Introduction

Operating rooms are typically the most resource-intensive area of a hospital,(1, 2) generating 21-30% of hospital waste(2-4) (Figure 1), with theatres being three to six times more energy intensive than the rest of the hospital.(5)

Carbon footprinting can be used to estimate the direct and indirect greenhouse gas emissions associated with a given process (such as an operation), one of the metrics for measuring environmental impact.

Aims

The primary aim of this systematic review was to evaluate existing literature calculating the carbon footprint of operating theatres (or components within), determining opportunities for improving the environmental impact of surgery which can contribute to the development of reduction strategies.

Methods

A systematic review was conducted in accordance with PRISMA guidelines. The Cochrane Database, Embase, Ovid MEDLINE and PubMed were searched and inclusion criteria applied. The study endpoints were extracted and compared, with the risk of bias determined.

Results

4,062 records were identified, and 16 were eligible for inclusion. Nine studies used ‘bottom-up’ process-based carbon footprinting approaches, one used a ‘top-down’ environmentally extended input out model, and the remaining five used hybrid approaches.

- National surgical pathways contributed 63,000-355,925 tonnes of carbon dioxide equivalents (CO₂e) per year (Figure 3)(1, 6, 7)
- The annual carbon footprint of whole operating suites ranged 3,219-5,188 tonnes CO₂e (Figure 2)(5)
- The carbon footprint of single operations ranged 5-814kg CO₂e (Figure 3)(1, 6, 8-13)
- The carbon footprint associated with an individual surgical device ranged ~0.07-4.47kg CO₂e (Figure 4)(8, 14-17)

The studies found that major carbon hotspots within the examined operating theatres were a) electricity use b) procurement of consumables c) anaesthetic gases

Studies demonstrated that it is possible to reduce the carbon footprint of surgery through several mechanisms:

- Use of reusable over disposable products: for example reusable scissors(14), laparotomy pads(15) and suction receptacles(16) have a footprint of just 3-50% of disposable equivalents
- Streamlining surgical instrument trays: estimated to reduce the carbon footprint of a hysterectomy by 46%(12)
- Reprocessing of single use surgical instruments: modelled to reduce the GHG emissions of an entire operation by 9%(12)
- Opting for traditional approaches (laparotomy or laparoscopy) over use of robotics: reducing the carbon footprint by up to two thirds (1, 11)

There were significant methodological limitations within included studies (Table 1).

Conclusions

This systematic review indicates that surgery has a large carbon footprint although this must be balanced against patient and population outcomes, in light of the impact of climate change on the health of future generation. Further research should focus on optimising the carbon footprint of operating theatres through leaning operations, expanding LCAs to other contexts and improving the eco-efficiency of theatre design.