Greening of Orthopedic Surgery

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abstract

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Every year, 4 billion pounds of waste are produced by health care facilities, and the amount continues to increase annually. In response, a movement toward greening health care has been building, with a particular focus on the operating room. Between 20% and 70% of health care waste originates from a hospital’s operating room, and up to 90% of operating room waste is improperly sorted and sent for costly and unnecessary hazardous waste processing. Recent successful changes include segregation of hospital waste, substitution of the ubiquitous polypropylene plastic wrap used for the sterilization and handling of surgical equipment with metal cases, and the reintroduction of reusable surgical gowns. Orthopedic-related changes include the successful reprocessing and reuse of external fixators, shavers, blades, burs, and tourniquets. These changes have been shown to be environmentally and economically beneficial. Early review indicates that these changes are feasible, but a need exists for further evaluation of the effect on the operating room and flow of the surgical procedure and of the risks to the surgeons and operating room staff. Other key considerations are the effects of reprocessed and reused equipment on patient care and outcome and the role of surgeons in helping patients make informed decisions regarding surgical care. The goals of this study were to summarize the amount and types of waste produced in hospitals and operating rooms, highlight the methods of disposal used, review disposal methods that have been developed to reduce waste and improve recycling, and explore future developments in greening health care.

Figure: At the authors’ institution, operating room waste is bagged in red regulated waste bags (A). They are separated and deposited in a hazardous waste bin (B).
Health care facilities in the United States produce 4 billion pounds of waste each year, and up to 70% of hospital waste comes directly from the operating room. Although the topic of the environment is not commonly visited among surgeons, it is of increasing importance to the communities that they serve and to the medical centers that they work for and with. A movement toward greening health care has been building. Individual hospital-based initiatives have been reported over the past decade, with strategies that have successfully reduced medical waste and operating cost. More recently, Practice Greenhealth, a nonprofit organization, formally launched an initiative to “identify strategies to reduce the environmental footprint of the operating room” in 2010. The organization has drawn from previous individual hospital successes to formulate recommendations and is identifying partnering medical institutions and awarding those that make substantial improvements.

Although one could attribute the health care system’s green movement to concerns about the environment, global warming, and the finite quantities of resources, in the end it is about an individual hospital’s bottom line. Reducing a hospital’s environmental footprint is not only positive for public relations, but it has also been shown to be an achievable goal that is economically sound. Although an orthopedic surgeon’s personal contribution to hospital waste is not likely to be a measured performance factor, surgeons need to be informed about the movement occurring around them and the green initiatives in the pipelines.

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How Much Garbage?

The 4 billion pounds of waste that the United States health care system produces annually equates to 6600 tons daily. This substantial amount is second only to that produced by the food industry, and the amount of waste production continues to increase at a rate of at least 15% each year since 1992, in part because of a trend toward using more disposable items. In terms of the operating room, estimates vary widely on waste production, depending on the institution and the surgical emphasis of the facility. Numbers range from 20% to 70% of total production, which translates to between 800,000 and 2.8 billion pounds of trash annually.

It is important to note that not all waste is created equal. Waste is divided into 2 main categories: general and regulated. This distinction is important for determining what constitutes proper waste disposal and what that disposal will cost. General waste is equivalent to most everyday household waste. It is by definition not hazardous or contaminated, and it does not require special processing or disposal. General waste is transported as is to a landfill. However, regulated waste poses a potential health hazard. These materials are generally infectious, sharps, pharmaceuticals, or radioactive materials, and they require special processing and disposal. In the past, all operating room waste was treated as regulated (ie, potentially clean waste was not segregated from that which was contaminated with blood or other bodily fluids) (Figure 1). In terms of disposal, currently 60% of regulated waste is incinerated. Close monitoring is necessary to minimize the release of toxic pollutants and heavy metals into the air. The remainder of the waste is steam sterilized, autoclaved, microwaved, or handled with various other mechanical and chemical methods (Figure 2). The additional
processing of regulated waste adds substantially to hospitals’ annual expenditures and costs, on average, 10 to 20 times more than that of general waste.8

The additional processing and the associated costs have been found to be unnecessary in many instances. Studies have reported that approximately 90% of operating room waste is improperly sorted11 and that almost 30% of operating room waste comprises packaging materials from instrumentation and supplies.13 The concern is the potential mixing of clean packaging with bloody and infectious material that hinders proper sorting of operating room waste.

With health care reimbursement shrinking and hospitals’ drive to continually cut costs, the large volume of operating room waste and the potential for savings may motivate hospitals to reform and refine how operating rooms operate.

SUCCESSFUL CHANGES

Even before the recent initiative by Practice Greenhealth,7 isolated reports existed of hospitals successfully making environmentally friendly changes that were also cost efficient.4,5

One approach was to separate general waste from the regulated waste stream.4 This hospital noted that 73% of its incinerator-bound waste was produced in the operating room but that not all of this waste met the federal guidelines of being visibly soiled, dripping, or caked with blood or bodily fluids.9 By isolating everything produced before the patient entered the operating room, they were able to easily siphon a portion of the clean waste generated in the operating room and separate it from operating room waste that would later be appropriately designated as regulated.9 By doing so, they reduced regulated annual waste output by 50%,4 showing that a simple step change in waste management can significantly reduce regulated waste.

The blue polypropylene plastic wrap that is ubiquitous in operating rooms is another large contributor to operating room waste. Its sole purpose is for the sterile processing and storage of surgical equipment, a function also served by hard surgical instrument cases. One hospital reduced its consumption of blue wrap by 5 tons annually by switching to hard surgical cases.5 Although there was an initial $35,000 investment for the instruments, it was estimated that use of blue wrap was reduced 70%.5 Based on the hospital’s previous year’s blue wrap expenses of $35,000, approximately $25,000 was saved the first year. In addition, the central processing department estimated that previously, the blue polypropylene plastic wrap failed 5 to 10 times per week, contaminating the sterilized instrumentation and requiring reprocessing of the instruments at cost of an additional $100 each time. With a conservative estimate of 5 failures per week, avoiding the reprocessing cost would result in an estimated $26,000 in savings. Furthermore, the actual blue polypropylene plastic wrap, which is disposed of along with other regulated operating room waste, is reduced. The estimated savings of $51,000 annually, in addition to the reduction in regulated waste tonnage, would easily cover the initial investment in the instrument cases.5 The replacement of blue polypropylene plastic wrap with hard surgical instrument cases is an environmentally and economically friendly solution.

Reusable surgical gowns were once preferred by many hospitals, but regulations and the increasing use of disposal gowns made self-reprocessing of reusable gowns cost prohibitive. Surgical gowns are used in every surgical case during initial instrumentation setup and during the surgical procedure. These gowns are crucial to maintaining a sterile environment and providing protection for the surgical team. The disposable version is a contributor to the regulated waste stream. However, renewed interest in greening the hospital has...
prompted facilities to reintroduce reusable gowns. Hospitals have found new methods and third-party groups to make reprocessing gowns cost efficient. One hospital found that it reduced waste by 50,000 pounds annually and achieved annual savings of $60,000 by switching back to reusable surgical gowns. Reintroducing reusable surgical gowns has proven to make both economical and environmental sense.

Other hospital-based changes involved recycling plastic and batteries. Use of plastic intravenous solution bags is widespread, making up a large proportion (up to 20% to 25%) of hospital waste. Theoretically, there is a savings from recycling these plastics, and I hospital has studied its potential, although it has not yet reported successful implementation of this recycling effort. Another widespread contributor to hospital waste is disposable batteries, which power countless devices in the hospital as well as operating room equipment. One hospital system aimed to reduce the batteries in its medical waste system and reduce metal emissions; with their program of consolidating and recycling batteries, they have estimated that a reduction of 10 tons of batteries is possible.

Reprocessing and reusing surgical equipment, the external fixator in particular, has been trialed and debated for many years. In the 1980s, as external fixation was regaining popularity, there was debate about whether reprocessed external fixators provided the same mechanical properties. Because implant manufacturers would not accept liability for constructs consisting of components reprocessed by third parties, despite the potential cost savings, hospitals were reluctant assume the additional liability, and reuse of the external fixator did not gain widespread popularity. However, more recently, implant manufacturers have begun offering a reprocessing service and guaranteeing the reuse of their own devices. A randomized study in a trauma center showed that reused external fixator clamps performed no differently than new clamps. The potential cost savings was 25% the cost of new frames or, at this institution, $65,452. This environmentally friendly change is not only cost efficient but has also been shown to have no effect on patient care outcomes. The increasing acceptance of reprocessed instrumentation has spurred the offering of other devices. Arthroscopic shavers and wands, pneumatic tourniquets, saw blades, and burs are among the items offered. Great green potential exists in reprocessing surgical devices and instrumentation, as the most environmentally beneficial portion of the adage “recycle, reduce, and reuse” is reuse.

On the Horizon

With the organized “Greening the OR” movement spearheaded by the nonprofit Practice Greenhealth group, orthopedic surgeons can anticipate more uniform changes for the operating room. Many of these changes will be outside the orthopedic surgeons’ direct management and will minimally affect the flow and function of the operating room, such as alterations in instrumentation setup, changes in medical device reprocessing, and increasing the use of hard cases for surgical instruments—changes that will occur before and between surgical procedures. At most, turnover time may be minimally affected, and time may be saved by avoiding the failures of blue polypropylene plastic wrap. During the anesthesia-directed portion of the case, waste anesthetic gas capture and reclamation will be the priority of those on the other side of the sterile barrier. During the procedure, adjusting heating, ventilation, and air conditioning control schedules for energy efficiency and transitioning to light-emitting diode lighting for energy efficiency may somewhat influence surgeon and patient comfort, but, again, the overall effect will be minimal. At the conclusion of the surgical procedure, new technologies in fluid waste management and medical equipment donation and recovery will influence clean-up and turnover time.

However, some changes will directly affect orthopedic surgeons and may influence patient care. The first involves surgical instrumentation and the contents of the operating room kits. Practice Greenhealth recommends that instrumentation kits be reformulated to minimize unused equipment, with an eventual goal of having only the key instrumentation opened for each case. However, without proper surgeon and staff input, this change could be self-defeating. Needed instrumentation may be removed from sets, which could lead to intraoperative opening of additional separate kits in search of needed instrumentation. Inadequately reformulated instrumentation kits can potentially add to procedure length, result in case delays, and increase the amount of equipment left to reprocess. Proper participation of orthopedic surgeons in the decision-making process is necessary.

Second, regulated medical waste segregation and medical plastics recycling will be an added element in the operating room. The surgical team, surgical technicians, and circulating nursing staff will all have an added responsibility to make efficient waste segregation and recycling work. Although at least one report exists of successful implementation of a program, none have examined in depth the effect of the changes in the flow of the operating room itself. Previous efforts have also been limited because of concern over the risk of infection to the staff and contamination potential of general waste stream. However, a previous effort has also shown a substantial cost savings when a hospital can overcome the issues surrounding waste segregation. This process will be the responsibility of all staff before, during, and after procedures.

Third, the reintroduction of reusable surgical linens will directly affect how the surgeon is protected, how the surgical field is draped, and how the patient is protected from infection. Of primary concern is the ability of the cloth gown to remain impermeable and protect the surgical team from infectious and bloody fluids. Additional studies are needed to determine how durable reusable gowns are with ongoing use.
and reprocessing. A key will be the recognition of when the resterilizable linens eventually need replacement, ideally by the reprocessing team during the reprocessing process, rather than by the surgical team during or after a surgical procedure.

Lastly, as reprocessing and reuse of surgical equipment gains a foothold, the surgeon will be confronted with a new set of patient care issues. Although studies suggest that reuse of external fixators can proceed without increased complications, it is important to note the patient’s perspective. In one study, 65% of patients declined participation to avoid the potential of being treated with reprocessed equipment. As always, the role of the surgeon should be to advocate for and educate the patient, enabling each to make informed decisions regarding his or her care. In the operating room, the surgeon will play a role as the final evaluator of reprocessed equipment.

Studies of external fixators have found mechanical wear and fatigue after a single application, which should limit the number of potential reuses. As with new equipment, the surgeon will perform the last quality check in recognizing when equipment, previously inspected by the hospital, a third party, or the original manufacturer, is unsuitable for continued use. With the acceptance of reprocessed instrumentation spurring the offering of other devices, prudence should be used when adopting newly reusable devices. Studies on reprocessed arthroscopy shavers have found detectable levels of contamination, and mechanical damage and blade wear resulting in rougher cuts. Whether these laboratory studies affect clinical practice is yet unknown, but as with many reprocessed items, additional study is required before widespread use should be adopted.

**Conclusion**

Although it is evident that greening the operating room is achievable and potentially cost efficient, reports have been sparse with regard to the effects of these changes on the flow of the operating room, patient care and satisfaction, and acceptance by the staff. Additional study in this area is needed and will be possible as more green changes are trialed in health care facilities around the country.

As the greening movement continues to gain momentum as the medical care system looks to trim costs, the authors recommend that the average orthopedic surgeon be made aware of the upcoming changes. Surgeons should be active participants in this movement, not merely bystanders. In that way, they will be able to continue to direct how their work environment operates under these new recommendations and to facilitate the transition to maintain operating room flow, surgeon and staff safety, and overall excellent patient care.

**REFERENCES**

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