The environmental impact of orthopaedic surgery: assessing strategies for change

Abstract

Climate change poses one of the most critical threats to humanity. Surgical care needs to be considered in relation to the impending climate emergency. Little thought appears to have been given to the role of operating departments as a high-yield target for environmental change. This article evaluates the environmental impact of orthopaedic surgery, focusing on anaesthesia, waste management and surgical hardware. Developing 'green' operating protocols should be the minimum expectation of orthopaedic departments. Just as the management of complex surgical pathology requires a multidisciplinary approach, mitigating the environmental impact of surgical endeavour requires collective action and buy-in.

Key words: Climate change; COVID-19; Environment; Orthopaedic surgery; Renewable processes

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Introduction

Climate change poses one of the most critical threats to humanity (Costello et al, 2009; Harmer et al, 2020). Globally, healthcare institutions produce significant quantities of environmentally damaging waste; approximately £4 billion-worth of waste is produced by healthcare facilities annually, with up to 90% of operating room waste sent for resource intensive waste disposal (Lee and Mears, 2012). Between 20% and 70% of all healthcare-related waste originates from operating theatre complexes (Lee and Mears, 2012). Operating theatres contribute disproportionately to waste output and greenhouse gas emissions, through the use of single use devices, anaesthetic gases and energy-intensive sterilisation processes (Wyssusek et al, 2019). Surgical care needs to be considered in relation to the impending climate emergency. Little thought appears to have been given to the role of operating departments as a high-yield target for environmental change (Kagoma et al, 2012). The surgical community needs to develop forward-thinking ecological strategies that allow surgical care to be delivered in an environmentally considerate manner. This article looks at the environmental impact of orthopaedic surgery, focusing on anaesthesia, waste management and surgical hardware.

Evaluating the need for change

The COVID-19 pandemic has refocused the standard operating procedures of all healthcare institutions, affecting multiple aspects of patient care. The use of personal protective equipment has been central to controlling the spread of COVID-19 (Zhang et al, 2021), but as this largely comprises single use plastic, this has led surgical practitioners to consider more environmentally-friendly operating room strategies (Rizan et al, 2021). The estimated carbon footprint of all personal protective equipment distributed within England during the first COVID-19 pandemic (March 2020–August 2021) was 106 478 tonnes of carbon dioxide emissions, equivalent to 0.8% of all emissions (Rizan et al, 2021).

Orthopaedic surgery can be considered a high-volume surgical specialty, with the demand for orthopaedic intervention set to outstrip current service provision in the near future (Kurtz et al, 2007). Elective orthopaedic waiting lists in the UK are approximately three times the pre-COVID-19 average, with the cost of clearing the backlog estimated at £198 811 335 (Oussedik et al, 2021).

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The wider environmental impact of orthopaedic surgery is not quantified definitively within the literature (Kellish et al, 2021). The processes of implant manufacture, sterilisation, delivery, surgical implantation and disposal of waste are all resource-intensive practices, with each point along this chain a potential focus for energy conservation and efficiency improvement.

Anaesthetic considerations in orthopaedic surgery

Anaesthetic delivery for orthopaedic procedures is a key environmental consideration. Halogenated anaesthetic gases, such as desflurane and nitrous oxide, are known major contributors to climate change (Roa et al, 2020). Such volatile agents are exhaled by the anaesthetised patient and released into the atmosphere (Kuvadia et al, 2020; Roa et al, 2020). Strategies to mitigate the environmental and cost impact of general anaesthesia have been evaluated in the orthopaedic community at an institutional level.

The Hospital for Special Surgery in New York carried out 96% of orthopaedic procedures using regional anaesthesia in 2019, theoretically 'saving' the equivalent of 27 000 lbs of coal burned (Kuvadia et al, 2020). Using regional and neuraxial blockade for routine elective orthopaedic surgery may be a viable strategy for resource conservation, although due consideration must be given to unit-level anaesthetic preferences and available skill set.

The use of total intravenous anaesthesia in the wider surgical setting is well validated clinically, and avoids the use of volatile gas agents entirely (Irwin et al, 2020). In lifecycle assessment analysis, total intravenous anaesthesia produces four times fewer greenhouse gas emissions than volatile anaesthetic agents (Sherman et al, 2012). The use of total intravenous anaesthesia as an environmentally beneficial measure in orthopaedics has not been validated, but would appear to be less environmentally damaging. There is no agreement on the balance between the immediacy of safe delivery of an anaesthetic to a patient and the potential long-term environmental cost (Charlesworth and Swinton, 2017).

Optimising the surgical environment

A central focus of orthopaedic surgery is restoring joint and limb function through the implantation of surgical hardware. Orthopaedic surgical trays either contain single-use disposable items or are reusable trays that require further sterilisation before reuse. There is no consensus favouring either disposable or non-disposable instruments, with lifecycle analyses supporting both set ups in different surgical contexts (Ibbotson et al, 2013; Thiel et al, 2017).

Initiatives supporting environmental awareness and resource conservation in orthopaedical have been successful. The 'lean and green' initiative was developed by the American Association for Hand Surgery to reduce surgical waste, cost and improve patient satisfaction. This involves delivering hand surgery in an outpatient setting, with local anaesthesia delivered by the surgeon (Van Demark et al, 2018). 'Minor field sterility' has also been used alongside this approach, using minimal sterile drapes, no gown or antibiotics, with resulting unchanged wound infection rates and decreased waste production (LeBlanc et al, 2011). Thiel et al (2017) produced a minimal custom surgical pack for use in hand surgery under local anaesthetic, halving surgical material costs and reducing surgical waste by 13% per case. Hand surgeons used the 'wide-awake' approach more often during the COVID-19 pandemic, because of the lack of routine anaesthetic provision (Atia et al, 2020; Picardo et al, 2021). This should allow the wide-awake approach to be perfected and further disseminated, hopefully with positive environmental consequences.

There is limited work evaluating the environmental impact of single use vs reusable trays in orthopaedic surgery. Leiden et al (2020) demonstrated that, in one-level lumbar fusion surgery, single use kits had a favourable environmental advantage over reusable kits because of the high energy cost of sterilising reusable instruments, which contributed to 90% of overall greenhouse gas emissions. Further, Marchand et al (2020) demonstrated that novel rapid sterilisation methods used in conjunction with highly-customised surgical trays can have advantages, including cost, theatre efficiency and sterilisation time, over traditional tray preparations in total knee arthroplasty surgery.

Key points

- Climate change poses one of the most critical threats to humanity. Surgical care needs to be considered in relation to the climate emergency.
- This article evaluates the environmental impact of orthopaedic surgery, focusing on anaesthesia, waste management and surgical hardware.
- The primary focus should be on delivering high-quality environmentally friendly surgery for the patients of today, without disadvantaging the patients of tomorrow.

External fixation is an accepted, well-validated treatment in the stabilisation of complex periarticular fractures (Scalea et al, 2000). Production of external fixators to treat complex injuries is a resource-intensive process, with an average cost of $5900 per external fixator (Chaus et al, 2014). Such devices are typically single use. Thamyongkit et al (2018) found that reprocessing external fixator components, although a sensible, attractive and feasible option for surgeons, was difficult to achieve practically. Barriers included a lack of understanding and fears surrounding litigation, despite reprocessing being a practice accepted by the Food and Drug Administration. Cost savings through external fixator reprocessing at their institution were $291 252 in 1 year.

Conclusions

Climate change cannot be left to be addressed by future generations of orthopaedic surgeons; it is a process that is happening now with devastating effects. Developing green operating protocols for theatres should be the minimum expectation of orthopaedic departments. Just as the management of complex surgical pathology requires a multidisciplinary approach, mitigating the environmental impact of surgery requires a degree of collective action and buy-in.

The COVID-19 pandemic forced the surgical community to embrace innovative thought and rapid implementation of service redelivery, ultimately to continue to deliver patient-centred care. The same immediacy and innovation must be applied to mitigating the deleterious effects of surgery on the environment. The primary focus should be on delivering high-quality environmentally friendly surgery for the patients of today, without disadvantaging the patients of tomorrow.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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