

PERSPECTIVE

Environmental sustainability in simulation education in healthcare

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Healthcare delivery is responsible for approximately 4% of global greenhouse gas (GHG) emissions [1], but 10% of national GHG emissions in the USA [2] and 7% in Australia [3].

The proportion of global emissions attributed to the entire education sector is less well understood but estimates suggest it is in the range of 2–3% [4,5]. However, the impact of simulation education in healthcare on the environment has not been scientifically explored. This article will review the existing data and draw on lessons learned from healthcare delivery to lay the foundations for the decarbonization of simulation education in healthcare.

The GHG Protocol Corporate Standard classifies these emissions into three scopes: Scope 1, Scope 2 and Scope 3 emissions [6]. The healthcare sector's emissions are largely due to goods and services purchased, used and disposed of in the delivery of healthcare (known as Scope 3 emissions) (Figure 1).

Understanding the sources of GHG emissions (Figure 2)

Scope 1 emissions

Scope 1 emissions, also known as direct emissions, originate from sources that are owned or controlled by the institution [7]. They include emissions from fossil fuels burned on site, emissions from entity-owned or entity-leased vehicles, and other direct sources. In the health sector, Scope 1 emissions may originate from the combustion of fossil fuels in health organizations boilers or emergency generators. Moreover, the use of organizationally owned vehicles for patient transportation or the use of certain inhaled anesthetics, such as nitrous oxide or desflurane, are also considered Scope 1 emissions [8].

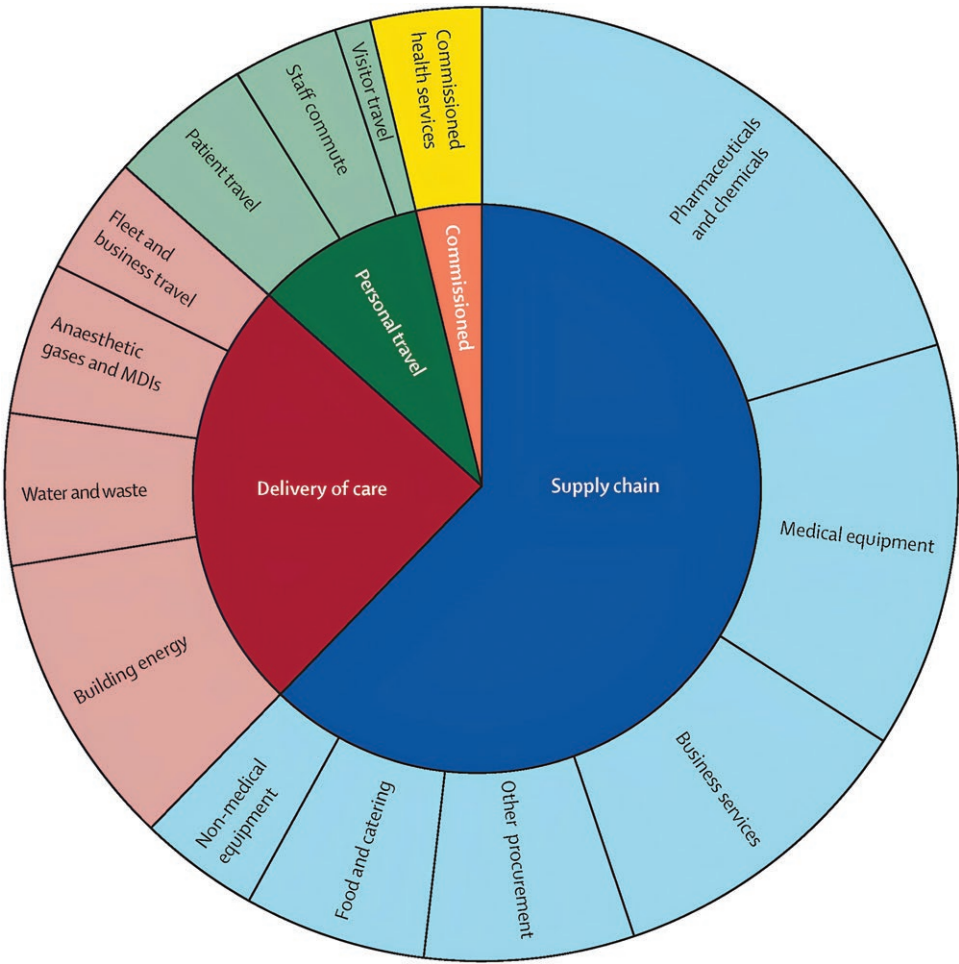
Scope 2 emissions

Scope 2 emissions are indirect emissions resulting from the generation of purchased or acquired electricity, steam, heat or cooling consumed by the institution [7]. In health or education, Scope 2 emissions primarily derive from the purchased electricity used for lighting, cooling, heating and powering medical devices [2].

Scope 3 emissions

Scope 3 emissions are all emissions that occur as a result of the manufacture, transport, use and disposal of goods and services used by an organization [7]. In the health sector, upstream Scope 3 emissions can include those from the production of purchased goods or services, such as medical equipment and supplies. Downstream

Figure 1: The carbon footprint of the NHS [11]



Scope 3 emissions might include those from the disposal of medical waste or from employee commuting [6].

Healthcare education using simulation, by design, aims to emulate real-world scenarios for learners. It is reasonable to conclude that the Scope 3 emissions associated with healthcare simulation education mirrors that of the environment being simulated – healthcare delivery. When using simulation to teach procedural skills, although the concerns around sterility are less in a simulated environment, most of the equipment is plastic and often single-use [9]. Detailed life cycle analysis studies of common surgical procedures highlights that 50–80% of the carbon footprint of a surgical procedure is related to the production, utility and disposal of single-use items [10]. Although similar data for simulation education have not been published, it can be assumed that Scope 3 emissions make up a significant component of the carbon footprint of simulation education.

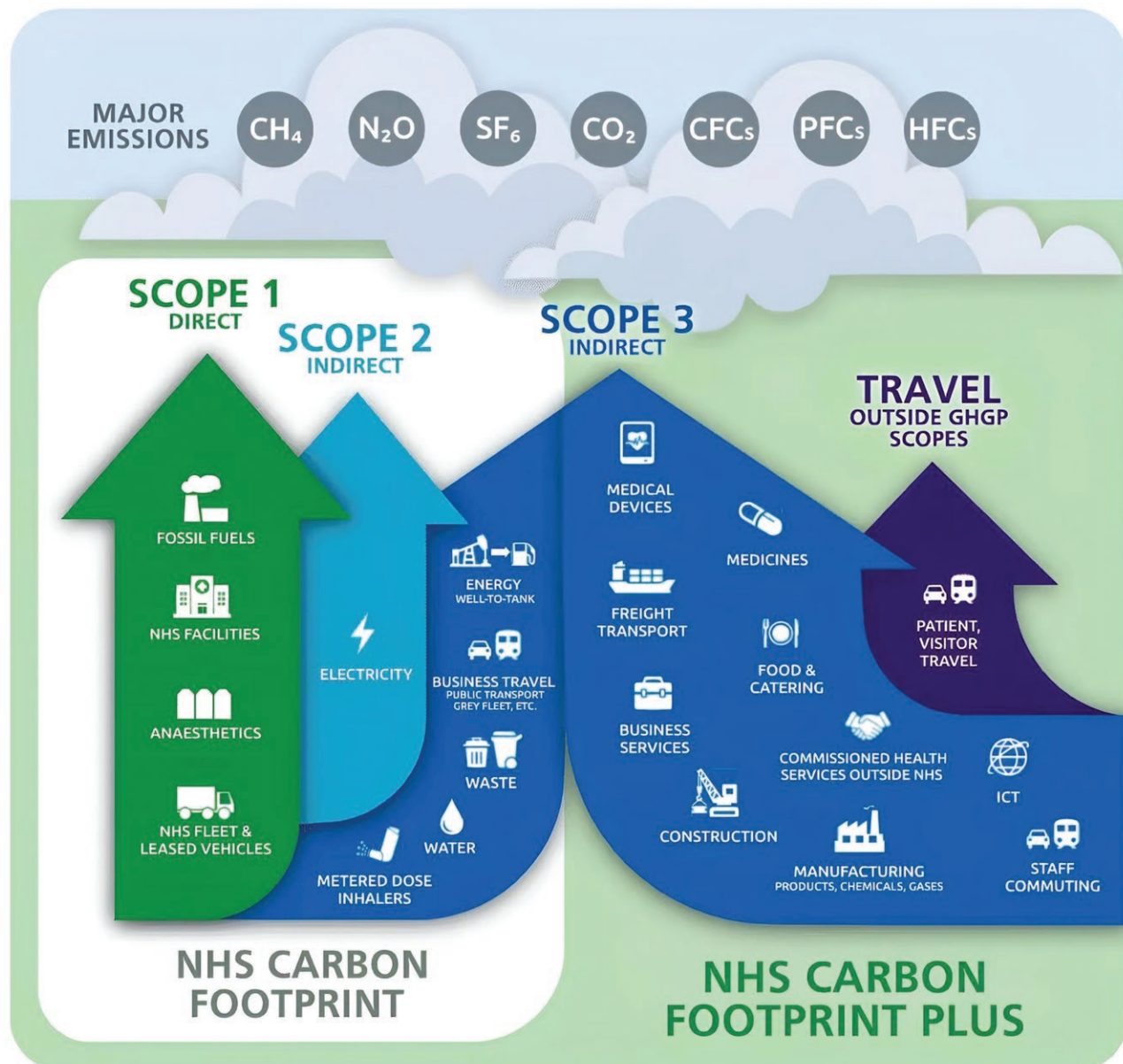
Despite limited data examining the carbon footprint or emissions profile of healthcare simulation education, there is benefit in reflecting on the work done in healthcare in general and adopting many of the solutions currently being implemented in healthcare organizations internationally [11].

Survey data of healthcare simulation centres confirm they are unlikely to have a formally documented sustainability plan (only 18.2% of respondents had one);

however, most have been found to strongly endorse reusing simulation equipment (96.1%) and include education on sustainable practice (51.7%). Only 42.9% endorsed a policy of environmentally preferable purchasing and only 40% had programs in place for recycling [12].

Opportunities to reduce Scope 1 and 2 emissions in healthcare simulation education

Scope 1 and 2 emissions are largely related to stationary energy use – building electricity, heating and hot water – as well as fleet vehicles. The most efficient way to reduce Scope 1 and 2 emissions is to switch to a renewable electricity provider. If your institution has separate gas-fired heating and hot water this will be a significant project to undertake in conjunction with your facilities team to explore converting to electric heat pumps. As energy supply goes hand in hand with energy efficiency, it is important to ensure the institution has converted to LED lightbulbs, switched out ageing electrical apparatus, and ensured areas and equipment are powered down when out of hours or not in use. Significant steps are being taken in healthcare delivery to reduce Scope 1 and 2 emissions. For example, in Victoria, Australia, the state government has committed to 100% renewable electricity supply for public hospitals from 2025 [13] and that all hospitals built from 2024 will be fossil-fuel free [14].

Figure 2: Scope 1, 2 and 3 emissions in the NHS [11]

Opportunities to reduce Scope 3 emissions in simulation education

Given the nature of simulation is to emulate real-world scenarios, scope 3 emissions are likely a significant source of the carbon footprint of simulation education, particularly in simulation of practical or procedural skills.

The most effective way of limiting the Scope 3 emissions associated with simulation education will be to move away from single-use plastic models and equipment. The carbon footprint of many surgical/medical items is largely related to the raw materials and manufacture, with waste disposal responsible for only 5–15% of the carbon footprint [10]. Therefore, although recycling is important, the most effective approach is to reduce the number of single-use items and move to reusable versions wherever possible. Examples from surgery are widespread with reusable sterile gowns having a carbon footprint that is only 35% of the carbon footprint of a disposable gown [15] (including emissions associated with resterilization) and reusable

surgical instruments having a carbon footprint of only 25% of the disposable version [16].

Digital solutions, such as augmented reality and virtual reality (AR/VR), may have a role in improving the environmental sustainability of simulation education. Evidence of their effectiveness in surgical training is mounting [17]. Integrating these technologies into medical and surgical education may help reduce plastic waste by providing realistic, immersive training environments that do not require physical models or consumables. These technologies can simulate complex procedures and anatomical structures without generating plastic waste, contributing to a more sustainable educational approach. These technologies may also enable complex simulation-based education delivery in local environments reducing the need for participants to travel, thus reducing travel-related emissions. However, this equipment is expensive to acquire and maintain, augmented reality solutions in particular still require consumables, and although it remains challenging

to accurately calculate, digital solutions also have a carbon footprint that requires further exploration and consideration [18].

The role of industry

Partnering with industry to facilitate delivery of more sustainable high-quality simulation education will be important. Companies, such as Laerdal, have shown a commitment to reduce the environmental impact of their products – aiming for a 70% reduction in their carbon footprint (including Scopes 1, 2 and 3) by 2030 [19]. As we move towards a circular economy in healthcare simulation, it is through partnership and innovation that carbon neutral and reusable versions of simulation equipment can be developed and produced followed by reprocessing or repurposing at the end of their use. Preferential procurement from companies with more sustainable products should become part of organizational decision-making. The NHS Net Zero Supplier Roadmap [20] provides a blueprint for any organization to integrate into their procurement policies and is an excellent example of how healthcare organizations are demanding action from the general medical supply industry.

The contribution of simulation to improving environmental sustainability in healthcare

It is important to recognize the role that simulation education can play in reducing the carbon footprint of healthcare delivery more broadly. First and foremost, it is through high-quality education and training that we improve healthcare delivery, patient outcomes, and avoid the human, financial and carbon cost of complications. A low-carbon health system is a system that provides the right care at the right time in the right place and ensures the best outcomes for our patients [21].

Research opportunities

Given the paucity of data in this field there are clear opportunities for research that explores the carbon footprint of simulation education in healthcare using life cycle assessment techniques such as have been performed in healthcare delivery [22] to help identify carbon 'hot spots' that can be targeted to reduce emissions. Similarly, case studies on successful initiatives to reduce waste, introduce reusable versions of equipment and improve recycling will prove valuable to provide guidance to other simulation educators and facilitate broad adoption of successful initiatives.

Conclusion

Although specific data on the carbon footprint of simulation education in healthcare are not available, it likely has a similar emissions profile to that of healthcare delivery. Many strategies devised to reduce the carbon footprint of healthcare delivery are highly applicable to simulation with unique opportunities for the simulation community to reduce our reliance on single-use items, embrace new technology and work collaboratively with health services to design safer, environmentally sustainable models of

care to ensure the best outcomes for both our patients and our planet.

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