VIEWPOINT

Green Operating Room—Current Standards and Insights From a Large North American Medical Center

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Climate change poses an imminent threat to environmental and public health. Despite recent efforts to decrease our carbon footprint, the United States remains one of the highest contributors to this problem, ranking second in greenhouse gas emissions and energy usage worldwide.[1,2] Health care alone accounts for nearly 10% of this energy expenditure.[2] Within hospitals, operating rooms (ORs) produce a disproportionate amount of greenhouse gases and disposable waste and consume an inordinate amount of energy. Recent studies attribute more than 30% of hospital medical waste to ORs and estimate their energy intensity, defined by amount of energy used per occupied space, to be 3 to 6 times that of a hospital in its entirety.[3,4]

While other industries are trending downward in both emissions and spending, health care has noticeably lagged.[1] Although nationwide standards for energy consumption and waste management have been set by the Centers for Disease Control and Prevention as well as private organizations, improvements to these standards have been sparse and inconsistent. Critical assessment of existent steps toward more sustainable health care may help create an informed, reproducible model for future policies and investments. Here we seek to describe current initiatives from the literature and the University of Pittsburgh Medical Center (UPMC) related to energy consumption and waste management.

Energy Consumption

Health care facilities in the United States consume 2 to 3 times more energy per square meter than other commercial buildings.[2] Major components of this, including space heating, ventilation, water heating, and cooling, can be reduced with energy-efficient technology and infrastructure designs. Even seemingly simple systemic efforts like using LED lights as opposed to standard halogen lamps have been found to reduce direct energy consumption by 49%.[3] Similarly initiating "power-saving" mode in ORs may have a major ecologic and economic effect. One study found turning off anesthesia and electronic equipment in 35 ORs during unoccupied hours saved approximately $33 000 a year and reduced annual carbon dioxide emissions by 234.3 metric tons.[5] Another study indicated that shutting down heating, ventilation, and air conditioning systems during idle hours led to an estimated annual savings of $6105 per OR.[6] Importantly, this study also found particle and microbial counts remained at a safe level following this measure if adequate ventilation was restarted within 30 minutes.[6] In addition to following nationwide standards for energy consumption, UPMC has initiated power-saving modes in ORs, automatically shutting down ventilation and lighting when the OR is not in use.

Anesthetic Gas

Anesthesia contributes significantly to pollution and energy costs associated with OR air. Inhaled anesthetic agents, including nitrous oxide and halogenated vapors, are recognized deleterious greenhouse gases. Minimizing anesthetic gas release from closed loop anesthesia machines and patient airways remains a major focus for the American Society of Anesthesiologists. Their article "Greening the Operating Room" cautions clinicians against using anesthetic gases that are most harmful to the environment, such as desflurane, and describes methods to decrease the environmental impact of these gases.[7] The former is corroborated by a study that found using desflurane for 1 hour is equivalent to 235 to 470 miles of driving in terms of environmental impact.[8,9] The latter includes minimizing fresh gas flow during maintenance of anesthesia, turning off fresh gas flow during intubation, and adjusting the vaporizer to increase the concentration of anesthetic gas delivery with lower fresh gas flow. These measures must be balanced with adequate anesthetic effect and safe patient care. Recent industry-based initiatives such as the Dynamic Gas Scavenging System and Deltasorb work to collect and reuse up to 99% of anesthetic gases.[8] At UPMC surgery centers, clinicians are strongly encouraged to follow American Society of Anesthesiologists guidelines for reducing anesthetic gas use, while building codes and maintenance staff ensure proper upkeep of anesthetic gas delivery systems and ventilation systems.

Waste Management

Waste management is an essential responsibility of all hospitals. Efforts toward green management of OR waste can be broadly classified into decreasing the amount of OR waste and properly classifying OR waste into general (noncontaminated) waste or regulated medical waste (RMW), which must be processed via sterilization, incineration, or both before safe disposal. Up to 75% of supplies used in the OR are recyclable, largely consisting of items such as blue OR towels, polypropylene wrap, sterile plastic containers, oxygen masks and tubing, and plastic bottles.[3] Single-use devices also account for a significant portion of OR waste. Initiatives to reuse and recycle such devices as laparoscopic instruments, blood pressure cuffs, staplers, external fixators, cautery, burrs, and saw blades can potentially save the US health care system $150 million annually, while maintaining efficacy and greatly reducing ecological impact.[3,5] Collaborations with medical technology or recycling companies can facilitate these processes. Simple measures to promote properly classifying OR waste can also have significant effects. For example, Wormer et al[5] described an education-based initiative that resulted in

a 75% decrease in RMW and an annual $60 000 in savings. They also found that switching to reusable gel padding instead of foam pads saves nearly $50 000 annually.[5]

Increased RMW leads to increased processing costs and increased release of pollutants; nevertheless, an estimated 50% to 85% of noncontaminated waste is improperly discarded as RMW.[3] A study from UPMC found that closing all RMW wastebins before the patient enters the OR and disposing anesthesia-related waste in standard wastebins could provide a potential annual reduction of 13 800 kg of RMW.[10] Other methods used by UPMC include recycling, whereby single-use items are sterilized and reused, and reprocessing, whereby opened, unused items are shipped to other countries for use, to reduce waste production. Furthermore, UPMC autoclaves all RMW in house before sending the waste to a landfill for permanent disposal. This process theoretically reduces the environmental impact of RMW by decreasing the energy required to transport this waste from hospital to intermediary and finally to the landfill. However, the quantitative economic and ecologic benefits of this method have not been elucidated.

Future Directions

As highlighted throughout this Viewpoint, numerous groups have sought to push the health industry forward in the OR by reducing energy consumption, reducing waste production, and recycling or reprocessing more single-use items. Seemingly simple measures can have dramatic effects. Likely the easiest changes to implement include individual institution-level cultural changes such as switching halogen lights to LED lights, educating employees on proper waste disposal, and decreasing waste overall, as well as ensuring that anesthesia professionals are conscientious of safe but eco-friendly anesthetic gas use. The next tier of green changes (in difficulty of implementation and in effect) may include corporate partnerships between hospitals and companies that reprocess single-use items or capture and recycle anesthetic gases. As data on the ecologic and economic benefit of these changes become more widely reported, arguably the most wide-reaching effect may come from surgical and medical societies (such as the American Medical Association) lobbying for government-implemented regulations or policies that promote green changes within the health industry.

While the specific future policies are debatable, tax deductions such as those in the Energy Policy Act of 2005 and the Department of Health and Human Services 2021 Climate Action Plan provide examples of the role government may play in this process. Ultimately, climate change is an urgent issue that requires a concerted, systemic effort in which the health care industry's contribution has been lacking. We hope this Viewpoint both highlights avenues for improvement and inspires active change within the OR and industry overall.

ARTICLE INFORMATION

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