

Simple Green Changes for Anesthesia Practices to Make a Difference

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Abstract

The environmental debate on going green in the operating room (OR) has been a controversial topic for many years. Challengers of greening efforts cite various obstacles and arguments against these initiatives. However, ORs in the United States continue to generate a staggering amount of waste daily. In this article, we review major barriers to going green and highlight simple, yet effective greening strategies that anesthesia practices could adopt to reduce our carbon footprint.

Keywords: Green; Environment; Operating Room; Anesthesia; Greenhouse Gases

Introduction

Going green is a broad term that refers to the attempt to embrace practices that are ecologically sustainable and environmentally friendly. The goal is to preserve natural resources and protect the environment for future generations.

The environmental impact of gas emissions and material waste generated in operating rooms (ORs) are externalized costs of health care delivery. An estimated 40 - 70% of U.S. hospital waste is generated from the OR and labor and delivery (L&D) suites [1,2]. Of these wastes, anesthesia care contributes to 25% of material wastes [3] and inhalation anesthetics are estimated to contribute to 50% of surgical gas emissions [4]. While large structural changes are difficult to make in a health care system, many studies have shown that each anesthesia group and its members can adopt changes to the benefit of not just the environment, but for hospital finances and patient safety.

Reducing emissions

Inhaled anesthetic agents are potent greenhouse gases. As more people have access to healthcare, use of inhaled anesthetics has significantly increased. Inhaled anesthetics undergo minimal metabolism after administration. Instead, they become exhaled gases that are subsequently vented from hospital scavenging systems. With less than 5% of halogenated anesthetics metabolized by the patient, these gases enter the atmosphere directly and exert their effect as greenhouse gases (GHG), thereby contributing to ozone depletion [5,6]. Sevoflurane, isoflurane, desflurane and nitrous oxide are estimated to exert their atmospheric effect as GHG for 1.1, 3.2, 14 - 21 and 114 years, respectively, before they undergo degradation [7,8]. In 2010, Sulbaek Andersen, *et al.* estimated that yearly global emission from inhaled anesthetics is equivalent to gas emissions by 1 million passenger cars [9].

Global warming potential (GWP) of a gas is defined as the contribution of emission of one unit of that gas relative to the reference gas, usually carbon dioxide, which is assigned a value of 1. The GWP of inhalation anesthetics has been studied and further supports the fact that desflurane has a greater global warming impact than isoflurane or sevoflurane [6]. However, it is interesting to note that use of 60% nitrous oxide/40% oxygen with isoflurane or sevoflurane, to deliver a minimum alveolar concentration (MAC) of 1, results in higher GWP values than sevoflurane and isoflurane alone. Conversely, GWP for desflurane (when combined with nitrous oxide) is lower [10]. This study underscores the longer-lasting negative impact of nitrous oxide compared to halogenated anesthetics on the environment and demonstrates that nitrous combined with sevoflurane and isoflurane may not be a reasonable substitute for desflurane from an environmental standpoint.

There are crucial health benefits from the reduction of GHG emissions. According to the World Health Organization, evolving climate change is a threat to the global public health community [11]. The incidence of cardiovascular and respiratory disease is on the rise as a result of heat waves and increased air pollutants. The adverse health effects of heat waves are well-documented. Extremes in heat have been associated with increased pulmonary and cardiovascular events, as documented by increased emergency department visits for cardiopulmonary diseases such as asthma, myocardial infarctions, and cardiac failure [12-14]. In addition to established effects on climate, increasing concentrations of air pollutants have also been associated with adverse respiratory and cardiovascular health effects [12,15-17]. Infectious diseases are also becoming harder to control, as basic health requirements, such as clean water and air, are becoming increasingly compromised [18].

To reduce GHG emissions, studies recommend:

1. Utilize low fresh gas flow (FGF) rates (usually ≤ 1 L/min)
2. Avoid routine use of high impact agents like desflurane and nitrous oxide
3. Consider regional and intravenous techniques [4,19,20].

In addition to reducing emissions, low FGF rates has also been established as an area where OR cost reduction can be readily achieved [20,21]. Through education and increased awareness of adverse effects of inhaled anesthetics on the environment, seven hospitals from British Columbia (Canada) changed their daily practice, resulting in a 66% reduction of GHG emissions over a four-year period. This was accomplished through a decreased use of desflurane and a corresponding increased use of sevoflurane. Consequently, a reduction in use of desflurane results in a significant reduction in the environmental impact of inhaled anesthetics [22].

Another way to reduce the environmental impact of inhaled anesthetics is through use of total intravenous anesthesia (TIVA). TIVA avoids the use of inhaled agents and eliminates the GHG emissions of inhaled anesthetics [23]. Unlike inhaled anesthetics, the GHG impacts of propofol are relatively minimal and are estimated to be four orders of magnitude lower than those of desflurane and nitrous oxide [24].

Reducing material waste and costs

The field of anesthesiology depends heavily on medical devices. Hospitals have different criteria for the selection and purchase of equipment depending on cost, patient safety, efficacy, ease of use, and environmental considerations. Single-use disposable (SUD) medical devices are becoming increasingly popular across the country, mainly due to perceived reduction in cost and increased patient safety. However, recent studies showed benefit of reusable devices such as laryngeal mask airways (LMAs) and laryngoscope blades without increasing infection risks [25-27].

Life cycle assessment (LCA) is a tool used to evaluate medical devices along many dimensions and throughout a product's entire life cycle. These studies an analysis of environmental and human health (HH) impacts. A study by Eckelman., *et al.* showed that reusable LMAs

had less of a life cycle impact in all 10 categories compared to that of disposable LMAs. Compared with the 100% environmental and HH impact of disposable LMAs, reusable LMAs had a comparative impact of over 60% on global warming, 20% on acidification, 90% on eutrophication, 20% on ecotoxicity, 40% on smog, 40% on water intake, 20% on ozone depletion, approximately 5% on HH cancer, < 10% on HH noncancer, and > 20% on HH air pollutants [28].

Disposable LMAs are also perceived to be more harmful because they are produced mainly from polyvinyl chloride (PVC) plastic and 40% diethyl-hexyl phthalate (DEHP). DEHP is a compound added to impart flexibility to PVC-based products in intravenous bags, tubing and endotracheal tubes. The Environmental Protection Agency labeled DEHP as a probable carcinogen and possible endocrine disrupter, and in 2012 the Federal Drug Agency recommended alternatives for infants, toddlers, and pregnant and lactating women [29]. In contrast, reusable LMAs, produced mainly from silicone, generally do not have PVC or DEHP [28]. Eckelman's study also showed that disposable LMAs are comparatively more costly (by \$1.60) than fully utilized reusable LMAs [28].

Disposable laryngoscope handles and blades have generally been perceived to be less costly with a superior patient safety profile due to less cross contamination. A life cycle assessment and cost study by Sherman, *et al.* showed that reusable handles and blades have a clear benefit over single-use disposable (SUD) laryngoscopes [30]. The use of reusable stainless-steel handles treated to high level disinfection (HLD) standards have the lowest impact on GHG emissions. Single-use plastic handles not only incur health risks due to PVC content, but also generate approximately 25 times more GHG emissions than metal reusable handles treated with HLD. Sherman's study estimated that reusable handles are more cost effective despite costs of labor and sterilization. Reusable handles were found to have a decreased cost of \$7 - \$10 per use compared to SUD handles. With over 60,000 intubations at Yale New Haven Hospital, Sherman, *et al.* estimated an overall increased cost of \$495,000 - \$604,000 and \$180,000 - \$265,000 due to use of SUD laryngoscope handles and SUD laryngoscope blades respectively [30].

Interestingly, due to a lack of consensus and clarification over risk classification of laryngoscope handle and blade for sterilization purposes, some hospitals have chosen to err on the side of safety with high level decontamination or eliminating the need for sterilization altogether by adopting SUD laryngoscopes [31]. This highlights a need for re-evaluation and assessment of existing institutional sterilization procedures. Factors that must be considered include current data, cost, and environmental impacts when making these decisions.

Due to a lack of emphasis on reduction of waste, reuse and recycling, ORs are responsible for 20 - 30% of total hospital waste [32]. The importance of proper waste separation is evident when considering the costs associated with disposal. Hazardous and Regulated Medical Waste (RMW) make up only 24% of medical waste but accounts for 86% of costs associated with disposal [1]. Costs for RMW disposal can be as much as 500% higher than for non-infectious waste [19]. Reducing the volume of RMW and the amount of improperly discarded non-infectious waste can lead to substantial dollar and environmental savings. To achieve these savings, hospitals have had success implementing simple strategies [1]:

1. Closing waste bins before a patient enters the OR since most of recyclable waste is generated before a case starts.
2. Educating OR staff.
3. Mounting posters to serve as reminders of appropriate "red bag waste" items.

In addition, changes can be implemented to reduce packaging costs financially and environmentally. The sterile blue polypropylene instrument wrap used to cover surgical instruments contributes 19% of the total waste from ORs and is associated with substantial disposal costs. Some hospitals, like the MetroWest in Massachusetts switched to reusable hard metal cases eliminating > 5,000 pounds of blue wrap waste with a saving of \$29,843 [33]. Furthermore, the reprocessing and reselling of SUDs, such as, pulse oximeter probes, blood pressure cuffs, through reprocessing companies is an additional means for hospitals to further reduce cost and medical waste [19,34].

Conclusion

Awareness is the first step towards meaningful change. With understanding and acceptance of the need for change, anesthesia groups can implement many of these greening strategies and initiatives. For instance, an easy turn of a vaporizer dial and flowmeter can have sustained negative environmental effects lasting more than 100 years. Additionally, given global supply chain issues brought to light with the COVID-19 pandemic [35,36], one should not depend on perpetual supplies of disposable equipment, material and drugs. By adopting conscious and informed effort towards resiliency, sustainability, recycling and reusing of resources, hospital administrators, physicians and staff can benefit the environment and finances without compromising patient safety.

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