Environ Health Perspect

DOI: 10.1289/EHP14754

Supplemental Material

The Carbon Footprint of Hospital Services and Care Pathways: A State-of-the-Science Review

Lisanne H.J.A. Kouwenberg, Eva S. Cohen, Wouter J.K. Hehenkamp, Lynn E. Snijder, Jasper M. Kampman, Burcu Küçükkeles, Arno Kourula, Marijn H.C. Meijers, Eline S. Smit, Nicolaas H. Sperna Weiland, and Dionne S. Kringos

Table of Contents

References

Table S1. Completed STARR-LCA Checklist

Item	Description	Included? [1]	Comments
1. Document title, structured summary, and key words	• Title identifies article as systematic review, meta-analysis or both • Abstract contains background; objectives; data sources; study eligibility criteria; scope, system boundaries and functional unit; study appraisal and synthesis methods; results; limitations; and conclusions with implications for key findings • Key words include meta-analysis and/or systematic review	I	*Title and key words include 'systematic review'. Abstract contains background, objectives, data sources, eligibility criteria, scope, study appraisal and synthesis methods, results, and conclusions with implications for key findings. System boundaries and functional unit were not included in the abstract.*
2. Rationale of the review	• Purpose of review study in the context of current knowledge	Y	*Current knowledge base and research gaps described in background section.*
3. Review questions and objectives	• Question elements consistent with PIFT format[2]	Y	*While not explicitly described in PIFT format in the article, the research question elements are consistent with PIFT format:* - *Products of interest: hospital services and care pathways* - *Impact of interest: climate change* - *Flows: energy and materials* - *Type of LCA included: all types*
4. Description of review protocol	• How possible studies or data for review were located • Information sources • Description of electronic search strategies • Process for selecting studies or data to include in the review summary • Description of further analyses	Y	*A review protocol was published on PROSPERO. Complete search strategies for each electronic database can be found in Appendix A. Inclusion and exclusion criteria are listed in Appendix B.*
5. Findings and features of individual studies in the review	• Include major findings, methods and limitations • Present data graphically if possible	Y	*Major findings and methods are presented in Tables 1 – 3 and text. Data was presented graphically in Figure 1. Limitations are discussed in the discussion section.*
6. Assessment of bias	• Assessment of bias for individual studies included and across studies when summarized • Statement of funding source for the review	Y	*Quality of each individual study was assessed by two reviewers independently. Funding source for the review was stated.*
7. Synthesis methods	• Description of how data was summarized qualitatively and quantitatively	Y	*Synthesis methods were described in the Methods section.*
8. Limitations of the Review	• Limitations of methodology • Guidance about appropriate generalization or application of review findings	Y	*Limitations of the review and application of review findings were discussed in the Discussion section.*
9. Summary of findings and conclusions	• Clear conclusions • Discussion of conclusions in the context of other evidence	Y	*Findings were summarized and conclusions were discussed in the context of other evidence.*

1. Abbreviations for item inclusion: Y = yes; N = no; I = incomplete
2. PIFT = Product or process; Impacts of interest; Flows or economic sectors included; Type(s) of life cycle assessment

Full search strategy

Medline (OVID)

#1	*Greenhouse Effect/ OR *Carbon Footprint/ OR *Global Warming/
#2	(((environmental OR ecological) ADJ sustainability) OR ((climate OR environmental OR ecological) ADJ2 (impact* OR friendly OR footprint*)) OR (global ADJ warming) OR (Greenhouse ADJ1 (effect* OR gas*)) OR GHG OR ((carbon OR co2 OR gas) ADJ2 (emission* OR footprint)) OR (((life ADJ cycle) OR lifecycle) ADJ3 (analys* OR assessment* OR inventory)) OR (cradle ADJ to ADJ (grave OR gate OR cradle)) OR cradle-to-grave OR cradle-to-gate OR cradle-to-cradle).ab,kf,ti.
#3	exp *Surgical Procedures, Operative/ OR exp *Specialties, Surgical/ OR exp *Hospital Units/ OR *Diagnosis/ OR exp *Therapeutics/ OR exp *Patient Care/ OR exp *Patient Care Management/
#4	(hospital? OR ((medical OR clinical OR pharmacological OR pharmaceutical OR drug OR operative OR surg* OR interventional OR inpatient OR outpatient OR diagnostic OR therapeutic) ADJ2 (care OR service* OR procedure* OR intervention* OR operation* OR technique* OR surger* OR treatment* OR therapy OR therapies OR management OR test)) OR ((clinical OR care OR treatment OR patient) ADJ1 (path? OR pathway? OR plan OR journey))).ab,kf,ti.
#5	exp animal/ not human/) or disease models, animal/ or exp animals, laboratory/ or exp animals, genetically modified/ or (animal adj3 (model* or experiment*)).ti.
#6	(#1 OR #2) AND (#3 OR #4) NOT #5

Embase (OVID)

#1	*Greenhouse effect/ OR *Carbon Footprint/ OR *Climate Warming/ OR *Life cycle assessment/
#2	(((environmental OR ecological) ADJ sustainability) OR ((climate OR environmental OR ecological) ADJ2 (impact* OR friendly OR footprint*)) OR (global ADJ warming) OR (Greenhouse ADJ1 (effect* OR gas*)) OR GHG OR ((carbon OR co2 OR gas) ADJ2 (emission* OR footprint)) OR (((life ADJ cycle) OR lifecycle) ADJ3 (analys* OR assessment* OR inventory)) OR (cradle ADJ to ADJ (grave OR gate OR cradle)) OR cradle-to-grave OR cradle-to-gate OR cradle-to-cradle).ab,kf,ti.
#3	*Hospital care/ OR *Medical Procedures/ OR exp *Surgery/ OR *Therapy/ OR *Invasive procedure/ OR *Diagnostic procedure/ OR *Pharmaceutical care/ OR exp *Drug therapy/ OR exp *"Hospital subdivisions and components"/ OR exp *Patient Care/ OR exp *Practice guideline/
#4	(hospital? OR ((medical OR clinical OR pharmacological OR pharmaceutical OR drug OR operative OR surg* OR interventional OR inpatient OR outpatient OR diagnostic OR therapeutic) ADJ2 (care OR service* OR procedure* OR intervention* OR operation* OR technique* OR surger* OR treatment* OR therapy OR therapies OR management OR test)) OR ((clinical OR care OR treatment OR patient) ADJ1 (path? OR pathway? OR plan OR journey))).ab,kf,ti.
#5	(#1 OR #2) AND (#3 OR #4)
#6	Limit #5 to conference abstracts
#7	(exp animal/ not human/) or disease models, animal/ or exp animals, laboratory/ or exp animals, genetically modified/ or (animal adj3 (model* or experiment*)).ti.
#8	#5 NOT #6 NOT #7

EBSCO CINAHL

S1	MM("Greenhouse Effect" OR "Carbon Footprint")
S2	TI (((environmental OR ecological) N0 sustainability) OR ((climate OR environmental OR ecological) N2 (impact* OR friendly OR footprint)) OR (global N2 warming) OR (Greenhouse N1 (effect* OR gas*)) OR GHG OR ((carbon OR co2 OR gas) N2 (emission* OR footprint)) OR (("life cycle") OR lifecycle) N3 (analys* OR assessment* OR inventory)) OR (cradle to (grave OR gate OR cradle)) OR cradle-to-grave OR cradle-to-gate OR cradle-to-cradle)
S3	AB (((environmental OR ecological) N0 sustainability) OR ((climate OR environmental OR ecological) N2 (impact* OR friendly OR footprint)) OR (global N2 warming) OR (Greenhouse N1 (effect* OR gas*)) OR GHG OR ((carbon OR co2 OR gas) N2 (emission* OR footprint)) OR (("life cycle") OR lifecycle) N3 (analys* OR assessment* OR inventory)) OR (cradle to (grave OR gate OR cradle)) OR cradle-to-grave OR cradle-to-gate OR cradle-to-cradle)
S4	MM ("Surgery, Operative" OR "Hospital Units+" OR "Diagnosis+" OR "Therapeutics+" OR "Patient Care+")
S5	TI (hospital? OR ((medical OR clinical OR pharmacological OR pharmaceutical OR drug OR operative OR surg* OR interventional OR inpatient OR outpatient OR diagnostic OR therapeutic) N2 (care OR service* OR procedure* OR intervention* OR operation* OR technique* OR surger* OR treatment* OR therapy OR therapies OR management OR test)) OR ((clinical OR care OR treatment OR patient) N2 (path OR pathway* OR plan OR journey)))
S6	AB (hospital? OR ((medical OR clinical OR pharmacological OR pharmaceutical OR drug OR operative OR surg* OR interventional OR inpatient OR outpatient OR diagnostic OR therapeutic) N2 (care OR service* OR procedure* OR intervention* OR operation* OR technique* OR surger* OR treatment* OR therapy OR therapies OR management OR test)) OR ((clinical OR care OR treatment OR patient) N1 (path? OR pathway? OR plan OR journey)))
S7	(S1 OR S2 OR S3) AND (S4 OR S5 OR S6)

EBSCO GreenFILE

S1	DE ("Greenhouse Effect" OR "Greenhouse Gases" OR "CARBON dioxide" OR "Ecological impact" OR "Sustainability" OR "GLOBAL warming")
S2	TI (((environmental OR ecological) N0 sustainability) OR ((climate OR environmental OR ecological) N2 (impact* OR friendly OR footprint)) OR (global N2 warming) OR (Greenhouse N1 (effect* OR gas*)) OR GHG OR ((carbon OR co2 OR gas OR environmental OR ecological) N2 (emission* OR footprint)) OR (("life cycle") OR lifecycle) N3 (analys* OR assessment* OR inventory)) OR (cradle to (grave OR gate OR cradle)) OR cradle-to-grave OR cradle-to-gate OR cradle-to-cradle)
S3	AB (((environmental OR ecological) N0 sustainability) OR ((climate OR environmental OR ecological) N2 (impact* OR friendly OR footprint)) OR (global N2 warming) OR (Greenhouse N1 (effect* OR gas*)) OR GHG OR ((carbon OR co2 OR gas OR environmental OR ecological) N2 (emission* OR footprint)) OR (("life cycle") OR lifecycle) N3 (analys* OR assessment* OR inventory)) OR (cradle to (grave OR gate OR cradle)) OR cradle-to-grave OR cradle-to-gate OR cradle-to-cradle)
S4	TI (hospital? OR ((medical OR clinical OR pharmacological OR pharmaceutical OR drug OR operative OR surg* OR interventional OR inpatient OR outpatient OR diagnostic OR therapeutic) N2 (care OR service* OR procedure* OR intervention* OR operation* OR technique* OR surger* OR treatment* OR therapy OR therapies OR management OR test)) OR ((clinical OR care OR treatment OR patient) N2 (path OR pathway* OR plan OR journey)))
S5	AB (hospital? OR ((medical OR clinical OR pharmacological OR pharmaceutical OR drug OR operative OR surg* OR interventional OR inpatient OR outpatient OR diagnostic OR therapeutic) N2 (care OR service* OR procedure* OR intervention* OR operation* OR technique* OR surger* OR treatment* OR therapy OR therapies OR management OR test)) OR ((clinical OR care OR treatment OR patient) N1 (path? OR pathway? OR plan OR journey)))
S6	(S1 OR S2 OR S3) AND (S4 OR S5)

Web of Science

#1	TS=(((environmental OR ecological) NEAR/0 sustainability) OR ((climate OR environmental OR ecological) NEAR/2 (impact* OR friendly OR footprint*)) OR (global NEAR/0 warming) OR (Greenhouse NEAR/1 (effect* OR gas*)) OR GHG OR ((carbon OR co2 OR gas) NEAR/2 (emission* OR footprint)) OR (("life cycle" OR lifecycle) NEAR/3 (analys* OR assessment* OR inventory)) OR "cradle to grave" OR "cradle-to-grave" OR "cradle to gate" OR "cradle-to-gate" OR "cradle to cradle" OR "cradle-to-cradle")
#2	TS=(hospital? OR ((medical OR clinical OR pharmacological OR pharmaceutical OR drug OR operative OR surg* OR interventional OR inpatient OR outpatient OR diagnostic OR therapeutic) NEAR/2 (care OR service* OR procedure* OR intervention* OR operation* OR technique* OR surger* OR treatment* OR therapy OR therapies OR management OR test)) OR ((clinical OR care OR treatment OR patient) NEAR/1 (path? OR pathway? OR plan OR journey)))
#3	#1 AND #2

Scopus

#1	TITLE-ABS(((environmental OR ecological) PRE/0 sustainability) OR ((climate OR environmental OR ecological) W/2 (impact* OR friendly OR footprint*)) OR (global W/0 warming) OR (Greenhouse W/1 (effect* OR gas*)) OR GHG OR ((carbon OR co2 OR gas) W/2 (emission* OR footprint)) OR (("life cycle" OR lifecycle) W/3 (analys* OR assessment* OR inventory)) OR "cradle to grave" OR "cradle-to-grave" OR "cradle to gate" OR "cradle-to-gate" OR "cradle to cradle" OR "cradle-to-cradle")
#2	TITLE-ABS (hospital? OR ((medical OR clinical OR pharmacological OR pharmaceutical OR drug OR operative OR surg* OR interventional OR inpatient OR outpatient OR diagnostic OR therapeutic) PRE/2 (care OR service* OR procedure* OR intervention* OR operation* OR technique* OR surger* OR treatment* OR therapy OR therapies OR management OR test)) OR ((clinical OR care OR treatment OR patient) PRE/1 (path? OR pathway? OR plan OR journey)))
#3	#1 AND #2

Search strategies were developed based on five known relevant articles[1-5].

Grey literature from the following organizations was searched:

- National Health Service (NHS), accessed via: https://www.england.nhs.uk/
- Sustainable Healthcare Coalition (SHC), accessed via: https://shcoalition.org/
- Healthcare Without Harm (HCWH), accessed via: https://noharm.org/
- Organisation for Economic Co-operation and Development (OECD), accessed via: https://www.oecd-ilibrary.org/
- Rijksinstituut voor Volksgezondheid en Milieu (RIVM), accessed via: https://www.rivm.nl/

Table S2. Inclusion and exclusion criteria

Description	Inclusion criteria	Exclusion criteria
Research scope	Studies reporting on the impact of hospital services on the environment	Studies reporting on the impact of environmental change on hospital services: i.e. effect of climate change on health or health service use
Research topic	Hospital services or hospital care pathways	No hospital service (i.e. primary care, long-term care) or hospital care was not main part of care pathway
Unit of analysis	Study included and reported impact(s) on: 1. Individual hospital service or care pathway level: i.e. one type of surgery or a care pathway for an average patient 2. For a group of hospital services: i.e. carbon footprint for all hemodialysis patients	Study only included or reported impact(s) on: 3. A macro level: i.e. national level or whole hospital 4. A micro level: i.e. product level, pharmaceutical ingredient, only one element of care delivery included (waste, travel)
Outcome measures	Carbon footprint reported	No carbon footprint reported
		Only differential carbon savings reported
		No data reported per contributing factor, i.e. no relative contribution
Type of article	Original empirical research articles	Opinion-based reports, conference abstracts, commentaries, editorials, reviews
		Studies not written in English or Dutch
		No full text available

Table S3. Carbon footprint of hospital care in Anesthesiology: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS			
					General anesthesia	*Spinal anesthesia*		*Combined anesthesia*
McGain et al., 2021 [6] (Australia)	General anesthesia, spinal anesthesia, and combined (general and spinal) anesthesia for total knee replacement surgery	**Method:** Prospective, nonrandomized single center LCA **Protocol(s):** ISO-14040 standards **Type of activity data:** Process (primary + secondary) **Characterization method:** International Reference Life Cycle Data System 2016 (European Commission) **Software:** SimaPro-9	Consumables and disposal	Copper	0%	0%		0%
				Cotton	3%	3%		4%
				Glass	4%	4%		4%
				Plastics, non-polyvinyl chloride	13%	10%		12%
				Plastics, non-polyvinyl chloride recycled	1%	<1%		<1%
				Plastics, polyvinyl chloride	4%	2%		3%
				Plastics, polyvinyl chloride recycled	1%	1%		1%
				Rubber, synthetic and natural	<1%	1%		1%
				Stainless steel	<1%	1%		1%
			Equipment	Energy use of patient air warmer	20%	21%		19%
				Energy use of anesthesia machine	2%	2%		2%
				Energy use for washing, sterilization of reusable equipment	5%	30%		25%
			Pharmaceuticals	Oxygen	3%	18%		3%
				Compressed air	<1%	-		-
				Sevoflurane global warming potential	35%	0%		19%
				Other pharmaceuticals	9%	8%		8%
			Total *		14.9 kgCO2e (95% CI 9.7 – 22.5)	16.9 kgCO2e (95% CI 13.2 – 20.5)		18.5 kgCO2e (95% CI 12.5-27.3)
			* *Read from Table 2*					
					1 MAC-h with desflurane	*1 MAC-h with isoflurane*	*1 MAC-h with sevoflurane*	*1 MAC-h with propofol*
Sherman et al., 2012 [7] (USA)	Maintenance anesthesia for an average 70 kg adult patient for 1 hour (1 MAC-h)	**Method:** Life Cycle Assessment **Protocol(s):** *NA* **Type of activity data:** Process (Secondary) **Characterization method:** Global Warming Potential (GWP100 factors	Pharmaceuticals	Agent manufacturing	0.7%	0.2%	0.3%	0.0%
				N_2O Manufacturing	0.2%	0.5%	0.6%	0.0%
				Packaging	0.0%	0.0%	0.0%	25.0%
				Transport	0.0%	0.0%	0.0%	56.3%
				Agent release	59.1%	8.0%	3.2%	0.0%
				N_2O release	39.6%	90.7%	95.9%	0.0%
			Equipment and/or consumables	Drug delivery (energy use machines, desflurane vaporizer heating element and disposables for propofol maintenance)	0.3%	0.0%	0.0%	0.0%
			Disposal	Waste management	0.0%	0.8%	0.0%	18.8%

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS	RELATIVE CONTRIBUTIONS			
		from Sulbaek Andersen et al.) **Software:** SimaPro 7.3.2 Life Cycle Assessment Software	Total * * *Read from Figure 1*	56.5 kgCO2e	24.6 kgCO2e	46.6 kgCO2e	0.01 kgCO2e

Table S4. Carbon footprint of hospital care in Cardiology and cardiac surgery: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS
					1 atrial fibrillation catheter ablation procedure
Ditac et al., 2022 [8] (France)	AF catheter ablation, with radiofrequency energy or single shot cryoballoon device	**Method:** Eco-audit method by Ashby **Protocol(s):** *NA* **Type of activity data:** Process (primary) **Characterization method:** *NA* **Software:** Ansys Granta EduPack software	Equipment	Energy consumption (electricity and gas) of the device during its use	1%
			Consumables	Catheters	39%
				Patches	9%
				Sheath	8%
				Other disposable materials, i.e. packaging	17%
			Other	Anesthesia workstation and drugs	26%
			Other	Material production	71.3%
				Product manufacture	17%
				Product transport	10.6%
				Product use	1.1%
			Total * ** Results reported in two different figures, one based on products (Figure 5) and one based on life cycle stages (Figure 4)*		76.9 kgCO2e
					1 cardiac surgery
Grinberg et al., 2021 [9] (France)	Conventional isolated cardiac surgery procedures (single valve repair or replacement and isolated on-pump coronary artery bypass grafting)	**Method:** Prospective, observational, single-centre study, 'eco-audit' method proposed by Ashby **Protocol(s):** *NA* **Type of activity data:** Process (primary + secondary) **Characterization method:** 2013 IPCC AR5 Fifth Assessment Report **Software:** Ansys Granta EduPack software	Facilities	Electricity consumption of healthcare buildings	3%
			Consumables	Disposables for anesthesia	31%
				Disposables for surgical field	12%
				Disposables for cardio pulmonary bypass	44%
			Pharmaceuticals	Intravenous pharmaceutical products	1%
				Gas pharmaceutical products (sevoflurane)	10%
			Total * * *Calculated from Table 1*		124.3 kgCO2e
					1 CABG
Hubert et al., 2022 [10] (USA)	Elective CABG with utilization of cardiac bypass	**Method:** Not specified **Protocol(s):** *NA* **Type of activity data:** Process (not stated) **Characterization method:** *NA*	Consumables	Manufacturing sharps waste	2%
				Manufacturing red bag waste	78%
			Disposal	Disposal sharps waste	0%
				Disposal red bag waste	8%
			Equipment	Electricity consumption	5%
			Pharmaceuticals	Volatile anesthetic agents consumed by anesthetic machine	5%

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
		Software: *NA*		Volatile anesthetic agents consumed by CPB machine	1%	
			Total *		505.1 kgCO2e	
			* *Calculated from Table 2*			
					Warfarin	*DOAC*
Orton and Pierce, 2021 [11] **(UK)**	Elective direct current cardioversion care pathway	**Method:** Sustainable Care Pathway Guidance tool **Protocol(s):** Sustainable Care Pathway Guidance **Type of activity data**: Hybrid (primary + secondary) **Characterization method:** *NA* **Software:** Sustainable Care Pathway Guidance (SCPG)	Travel	Patient travel	15%	16%
			Facilities	Building energy use for duration of stay	20%	29%
			Other	GP consultations, blood tests, procedural pharmaceutical and equipment procurement, waste incineration, water usage (bed day and procedure)	65%	54%
			Total *		85.49 kgCO2e	58.16 kgCO2e
			* *Calculated from Table 1 and values in the text*			
					1 average care pathway	
Zhang et al., 2022 [5] **(Germany)**	Hospital care pathway for acute decompensated heart failure	**Method:** Environmentally Extended Input-Output (EEIO) LCA **Protocol(s):** GHG Protocol Product Standard **Type of activity data:** Financial (Secondary) **Characterization method:** IPCC, 2013 **Software:** *NA*	Other	Normal ward	74.8%	
				Intensive care unit	9.2%	
				Dialysis department	1.1%	
				Endoscopy diagnosis/therapy	1.9%	
				Cardiology	0.0%	
				Radiology	1.1%	
				Lab	3.2%	
				Diagnostic area	1.6%	
				Therapeutic area	1.1%	
				Patient admission	5.9%	
			Facilities	Electricity, steam and air conditioning supply	87%	
				Water collection, treatment and supply	1%	
			Pharmaceuticals	Manufacture of basic pharmaceutical products and pharmaceutical preparations	2%	
			Disposal	Sewerage, waste management, remediation activities	1%	
			Other	Land transport	1%	
				Manufacture of chemicals and chemical products	1%	
				Manufacture of food products, beverages and tobacco products	1%	
				Manufacture of rubber and plastic products	1%	
				Miscellaneous	6%	
			Total		263 kgCO2e	
			** Results reported in two different ways, one based on Cost-center groups (Table 4) and one based on industry categories (Figure 3)*			

Table S5. Carbon footprint of hospital care in Dermatology: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
					1 pathway according to 2015 guideline	*1 pathway according to 2022 guideline*
Grover et al., 2024 [12] (UK)	Melanoma follow-up pathway, various melanoma stages (1a – 3d), following 2015 vs. 2022 guideline	**Method:** Carbon footprint **Protocol(s):** *NA* **Type of activity data**: Process (secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient travel to outpatient clinic	4%	3 – 4%
				Patient travel to scans	0%	0 – 4%
			Other	Outpatient clinic	96%	83 – 96%
				Ultrasound	0%	0 – 0.4%
				CT scan	0%	0 – 10%
			Total *		315.76 – 1657.74 kgCO2e	157.88 – 1457.28 kgCO2e
			* *Percentages calculated from Table 1, relative contributions and total emissions varied per melanoma stage with different follow-up durations (1 to 10 years).*			

Table S6. Carbon footprint of hospital care in Emergency Medicine: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
					1 bed day in the ICU	
Hunfeld et al., 2023 [13] (the Netherlands)	Material consumption of a bed day in the ICU	**Method:** Material flow analysis	Consumables	Disposable Medical clothing	15%	
				Bed liners	2%	
				Disposable gloves	30%	
				Syringes	16%	
				Syringe packaging	9%	
				Surgical mask	5%	
				Tubes & connectors	3%	
				Disposable bags	3%	
				Surgical mask packaging	1%	
				Disposable covers	0%	
			Pharmaceuticals	Glass ampoule	5%	
				Flexible plastic bag for liquid solution	3%	
				Glass bottle/vials	1%	
				Plastic bottle/vial	0%	
			Other	Waste bags	4%	
				Sterile water	0%	
				Laundry detergent	1%	
			Total *		12 kgCO2e	
			** Calculated and read from Figure 5*			
					Treatment of 1 patient / day in US ICU	*Treatment of 1 patient / day in Australian ICU*
McGain et al., 2018 [14] (USA & Australia)	Treatment of ICU patients with septic shock	**Method:** Hybrid LCA (a process-based LCA, and an economic input–output (EIO) LCA) **Protocol(s):** ISO 14040 **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** ReCiPe 2016 **Software:** *NA*	Facilities	Electricity and gas	87.1%	76.0%
			Consumables and disposal	Plastics	5.2%	8.8%
				Rubber	0.5%	3.8%
				Laundered cotton	3.1%	2.9%
				All other items	1.9%	4.5%
			Equipment	Chest X-rays energy use	2.1%	3.9%
			Pharmaceuticals	Pharmaceuticals, fluids and pathology	*Not included in total*	*Not included in total*
			Total *		178 kgCO2e	88 kgCO2e
			** Relative contributions based on Figure 3*			
					Emergency department visit for an average patient	
Penny et al., 2015a [15] (UK)	Emergency department consultation for a	**Method:** Life Cycle Assessment	Travel	Staff travel	6.3%	
			Consumables	Consumables	6.1%	
			Equipment	Equipment	2.0%	

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
	condition or injury (including stabilization, treatment, referral or discharge)	**Protocol(s):** Sustainable Care Pathways Guidance **Type of activity data:** Unknown (primary + secondary) **Characterization method:** IPCC **Software:** Unknown	Facilities	Energy	69.9%	
				Water	0.3%	
			Pharmaceuticals	Medical gases	15.2%	
			Disposal	Waste	0.3%	
			Total		13.8 kgCO2e	
					1 inpatient bed day in low-intensity ward	*1 inpatient bed day in high-intensity ward*
Penny et al., 2015b [16] (UK)	An average bed day (24 hour period over which a patient stays overnight at a hospital in a low-intensity ward for treatment and monitoring)	**Method:** Life Cycle Assessment **Protocol(s):** Sustainable Care Pathways Guidance **Type of activity data:** Unknown (unknown) **Characterization method:** IPCC **Software:** Unknown	Travel	Staff and visitor travel	10.3%	5.5%
			Consumables	Consumables and food	39.6%	15.6%
			Equipment	Equipment	4.5%	4.2%
			Facilities	Energy	39.6%	68.2%
				Water	0.2%	0.4%
			Pharmaceuticals	Medical gases	4.5%	3.8%
			Disposal	Waste	1.4%	2.3%
			Total		37.9 kgCO2e	89.5 kgCO2e
					Treatment of 1 patient / day in Acute care unit	*Treatment of 1 patient / day in ICU*
Prasad et al., 2022 [17] (USA)	Inpatient stays in regular inpatient units/acute care units and intensive care units	**Method:** Augmented process-based hybrid LCA approach **Protocol(s):** NHS' (National Health Services) life cycle assessment (LCA)-based guideline **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** IPCC Fifth Assessment Report, AR5 (IPCC GWP 100a) **Software:** SimaPro 8.5.2.0	Travel	Staff travel	7 – 8%	6 – 7%
			Facilities	Energy (HVAC, lighting, equipment usage)	34 – 42%	21 – 28%
				Water (provision and wastewater treatment)	0%	0%
			Consumables	Medical consumables, i.e. catheterization kits, pulse oximeters, gloves, syringes, gowns etc.	16 – 19%	27 – 31%
			Pharmaceuticals	Medical gases	3%	2%
			Equipment	Purchasing of capital equipment, i.e. computers, monitors, printers, patient beds, ultrasound machines	9 – 10%	24 – 27%
			Disposal	Waste	5%	3%
			Other	Food	19 – 22%	27 – 31%
			Total *		64,1 - 74,1 kgCO2e	145 – 161,6 kgCO2e

* *Recalculated from Table 4*

Table S7. Carbon footprint of hospital care in Gastroenterology: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
					Esophago-gastroduodenoscopy	*Colonoscopy*
Elli et al., 2024 [18] (Italy)	Esophago-gastroduodenoscopy and colonoscopy	**Method:** Carbon footprint evaluation **Protocol(s):** *NA* **Type of activity data**: Process (primary + secondary) **Characterization method:** *NA* **Software:** U.S. Environmental Protection Agency calculator	Consumables	Face shield	6.4%	5.2%
				Hair covering	0.6%	0.4%
				Gown	11.6%	9.4%
				Face mask (FFP2)	1.8%	1.5%
				Surgical mask (and waste)	1.3%	1.0%
				Gloves	0.2%	0.1%
				Shoe covering	0.2%	0.1%
				Plastic bottle	1.8%	1.5%
				Plastic plug	1.5%	1.2%
				Biohazard plastic bag	0.4%	0.3%
				Plastic tube	12.5%	10.1%
				Biopsy forceps	5.9%	4.8%
				Mouthpiece	0.9%	0.7%
				Clothes	4.2%	3.4%
				Syringe (10 mL)	1.7%	1.3%
				Syringe (50 mL)	2.0%	1.6%
				Needle cannula	0.6%	0.4%
				Catheter	0.6%	0.4%
				Operative channel rubber valve	0.4%	0.3%
				Paper	0.9%	0.7%
				Cloth	0.9%	0.7%
				Disinfectant wipes	0.9%	0.7%
				Transport liner	4.1%	3.3%
				Valve brush	0.4%	0.3%
				Chanel brush	0.9%	0.7%
				Isopropyl alcohol 70% and* sekusept	1.8%	1.5%
			Equipment	Autoclave sterilization	3.1%	2.5%
				Washing machine	1.8%	1.5%
				Endoscopic processor	3.3%	5.4%
				Anesthetic machine	1.5%	2.4%
				Personal computer	0.9%	1.5%
			Facilities	Room light	5.7%	9.3%
				Climate control	12.0%	19.4%
			Other	Histology (single jar)	7.2%	5.8%

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
			Total *		5.43 kgCO2e	6.71 kgCO2e
			** Percentages calculated from Supplementary Table 2.*			
Gatenby 2011 [1] (UK)	Medical treatment of gastro-esophageal reflux		*See Supplementary Table S17 - Results Surgery*			
					1 endoscopic procedure	
Lacroute et al., 2023 [19] (France)	Ambulatory gastrointestinal endoscopy (gastroscopy, colonoscopy with or without polypectomy etc.)	**Method:** Bilan Carbone method (a multi-criteria method) **Protocol(s):** *NA* **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** IPCC **Software:** Bilan Carbone tool (version 8.7.1)	Travel	Patient and staff travel	45%	
			Consumables	Single-use products (gloves, detergents, hemoclips etc.)	3.3%	
			Facilities	Energy	12%	
			Equipment	Medical and non-medical equipment: endoscopy columns, endoscope washer disinfectors, gastroscopes, colonoscopes, echoendoscopes, electrical scalpels, drying and storage machine for endoscope, monitoring scopes, respirator	32%	
			Pharmaceuticals	Production oxygen	0.7%	
				Production carbon dioxide	0.0%	
				Medical gases	0.005%	
			Disposal	Waste (pre and post procedure care, sedation-related waste and reprocessing of endoscopes)	3%	
			Other	Freight	0.4%	
				Laundry	1.2%	
				Packaging	1.0%	
				Food	0.9%	
			Total * ** Relative contributions recalculated for several categories of consumables, based on Table 3.*		28.4 kgCO2e	
					1 average endoscopy without EndoFaster®	*1 average endoscopy with EndoFaster®*
Zullo et al., 2023 [20] (Italy)	1 average endoscopy, with or without EndoFaster® to reduce rate of biopsy	**Method:** CO2 production evaluation **Protocol(s):** NA **Type of activity data:** Unknown (unknown) **Characterization method:** IPCC **Software:** Unknown	Consumables	Biopsy forceps	9%	8%
				Biopsy jar	12%	10%
				Bottle 1 for calibration + liquid-draining system	-	1%
				Bottle 2 for calibration + liquid-draining system	-	1%
				Bottle 3 for calibration + liquid-draining system	-	1%
				Cardboard box for the 3 bottles	-	1%

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
				Washing solution tank	-	2%
				Gastric juice suction tube	-	2%
			Equipment	Energy use EndoFaster®	-	3%
			Disposal	Disposal liquid residues	-	0.1%
			Other	Biopsy processing in pathology laboratory	80%	72%
			Total *			
			** Total emissions per test calculated for one average endoscopy, by dividing total emissions by 2000 procedures while taking into account the different biopsy sampling rates. Relative contributions calculated based on Table 1 and values in text.*		0.63 kgCO2e	0.35 kgCO2e

Table S8. Carbon footprint of hospital care in Gynecology and obstetrics: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
					1 cesarean section	*1 vaginal birth*
Campion et al., 2012 [21] (USA)	A vaginal delivery in a labor and delivery room and a caesarean birth in an operating room	**Method:** Process life cycle assessment **Protocol(s):** ISO 14040 and 14044 **Type of activity data:** Process (primary) **Characterization method:** TRACI 2 version 3.01 **Software:** *NA*	Facilities	HVAC	54%	55%
				Lighting load	4%	3%
			Consumables	Disposable custom pack production	12%	5%
			Equipment	Machine load	20%	19%
				Surgical instruments, production and sterilization	8%	12%
			Disposal	Waste disposal	4%	6%
			Total *		37 kgCO2e	17 kgCO2e
			** Carbon footprint and relative contributions based on Drew et al. (2021)*			
					Vaginal	*Abdominal*	*Laparo-scopic*	*Robotic*
Thiel et al., 2015 [4] (USA)	Vaginal, abdominal, laparoscopic and robotic hysterectomy	**Method:** Hybrid life cycle assessment **Protocol(s):** ISO 14040 and 14044 **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** TRACI 2.1, cumulative energy demand (CED) version 1.08 **Software:** *NA*	Facilities	HVAC (electricity and natural gas)	10%	11%	6%	4%
				Lighting (electricity)	0%	0%	*0%*	*0%*
			Consumables	Single-use surgical instruments	0%	0%	52%	58%
				Single-use materials (gowns, gloves)	14%	16%	7%	6%
			Equipment	Surgical machines (electricity)	4%	5%	2%	2%
				Production of reusables (allocation)	2%	2%	1%	1%
			Pharmaceuticals	Anesthetic gases	69%	64%	29%	28%
			Other	CO_2 for abdominal inflation	0%	0%	0%	0%
				Treatment and sterilization of reusables	2%	2%	4%	1%
			Disposal	Disposal of reusables (allocation)	0%	0%	0%	0%
				Uterus (chemo / pathogenic)	0%	0%	0%	0%
				Recycling	0%	0%	0%	0%
				Surgical instruments (non-needle sharps)	0%	0%	0%	0%
				Municipal Solid Waste	0%	0%	0%	0%
			Total *		285 kgCO2e	293 kgCO2e	562 kgCO2e	814 kgCO2e
			** Relative contributions read from Figure 2. Total (absolute) footprint based on Drew et al. (2021)*					
					Laparotomy	*Laparoscopy*	*Robot-assisted laparoscopy*
Woods et al., 2015 [22] (USA)	Laparotomy, conventional laparoscopy and robotic-assisted	**Method:** Carbon audit, based on British Standards Institute Publicly Available Specification	Facilities and equipment	Energy use (HVAC, lighting, computers, laparoscopy tower etc.)	63%	62%	65%
			Disposal	Blue pack items waste (basins, suction tubing, towels, sponges)	26%	21%	17%

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS	RELATIVE CONTRIBUTIONS		
	laparoscopy for endometrial cancer staging	2050 (BSI PAS2050) and GHG protocol **Protocol(s):** British Standards Institute Publicly Available Specification 2050 (PAS 2050), GHG protocol **Type of activity data:** Process (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Infection control waste (drapes, gowns, gloves)	7%	5%	10%
			Single-use device waste (surgical instruments, skin stapler)	4%	11%	6%
			Sterile blue wrap waste	2%	3%	2%
			Total * ** Calculated from Table 2*	22.7 kgCO2e	29.9 kgCO2e	40.3 kgCO2e

Table S9. Carbon footprint of hospital care in Nephrology: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS			
					A 72-hour treatment with Prismaflex Continuous Renal Replacement Therapy			
Aspin, 2018 - Baxter International Inc. [23] (UK)	In-center hemodialysis per year (3 sessions/week) & per dialysis session	**Method:** Not specified **Protocol(s):** Care Pathways Guidance **Type of activity data:** Unknown (primary + secondary) **Characterization method:** IPCC **Software:** *NA*	Medical equipment	Production of Prismaflex machine	6%			
				Production of hemodiafilter and set	10%			
				Use of the system	4%			
			Consumables	Production of filled CRRT fluid bags, including transportation of filled bags to hospital	78%			
			Other	Other	2%			
			Total		113 kgCO2e			
					DAPD at home	*DAPD in PD center*	*CAPD at home*	*CAPD in PD center*
Chen et al., 2017 [24] (China)	Continuous ambulatory peritoneal dialysis (CAPD) and daytime ambulatory peritoneal dialysis (DAPD), at home or in PD center, for 1 patient during 1 year	**Method:** Not specified **Protocol(s):** PAS 2050 **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient travel	2.0%	0.0%	2.6%	0.0%
			Facilities and equipment	Electricity (dialysate heating and disinfection)	6.6%	9.0%	6.5%	9.0%
			Consumables	Dialysate packaging materials	79.4%	89.0%	79.0%	88.6%
			Disposal	Waste disposal	8.3%	- 2.0%	8.2%	- 1.6%
			Other	Laundry	0.9%	1.0%	0.9%	1.0%
				Paper (office)	0.2%	0.2%	0.2%	0.2%
				Paper (towels)	2.6%	2.9%	2.6%	2.9%
			Total *		407.1 kgCO2e	363.5 kgCO2e	409.5 kgCO2e	365 kgCO2e
			** Based on Table 5: total emissions of two-litter dialysate consumption*					
					HD + PD per year		*1 outpatient appointment*	*1 bed day of inpatient care*
Connor et al., 2010 [25] (UK)	Provision of hemodialysis and peritoneal dialysis, outpatient appointment, inpatient bed day)	**Method:** Component analysis **Protocol(s):** PAS 2050 **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient travel	25.8%		45.5%	2.2%
				Staff-commuting travel			13.0%	9.5%
				Staff-business travel			2.5%	0.7%
				Visitor travel			-	2.2%
			Facilities	Building energy use	14.2%		9.3%	7.7%
			Other	Procurement (pharmaceuticals, medical equipment, paper, food, sanitation products and information technology)	46.6%		26.6%	71.4%
			Disposal	Waste	13.3%		3.2%	6.2%

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS		
			Total *		7,094 kgCO2e	22 kgCO2e	161 kgCO2e
			* Percentages recalculated to 100% (based on Tables 7 – 9)				
					ICHD per year	*HHD per year*	
Connor et al., 2011 [26] (UK)	Two forms of hemodialysis (HD): in-center HD (ICHD) and home HD (HHD) Including dialysis access surgery	**Method:** Component analysis study **Protocol(s):** PAS 2050 **Type of activity data:** Process (Primary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient travel	19.6%	0.3 – 1.1%	
				Staff travel	4.6%	0.4 – 1.5%	
			Facilities and equipment	Energy use	20.8%	0.2 – 47.8%	
				Water	0.4%	0.1 – 0.9%	
				Construction installation	7.3%	0.0 – 8.3%	
				Construction maintenance	1.4%	0.8 – 1.5%	
				Sanitation	0.7%	0.7 – 2.6%	
			Equipment and/or consumables	Medical equipment consumables	36.6%	35.9 – 58.8%	
				Medical equipment packaging	0.6%	0.6 – 1.6%	
			Disposal	Waste management (collection, treatment and disposal)	3.4%	3.3 – 16.2%	
			Other	Paper and office supplies	0.2%	0.2 – 0.7%	
				Laundry	1.4%	0.1 – 0.6%	
				Access surgery	0.8%	0.4 – 1.6%	
				Outpatient visits	2.3%	1.2 – 4.8%	
			Total * ** Based on minimum and maximum values for different HHD modalities and regimes in Table 6*		3,818 kgCO2e	Between 1,844 – 7,179 kgCO2e	
					Unit based hemodialysis per year	*Home based hemodialysis per year*	
James, 2007 [27] (UK)	Home and hospital-based hemodialysis	**Method:** 'Environmental aspect analysis' **Protocol(s):** *NA* **Type of activity data:** Process (Not stated) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient travel	68%	0%	
			Facilities	Water treatment	28%	77%	
				Water supply	4%	23%	
			Total ** Calculated from Table 4*		1,404 kgCO2e	207 kgCO2e	
						1 patient treated with hemodialysis per year	
Lim et al., 2013 [28] (Australia)	Hemodialysis treatment	**Method:** Component analysis (same methodology as study by Connor et al., 2010) **Protocol(s):** PAS 2050 **Type of activity data:** Hybrid (primary + secondary)	Travel	Patient travel		5.8%	
				Staff commuting		3.0%	
			Facilities	Dialysis electricity use		15.0%	
				Non-dialysis electricity use (including building heating and cooling)		3.6%	
				Water treatment and supply		1.2%	
				Sewerage treatment and management		6.4%	

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS
		Characterization method: *NA* **Software:** *NA*	Pharmaceuticals	Pharmaceuticals	35.7%
			Equipment and/or consumables	Medical equipment	23.4%
			Disposal	Waste (landfill)	1.1%
				Waste (incinerated)	3.1%
				Waste (recycled)	-0.8%
			Other	Food	1.6%
				Sanitation products	0.7%
				Laundry services	0.1%
				Paper	<0.1%
				Diagnostics	<0.1%
			Total ** Depending on site, Table 4*		10,200 kgCO2e
					1 patient treated with haemodialysis per year
Mtioui et al., 2021 [29] (Morocco)	Hemodialysis treatment	**Method:** A carbon calculation tool by the methodology of Bilan Carbone (mainly follows ISO14064-1 and future ISO14069) **Protocol(s):** ISO 14064-1, as well as the latest available information on the future ISO 14069 **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** *NA* **Software:** L'outil Bilan Carbon	Travel	Patient travel	13.4%
				Staff travel	9.0%
			Facilities and equipment	Electricity consumption (dialysis machines, lighting, air conditioning, the water treatment room, other equipment)	27.8%
				Manufacturing of durable goods for hemodialysis unit: buildings, IT, biomedical equipment, furniture	16.6%
				Direct fugitive emissions from air conditioning leakage	0.2%
				Water consumption for hemodialysis	0.1%
			Other	Purchases of products and services (medicines, pharmacy products, small care equipment, printed paper, magazines, office supplies)	26.7%
				Cost of merchandise transport that can be handled by the organization	0.2%
			Disposal	Wastes (solids, liquids)	6.2%
			Total * ** Calculated from Table 6*		5,110 kgCO2e
					1 dialysis session or 1 year of 3-weekly sessions
		Method: Not specified	Travel	Patient travel	27.2%

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS
Newcastle upon Tyne Hospitals NHS Foundation Trust – NUTH [30] (UK)	In-center hemodialysis per year (3 sessions/week) & per dialysis session	**Protocol(s):** Care Pathways Guidance **Type of activity data:** Unknown (unknown) **Characterization method:** IPCC **Software:** Unknown		Staff travel	4.5%
			Consumables	Consumables	9.6%
			Equipment	Equipment manufacture	2.3%
			Facilities	Utilities (Combined heat and power: electricity & heat)	31.5%
				Water supply	0.8%
			Pharmaceuticals	Pharmaceuticals	17.9%
			Disposal	Solid waste	4.7%
				Waste Water Treatment	1.7%
			Total		21.7kg CO2e per dialysis session, total annual: 3,382 kgCO2e
					1 patient treated with haemodialysis per treatment
Sehgal et al., 2022 [3] (USA)	Hemodialysis treatment	**Method:** Life Cycle Assessment **Protocol(s):** International Organization for Standardization 14040 family of standards **Type of activity data:** Process (primary + secondary) **Characterization method:** Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts version 2.1 **Software:** SimaPro 9.2.0.1 & JMP Pro 15 (SAS, Cary, NC)	Travel	Patient and staff transportation	31%
			Facilities and equipment	Electricity	27%
				Natural gas	14%
				Water	2%
			Consumables	Single-use supplies (i.e. dialyzers)	9%
			Disposal	Biohazard waste	5%
				Landfill waste	12%
			Total *		58.9 kgCO2e (CI 54.6 – 64.5)
			* *Mean emissions, calculated from Table 2*		

Table S10. Carbon footprint of hospital care in Ophthalmology: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
					Intravitreal injection	
Chandra et al., 2023 [31] (New Zealand)	Intravitreal injection	**Method:** Based on Latta et al. (adjusted Eyeficiency tool) **Protocol(s):** *NA* **Type of activity data:** Hybrid (Secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient and staff travel	39.7%	
			Facilities	Building energy use (gas, electricity)	14.2%	
			Disposal	Waste disposal	0.7%	
			Pharmaceuticals and consumables	Procured pharmaceuticals and disposables	45.4%	
			Total * * *Percentages calculated from text*		14.1 kgCO2e	
					Cataract surgery	
Ferrero et al., 2022 [32] (France)	Cataract surgery	**Method:** Economic input-output Life Cycle Assessment **Protocol(s):** "Bilan Carbone" protocol, the Greenhouse Gas Protocol, PAS2050 **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient travel	8.95%	
				Staff travel	0.08%	
			Facilities	Electricity and steam	0.76%	
			Consumables	Manufacturing and procurement (including transport) of disposable medical devices	73.32%	
			Disposal	Waste destruction	1.39%	
			Equipment	Sterilization of phacoemulsifier handpiece	2.61%	
			Pharmaceuticals	Manufacturing and procurement (including transport) of pharmaceutical products	12.68%	
			Total		81.13 kgCO2e	
					Phacoemulsification	*MSICS*
Goel et al., 2021 [33] (Mexico, Chile, Swaziland, South Africa, India, New Zealand, UK, Hungary)	Two types of cataract surgery in different countries: phacoemulsification and manual small incision cataract surgery (MSICS)	**Method:** Hybrid Life Cycle Assessment (Eyefficiency tool) **Protocol(s):** ISO 14040 **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient and staff travel	27 – 72%	27 – 71%
			Facilities	Energy	0 – 53%	1 – 54%
			Consumables	Disposable supplies	6 – 67%	3 – 65%
			Disposal	Waste products	0 – 3%	0 – 4%
			Equipment	Reusable supplies	1 – 9%	1 – 9%
			Total * *Depends on country, calculated from Table 1*		Between 41 – 130 kgCO2e	Between 40 – 119 kgCO2e
					Phacoemulsification	
Hong et al., 2022 [34] (Australia)			Travel	Patient and staff travel	26.3%	
			Facilities	Energy	21.4%	

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
	Cataract surgery (phaco-emulsification)	**Method:** Eyefficiency tool, based on hybrid lifecycle analysis (LCA) **Protocol(s):** *NA* **Type of activity data:** Hybrid (not stated) **Characterization method:** *NA* **Software:** Eyefficiency	Consumables	Disposable supplies	45.2%	
			Disposal	Waste treatment	2%	
			Equipment	Reusable supplies	6%	
			Total * * *Calculated from Table 1*		164 kg kgCO2e	
					Cataract surgery at public hospital	*Cataract surgery at private hospital*
Latta et al., 2021 [35] (New Zealand)	Cataract surgery (elective phacoemulsification with lens implant)	**Method:** Adjusted Eyefficiency tool **Protocol(s):** *NA* **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** *NA* **Software:** Eyefficiency	Travel	Patient travel	8%	7%
				Staff travel	11.8%	3.5%
			Facilities	Electricity consumption	1.2%	1.2%
			Pharmaceuticals	Pharmaceuticals	10.3%	3.8%
			Equipment and/or consumables	Medical equipment	68.0%	84.6%
			Disposal	Waste emissions	0.1%	0.1%
				Waste freight	0.0%	0.0%
			Total * * *Calculated from Table 2*		145.2 kgCO2e	158.6 kgCO2e
						Cataract pathway
Morris et al., 2013 [2] (UK)	Cataract pathway	**Method:** A component analysis study **Protocol(s):** PAS 2050 **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient travel		7.0%
				Staff travel		3.0%
			Facilities	Total building energy use		36.1%
				Water		0.1%
			Pharmaceuticals	Pharmaceuticals		18.0%
			Equipment and/or consumables	Medical equipment		32.6%
			Other	Paper and ink		0.5%
				Food		0.0%
				Laundry services		0.5%
				Information technology		0.2%
			Disposal	Waste		1.9%
			Total			181.8 kgCO2e
						Cataract surgery
Pascual-Prieto et al., 2023 [36] (Spain)	Cataract surgery	**Method:** Non-specified **Protocol(s):** ISO 14064-1	Travel	Patient and staff travel		10.9%
			Facilities	Building energy use		4.2%
			Consumables	Equipment supplies		77.8%

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS
		Type of activity data: Hybrid (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Pharmaceuticals	Pharmaceuticals	6.6%
			Disposal	Waste management	0.4%
			Total		86.62 kgCO2e
					Intravitreal injection
Power et al., 2021 [37] (UK)	Intravitreal injection	Hybrid Life Cycle Analysis (LCA) **Protocol(s):** *NA* **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient travel	77.0%
			Facilities	Building energy use	4.3%
			Consumables	Medical injection pack, excluding anti-VEGF medication (Bevacizumab, Ranibizumab, Aflibercept)	18.6%
			Disposal	Waste disposal	0.04%
			Total		13.68 kgCO2e
					Cataract surgery
Thiel et al., 2017 [38] (India)	Phacoemulsification cataract surgery	**Method:** Hybrid environmental Lifecycle Assessment (LCA) **Protocol(s):** ISO 14040 **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** TRACI 2.1 v1.02; CML-IA baseline (version 3.02, World 2000); Cumulative Energy Demand (version 1.09) **Software:** *NA*	Facilities	Electricity	16%
				Diesel	2%
				Water use and treatment	4%
			Consumables	Production of single use materials	15%
			Equipment	Production of reusable materials	1%
				Sterilization of reusable materials	62%
			Pharmaceuticals	Pharmaceuticals	4%
			Disposal	Materials disposal - Incineration & landfill	1%
				Materials disposal - Recycling	- 4%
			Other	Cleaning compounds	0%
			Total * * *Based on Table 5*		5.89 kgCO2e

Table S11. Carbon footprint of hospital care in Orthopedics: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
					Pre-Care4Today / patient	*Post- Care4Today / patient*
Chang, 2018 - Johnson & Johnson [39] (UK)	Primary Total Knee Replacement surgery care pathway, before and after Care4Today implementation (a digital care pathway program)	**Method:** As described in Care Pathways Guidance document **Protocol(s):** Care Pathways Guidance **Type of activity data:** Unknown (secondary) **Characterization method:** IPCC **Software:** Unknown	Travel	Patient travel	3%	3%
			Other	Inpatient	65 – 67%	61 – 63%
				Surgical procedure	25 – 27%	28 – 31%
				Outpatient (all clinics, pre-op and post-op)	1%	1 – 2%
				Clinical outcomes	5%	3 – 4%
			Total * * *Read from Figure on page 2 and recalculated for 1 patient*		389 – 421 kgCO2e (depending on type of implant)	336 – 360 kgCO2e (depending on type of implant)
						Total Knee Replacement surgery
Delaie et al., 2023 [40] (France)	A posterior-stabilized cemented Total Knee Replacement with tibial extension stem, performed by a medial parapatellar approach	**Method:** Lifecycle Assessment (LCA) **Protocol(s):** ISO 04014 and 14440 **Type of activity data:** Process (primary + secondary) **Characterization method:** *NA* **Software:** Ecodesign Studio software (Altermaker Rosiere, France)	Travel	Patient travel		17%
				Staff travel		10%
			Facilities	Electricity consumption of the operating theatre and monitoring in the recovery room		0.2%
			Consumables	Raw materials consumables		21%
				Manufacture consumables		5%
				Transportation to supply and distribute		2%
			Equipment	Manufacture of prosthesis		28%
				Manufacture of instruments, ancillary equipment, and transport boxes		0.3%
				Sterilization		1%
			Disposal	Potential infectious medical waste		13%
				Noninfectious medical waste		2%
			Total			190.5 kgCO2e

Table S12. Carbon footprint of hospital care in Otolaryngology: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS		
					Monopolar electrocautery	*Cold excision without cautery*	*Coblation*
Meiklejohn et al., 2024 [41] **(USA)**	Tonsillectomy without adenoidectomy or other procedures, by 3 different techniques (monopolar electrocautery; cold excision without cautery; coblation)	**Method:** Hybrid Life Cycle Assessment **Protocol(s):** GHG protocol **Type of activity data:** Hybrid (primary; secondary) **Characterization method:** TRACI 2.1 **Software:** TRACI 2.1	Facilities and equipment	Electricity and natural gas consumed in the OR by HVAC, lighting and durable equipment	1%	1%	1%
			Equipment and disposal	Reusable surgical equipment including manufacture, sterilization and instrument reprocessing, and disposal	0%	0%	0%
			Consumables and disposal	Disposable equipment used by the anesthesia care team, including manufacture, and disposal	7%	8%	6%
				Disposable surgical equipment, including manufacture, and disposal	3%	2%	25%
			Pharmaceuticals	Pharmaceuticals used by the anesthesia care team	89%	88%	67%
			Other	Laundry (manufacture, laundering and disposal of reusable surgical linens)	1%	1%	1%
			Total *		184.5 kgCO2e	157.6 kgCO2e	204.7 kgCO2e

* *Relative contributions read from Figure 2*

Table S13. Carbon footprint of hospital care in Pediatric Medicine: Contributing factors reported per study

AUTHOR, YEAR (AUTHOR)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
					Without Smartinhaler™ / patient	*With Smartinhaler™ / patient*
Budgen, 2017 - AstraZeneca, Adherium [42] (UK)	Annual management of child with poorly controlled asthma, with and without Smartinhaler™ device (intelligent digitally connected Dry Powdered Inhaler)	**Method:** As described in Care Pathways Guidance document **Protocol(s):** Care Pathways Guidance **Type of activity data:** Unknown (secondary) **Characterization method:** IPCC **Software:** Unknown	Travel	Patient travel to GP	0%	2%
				Patient travel to A&E	2%	5%
			Pharmaceuticals	Self-management with long acting inhalers	3%	11%
				Self-management with short acting inhalers	50%	61%
				Oral steroids	0%	0%
			Other	GP consultations	2%	4%
				A&E Visits	0%	0%
				Hospital admission: inpatient episodes	19%	8%
				Hospital admission: day-case episodes	1%	0%
				Hospital admission: intensive care unit	4%	1%
				Ambulance for hospital admissions	19%	7%
			Total *		89 kgCO2e	39 kgCO2e

* *Read from Figure on page 4*

Table S14. Carbon footprint of hospital care in Pathology: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS					
					1 COVID-19 testing					
Ji et al., 2022 [43] (China)	A COVID-19 nucleic acid test (NAT) in a hospital	**Method:** Life Cycle Assessment **Protocol(s):** ISO 14040 and 14044 **Type of activity data:** Process (primary + secondary) **Characterization method:** TRACI 2.0 **Software:** SimaPro, version 9.0.0.27	Consumables	Testing kit production	14.5%					
				Transportation of testing kits from manufacturer to hospital	13.3%					
			Equipment	RNA extraction (electricity consumption)	0.0%					
				Testing (electricity consumption)	0.9%					
			Disposal	Waste treatment	71.3%					
			Total *		0.612 kgCO2e					
			* *Relative contributions calculated from Supplementary Table 3, where missing from the text*							
					Full blood examination	*Coagulation*	*U + E*	*C-Rp*	*ABG*	*Urinalysis*
McAlister et al., 2021 [44] (Australia)	Five pathology tests (full blood examination, coagulation profile (APPT or INR), Urea plus electrolytes (U + E), C-reactive protein (C-Rp), Arterial blood gas (ABG), Urinalysis	**Method:** Life Cycle Assessment (attributional) **Protocol(s):** ISO 14,040 and ISO 14,044 **Type of activity data:** Process (primary + secondary) **Characterization method:** ReCiPe method (2016) **Software:** SimaPro, version 9.0.0.27	Consumables and disposal	Swabs and Ziploc bags	16%	8%	7%	13%	20%	1%
				Gloves	12%	6%	5%	10%	19%	-
				Syringes	-	-	-	-	28%	-
				Tube holder and collection tube	40%	22%	23%	42%	-	-
				Pneumatic tube system	1%	0.3%	0.0%	1%	-	0.1%
				Sample jar	-	-	-	-	-	13%
				Test reagents	9%	0.2%	0.3%	0.2%	3%	-
				Test consumables	-	-	6%	12%	-	18%
				CO_2	-	-	-	-	-	4%
				Compressed air	-	-	-	-	-	29%
			Equipment	Electricity use of analyzer	14%	59%	55%	17%	30%	35%
				Electricity use of test storage	8%	4%	3%	6%	-	-
			Total *		0.117 kgCO2e	0.233 kgCO2e	0.274 kgCO2e	0.148 kgCO2e	0.074 kgCO2e	0.538 kgCO2e
			* *Calculated from Supplementary table 19*							
					Phlebotomy	*Chemistry*	*Coagulation factors*	*Haematology*	*Total protein*	
Spoyalo et al., 2023 [45] (Canada)	Phlebotomy and four bloodwork tests (Chemistry (Amylase, Lipase,	**Method:** PAS 2050 (Publicly Available Specification) methodology	Consumables	Consumable manufacturing	62%	18%	69%	79%	40%	
				Consumable transport	14%	2%	23%	11%	5%	
			Equipment	Laboratory processing	23%	79%	3%	4%	53%	
			Disposal	Waste	2%	1%	4%	6%	2%	

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS	RELATIVE CONTRIBUTIONS				
	ALP, ALT, AST, GGT, Na+, K+, Cl-, Calcium, Magnesium, Phosphate, Creatinine, Urea, Direct + Total bilirubin, Albumin), Coagulation factors (INR + PTT), Hematology (CBC + differential), Total protein	**Protocol(s):** PAS2050 **Type of activity data:** Process (primary) **Characterization method:** *NA* **Software:** *NA*	Total * * *Relative contributions calculated from Supplemental Table 2*	0.150 kgCO2e	0.689 kgCO2e	0.066 kgCO2e	0.039 kgCO2e	0.077 kgCO2e

Table S15. Carbon footprint of hospital care in Psychiatry: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS		
					PP1M / patient / year	*PP3M / patient / year*	*TI / patient / year*
Debaveye et al., 2019 [46] (Belgium)	Schizophrenia pathway with wo long-acting antipsychotic injections for schizophrenia: paliperidone palmitate once-monthly (PP1M) injection and paliperidone palmitate three-monthly (PP3M) injection and Treatment Interruption (TI)	**Method:** Life cycle Assessment in combination with Markov model **Protocol(s):** ISO 14040 and ISO 14044 **Type of activity data:** Process (primary + secondary) **Characterization method:** ReCiPe v1.11 **Software:** SimaPro v8	Travel	GP visits	0.8%	1.0%	0.4%
				Psychiatrist visits	52.7%	66.4%	30.4%
				Ambulatory care visits (by nurse)	0.4%	0.3%	0.6%
			Facilities	Energy and water use during general hospital days	5.7%	3.8%	8.0%
				Energy and water use during psychiatric hospital days	37.9%	25.2%	60.6%
			Pharmaceuticals	API	1.4%	2.2%	-
				Drug production	0.4%	0.7%	-
				Packaging	0.6%	0.0%	-
				Distribution & Supply	0.0%	0.0%	-
			Disposal	End-of-life disposal and drug fate	0.0%	0.0%	-
			Total *		457.7 kgCO2e	364.9 kgCO2e	766.5 kgCO2e
			** Based on supplementary Table A4, recalculated to kgCO2e with a hierarchist characterization factor.*				

Table S16. Carbon footprint of hospital care in Pulmonary medicine: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
					Without Benralizumab / patient	*With Benralizumab / patient*
Budgen, 2018 - AstraZeneca [47] (UK)	Annual management of a person with poorly controlled eosinophilic asthma, aged 12 years or above, taking regular inhaled steroids, with and without Benralizumab	**Method:** As described in Care Pathways Guidance document **Protocol(s):** Care Pathways Guidance **Type of activity data:** Unknown (secondary) **Characterization method:** IPCC **Software:** Unknown	Travel	Patient travel to GP	1%	4%
				Patient travel to hospital	1%	0%
				Self-management patient travel	2%	1%
			Pharmaceuticals	Self-management long acting inhalers	50%	35%
				Self-management short acting inhalers	10%	11%
				Self-management oral steroids	2%	1%
				Benralizumab supply and administration	-	3%
			Other	Hospital admission inpatient episodes	19%	19%
				Long term effects from Oral Steroid usage	9%	11%
				A&E Visits	5%	5%
			Total *		192 kgCO2e	91 kgCO2e
			** Read from Figure on page 4*			

					1 bronchoscopy
Patrucco et al., 2023 [48] (Italy)	Bronchoscopy (different types, including bronchoalveolar lavage, endobronchial ultrasound-guided transbronchial-needle aspiration)	**Method:** Not specified **Protocol(s):** *NA* **Type of activity data:** Process (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Equipment	Energy consumption for cleaning instruments	11%
				Energy consumption for using endoscopy machines	12.3%
			Disposal	Non-recyclable waste	76.7%
			Total *		1.13 kgCO2e
			** Relative contributions calculated from values provided in text, emissions per procedure calculated by dividing total emissions by the number of procedures (n = 60)*		

Table S17. Carbon footprint of hospital care in Radiology: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS		
					1 average procedure		
Chua et al., 2021 [49] (USA)	Interventional radiology procedures (i.e. drainage, CT-guided biopsy, venous access, arterial embolization, lumbar puncture etc.)	**Method:** Process LCA and environment-ally extended input-output LCA (EEIO LCA) **Protocol(s):** *NA* **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** Tool for the Reduction and Assessment of Chemicals and Other Environmental Impacts 2.1 version 1.04 **Software:** SimaPro version 8.5.2.0	Travel	Staff	2.23%		
			Facilities	HVAC	49.2%		
				Lighting	0.82%		
			Consumables	Production and delivery of single-use supplies (including surgical equipment, such as wires, catheters, and stents, as well as items used outside the patient, such as sterile drapes, towels, and dressing materials)	41.0%		
			Equipment	Nonimaging plug loads	0.90%		
				Imaging plug loads	2.78%		
			Pharmaceuticals	Gas anesthetics (sevoflurane)	0.08%		
			Disposal	Municipal waste disposal	0.79%		
				Sharps waste disposal	0.08%		
				Biohazard waste disposal	0.94%		
			Other	Linens (production, industrial cleaning, and disposal of bedsheets and blankets)	1.19%		
			Total		243 kgCO2e (SD 297)		
					1 MRI scan		
Esmaeili et al., 2018 [50] (USA)	Magnetic resonance imaging (MRI) diagnostic service	**Method:** Life Cycle Assessment **Protocol(s):** ISO 14040:2006 and ISO 14044:2006 **Type of activity data:** Process (primary) **Characterization method:** *NA* **Software:** *NA*	Facilities	Lighting Energy	1.8%		
			Consumables	Disposable materials	0.6%		
			Equipment	Active Energy	14%		
				Standby Energy	25%		
				Idle Energy	49%		
				Ancillary Devices Energy (including injection system)	6.6%		
			Other	Reusable textile	3.4%		
			Total *		22.4 kgCO2e		
			* *Read from Figure 6*				
					Ultrasound	*CT*	*MRI*
Martin et al., 2018 [51] (USA)	Ultrasound, CT, and MRI in abdominal pain	**Method:** Life Cycle Assessment **Protocol(s):** *NA*	Facilities	Lighting	11%	6%	6%
				HVAC	8%	11%	7%
			Equipment	Production	45%	60%	31%
				Energy use machines	35%	23%	57%

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS				
		Type of activity data: Hybrid (Secondary) **Characterization method:** TRACI 2.1 version 1.03/US 2008 **Software:** SimaPro version 8.2.3	Total * ** Calculated from Table 3 (relative contributions of energy use to total carbon footprint based on Table 4)*		1.1 kgCO2e	6.7 kgCO2e		19.8 kgCO2e	
					Chest X-ray	*Mobile chest X-ray*	*CT*	*MRI*	*Ultra-sound*
McAlister et al., 2022 [52] (Australia)	Chest X-ray (CXR), mobile chest X-ray (MCXR), computerized tomography (CT), magnetic resonance imaging (MRI) and ultrasound (US)	**Method:** LCA (both attributional and consequential method) **Protocol(s):** ISO 14040:2000 **Type of activity data:** Process (primary + secondary) **Characterization method:** ReCiPe 2016 (H) **Software:** SimaPro 9.0.0.27	Consumables and disposal	Gloves and wipes	9%	15%	1%	0.3%	10%
				Ultrasound gel	-	-	-	-	2%
				Contrast agent			1%	1%	-
				Contrast equipment			4%	0.2%	
				Slide sheet			3%	0.2%	
			Equipment	Electricity use imaging device & computer	3%	85%	88%	94%	88%
			Other	Washing and drying of cotton sheets and pillowcases	88%	-	4%	5%	-
			Total * ** Only results from attributional LCA presented, based on Supplementary Table S3*		0.8 kgCO2e	0.5 kgCO2e	9.2 kgCO2e	17.5 kgCO2e	0.5 kgCO2e

Table S18. Carbon footprint of hospital care in Radiotherapy: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS
					1 average treatment
Ali and Piffoux, 2024 [53] (France)	External beam radiotherapy (various disease sites)	**Method:** Carbon footprint analysis **Protocol(s):** GHG protocol, ISO 14064-2018, Bilan Carbone® methodology version 8 **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patients' transportation	43%
				Workers' transportation	5%
			Consumables	Medical consumables (e.g. glove, needle, syringe)	3%
			Equipment	Construction and maintenance of accelerators and scanners (excluding electricity consumption)	17%
				Medical material (e.g. hospitalization bed, drug fridge, medical chair for care infusion stand, textile)	6%
				SF6	1%
				Electricity accelerator	0.3 – 0.6%
			Facilities	Construction of buildings and bunkers	6%
				HVAC construction (excluding electricity consumption)	6%
				Electricity (excluding accelerator)	1.8 – 2.1%
				Oil	0%
				Gas	0%
				Collective heating	0%
			Pharmaceuticals	Drugs	0%
			Disposal	Waste	2%
			Other	Server construction and maintenance (excluding electricity consumption)	5%
				IT material (other than servers)	2%
				Other purchased services (laundry, software licenses)	2%
				Desk consumables	1%
				Desk material	0%
			Total		489 kgCO2e

					1 average patient / year pre-pandemic	1 average patient / year during pandemic
Cheung et al., 2023 [54] (Canada)	One year of external beam radiation therapy treatments, including radiation therapy visits,	**Method:** Not specified **Protocol(s):** *NA*	Travel	Patient travel for CT simulation and radiation treatment appointments, RNC and ER visits	61.5%	79.2%
				Patient travel for in-person consultations	4.0%	2.2%
				Patient travel for in-person follow-ups	33.9%	17.1%
			Equipment	LINAC power usage	0.0%	0.1%

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
	unplanned visits to the radiation nursing clinic (RNC) or emergency department (ER), outpatient hospital and virtual visits	**Type of activity data:** Process (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Consumables	PPE (bouffant cap, disinfectant wipes, face shields, gloves, disposal gowns, surgical masks and N95 respirators, safety glasses, and shoe covers)	0.5%	1.4%
			Total *		369 kgCO2e	249 kgCO2e
			** Relative contributions calculated based on Table 2, supplementary Tables E1 & E2 and values in text. Average carbon footprint per patient calculated by dividing total emissions per year by total number of patients treated (based on Table 1).*			

					Prostate, pre-COVID	*Prostate, during COVID*	*Breast, pre-COVID*	*Breast, during COVID*
Chuter et al., 2023 [55] (UK)	Two radiotherapy pathways: the breast IMRT and prostate VMAT pathway	**Method:** Carbon footprint **Protocol(s):** *NA* **Type of activity data:** Process (primary + secondary) **Characterization method:** IPCC GWP100 **Software:** *NA*	Travel	Patient travel	77.5%	82.0%	75.6%	85.3%
			Equipment	Linac (Idle)	17.4%	9.9%	19.2%	8.0%
				SF6	4.2%	2.6%	4.6%	2.1%
				Treatment	0.4%	0.3%	0.4%	0.3%
				CT	0.2%	0.2%	0.3%	0.4%
				MR	0.3%	0.2%	0.0%	0.0%
			Consumables	PPE	0.0%	4.9%	0.0%	3.9%
			Total		149.1 kgCO2e	226.9 kgCO2e	101.8 kgCO2e	74.8 kgCO2e
			** Percentages calculated from Supplementary Table S1. Only data for Centre 1 presented.*					

					1 patient treated / year
Dvorak et al., 2023 [56] (USA)	Proton therapy	**Method:** Carbon footprint analysis **Protocol(s):** GHG protocol **Type of activity data:** Process (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Equipment	BeamOn time	1 – 4%*
				Mevion proton system	80 – 83%*
			Facilities	Clinical and administrative area	16 – 17%*
			Total *		1371 kgCO2e (range 1361 – 1409)*
			** Relative contributions depend on disease site treated. Percentages calculated from relative contributions of energy usage.*		

Table S19. Carbon footprint of hospital care in Surgery: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS		
					Rhinoplasty	*Bilateral breast augmentation*	*Abdominoplasty*
Berner et al., 2017 [57] (Chile)	Rhinoplasties, bilateral breast augmentations with silicone implants and abdomino-plasties	**Method:** A 'multi-component analysis' **Protocol(s):** *NA* **Type of activity data:** Process (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient travel	19.7%	20.6%	14.1%
				Staff travel	16.3%	16.7%	18.4%
			Facilities	Energy consumption theatre	42.5%	42.5%	48.2%
				Energy consumption recovery	6.6%	6.9%	4.7%
			Disposal	Waste products	2.3%	2.8%	2.9%
			Equipment	Medical equipment energy	10.5%	8.2%	9.2%
			Other	Laundry transport	2.1%	2.2%	2.5%
			Total		16.99 kgCO2e	16.23 kgCO2e	23.68 kgCO2e
						1 average care pathway	
Bischofberger et al., 2023 [58] (UK)	Anastomotic leak care pathway (grade A, B, and C) Grade A: relatively minor leaks, do not require radiological or surgical intervention. Grade B: require radiological intervention, in the form of a CT-guided drain, to remove the perianastomotic fluid that collects as a result of AL. Grade C: the most serious leaks, that require further surgical intervention in the form of an anastomotic	**Method:** Environmental impact assessment **Protocol(s):** Sustainable Care Pathway Guidance **Type of activity data**: Process (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient travel to elective care due to stoma closure operation		0.46%	
			Pharmaceuticals	Tablet antibiotics		0.83%	
				Intravenous antibiotics		2.52%	
			Consumables	Intravenous antibiotic bags		0.02%	
				Syringes		0.10%	
				Intravenous cannula		0.03%	
				Intravenous tubing		0.00%	
				Central venous catheter		0.09%	
				Total parenteral nutrition – cannula		0.00%	
				Total parenteral nutrition – tubing		0.00%	
				Total parenteral nutrition bags		0.04%	
			Other	CT scan		0.17%	
				Full blood test		0.18%	
				Total parenteral nutrition		0.05%	
				CT guided drain		0.17%	
				Hartmann's procedure		3.34%	
				Ileostomy		1.09%	
				Stoma closure operation		3.59%	
				Stoma home management: Ostomy bag (stoma-closure patient)		40.56%	
				Stoma home management: Ostomy bag (no-stoma closure patient)		6.01%	
				In-patient days intensive care unit		10.36%	
				In-patient days general ward		24.39%	

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
	revision with protective ileostomy or a Hartmann's procedure.			In-patient days general ward (due to stoma closure operation)	6.00%	
			Total		1302.97 kgCO2e	
					Medical treatment	*Antireflux surgery*
Gatenby 2011 [1] (UK)	Surgical and medical treatment of gastro-esophageal reflux	**Method:** 'A top-down model of carbon emissions' **Protocol(s):** *NA* **Type of activity data:** Financial (secondary) **Characterization method:** *NA* **Software:** *NA*	Consumables	Not specified	-	37%
			Other	Endoscopy	-	5%
				pH tests	-	2%
				Manometry	-	1%
				Operation time	-	16%
				High Dependency Unit (HDU)	-	21%
				Inpatient care / day	-	1%
				Outpatient appointment	9%	3%
				Day case	17%	9%
				Inpatient care	6%	2%
				Non-randomized surgery	28%	0%
			Pharmaceuticals	Proton pump inhibitors	40%	3%
			Total ** Calculated from Table 2*		247 kgCO2e	1,038 kgCO2e
					Standard carpal tunnel release	*Lean and green carpal tunnel release*
Kodumuri et al., 2023 [59] (UK)	Carpal tunnel release	**Method:** Online calculator based on life cycle assessment (LCA) **Protocol(s):** GHG protocol **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** *NA* **Software:** Online calculator from Centre for Sustainable Healthcare	Consumables	Consumables	3%	7%
				Drapes	32%	3%
			Equipment	Instruments	49%	71%
				Resterilization	16%	19%
			Total ** Read from Figure 5*		28.8 kgCO2e (range 24.1 – 35.2)	6.6 kgCO2e (range 6.2 – 7.3)
					1 average surgery at Canadian hospital (VGH)	*1 average surgery at American hospital (UMMC)*	*1 average surgery at UK hospital (JHR)*

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS		
MacNeill et al., 2017 [60] (Canada, USA, UK)	Surgical suites at three academic quaternary-care hospitals: Vancouver General Hospital (VGH), University of Minnesota Medical Center (UMMC), John Radcliffe Hospital (JHR)	**Method:** Greenhouse gas inventory according to the Greenhouse Gas Protocol **Protocol(s):** GHG protocol **Type of activity data:** Process (primary) **Characterization method:** Global Warming Potential (GWP100 work of Sulbaek Andersen and colleagues) **Software:** *NA*	Facilities	Heating	16%	15%	44%
				Cooling	0%	5%	15%
				Ventilation	0%	14%	21%
				Lighting	0%	2%	3%
			Equipment	Plug-loads	0%	1%	
			Consumables and disposal	Municipal solid waste	14%	10%	6%
				Hazardous waste	2%	1%	4%
				Fluid waste	0%	-	0%
				Sharps waste	0%	0%	1%
				Cytotoxic waste	0%	0%	-
				Recycling	3%	1%	0%
				Domestic waste	-	-	0%
				Waste transport	0%	0%	0%
			Other	Reusable textiles laundering	2%	1%	0%
			Pharmaceuticals	Desflurane	62%	47%	0%
				Isoflurane	1%	3%	3%
				Sevoflurane	1%	1%	1%
			Total *		146 kgCO2e	232 kgCO2e	173 kgCO2e
			** Percentages calculated from Tables 1 – 4*				
						1 minimally invasive procedure	
Power et al., 2012 [61] (USA)	Minimally invasive surgery	**Method:** Environment Input-Output Life-Cycle Assessment (EIOLCA) **Protocol(s):** GHG protocol **Type of activity data:** Hybrid (Secondary) **Characterization method:** *NA* **Software:** *NA*	Other	CO_2 used for insufflation		0.1%	
				Industrial gas manufacturing		70.5%	
				Power generation and supply		23.5%	
				Gas extraction		4.7%	
				CO_2 transportation		0.8%	
			Disposal	Incineration of medical waste (disposable trocar and robotic instrument use)		0.4%	
			Total *			141 kgCO2e	
			** Percentages based on Tables 1 – 2*				
						1 surgical procedure	
Penny et al., 2015c [62] (UK)	An average surgical procedure (66 minutes) in an operating room	**Method:** Life Cycle Assessment **Protocol(s):** Sustainable Care Pathways Guidance	Travel	Staff travel		3.1%	
			Consumables	Consumables		21.9%	
			Equipment	Equipment used in operating room and (pre- & post-) anesthesia services		3.4%	
			Facilities	Energy		39.9%	
				Water		0.2%	

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
		Type of activity data: Unknown (unknown) **Characterization method:** IPCC **Software:** Unknown	Pharmaceuticals	Anesthetic gases	31.3%	
			Disposal	Waste	0.2%	
			Total		35.1 kgCO2e	
					1 EVAR	
Senemaud et al., 2023 [63] (France)	Elective endovascular aortic repair (EVAR)	**Method:** Carbon footprinting **Protocol(s):** ISO 14067:2018 **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** Not stated **Software:** Bilan Carbone	Travel	Staff and patient travel	9%	
			Consumables and equipment	Draping and gowns	7%	
				Stent grafts	2%	
				Sterile gauze	1%	
				Guidewires	1%	
				Closure devices	<1%	
				Freight	2%	
				Others	12%	
			Facilities	Energy (heating and electricity use)	<1%	
			Pharmaceuticals	Pharmaceuticals	49%	
			Disposal	Waste	16%	
			Total		108 kgCO2e	
					1 clinic-based skin cancer surgery	*1 hospital-based skin cancer surgery*
Tan and Lim, 2021 [64] (Australia)	Conventional surgery of one skin cancer	**Method:** Life Cycle Assessment **Protocol(s):** ISO 14040 and 14044 **Type of activity data:** Process (Secondary) **Characterization method:** IMPACT World+TM assessment Midpoint 1.29 **Software:** OpenLCA© version 1.10.3	Travel and transportation	Staff, patient, delivery of consumables, removal of waste	75%	28%
			Facilities	Electricity	17%	65%
				Water	0%	0%
			Consumables	Drapes, gowns, gauze, dressings, gloves, packaging	3%	7%
			Equipment	Manufacture of surgical instruments	7%	0%
			Disposal	Waste	- 2%	0%
			Other	Repackaging	0%	0%
			Total *		28.5 kgCO2e	80.8 kgCO2e
			* *Data retrieved from Supplementary Table S3 Drew et al., 2021*			
						1 average surgery
Umo et al., 2023 [65] (Papua New Guinea)	Surgical suite	**Method:** Carbon foot print accounting **Protocol(s):** GHG protocol **Type of activity data:** Process (primary)	Facilities	Energy use surgical suite (diesel)		20.8%
			Pharmaceuticals	Isoflurane		43.0%
				Halothane		0.9%
			Disposal	Cardboard waste		3.1%
				Average plastic waste		1.2%
				Polypropylene waste		4.6%
				Sharps waste		4.4%

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS
		Characterization method: *NA* **Software:** *NA*		Transportation to landfill	20.2%
				Body tissue waste	1.8%
			Total *		8.4 kgCO2e
			* *Calculated based on Tables 3 – 5*		
					Open CTR / *Endoscopic CTR*
Zhang et al., 2023 [66] **(USA)**	Open and endoscopic carpal tunnel release surgery	**Method:** Life Cycle Assessment **Protocol(s):** *NA* **Type of activity data:** Process (primary) **Characterization method:** *NA* **Software:** *NA*	Facilities	Energy use by operating room lights, anesthesia equipment, endoscopy equipment, and heating, ventilation, and air conditioning	31.0% / 23.1%
				Electricity use for central processing (sterilization)	68.3% / 76.4%
			Disposal	Solid waste disposal	0.7% / 0.5%
			Total		59.6 kgCO2e / 106.5 kgCO2e

Table S20. Carbon footprint of hospital care in Urology: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
					Laparoscopic prostatectomy	*Robot assisted prostatectomy*
Fuschi et al., 2023 [67] (Italy)	Laparoscopic or robot-assisted radical prostatectomy with or without lymphadenectomy	**Method:** Life Cycle Assessment **Protocol(s):** ISO 14044, GHG protocol **Type of activity data:** Process (Primary) **Characterization method:** *NA* **Software:** *NA*	Equipment and/or consumables	Instrument production, disposal, and sterilization	21.7%	20.1%
			Facilities and equipment	Energy consumption	78.3%	79.9%
			Total		59.67 kgCO2e	47.31 kgCO2e

					MRI	*Prostate biopsy*	Pathology analysis
Leapman et al., 2023 [68] (USA)	Prostate biopsy pathway (including prebiopsy prostate MRI, TRUS biopsy and pathology analysis)	**Method:** Life Cycle Assessment **Protocol(s):** ISO 14040 **Type of activity data:** Process (Primary) **Characterization method:** TRACI 2.1 version 1.04 **Software:** SimaPro version 8.5.2.3	Travel	Patient travel	22%	32%	-
				Staff travel			15%
			Facilities and equipment	Energy – procedure	49%	51%	5%
				Energy – [48] hours	16%	5%	0%
			Equipment and/or consumables	Supply production	11%	11%	64%
			Disposal	Waste treatment	0%	1%	16%
			Other	Reuse process (laundering and sterilization)	1%	0%	0%
			Total *		42.7 kgCO2e	33.3 kgCO2e	4.8 kgCO2e

* *Relative contributions calculated from Table 1*

Table S21. Carbon footprint of Outpatient consultations in multiple medical specialties: Contributing factors reported per study

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS	
					Face-to-face consultation	*Virtual consultation*
Bartlett and Keir, 2022 [69] (UK)	Face-to-face and virtual consultation at an outpatient Geriatric Medicine clinic	**Method:** Method not specified: 'footprint calculation' **Protocol(s):** GHG protocol **Type of activity data:** Process (Secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient travel	60%	-
				Staff travel	35%	56%
			Facilities and equipment	Energy use for rooms (heating, lighting, computer, cordless phone, waiting room TV)	1%	7%
				Water use for hand wash	0.1%	0%
			Consumables	PPE	3%	0%
				Paper towels	?	?
			Other	Telecommunications (internet)	1%	37%
			Total		4.824 kgCO2e	0.994kg CO2e
					1 face-to-face consultation	*1 virtual consultation*
Filfilan et al., 2021 [70] (France)	In-person consultation and teleconsultation in two urology departments	**Method:** Method not specified: 'Environmental outcome analysis' **Protocol(s):** *NA* **Type of activity data:** Process (primary + secondary) **Characterization method:** *NA* **Software:** R version 3.6.2. (2009-2019 RStudio, Inc.)	Travel	Patient travel	>99%	-
			Equipment	Energy consumed by teleconference equipment	<1%	100%
			Total * * *Based on Table 2, recalculated for 1 consultation*		14.3 kgCO2e	0.014 kgCO2e
					1 face-to-face consultation		*1 virtual consultation*	
					Hand rehabil-itation	*Speech therapy*	*Hand rehabil-itation*	*Speech therapy*
Holmner et al., 2014 [71] (Sweden)	Telemedicine appointments and face-to-face visit in rehabilitation unit of the hand and plastic	**Method:** Life Cycle Assessment (simplified) **Protocol(s):** *NA*	Travel	Patient travel	100%		-	
			Equipment	Manufacturing, distribution, energy consumption during operation and end-of-life for PC, monitor, camera and LAN end-points (internet)	-		100%	

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS			
	surgery section & speech therapy clinic	**Type of activity data:** Process (Secondary) **Characterization method:** *NA* **Software:** Microsoft Excel	Total ** Only results for Hand rehabilitation clinic are reported here, recalculated for 1 consultation*		89.9 – 178.5 kgCO2e	83.7 – 166.1 kgCO2e	2.5 kgCO2e (range 0.8 – 5.7)	0.9 – 4.1 kgCO2e
					1 face-to-face consultation		*1 virtual consultation*	
Penaskovic et al., 2022 [72] (USA)	Outpatient visits to psychiatry clinics: virtual appointments and in-person appointments	**Method:** Not specified **Protocol(s):** *NA* **Type of activity data:** Process (Secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient travel	100%		-	
			Equipment	Energy use of technology use by patients	-		100%	
			Total * ** Recalculated for 1 consultation*		21.6 kgCO2e		0.13 kgCO2e	
					1 in-person visit		*1 virtual visit*	
Sillcox et al., 2023 [73] (USA)	Preoperative visit to benign foregut clinic: telemedicine visits and in-person visits	**Method:** Life Cycle Assessment **Protocol(s):** *NA* **Type of activity data:** Hybrid (primary + secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient travel	99%		-	
			Equipment	Computer usage by patients (including manufacturing, disposal), network data usage	-		100%	
				Blood pressure cuff	0.03%		-	
				Thermometer	0.18%		-	
				Pulse oximeter	0.02%		-	
				Weight scale	0.11 – 0.12%		-	
			Consumables	Hand sanitizer	0.04%		-	
				Table sheet	0.07%		-	
				Paper sheet	0.07%		-	
				Gloves	0.16 – 0.17%		-	
				Cleaning wipe	0.10%		-	
			Total ** Relative contributions calculated from Table 1*		38.22 – 39.61 kgCO2e* (depends on travel mode, car vs. plane)		2.22 – 2.99 kgCO2e (depends on equipment type, i.e. desktop, all-in-one computer, laptop, tablet or phone)	
					In-person visit	*Virtual visit by phone*	*Virtual visit by video*	
Thiel et al., 2023 [74] (USA)	One clinic visit, conducted either in-person or virtually, at different departments	**Method:** Life Cycle Assessment **Protocol(s):** ISO 14040 **Type of activity data:** Process (primary + secondary)	Travel	Patient air travel	44%	-	-	
				Patient car travel	55%	-	-	
			Facilities	HVAC & lighting	1%	-	-	
			Equipment	Energy use computers and phones (both patient and clinician)	-	100%	100%	
			Consumables	Supplies (PPE, table cover, sanitizing wipe etc.)	<1%	-	-	

AUTHOR, YEAR (COUNTRY)	HOSPITAL SERVICE(S) STUDIED	TYPE OF STUDY / STUDY METHOD	CONTRIBUTING FACTORS		RELATIVE CONTRIBUTIONS		
		Characterization method: TRACI 2.1 v1.06/ US 2008 **Software:** SimaPro 9.3.0.2	Disposal	Waste	<1%	-	-
			Total* * *Only results from 2021 included, based on text and Figure 2*		20 kgCO2e (range 7.33 – 63.5)	0.02 kgCO2e	0.04 kgCO2e
					Mean emissions per patient (pre-intervention)	*Mean emissions per patient (post-intervention)*	
Wang et al., 2021 [75] (USA)	Preoperative management by telehealth: scripted phone call for patient triage, followed by either an in-person clinical visit or electronic chart review	**Method:** Life Cycle Assessment in retrospective cross-sectional study **Protocol(s):** *NA* **Type of activity data:** Hybrid (Secondary) **Characterization method:** *NA* **Software:** OpenLCA v1.8 interface, Python 3.6	Travel	Patient travel	44%	51%	
			Other	Testing	18%	17%	
				Primary care physician in-person evaluation	14%	15%	
				Pre-operative Evaluation Center	22%	5%	
				Telehealth consult	1%	12%	
			Total * *Calculated from Table B*		84.52 kgCO2e	76.43 kgCO2e	
					1 patient consultation (all air transfer, without ACCESS program)	*1 patient consultation (some virtual consultation, some air transfer, with ACCESS program)*	
Whetten et al., 2019 [76] (USA)	Neuro-emergent telemedicine consultations	**Method:** Not specified **Protocol(s):** *NA* **Type of activity data:** Process (Secondary) **Characterization method:** *NA* **Software:** *NA*	Travel	Patient travel by air ambulance (helicopter)	50%	49.98%	
				Staff return flight	50%	49.98%	
			Equipment	Energy consumption of telemedicine equipment (PC and monitor)	-	0.02%	
			Total * *Calculated from Table 3*		437 kgCO2e	131 kgCO2e	

Table S22. Quality assessment per study

Numerical outcomes indicate total given points for each item. Colours indicate given points for each item (green = maximum number of points given; red = no points given; yellow = only part of total points given).

		Anesthe-siology		Cardiology and cardiac surgery					Derma-tology	Emergency medicine					Gastro-enterology			Gynecology			Nephrology					
Appraisal criteria	Indicator(s)	McGain et al., 2021[6]	Sherman et al., 2012[7]	Ditac et al., 2022[8]	Grinberg et al., 2021[9]	Hubert et al., 2022[10]	Orton and Pierce, 2021[11]	Zhang et al., 2022[5]	Grover et al., 2024[12]	Hunfeld et al., 2023[13]	McGain et al., 2018[14]	Penny et al., 2015a[15]	Penny et al., 2015b[16]	Prasad et al., 2022[17]	Elli et al., 2024[18]	Lacroute et al., 2023[19]	Zullo et al., 2023[20]	Campion et al., 2012[21]	Thiel et al., 2015[4]	Woods et al., 2015[22]	Aspin, 2018[23]	Chen et al., 2017[24]	Connor et al., 2010[25]	Connor et al., 2011[26]	James, 2007[27]	Lim et al., 2013[28]
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	1	0	3	1	1	1	3	3	3	1	2	2	2	3	3	0	3	3	2	2	3
Lifecycle assessment method is clearly stated (1)	Transparency	1	1	0	0	0	0	1	0	0	1	1	1	1	0	0	0	1	1	0	0	0	0	0	0	0
Functional unit is clearly defined and measurable (1), justified (1), and consistent with the study's intended application (1)	Consistency	3	3	0	0	0	0	3	3	0	3	3	1	3	3	1	2	3	3	0	3	3	3	3	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	3	3	1	1	1	0	2	1	1	2	1	1	2	2	1	1	3	2	1	0	1	3	3	2	3
The system covers production (1), use/reuse (1) and disposal (1) of materials and energy	Internal Validity, Completeness	3	3	2	2	3	1	2	1	1	3	3	3	3	3	3	2	3	3	2	3	3	3	3	1	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	1	1	2	1	2	2	2	2	1	1	3	2	2	2	3	3	3	2	1	3	3	1	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	3	2	0	0	1	0	1	0	0	2	0	0	1	3	1	1	1	2	0	0	0	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	0	0	1	1	0	1	1	1	1	0	1	1	1	1	1	0	0	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	2	3	2	1	2	1	2	2	2	2	3	2	3	2	2	2	1	2	1	1	1	1	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	0.5	1	1	1	1	1	1	0.5	1	1	1	1	0.5	1	1	0	0	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	1	1	2	0	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	1	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	1	2	2	2	2	0	0	2	2	2	2	1	2	2	2	2	2	2	2	2
Results are contextualized through the use of sensitivity analysis (1) and uncertainty analysis (1)	Internal validity	2	1	0	1	0	1	1	0	0	1	0	0	1	1	1	0	1	1	0	0	0	0	0	0	1

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	1	1	0	2	0	1	2	0	0	1	2	2	0	0	0	1	0	1	2	2	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	1	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	1	0	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	2	2	2	1	0	2	2	0	1	1	1	2	2	2	2	2	2	1	0	1	2	0	0	1
Total (%)		97%	87%	54%	53%	49%	20%	80%	46%	39%	77%	54%	49%	86%	76%	71%	54%	74%	80%	57%	43%	57%	83%	74%	43%	83%

		Nephrology			Ophthalmology									Ortho-pedics		Oto-laryngology	Pediatric medicine	Pathology			Psychiatry	Pulmonary medicine		Radiology		
Appraisal criteria	Indicator(s)	Mtioui et al., 2021[29]	Newcastle upon Tyne Hospital,	Sehgal et al., 2022[3]	Chandra et al., 2022[31]	Ferrero et al., 2022[32]	Goel et al., 2021[33]	Hong et al., 2022[34]	Latta et al., 2021[35]	Morris et al., 2013[2]	Pascual-Prieto et al., 2023[36]	Power et al., 2021[37]	Thiel et al., 2017[38]	Chang, 2018[39]	Delaie et al., 2023[40]	Meiklejohn et al., 2024[41]	Budgen, 2017[42]	Ji et al., 2022[43]	McAlister et al., 2021[44]	Spoyalo et al., 2023[45]	Debaveye et al., 2019[46]	Budgen, 2018[47]	Patrucco et al., 2023[48]	Chua et al., 2021[49]	Esmaeili et al., 2018[50]	Martin et al., 2018[51]
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	3	2	1	1	3	1	2	2	2	3	3	0	2	2	0	2	3	3	1	0	1	2	3	3
Lifecycle assessment method is clearly stated (1)	Transparency	0	0	1	0	1	1	1	0	0	0	1	1	0	1	1	0	1	1	0	1	0	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	0	0	0	0	1	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	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	1	2	3	1	3	3	0	3	2	2	2	3	0	2	2	0	3	3	3	3	0	1	3	3	1
The system covers production (1), use/reuse (1) and disposal (1) of materials and energy	Internal Validity, Completeness	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	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	0	3	1	2	2	0	3	3	2	3	3	2	3	3	2	3	3	1	3	2	2	3	3	2
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	0	2	0	2	3	0	1	1	2	1	2	0	1	2	0	2	2	2	1	0	2	2	1	2
Allocation procedures, where necessary, are described and appropriately justified (1; mark given if no allocation used)	Transparency; Bias	1	0	1	1	0	1	0	1	1	1	1	1	0	0	1	0	1	1	0	0	0	0	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	1	2	2	2	2	1	1	1	2	2	2	3	2	3	3	2	3	2	1	3	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	0	1	1	1	1	1	1	1	1	0.5	1	1	0.5	1	1	1	1	0.5	1	1	1	1
A contribution analysis is performed and clearly reported (1), and hotspots are identified (1)		2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	0	2	2	2	2	0	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	0	2	2	2	2	2	2	2	2	1	2	1	1	2	2	2	2	1	1	2	2	2
Results are contextualized through the use of sensitivity analysis (1) and uncertainty analysis (1)	Internal validity	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	2	0	1	0	0	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	0	0	2	0	0	1	1	1	1	1	2	1	0	2	1	0	2	0	2	2	0	2	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	0	1	0	1	1	0	1	1	1	1	1	0	1	1	0	1	1	1	1	0	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	0	0	2	0	1	2	2	1	1	1	2	2	0	2	0	0	2	1	2	1	0	2	1	0	1
Total (%)		60%	51%	91%	29%	60%	77%	43%	69%	69%	69%	80%	89%	33%	77%	77%	33%	91%	89%	77%	80%	33%	54%	86%	74%	77%

		Radio-logy	Radiotherapy				Surgery										Urology		Outpatient consultations (multiple medical specialties)							
Appraisal criteria	Indicator(s)	McAlister et al., 2022[52]	Ali and Piffoux, 2024[53]	Cheung et al., 2023[54]	Chuter et al., 2023[55]	Dvorak et al., 2023[56]	Berner et al., 2017[57]	Bischofberger et al., 2023[58]	Gatenby, 2011[1]	MacNeill et al., 2017[60]	Penny et al., 2015c[62]	Power et al., 2012[61]	Kodumuri et al., 2023[59]	Senemaud et al., 2023[63]	Tan and Lim, 2021[64]	Umo et al., 2023[65]	Zhang et al., 2023[66]	Fuschi et al., 2023[67]	Leapman et al., 2023[68]	Bartlett and Keir, 2022[69]	Filfilan et al., 2021[70]	Holmner et al., 2014[71]	Penaskovic et al., 2022[72]	Sillcox et al., 2023[73]	Thiel et al., 2023[74]	Wang et al., 2021[75]	Whetten et al., 2019[76]
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	2	3	1	3	1	1	2	2	3	2	2	2	2	2	2	1	2	1	1	2	3	2	3	2	1
Lifecycle assessment method is clearly stated (1)	Transparency	1	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	1	1	0	0	1	0	1	1	1	0
Functional unit is clearly defined and measurable (1), justified (1), and consistent with the study's intended application (1)	Consistency	3	2	3	3	0	0	3	1	3	1	0	3	1	3	2	2	2	3	0	0	3	0	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	3	3	0	2	1	1	1	1	2	1	1	0	1	2	1	2	2	2	2	0	3	0	3	3	0	0
The system covers production (1), use/reuse (1) and disposal (1) of materials and energy	Internal Validity, Completeness	3	3	1	1	1	2	3	0	3	3	2	1	3	3	2	2	3	3	3	1	3	1	3	3	1	1
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	2	2	2	2	2	2	3	1	3	1	2	2	2	2	1	3	1	1	2	2	1	3	3	2
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	2	2	1	1	2	2	2	0	1	1	0	2	1	2	1	2	0	0	2	1	2	2	1	1
Allocation procedures, where necessary, are described and appropriately justified (1; mark given if no allocation used)	Transparency; Bias	1	1	0	1	0	0	1	1	1	1	1	0	1	1	1	1	0	1	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	1	1	2	2	2	1	1	2	2	1	2	2	3	1	1	1	3	1	2	2	1	1	3	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	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0.5	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	1	1	2	0	2	2	2	2	2	1	2	2	2	2	2	0	1	0	0	2	2	0
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	0	2	2	2	0	2	0	2	1	2	2	2	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	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1	0	0
Limitations are adequately discussed (1), and the potential impact of omissions or assumptions on the study's outcomes are described (1)	Bias	2	1	1	2	2	0	1	2	2	0	1	1	0	1	2	2	0	2	0	0	1	2	1	2	2	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	1	0	1	1	1	0	1	1	1	1	1	1	1	1	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	1	1	2	1	2	1	2	2	1	2	2	2	2	1	1	1	2	2	1	2	1	2	2	2	2
Total (%)		89%	69%	57%	71%	51%	37%	63%	51%	80%	49%	60%	51%	57%	71%	60%	69%	53%	89%	49%	31%	80%	46%	71%	94%	69%	46%

References supplementary materials

1. Gatenby, P.A., *Modelling the carbon footprint of reflux control.* International Journal Of Surgery, 2011. **9**(1): p. 72-4.
2. Morris, D.S., et al., *The carbon footprint of cataract surgery.* Eye, 2013. **27**(4): p. 495-501.
3. Sehgal, A.R., J.E. Slutzman, and A.M. Huml, *Sources of Variation in the Carbon Footprint of Hemodialysis Treatment.* Journal of the American Society of Nephrology, 2022. **33**(9): p. 1790-1795.
4. Thiel, C.L., et al., *Environmental impacts of surgical procedures: life cycle assessment of hysterectomy in the United States.* Environmental Science & Technology, 2015. **49**(3): p. 1779-86.
5. Zhang, X.G., et al., *Carbon footprinting for hospital care pathways based on routine diagnosis-related group (DRG) accounting data in Germany: An application to acute decompensated heart failure.* Journal of Industrial Ecology, 2022. **26**(4): p. 1528-1542.
6. McGain, F., et al., *Carbon Footprint of General, Regional, and Combined Anesthesia for Total Knee Replacements.* Anesthesiology, 2021. **135**(6): p. 976-991.
7. Sherman, J., et al., *Life cycle greenhouse gas emissions of anesthetic drugs.* Anesthesia & Analgesia, 2012. **114**(5): p. 1086-90.
8. Ditac, G., et al., *Carbon footprint of atrial fibrillation catheter ablation.* Europace, 2022. **15**: p. 15.
9. Grinberg, D., et al., *Eco-audit of conventional heart surgery procedures.* European Journal of Cardio-Thoracic Surgery, 2021. **60**(6): p. 1325-1331.
10. Hubert, J., et al., *Carbon emissions during elective coronary artery bypass surgery, a single center experience.* Journal of Clinical Anesthesia, 2022. **80**: p. 110850.
11. Orton, A. and J.T. Pierce, *Elective DC cardioversion: a comparison of the carbon footprint of the care pathways for warfarin and DOAC treated patients.* Future Healthcare Journal, 2021. **8**(2): p. e330-e331.
12. Grover, S., N. Patel, and S. Tso, *Relative carbon footprint differences between National Institute for Health and Care Excellence melanoma follow-up pathways 2015 and 2022.* Clinical and Experimental Dermatology, 2024. **49**(6): p. 633-635.
13. Hunfeld, N., et al., *Circular material flow in the intensive care unit-environmental effects and identification of hotspots.* Intensive Care Medicine, 2023. **49**(1): p. 65-74.
14. McGain, F., et al., *The carbon footprint of treating patients with septic shock in the intensive care unit.* Critical Care & Resuscitation, 2018. **20**(4): p. 304-312.
15. Penny, T., et al., *Care pathways: guidance on appraising sustainability - Emergency Department Visit Module*, in *Coalition for Sustainable Pharmaceuticals and Medical Devices (CSPM)*. 2015.
16. Penny, T., et al., *Care pathways: guidance on appraising sustainability - Inpatient Bed Day Module*, in *Coalition for Sustainable Pharmaceuticals and Medical Devices (CSPM)*. 2015.
17. Prasad, P.A., et al., *Environmental footprint of regular and intensive inpatient care in a large US hospital.* International Journal of Life Cycle Assessment, 2022. **27(1)**: p. 38-49.
18. Elli, L., et al., *The carbon cost of inappropriate endoscopy.* Gastrointestinal Endoscopy, 2024. **99**(2): p. 137-145.e3.

19. Lacroute, J., et al., *The carbon footprint of ambulatory gastrointestinal endoscopy.* Endoscopy, 2023(AAM).
20. Zullo, A., et al., *Can Gastric Juice Analysis with EndoFaster ® Reduce the Environmental Impact of Upper Endoscopy?* Healthcare (2227-9032), 2023. **11**(24): p. 3186.
21. Campion, N., et al., *Life cycle assessment perspectives on delivering an infant in the US.* Science of the Total Environment, 2012. **425**: p. 191-8.
22. Woods, D.L., et al., *Carbon footprint of robotically-assisted laparoscopy, laparoscopy and laparotomy: a comparison.* The International Journal Of Medical Robotics + Computer Assisted Surgery: MRCAS, 2015. **11**(4): p. 406-12.
23. Aspin, J., *Continuous Renal Replacement Therapy (CRRT) with Prismaflex*. 2018, Baxter International Inc.
24. Chen, M., et al., *The carbon footprints of home and in-center peritoneal dialysis in China.* International Urology & Nephrology, 2017. **49**(2): p. 337-343.
25. Connor, A., R. Lillywhite, and M.W. Cooke, *The carbon footprint of a renal service in the United Kingdom.* Qjm, 2010. **103**(12): p. 965-75.
26. Connor, A., R. Lillywhite, and M.W. Cooke, *The carbon footprints of home and in-center maintenance hemodialysis in the United Kingdom.* Hemodialysis International, 2011. **15**(1): p. 39-51.
27. James, R., *Dialysis and the environment: comparing home and unit based haemodialysis.* Journal of Renal Care, 2007. **33**(3): p. 119-23.
28. Lim, A.E., A. Perkins, and J.W. Agar, *The carbon footprint of an Australian satellite haemodialysis unit.* Australian Health Review, 2013. **37**(3): p. 369-74.
29. Mtioui, N., et al., *Carbon footprint of a hemodialysis unit in Morocco.* Therapeutic Apheresis & Dialysis: Official Peer-Reviewed Journal of the International Society for Apheresis, the Japanese Society for Apheresis, the Japanese Society for Dialysis Therapy, 2021. **25**(5): p. 613-620.
30. *In-Centre Haemodialysis at Newcastle upon Tyne Hospital*. 2022, Newcastle upon Tyne Hospitals NHS Foundation Trust (NUTH).
31. Chandra, P., et al., *The carbon footprint of intravitreal injections.* Clinical & Experimental Ophthalmology, 2022.
32. Ferrero, A., et al., *The carbon footprint of cataract surgery in a French University Hospital.* Journal Francais d Opthalmologie, 2022. **45**(1): p. 57-64.
33. Goel, H., et al., *Improving productivity, costs and environmental impact in International Eye Health Services: using the 'Eyefficiency' cataract surgical services auditing tool to assess the value of cataract surgical services.* BMJ Open Ophthalmology, 2021. **6**(1): p. e000642.
34. Hong, Z., E.W. Chong, and H.H.L. Chan, *One step forward to sustainability: The carbon footprint of cataract surgery in Australia.* Clinical & Experimental Ophthalmology, 2022. **07**: p. 07.
35. Latta, M., C. Shaw, and J. Gale, *The carbon footprint of cataract surgery in Wellington.* New Zealand Medical Journal, 2021. **134**(1541): p. 13-21.
36. Pascual-Prieto, J., C. Nieto-Gómez, and I. Rodríguez-Devesa, *The carbon footprint of cataract surgery in Spain.* Archivos de la Sociedad Española de Oftalmología (English Edition), 2023. **98**(5): p. 249-253.
37. Power, B., R. Brady, and P. Connell, *Analyzing the Carbon Footprint of an Intravitreal Injection.* Journal of Ophthalmic & Vision Research, 2021. **16**(3): p. 367-376.
38. Thiel, C.L., et al., *Cataract surgery and environmental sustainability: Waste and lifecycle assessment of phacoemulsification at a private healthcare facility.* Journal of Cataract & Refractive Surgery, 2017. **43**(11): p. 1391-1398.
39. Chang, S., *Environmental Impact and Benefits of Care4Today TKR Care Pathway*. 2018, Johnson & Johnson.

40. Delaie, C., et al., *Ecological Burden of Modern Surgery: An Analysis of Total Knee Replacement's Life Cycle.* Arthroplasty Today, 2023. **23(no pagination)**.
41. Meiklejohn, D.A., et al., *Environmental impact of adult tonsillectomy: life cycle assessment and cost comparison of techniques.* The Laryngoscope, 2024. **134**(2): p. 622-628.
42. Budgen, N., *Digital Adherence Monitoring in Poorly Controlled Paediatric Asthma*. 2017, AstraZeneca.
43. Ji, L., et al., *Potential Life-Cycle Environmental Impacts of the COVID-19 Nucleic Acid Test.* Environmental Science and Technology, 2022. **56(18)**: p. 13398-13407.
44. McAlister, S., T. Grant, and F. McGain, *An LCA of hospital pathology testing.* International Journal of Life Cycle Assessment, 2021. **26(9)**: p. 1753-1763.
45. Spoyalo, K., et al., *Patient, hospital and environmental costs of unnecessary bloodwork: capturing the triple bottom line of inappropriate care in general surgery patients.* BMJ Open Quality, 2023. **12**(3): p. e002316.
46. Debaveye, S., et al., *Human health benefit and burden of the schizophrenia health care pathway in Belgium: paliperidone palmitate long-acting injections.* BMC Health Services Research, 2019. **19**(1): p. 393.
47. Budgen, N., *Care pathway for Monoclonal Antibody Therapy of Severe Eosinophilic Asthma*. 2018, AstraZeneca.
48. Patrucco, F., F. Gavelli, and P.E. Balbo, *Environmental Impact of Bronchoscopy: Analysis of Waste Mass and Recyclability of Bronchoscopic Equipment and Consumables.* Respiration, 2023. **102(10)**: p. 905-911.
49. Chua, A.L.B., et al., *The Environmental Impact of Interventional Radiology: An Evaluation of Greenhouse Gas Emissions from an Academic Interventional Radiology Practice.* Journal of Vascular & Interventional Radiology, 2021. **32**(6): p. 907-915.e3.
50. Esmaeili, A., et al., *Environmental impact reduction as a new dimension for quality measurement of healthcare services.* International Journal of Health Care Quality Assurance, 2018. **31**(8): p. 910-922.
51. Martin, M., et al., *Environmental Impacts of Abdominal Imaging: A Pilot Investigation.* Journal of the American College of Radiology, 2018. **15**(10): p. 1385-1393.
52. McAlister, S., et al., *The carbon footprint of hospital diagnostic imaging in Australia.* The Lancet Regional Health. Western Pacific, 2022. **24**: p. 100459.
53. Ali, D. and M. Piffoux, *Methodological guide for assessing the carbon footprint of external beam radiotherapy: A single-center study with quantified mitigation strategies.* Clinical and Translational Radiation Oncology, 2024. **46**: p. 100768.
54. Cheung, R., et al., *Evaluating the Short-Term Environmental and Clinical Effects of a Radiation Oncology Department's Response to the COVID-19 Pandemic (STEER COVID-19).* International Journal of Radiation Oncology, Biology, Physics, 2023. **115**(1): p. 39-47.
55. Chuter, R., et al., *Towards estimating the carbon footprint of external beam radiotherapy.* Physica Medica, 2023. **112**: p. 102652.
56. Dvorak, T., et al., *Evaluating Carbon Footprint of Proton Therapy Based on Power Consumption and Possible Mitigation Strategies.* International Journal of Radiation Oncology* Biology* Physics, 2023. **117**(1): p. 22-30.
57. Berner, J.E., et al., *Measuring the carbon footprint of plastic surgery: A preliminary experience in a Chilean teaching hospital.* Journal of Plastic, Reconstructive & Aesthetic Surgery: JPRAS, 2017. **70**(12): p. 1777-1779.

58. Bischofberger, S., et al., *Assessing the environmental impact of an anastomotic leak care pathway.* Surgery Open Science, 2023. **14**: p. 81-86.
59. Kodumuri, P., E.P. Jesudason, and V. Lees, *Reducing the carbon footprint in carpal tunnel surgery inside the operating room with a lean and green model: a comparative study.* Journal of Hand Surgery (European Volume), 2023. **48**(10): p. 1022-1029.
60. MacNeill, A.J., R. Lillywhite, and C.J. Brown, *The impact of surgery on global climate: a carbon footprinting study of operating theatres in three health systems.* The lancet. Planetary Health, 2017. **1**(9): p. e381-e388.
61. Power, N.E., et al., *Environmental impact of minimally invasive surgery in the United States: an estimate of the carbon dioxide footprint.* Journal of Endourology, 2012. **26**(12): p. 1639-44.
62. Penny, T., et al., *Care pathways: guidance on appraising sustainability - Surgical Procedure Module*, in *Coalition for Sustainable Pharmaceuticals and Medical Devices (CSPM)*. 2015.
63. Senemaud, J., et al., *Carbon Footprint of Elective Endovascular Abdominal Aortic Aneurysm Repair.* European Journal of Vascular and Endovascular Surgery, 2023. **66(6)**: p. 877-878.
64. Tan, E. and D. Lim, *Carbon footprint of dermatologic surgery.* Australasian Journal of Dermatology, 2021. **62**(2): p. e170-e177.
65. Umo, I., et al., *Estimating the carbon emissions from a resource-limited surgical suite in Papua New Guinea: The climate change potential.* Dialogues in Health, 2023. **2**: p. 100108.
66. Zhang, D., et al., *The Environmental Impact of Open Versus Endoscopic Carpal Tunnel Release.* Journal of Hand Surgery - American Volume, 2023. **48**(1): p. 46-52.
67. Fuschi, A., et al., *The impact of radical prostatectomy on global climate: a prospective multicentre study comparing laparoscopic versus robotic surgery.* Prostate Cancer and Prostatic Diseases, 2023: p. 1-7.
68. Leapman, M.S., et al., *Environmental Impact of Prostate Magnetic Resonance Imaging and Transrectal Ultrasound Guided Prostate Biopsy.* European Urology, 2023. **10**: p. 10.
69. Bartlett, S. and S. Keir, *Calculating the carbon footprint of a Geriatric Medicine clinic before and after COVID-19.* Age & Ageing, 2022. **51**(2): p. 02.
70. Filfilan, A., et al., *Positive environmental impact of remote teleconsultation in urology during the COVID-19 pandemic in a highly populated area.* Progres en Urologie, 2021. **31**(16): p. 1133-1138.
71. Holmner, A., et al., *Carbon footprint of telemedicine solutions--unexplored opportunity for reducing carbon emissions in the health sector.* PLoS ONE [Electronic Resource], 2014. **9**(9): p. e105040.
72. Penaskovic, K.M., et al., *Telehealth: Reducing Patients' Greenhouse Gas Emissions at One Academic Psychiatry Department.* Academic Psychiatry, 2022. **46**(5): p. 569-573.
73. Sillcox, R., et al., *The environmental impact of surgical telemedicine: life cycle assessment of virtual vs. in-person preoperative evaluations for benign foregut disease.* Surgical Endoscopy, 2023. **37**(7): p. 5696-5702.
74. Thiel, C.L., et al., *Telemedicine and the environment: life cycle environmental emissions from in-person and virtual clinic visits.* NPJ Digital Medicine, 2023. **6**(1): p. 1-8.
75. Wang, E.Y., et al., *Environmental emissions reduction of a preoperative evaluation center utilizing telehealth screening and standardized preoperative testing guidelines.* Resources, Conservation and Recycling, 2021. **171 (no pagination)**.

76. Whetten, J., J. Montoya, and H. Yonas, *ACCESS to Better Health and Clear Skies: Telemedicine and Greenhouse Gas Reduction.* Telemedicine Journal & E-Health, 2019. **25**(10): p. 960-965.