*".mp OR "unidirectional downflow system".mp OR "unidirectional downflow".mp OR "unidirectional down flow".mp OR 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(("ventilation".mp OR "ventilat*".mp OR "airflow".mp OR "air flow".mp) AND ("mixed".mp OR "mixing".mp OR "turbulent".mp)) OR "airflow"/ OR "conventional airflow".mp OR "conventional air flow".mp OR "ceiling diffusers".mp OR "ceiling diffuser".mp OR "ceiling diffus*".mp OR "circulatory system".mp OR "circulatory systems".mp OR "laminar airflow"/ OR "laminar flow".mp OR "unidirectional flow".mp OR "laminar-air-flow".mp OR "laminar airflow".mp OR "laminar flow*".mp OR "laminar-air-flow*".mp OR "laminar airflow*".mp OR "laminar air".mp OR "conventional ventilation".mp OR "ultraclean ventilation".mp OR "ultraclean air".mp OR "conventional ventilat*".mp OR "ultraclean air".mp OR "ultra clean ventilation".mp OR "ultra clean air".mp OR "ultraclean ventilat*".mp OR "ultraclean air*".mp OR "ultra clean ventilat*".mp OR "ultra clean air*".mp OR "clean-airflow".mp OR "clean-airflow*".mp OR "partial unidirectional airflow".mp OR "partial uni directional airflow".mp OR "partial unidirectional 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impact"/ OR "environmental impact".mp OR "environmental impact*".mp OR "environmental impacts".mp OR "environmental pollut*".mp OR exp "pollution"/ OR "environmental pollution".mp OR "environmental sustainab*".mp OR "environmental sustainability"/ OR "environmental sustainability".mp OR "Global Warming"/ OR "Global Warming".mp OR "Greenhouse Effect"/ OR "greenhouse effect*".mp OR "greenhouse effects".mp OR "greenhouse gas emission".mp OR "greenhouse gas emissions".mp OR "Greenhouse Gas"/ OR "greening".mp OR "hospital waste".mp OR "life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp OR exp "Waste Disposal"/ OR exp "Hospital Waste"/ OR "medical waste".mp OR "Rising Sea Level".mp OR "Rising Sea Levels".mp OR "Sea Level Rise"/ OR "Sea Level Rise".mp OR "sustainability".ti OR "Waste Disposal".mp OR "waste water recycling"/ OR "Recycling"/ OR "recycling".mp OR "recycle*".mp OR "Equipment reuse".mp OR "Reusables".mp OR "reusable".mp OR "reuse".mp OR "reused".mp OR "reusing".mp OR exp "Waste Disposal"/ OR exp "Waste Management"/ OR "Plastic overuse".mp OR "Green surgery".mp OR "Emission reduction".mp OR "Emission reduction strategy".mp OR "air pollution control"/ OR "air pollution control".mp OR "Environment"/ OR "Environmental*".ti OR "acidification"/ OR "soil acidification"/ OR "ocean acidification"/ OR "acidification".mp OR "Acidification potential".mp OR "AP in kg SO2 equivalents".mp OR "eco-efficiency".mp OR "ecoefficiency".mp OR "eco-efficien*".mp OR "ecoefficien*".mp OR "ecotoxicity"/ OR "ecotoxicity".mp OR "ecotoxic*".mp OR "eco toxicity".mp OR "eco toxic*".mp OR "EP in kg PO4 equivalent".mp OR exp "Eutrophication"/ OR "eutrophication".mp OR "Eutrophication potential".mp OR "FAETP in kg DCB equivalent".mp OR "Freshwater Aquatic Ecotoxicity Potential".mp OR "GWP in kg CO2 equivalents".mp OR "H+ moles equivalents".mp OR 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"Sustainable Development".mp OR (("Plastic".mp OR "plastics".mp) AND "overuse".mp) OR ("hydrogen*".mp AND "moles".mp AND "equiv*".mp) OR ("Dichlorobenzen*".mp AND "equiv*".mp) OR ("2,4-D".mp AND "equiv*".mp) OR ("NOx".mp AND "equiv*".mp) OR ("ethane".mp AND "equiv*".mp) OR ("PO4".mp AND "equiv*".mp) OR ("DCB".mp AND "equiv*".mp) OR ("sustainability".mp AND ("environment*".mp OR "carbon".mp)) OR (("Carbon Dioxide"/ OR "Carbon Dioxide".mp OR "CO2".mp) AND ("pollution".mp OR "emission".mp OR "emissions".mp OR "waste".mp OR "environment".mp OR "environmental*".mp OR "footprint".mp OR "footprint*".mp OR "sustainable".mp OR "hazard".mp OR "hazard*".mp))) NOT (conference review or conference abstract).pt AND 1980:2023.(sa_year) AND ((exp "meta analysis"/ OR exp "meta analysis (topic)"/ OR metaanaly*.ti,ab OR "meta analy*".ti,ab OR metanaly*.ti,ab OR "systematic review"/ OR "cochrane database of systematic reviews".jn OR prisma.ti,ab OR prospero.ti,ab OR (((systemati* OR scoping OR umbrella OR "structured literature") ADJ3 (review* OR overview*)).ti,ab) OR ((systemic* ADJ1 review*).ti,ab) OR (((systemati* OR literature OR database* OR "data base*") ADJ10 search*).ti,ab) OR (((structured OR comprehensive* OR systemic*) ADJ3 search*).ti,ab) OR (((literature ADJ3 review*).ti,ab) AND (search*.ti,ab OR database*.ti,ab OR "data base*".ti,ab)) OR (("data extraction".ti,ab OR "data source*".ti,ab) AND "study selection".ti,ab) OR ("search strategy".ti,ab AND "selection criteria".ti,ab) OR ("data source*".ti,ab AND "data synthesis".ti,ab) OR medline.ab OR pubmed.ab OR embase.ab OR cochrane.ab OR (((critical OR rapid) ADJ2 (review* OR overview* OR synthes*)).ti) OR ((((critical* OR rapid*) ADJ3 (review* OR overview* OR synthes*)).ab) AND (search*.ab OR database*.ab OR "data base*".ab)) OR metasynthes*.ti,ab OR "meta synthes*".ti,ab) OR (exp "clinical trial"/ OR exp "randomization"/ OR exp "single blind procedure"/ OR exp "double blind procedure"/ OR exp "crossover procedure"/ OR exp "placebo"/ OR exp "prospective study"/ OR rct.ti,ab OR random*.ti,ab OR "single blind".ti,ab OR "randomised controlled trial".ti,ab OR exp "randomized controlled trial"/ OR placebo*.ti,ab) OR (exp "Comparative Study"/ OR "comparison".ti,ab OR "comparative".ti,ab OR "compar*".ti,ab OR "major clinical study"/ OR "clinical study"/ OR "case control study"/ OR "family study"/ OR "longitudinal study"/ OR "retrospective study"/ OR "prospective study"/ OR "cohort analysis"/ OR cohort*.ti,ab OR (("case control" ADJ1 (study OR studies)).ti,ab) OR (("follow up" ADJ1 (study OR studies)).ti,ab) OR (observational ADJ1 (study OR studies)).ti,ab OR ((epidemiologic ADJ1 (study OR studies)).ti,ab) OR (("cross sectional" ADJ1 (study OR studies)).ti,ab)) OR ("life cycle assessment"/ OR "environmental impact assessment"/ OR "life cycle assess*".mp OR "life cycle assessment".mp OR "life cycle inventory".mp OR "LCA".mp OR "LCAs".mp OR "life cycle inventory".mp OR "life cycle inventories".mp))