The carbon footprint of surgical operations: a systematic review

Chantelle Rizan, Ingeborg Steinbach, Rosamond Nicholson, Rob Lillywhite, Malcolm Reed, Mahmood Bhutta

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Authorship:

Name	Highest degree	Department and Institution
Chantelle Rizan*	MRCS (ENT)	1) Brighton and Sussex University Hospitals NHS Trust 2) Brighton and Sussex Medical School 3) Royal College of Surgeons of England 4) Centre for Sustainable Healthcare
Ingeborg Steinbach	MA	1) Centre for Sustainable Healthcare
Rosamond Nicholson	MBChB	1) University Hospitals of Leicester NHS Trust
Rob Lillywhite	PhD	1) University of Warwick
Malcolm Reed	FRCS	1) Brighton and Sussex Medical School
Mahmood F Bhutta	FRCS	1) Brighton and Sussex University Hospitals NHS Trust 2) Medical Fair and Ethical Trade Group, BMA

***Corresponding author/ reprints requests:**
Phone: 01273696955
Email: chantelle.rizan@nhs.net

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Running head:
Carbon footprint of surgical operations

INTRODUCTION

Anthropogenic climate change poses one of the greatest current threats to public health in the 21st century, largely due to associated air pollution, rising temperatures, flooding and drought, and change in the spread of vector-borne diseases.(1) Whilst climate change may affect the health of current and future generations, the provision of healthcare itself produces greenhouse gases (GHGs) such as carbon dioxide, which are responsible for the majority of healthcare related climate change.(2, 3) The US healthcare sector produces 655 million tonnes of carbon dioxide (CO_2) equivalents per year,(4) contributing 8-10% of all national GHG emissions.(2, 4) In the UK, the National Health Service (NHS) generates 22.8 million tonnes of CO_2 per year,(5) responsible for 6% of UK net CO_2 emissions,(6) and one quarter of all those produced by the public sector.(3) Operating rooms make a large contribution to the healthcare carbon footprint as they are typically the most resource-intensive area of a hospital.(7, 8) Of UK NHS CO_2 emissions, 59% are associated with the supply chain, of which the largest hotspot is medical instruments and equipment (responsible for 15.5% of total emissions).(9) Operating rooms generate 21-30% of hospital waste(8, 10, 11) and are three to six times more energy intensive than the rest of the hospital which can be largely attributed to maintenance of the theatre environment (heating, ventilation and air-conditioning).(12)

There are different approaches used to estimate the environmental impact of a process or product. Life cycle assessment (LCA) is a method used to account for a number of different environmental indicators (such as GHG emissions, eutrophication, and ecotoxicity). LCA is an inclusive measure but the endpoints are numerous and vary with the approaches and data sources used, reducing the extent to which direct comparisons can be made between studies. Only the carbon footprint component of LCA studies are considered in this review.

Carbon footprinting estimates the direct and indirect GHG emissions associated with a sector (such as healthcare sector), process (such as an operation) or product (such as a surgical instrument).(13) Carbon dioxide is the dominant GHG emitted from healthcare and is responsible for 80-85% of the global warming potential of the healthcare sector in the US(2) and UK(3). Healthcare also emits other GHGs such as methane, nitrous oxide, chlorofluorocarbons and anaesthetic gases, which together with carbon dioxide, can be converted into carbon dioxide equivalents (CO_2e). The summation of all these different gases is a carbon footprint. Estimating the carbon footprint of surgical operations enables their GHG emissions to be quantified, and perhaps more importantly, allows the identification and targeting of carbon hotspots (largest GHG contributors) within surgery. Carbon footprinting can be used as a tool to model the relative impact of different measures aimed at reducing the GHG emissions of operative services, based upon existing variation in surgical care and hypothetical interventions. There are multiple guidelines on how to conduct carbon footprinting studies. The Greenhouse Gas Protocol(14) encompasses and builds on the other principal carbon footprint/LCA guidelines(15, 16) and will be used as the standard in this review.

There are two main methodologies used to estimate a carbon footprint. The first is a 'top-down' environmentally extended input-output (EEIO) model, which uses the monetary cost of a unit of interest to estimate the carbon footprint, on the premise that more expensive items involve greater resource use, with higher associated GHG emissions. An industry specific conversion factor (emission factor) is applied to the monetary cost.(13, 17) The EEIO approach incorporates all emission sources from upstream processes in the supply chain (either direct or indirect, and including flow between sectors), taking into account 'hidden' sectors such as marketing, and research and development (e.g. behind the drugs administered during an operation).(18) It is relatively inexpensive and simple to perform,(17) but lacks specificity and detail, and should not be used for comparing the carbon footprint of products from within the same industrial sector.(19) The main value of estimating a carbon footprint via an EEIO method is for the rapid identification of hotspots, indicating where it may be useful to perform a more detailed carbon footprint.

The alternative 'bottom-up' process-based method involves collecting data on all the component processes underpinning the unit of interest.(13, 17) Published emission factors can be applied, which provide average emissions for given attributable processes (for example electricity consumption, transportation, and production of a given material). This enables detailed analysis with high specificity, allowing comparison between items from the same sector.(20) However, this method is resource intensive and requires study boundaries to be carefully defined, resulting in 'truncation error' due to the omission of certain processes, or where the so called 'hidden' sectors are overlooked.(17) There is debate between the relative accuracy and value of top-down and bottom-up approaches.(21) Hybrid methods exist which attempt either to incorporate the detail of the process-based approach alongside inclusivity of EEIO models, or which use top-down approaches for attributable components for which process data cannot be obtained.(19, 21) Despite limitations, a given carbon footprinting methodology can be used to identify hotspots and evaluate alternatives if it is consistently applied within a study.

There are a number of guidelines available for greenhouse gas accounting. These include the International Organisation for Standardisation (ISO) 14067:2018,(22) the Greenhouse Gas Protocol,(14) and the Publicly Available Specification (PAS) 2050 guidelines.(15)

Previous reviews of the environmental sustainability of operating theatres have mostly focused on waste management strategies, encouraging reduction, reuse and recycling (alongside 'rethinking' and research).(23, 24) Other investigators have recommended adding in reprocessing of single-use devices (processing to allow for additional use(s)), environmentally preferable procurement, and energy consumption management.(25) However, these reviews are predominantly based on low level evidence such as opinion reports, and included studies using a wide variety of methods to measure environmental sustainability (e.g. weight of waste, volume of water, and cost).

The principle components making up the carbon footprint of an operating theatre are the hospital infrastructure, capital machinery, maintenance of the theatre environment (heating, ventilation, air-conditioning, lighting), electronic equipment energy, water, anaesthetic gases, pharmaceuticals, and reusable and disposable items. The relative contributions of each of these components is disputed,(12, 26, 27) and hotspots will vary in different settings and with different operations. The aim of this systematic review was to evaluate existing literature which examined the carbon footprint of surgical operations, and to identify hotspots which can be targeted to reduce the greenhouse gas emissions associated with surgery.

METHODS

This review was conducted and reported in accordance with PRISMA guidelines(28) and registered with the International Prospective Register of Systematic Reviews (PROSPERO, ID 109928).

Study selection

We included original peer-reviewed research evaluating the carbon footprint of individual surgical operations. We excluded case reports, opinion-based reports, congress abstracts, meta-analyses and studies not written in English. Studies were further excluded if they focused exclusively on a) pre- or post-operative care b) processes outside of the theatre itself (e.g. sterilisation) c) anaesthetic components of operations d) pharmaceuticals delivered intraoperatively, or e) examined whole systems (such as healthcare sector with surgery as a subset, or whole operating suites).

The following databases were searched; Cochrane Database (-4/10/19), Embase (1947-2019 week 32), Ovid MEDLINE (1946- Week 32 2019) and PubMed (1966-4/10/19). Two search domains were used (Supplementary Table 1), with terms within each domain combined by 'OR' and the two domains combined using 'AND'. The search was conducted independently by two authors (CR, RN). Study titles and their citations were screened, and irrelevant articles and duplicates discarded. Full texts were obtained for remaining articles and inclusion and exclusion criteria applied. The references of included studies were screened for studies not identified through the original search. Data were extracted independently by two authors (CR, IS).

Evaluation of study characteristics

For each study we recorded descriptive data on the study setting (including country of origin), focus of study (including surgical specialty), and carbon footprinting approach (EEIO model, process-based approach, or hybrid approach, alongside the carbon footprinting guideline used).

Evaluation of carbon footprint

The Greenhouse Gas Protocol(14) was used as a framework for extracting endpoints in this paper. Where there was conflicting terminology between studies, the GHG Protocol was used as the standard.

For each study, we determined the 'scope of the product inventory' which includes the functional unit and list of GHGs included. The functional unit is the process or product under examination (such as operation), for which the carbon footprint was estimated. The scope also identified the list of GHGs included (such as carbon dioxide, nitrous oxide and methane). The number of GHGs included was determined directly where explicitly stated, or otherwise deduced from the carbon footprinting guideline or databases used.

The inventory boundary was outlined for each included study, which describes the attributable processes that were included within the study. Where processes are omitted, this underestimates the carbon footprint of a given process. However, it is often difficult to obtain data on processes beyond the boundary of the hospital under investigation, and the inventory boundary could always be expanded, (e.g. to include higher tier supporting industries such as research and development, or even the food eaten by theatre staff). It is therefore reasonable for inventory boundaries to be set, but these should be clearly stated.

The processes that are included within study inventory boundaries were classified according to GHG Protocol(17) definitions of GHG emission types (scope one-three). Scope one emissions are those directly emitted from a given organisation (e.g. anaesthetic gases), scope two emissions are indirect GHG emissions associated with electricity use by an organisation (i.e. purchased directly by the hospital), and scope three gases incorporate all other indirect emissions (including those embedded within the supply chain, travel, and waste disposal). A carbon footprinting study is most reflective of true emissions where all processes attributable to the functional unit (from all three scopes) are included.

The data collected for the carbon footprint estimations were further categorised according to the data type. These are classified as direct emissions data where directly emitted emissions are measured (e.g. volume of anaesthetic gas released). Data is categorised as process activity data where this relates to the inputs and outputs known to contribute GHG, but where direct measurement is not possible. This is known as primary process activity data, where original data is collected that is specific to a given functional unit under examination (e.g. including the actual transportation used for theatre waste). Alternatively, secondary process activity data may be used, using average, or typical process data (e.g. based on previously published studies or databases which are not specific to the functional unit). Finally, secondary financial activity data is used in EEIO models based upon the monetary cost of items. Where reported, we also extracted data on the number of observations made for a given process, the assumptions made in data collection, and on how data regarding shared processes were attributed to a particular process. The latter is called the allocation method which, for example, describes the way in which annual electricity consumption of an operating theatre is assigned to a single operation.

For each study, the source of the emissions factors and global warming potentials were also recorded. In order to estimate the carbon footprint, the activity data (unit) must be multiplied by an emissions factor (kg GHG/unit) and also by the global warming potential (GWP). The GWP represents the extent to which a given GHG absorbs the sun’s infrared radiation and traps heat, relative to CO_2. Where the carbon footprint was conducted as part of a full LCA, the LCA database used was also extracted, which included information on embedded emission factors.

Where possible, numerical values for carbon footprinting results of overall operations and sub-processes were extracted, but descriptive data (e.g. percentages or proportions) and graphic summaries were used where actual values were not recorded.

Evaluation of quality and applicability of studies

There are three major sources of uncertainty within carbon footprint studies, and each of these were considered. Parameter uncertainty relates to the accuracy of direct emissions data, process activity data, emission factors and global warming potentials. Scenario uncertainty describes variation in results due to methodological choices, such as allocation methods or assumptions made. Finally model uncertainty describes the limitations associated with chosen top-down or bottom-up carbon footprinting method. All stated uncertainties and limitations were extracted.

Finally, we evaluated the quality of each study making reference to relevant guidelines(14-16) and critical appraisal tools.(29, 30) Studies were appraised independently by two researchers (CR, IS) using the system detailed in Supplementary Table 2, and discrepancies were discussed and resolved.

RESULTS

Study selection

The search strategy identified 4,604 records (Figure 1). Screening of titles excluded 4,381 of these and of the remaining 223, 83 were duplicates, leaving 140 articles for full text evaluation. Following application of the inclusion and exclusion criteria, eight studies were found to be eligible.(7, 26, 27, 31-35) Of these, four were conducted exclusively in the US,(7, 31, 33, 35) two in the UK,(27, 32), one in Chile(26), and one in India (Table 1).(34)

Variation in methods for carbon footprinting (Table 1)

The carbon footprinting method and terminology varied between studies. Three studies exclusively used ‘bottom-up’ process-based approaches, of which one simply described their method as a ‘carbon footprint’,(35) one described it as a ‘multi-component analysis/carbon footprint’,(26) and the other conducted full LCA.(31) A ‘top-down’ EEIO was used exclusively by one study(35) but was referred to as a ‘carbon footprint’. Five studies used a hybrid approach, using both EEIO and process-based methodologies, of which three termed this an ‘economic-’ or ‘environment input-output life cycle assessment (EIOLCA)’(7, 33, 34) and one a ‘component analysis study’.(27)

Four studies(7, 31, 33, 34) reported following ISO guidelines,(16) one(35) following the GHG Protocol(14) and two (27, 35) using PAS 2050 guidelines.(15) Two studies did not state the use of guidelines.(26, 32)

Variation in scope (Table 1)

The functional unit of all included studies were individual operations. Four studies examined operations in the field of Obstetrics and Gynaecology,(7, 31, 33, 35) two Ophthalmological operations,(27, 34) one Gastrointestinal,(32), and one Plastic surgery.(26) With regards to the scope of GHGs included, two studies calculated CO_2 emissions only.(26, 32) Other studies did not specify the number of GHGs included,(7, 31, 33-35) although this can be deduced (bracketed in Table 1) based on the guidelines or databases used.

Variation in inventory boundaries

Inventory boundaries are compared across studies in Table 2 and detailed in Supplementary Table 3. Stated exclusions of the inventory boundary are listed in Supplementary Table 4.

Across the eight studies(7, 26, 27, 31-35) the majority included electricity consumption (relating to electronic equipment, heating, ventilation, air conditioning & lighting), which constitute scope two GHG emissions. The majority also included theatre waste (with variable inclusion of specified waste streams) and linen laundering (scope three). There was variable inclusion of processes involved in the production of disposable and reusable items (raw material extraction, manufacturing and transport), and linen manufacture (all scope three). The majority of studies omitted pre- and post-operative processes, patient and staff travel, capital goods manufacture, water use, processing of reusable equipment (all scope three), and pharmaceuticals (including scope one anaesthetics gases).

Variation in data collected, allocation method and method for calculating inventory results

No studies collected direct emissions data (scope one). Three studies used primary process activity data only,(26, 31, 35) one used secondary financial activity data only(32) and all others used a mixture of data types *(*Supplementary Table 3*)*.(7, 27, 33, 34) Where studies used secondary financial activity data within an EEIO model, this incorporates all three scopes of GHG emissions where relevant. The assumptions made within data collection are listed in Supplementary Table 4. Allocation methods were explicitly stated by four studies.(7, 31, 33, 34) A range of data sources were used for emission factors and GWPs.

Heterogeneity in functional units, methodology and reporting of results limits comparison across studies, and means meta-analysis is inappropriate. The study carbon footprint results extracted are presented in full in Supplementary table 5.

Carbon footprint of operations

The carbon footprint of individual operations ranged from 6-814kg CO_2e (Figures 2-4).(7, 26, 27, 31-35) This variation may be due to differences in methods and boundaries, but is also affected by the type of operation and the institution where it is performed. The carbon footprint of different operations will vary, and are likely to be dependent upon the invasiveness of the procedure, patient factors, and the surgical team, which will each impact on operative time and consumables used.

Berner et al.(26) found that an abdominoplasty had a greater carbon footprint than rhinoplasty, which in turn was greater than bilateral breast augmentation. Morris et al.(27) calculated the carbon footprint of a cataract operation in the UK at 182kg CO_2e, whilst Thiel et al. estimated this to be 6kg CO_2e in India.(34) Whilst the decision to manage a patient medically or surgically (and the surgical approach taken), is a decision made by the surgeon based upon clinical grounds and taking into account patient preference, a number of studies compared their carbon footprints. Thiel et al.(7) and Woods et al.(35) found that the most carbon intensive approach to gynaecological surgery was robotic, followed by the laparoscopic approach, followed by laparotomy (followed by trans-vaginal approach within the former study). Two studies calculated the carbon footprint of an operation and compared it to non-surgical options. Campion et al.(31) found that the carbon footprint of a caesarean section is twice that of a vaginal delivery. However none of these studies considered any processes beyond the theatre boundary, and did not take into account the impact different surgical approaches have on length of stay, infection rate and need for further intervention (all with associated carbon dioxide emissions). Gatenby(32) found that the carbon footprint of surgical approaches to gastro-oesophageal reflux disease treatment is higher than medical treatment up to nine years after the operation, but becomes more carbon efficient thereafter, following patients up until end of life.

Two studies extrapolated results of individual operations to estimate national carbon footprints, concluding that hysterectomies in the USA generate 212,000 tonnes CO_2e per year (~285-562 kg CO_2e per operation)(7) and cataract surgery in the UK generates 63,000 tonnes CO_2e per year (182 kg CO_2e per operation).(27)

Analysis of contributions to overall carbon footprints and carbon hotspots

The relative contributions of individual processes to the overall carbon footprint of surgical operations is illustrated within Figures 2-4. Three studies(26, 31, 35) found electricity to be the largest source of GHG emissions, accounting for 63-78% of the carbon footprint of whole operations, and the amount of electricity consumed is likely to be closely linked with the operation duration. In two studies where electricity use was broken down, the highest consumption of electricity was for maintaining the theatre environment (heating, ventilation and air-conditioning).(7, 31) By contrast, four studies(7, 27, 33, 34) found procurement to be the largest hotspot, with three(7, 33, 34) specifically identifying single-use items to be largest contributors, responsible for up to 78% of the carbon footprint (with two of these studies referring to the same dataset). In the two studies that accounted for patient and staff travel to hospital, this was responsible for 10-37% of the footprint.(26, 27)

Quality and applicability of studies

There were a number of points limiting the internal and external validity of studies, in addition to methodological points previously raised. No study stated a clear hypothesis, increasing risk of post-hoc analysis and selective reporting. Transparency was limited by failure to state either assumptions *or* exclusions within two studies,(26, 33) and one(7) did not state either. For a given process, the number of observations or data points collected was reported in two studies for all processes,(32, 35) reported ambiguously or for a limited number of processes in five studies,(7, 26, 27, 33, 34) and not reported at all in one.(31) Five studies broke down the carbon footprint in numerical data for all key sub-processes,(26, 27, 32, 33, 35) and two (7, 34) reported limited numerical data, with some sub-process results presented as descriptive or graphical data. One study reported only descriptive or graphical data.(31)

Parameter uncertainty (uncertainty relating to the data collection or emissions factors) was calculated by two studies.(7, 35) Three studies performed scenario uncertainty tests to model the uncertainty due to methodological assumptions, two(31, 34) finding this affected results minimally, whilst another(36) finding this varied results by 0.3-19%.

The extent to which carbon footprint study results may hold external validity to other operations of the same type is limited, for example due to inventory boundaries, use of country-specific emission factors and differences in the operative processes between patients, surgeons and institutions. Further limitations and assumptions (both stated within studies and identified by us) are summarised in Supplementary Table 4. There is a risk of publication bias across studies, although we found published studies without statistically significant effect sizes.

DISCUSSION

This review found that the carbon footprint of a single operation ranged from 6 (for cataract surgery in India)(34) to 814 kg CO_2e, (for a robotic hysterectomy in the US),(7) with the largest value being equivalent to driving up to 2,273 miles in an average petrol car.(37) The carbon footprint estimates need to be considered with some caution, particularly in comparing results between studies due to significant differences in inventory boundaries, assumptions and other methodological considerations. MacNeill et al. calculated and compared the carbon footprint of whole operating suites across one year in three large hospitals in the UK, Canada and

US,(12) finding this ranged between 3,219- 5,188 tonnes CO_2e. Whilst this study did not look at specific individual operations, results of average operations were in keeping with included studies, with emissions of 146 kg CO_2e per average case at the Canadian hospital, compared with 173 kg CO_2e in the UK, and 232 kg CO_2e in the US.

This review found that the major carbon hotspots within operating theatres are a) energy use,(12, 26, 31, 35) and b) procurement of consumables,(27, 34) both of which can be targeted for improvement. Anaesthesia is another important consideration, but is beyond the scope of this systematic review and it is principally within the control of anaesthetic departments, and their policy development is an important component of future strategies.(12, 38)

Optimising electricity use in theatres

Approaches to minimising electricity use include developing and installing occupancy sensors,(31) low-energy lighting, energy-efficient air-conditioning systems and water cooling systems.(25) Improving the energy efficiency of USA hospitals by 30% has been estimated could save $1 billion and a reduction in carbon emissions of 11 million tonnes.(39) Electricity should also be switched to renewable rather than fossil fuel based sources.

Optimising use of consumable items

Two studies identified that consumables are a major carbon hotspot within operations.(27, 34) This is in line with estimates that attributable processes within the healthcare supply chain are responsible for 59% of the total NHS carbon footprint,(9) and 71% of healthcare's carbon footprint globally.(40) In light of this, attention should be given to reducing this footprint, for example through switching to reusable items and reducing resource use where clinically appropriate, and considering reprocessing of surgical instruments. Studies examining the carbon footprint of surgical scissors, laparotomy pads and suction receptacles found that this can be reduced by 50-97% through switching from single-use to reusable surgical devices(36, 41, 42). This is consistent with reports that favour reusable rather than disposable perioperative textiles,(43) and anaesthetic items (anaesthetic drug trays,(44) laryngeal mask airways(45), and laryngoscope handles and blades).(46)

Whereas use of reusable rather than disposable items is a good general principle, this preference is context specific and may not be universal. In Australia, Davis et al. found that reusable ureteroscopes are marginally more carbon intensive than single-use equivalents, a finding that is influenced by the predominant use of coal-based electricity in Australia.(47) Similar conclusions were drawn in two other Australian studies examining anaesthetic items,(48, 49) but if the carbon emissions were instead modelled using energy source mixes typical of the UK/Europe (principally renewables) or USA (largely natural gas), reusable equipment once again had a lower carbon footprint.(49)

Reprocessing of single-use surgical instruments is another potential target, modelled to reduce the GHG emissions of an entire operation by 9%,(33) and costing half the price of single-use equivalents.(50) In 2010 around one quarter of US hospitals used one or more reprocessed single-use device,(50) and the proportion of hospitals is likely to have increased since then, but reprocessing is not widely used in other countries such as the UK or Australia. A life cycle assessment study examining seven single use medical devices (including endoscopic trocars, ligasure, arthroscopic shavers and ultrasonic scalpels) found that reprocessed devices conferred lower global warming impacts alongside financial benefits.(51) The relative environmental impact of reprocessing specific single-use surgical instruments (compared with using new ones) is likely to be determined by the extent of reprocessing required (in turn depend upon the complexity of the instrument, extent of damage from use, and decontamination required), location of the reprocessing unit, and number of additional uses enabled.

Finally, there is potential from streamlining surgical instrument trays through minimising material use and selecting reusable surgical instruments.(33) Farrelly et al.(52) found that optimising paediatric surgical trays could eliminate an average of 60% of instruments, although the effects of this on carbon emissions was not evaluated in this study, and will depend upon how such trays are sterilised. Zygourakis et al.(53) reported that 13% of disposable items opened for neurosurgical procedures are discarded without use, hence changing processes to only open equipment when needed could bring financial as well as carbon savings. On a broader scale, it has been estimated that streamlining and optimising resource use in operating theatres holds the potential to save £7 million (~US$9 million) per NHS trust in the UK each year.(54)

Overall potential

The optimum approach to reducing the carbon emissions of a given operation should include a holistic approach, including looking at electricity use, anaesthetic gases, and use of equipment, especially where disposable. Thiel et al.(33) modelled that the carbon footprint of a hysterectomy operation could be reduced by up to 83%, through optimising the instrument tray via minimal materials and maximum reuse(49%), switching anaesthesia to intravenous anaesthesia with propofol or similar agents (28%), and using renewable energy (6%). It is also important to consider reducing the need for surgery through health promotion, disease prevention and correct patient selection.(55)

CONCLUSIONS

All studies estimating the carbon footprint of operations were published from 2011 onwards, reflecting that this field is still in its infancy, but needs further exploration as a priority. Future research evaluating the carbon footprint of operations should extend assessments to other surgical contexts, and focus on determining and evaluating targets to reduce the footprint. This may include reducing resource use, streamlining operations, switching to reusable equivalents, and improving the energy efficiency of theatre design. Studies comparing different surgical approaches or alternative models of care should include post-operative care, subsequent interventions, and patient outcomes. Full life cycle assessments should be performed where time, expertise and resources permit this, taking into account other environmental impacts beyond greenhouse gas emissions. Improving the environmental impact of surgery often leads to financial benefits and these should be reported alongside surgical carbon footprints, highlighting where green surgery is lean surgery, and providing additional impetus for change.

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LEGENDS

Legend for figures 2-4.

Bar colour	**Category**	**Sub-category**	
🟨	Electricity	E1=Building energy (theatre) E3=Electricity use E5=Lighting E7=Operation time	E2=Building energy (recovery) E4=HVAC E6=Medical equipment energy
🟦	Water	W=Water	
🟧	Consumables (General)	G1= Consumables procurement G3= Laundry	G2 = Waste
🟧	Consumables (Other)	O1=Other procurement O3= Pharmaceuticals (ongoing)	O2 =Pharmaceuticals
▧	Reusables	R1=Reusable instruments R3=Reusables production & sterilisation	R2=Reusables production R4=Reusables treatment & sterilisation
▨	Single-use items	S1=Single-use items production S3=Single-use materials (gowns, gloves etc)	S2=Single-use instruments production
🟩	Travel	T1=Patient travel T3=Waste transport	T2=Staff travel
⬜	Anaesthetics	A=Anaesthetics	
🟪	Beyond operation	B1=Day case B3=Outpatient appointment	B2=Inpatient care B4=Outpatient tests