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Managing barriers to recycling in the operating room

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ABSTRACT

Background: Among hospital staff, little is known concerning barriers to recycling and perception of waste in the operating room (OR), despite continued improvement in recycling programs. This study sought to identify barriers to OR recycling and implement a recycling improvement educational program. **Methods:** A survey was administered within Mayo Clinic at four campuses. Based on survey results, a recycling improvement program was devised and implemented at a surgery center in Paradise Valley, Arizona. A cost-savings analysis was performed thereafter.

Results: Of 524 participants, 56.7% reported being unclear which OR items are recyclable, and 47.7% thought the greatest barrier to recycling was lack of knowledge. After implementation of the recycling educational program, cost savings of 10.3% ($p = 0.004$) were achieved in sharps waste disposal when compared to the previous year at the surgery center.

Conclusions: Addressing barriers to recycling in the OR can significantly reduce waste and save valuable healthcare dollars.

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Introduction

Despite recent improvements in healthcare waste management, it is estimated that United States hospitals produce 6 billion tons of waste annually, with medical waste disposal costs projected to reach 3.2 billion USD in 2017.^{1,2} Healthcare waste production can be minimized in four ways: (1) source reduction (i.e. purchasing less wasteful supplies), (2) management and control measures that guide hospital product use, (3) waste segregation before disposal (i.e. waste groupings into general, infectious, radioactive, chemical/pharmaceutical and sharps), and (4) recycling or reuse of products.³ The operating room (OR) contributes approximately 20–33% to the total healthcare waste, which can be quite costly to dispose of.⁴ Although drastic improvements in sustainability have been made in other industries, such as food and transportation industries,⁵ a knowledge gap remains concerning barriers to reducing waste in

the operating room.

The lack of knowledge in proper waste segregation has been demonstrated in multiple studies. After an extensive literature review, Kwakye et al. found that up to 90% of “red-bag” waste does not meet criteria for “red-bag” waste.⁶ For instance, common items mistakenly disposed of in red bags are vent tubing, suction tubes, IV bags, foley bags, foley catheters, masks, casts and splints, urinals, and bedpans. Other authors found that of the regulated medical waste from ORs, which is the most costly to dispose of, up to 40% is packaging material.^{7,8} Further, one study showed minimal infectious waste cross-contamination of waste, and that 60% could be recycled with appropriate safeguards and training.⁹

Plastic accounts for at least 20% of medical waste, which is often disposed in landfills rather than recycled.¹⁰ Unlike many household plastic items, most medical plastic is not labeled with a recycling classification symbol. When surveying common medical items with plastic containers, the authors of this study found that only one fifth of items gathered had any form of recyclable identification. Surprisingly, products made of materials known to be recyclable in the home or commercial setting, are not labeled in the hospital setting. Some experts speculate that barriers to recycling plastics include concerns about infectious risks and reluctance to separate different plastics.¹¹ Despite these potential obstacles, improved

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recycling of plastics in the operating room may be an unrecognized and significant prospect for avoiding wasted healthcare dollars.^{12–15}

Many studies have demonstrated a significant reduction of OR waste through quality improvement initiatives, with particular focus on the proper separation of recyclable items such as plastic, paper and cardboard from general waste.^{16,17} Although prior literature suggests a clear benefit to recycling in the OR, no study to date has looked specifically at the potential cost savings of proper sharps disposal. Sharps disposal in particular offers a unique opportunity to avoid the most expensive waste produced in the operating room. Many syringes are made up of copolymers such as polypropylene and polyethylene that are readily recyclable if detached from the sharp. Compared to the disposal of sharps (\$2.00/lb), recyclables are 200 times cheaper to dispose of (\$0.01/lb). Proper separation of syringes and other medical sharps in the operating room could drastically reduce waste disposal costs over time, which may be especially true for physicians who produce a substantial amount of sharps waste during injections and minor procedures.

An Assessment of the attitudes of operating room staff towards recycling is crucial in addressing future improvements in OR recycling programs, and prior research has explored this topic. One such study found a significant correlation between hospital employees' personal beliefs on the importance of recycling with their waste management efforts.¹⁸ A large survey of anesthesiologists found that most participants support improved recycling initiatives, but cited negative staff attitudes as the second greatest barrier to reaching this goal.¹⁹ To date, no survey of the recycling attitudes of both physician & non-physician OR staff in the United States has been performed.

As a follow-up to the aforementioned research on the subject, our study sought to achieve two objectives: 1) delineate barriers, attitudes and behaviors to recycling in the OR environment and 2) determine if a recycling improvement program could reduce amount of sharps waste, thus decreasing the cost of its disposal and diverting waste from landfills.

Materials and methods

Recycling survey design

We created a 23-question survey of 21 closed response and 2 free response questions, we examined the attitudes of operating room personnel towards recycling in the operating room. The survey took approximately 5–10 min to complete. Six questions were related to demographic information, four elicited general waste practices at the respondent's hospital, and five were related to recycling volume. Four questions elicited attitudes toward barriers to recycling, with one question on Likert type scale of 5 points of potential improvements from most effective to least effective. Respondents were asked what they thought was the greatest barrier to recycling in operating rooms, which included handling of contaminated materials, lack of time, inconvenience, lack of knowledge, and lack of incentive. Additionally, three questions assessed attitudes toward the environment and personal recycling behaviors, with one question on the Likert scale of 4 points: *strongly agree*, *agree*, *disagree*, and *strongly disagree*.²⁰ Prospective approval was obtained via the International Review Board at the Mayo Clinic in Phoenix. Written informed consent was waived by the ethics committee, as consent was implied if the survey was returned. An anonymous web survey was developed using Survey Monkey (Portland, OR), and piloted with 20 participants to ensure administrative ease, clarity, timing, and order. The survey underwent clinical sensibility testing with 10 participants to evaluate interpretation, appropriateness, and redundancy (Fig. 1).

Survey Pilot Testing Flowchart

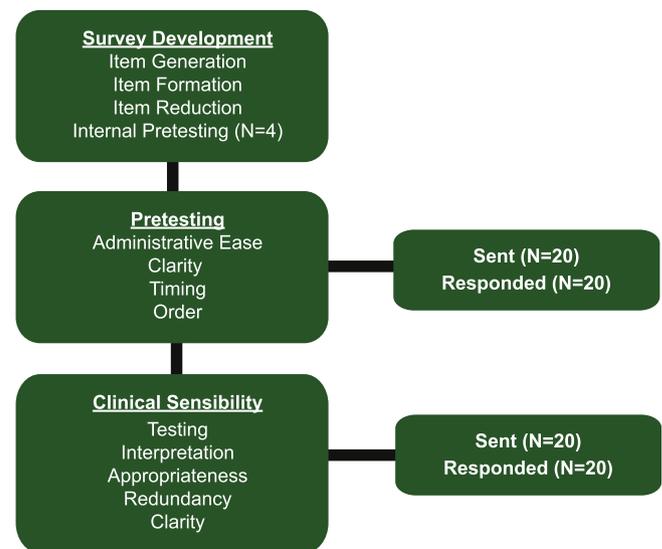


Fig. 1. Flowchart depicting the survey development and clinical sensibility testing algorithm used and response rate.

Subject recruitment

The survey was e-mailed to 1082 members of four Mayo Clinic campuses (Phoenix, Rochester, Eau Claire, Florida). Data was anonymous and subjects were permitted to opt-out of the survey if they desired. Inclusion criteria was to work as a surgical scrub technician, operating room nurse, physician's assistant, resident, fellow, anesthesiologist, or attending surgeon at participating hospitals. Patients or non-surgical hospital staff were not included. Exclusion criteria were defined as patients or non-surgical hospital staff.

Recycling improvement program

Following survey data collection, a recycling improvement program was implemented in a cosmetic surgery center with three operating rooms in Paradise Valley, Arizona. An education module was delivered to the operating room staff at this facility, addressing cost-effective OR waste disposal and safe handling of sharps. Signs describing proper disposal of sharps were created and placed on each sharps containers in the operating rooms. No new sharps containers were purchased for this intervention. The surgery center had completely independent staff and was purposefully chosen for the recycling improvement program in order to prevent survey respondents from participating in the recycling improvement program, reduce bias and prevent any influence from the survey implementation phase of the study.

Data analysis

Sharps disposal weight and its cost were measured prior to the implementation of the recycling program. The cost of sharps disposal at this clinic's three ORs was tracked over 10 months, 5 days per week. Cost savings were calculated from the difference between average monthly cost of sharps waste per pound pre-intervention and average monthly cost of sharps waste per pound post-intervention. A Student t-test was performed to assess for statistical significance using SAS JMP Pro 13.

Results

Recycling survey

Out of 1082 OR personnel recruited for the survey, 524 (48%) responded. The highest response rate was 62% (256/415) from Mayo Clinic Arizona. The majority of participants were staff of the Mayo Clinic in Arizona (62.8%), female (70.4%), aged 40 or older (60.2%), had an Associate's or Bachelor's degree as the highest level of education (54.7%), and have been in their current position for 6 years or longer (59.6%) (Fig. 2). Nearly half of respondents stated that they recycle less than 25% of generated operating room waste (Fig. 3). According to the survey, 56.7% of participants responded that it is unclear which items are recyclable, and 39.1% of participants reported that they never recycle or only sometimes recycle in the OR. When asked what the greatest barrier to recycling was, the greatest responses were (1) lack of knowledge of recyclable materials (47.7%) and (2) handling of contaminated materials (16.8%). Inconvenient bin location, lack of incentive, lack of time, and other were each thought by < 8% of respondents to be the greatest barrier to recycling (Fig. 4). Many respondents stated that proper training and labeling of recyclable materials would be most effective in improving operating room waste management (Fig. 5). Most participants (88.7%) stated that they were concerned about the amount of garbage produced at their hospital and have a positive attitude toward recycling. Additionally, 89.6% of respondents reported that they were active recyclers in their homes and 80.6% recycle in the community.

Of waste produced from your hospital's ORs, what percentage **do you recycle?**

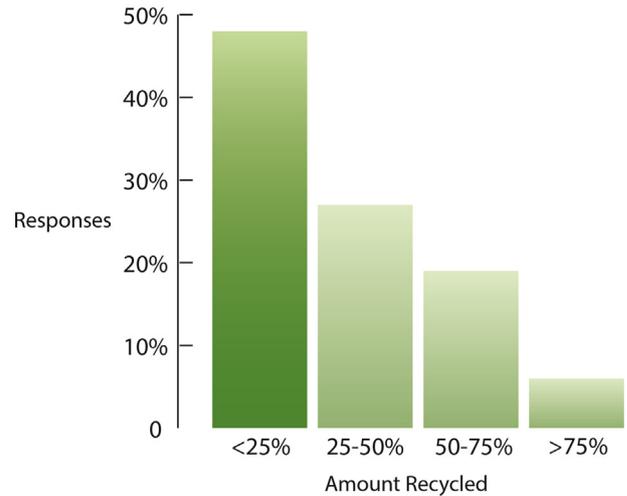


Fig. 3. Percentage of OR waste that respondents recycle. A total of 47.8% of respondents reported they recycle less than 25% of all OR waste.

Greatest barrier to recycling in the OR?

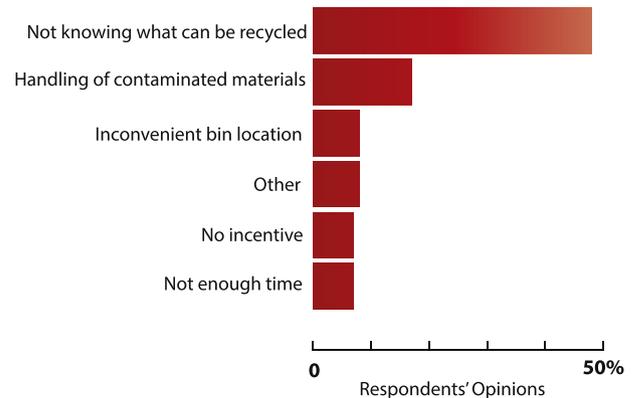


Fig. 4. Barriers to recycling in the OR. The most popular response was “not knowing what can be recycled” (47.7%) followed by “handling of contaminated materials” (16.8%).

Survey Demographics

Sample Size

N	524
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Gender

Female	71%
Male	28%
Prefer not answer	1%

Profile

Operating Room Nurse	34%
Anesthesiologist or CRNA	18%
Surgical Technician	14%
Other	13%
Consultant Surgeon	9%
Resident or Fellow	6%
Physician's Assistant	6%

Fig. 2. Sample size, gender and demographics. CRNA, Certified Registered Nurse Anesthetist.

Recycling improvement program

A cost savings of 10.3% was achieved in sharps waste disposal expenditure when compared to pre-intervention data on the previous year. Pre-intervention, the daily average sharps waste weight per month from all ORs was 108 kg (237.6 lbs). Post-intervention, the monthly average sharps waste weight per month from all ORs was 96.86 kg (213.1 lbs). At the surgery center where the program was implemented, the sharps waste disposal cost per pound was \$2.80, which is higher than the average in the non-private setting. Pre-intervention, the average monthly sharps waste disposal cost amounted to \$665.28 compared to \$596.66 post-intervention (p=0.004), resulting in a 10.3% of savings in sharps waste disposal expenditure (Fig. 6). Extrapolating the cost savings to a year would result in a difference of \$823.44 in savings for the three

What would improve recycling in the OR?

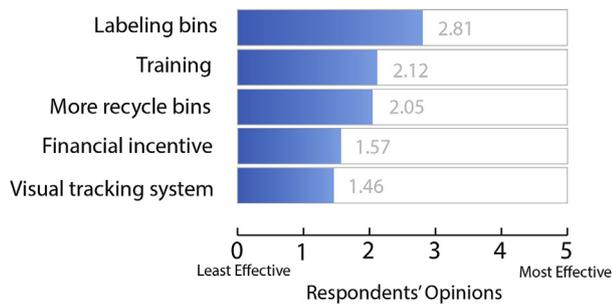


Fig. 5. Ideas to improve recycling in the OR, from most effective to least effective according to respondents.

Cost of Sharps Waste Disposal

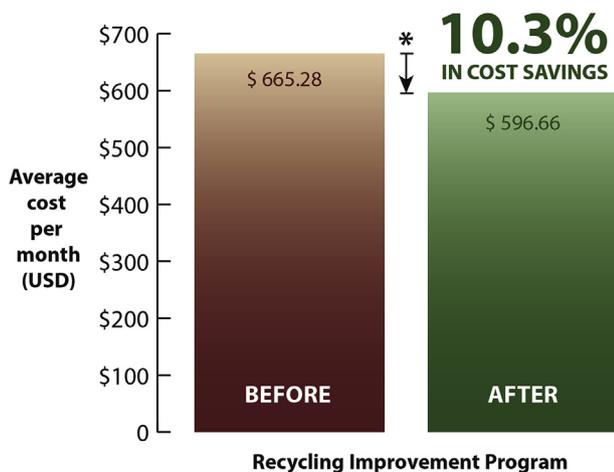


Fig. 6. The cost of monthly sharps waste disposal decreased from \$665.28 to \$596.66 ($p = 0.004$), amounting to a 10.3% in cost savings after the recycling improvement program was implemented at the three-OR surgery center outside of the Mayo Clinic system. USD, United States Dollar.

OR surgery center where the program was implemented. Since this surgical center already had sharps containers in place prior to this intervention, the monetary cost of printing recycling signs for this program was negligible. There were no changes in the 45 staff members involved at the surgery center before and after the intervention was implemented. The case mix was composed of only cosmetic surgery cases without reconstructive or emergency variability, both before and after the intervention.

Discussion

Recycling is an important component of dealing with operating room waste, and is critical in lowering disposal costs. Despite an active recycling program, the majority of respondents reported that improvements could be made in recycling education and availability in the operating room. The responses from the survey revealed general confusion regarding proper recycling techniques, rather than a lack of willingness to recycle. Our findings coincide with other research in the field, and McGain et al. also found inadequate information on how to recycle to be a major barrier to recycling in the OR.¹⁹

Nearly half of respondents erroneously believed only 25–50% of supplies from an OR are recyclable and reported recycling <25% of

the OR waste (Fig. 3). Interestingly, about 60% of respondents had been in the same position for >6 years. The majority of respondents supported greater operating room recycling, and are currently active recyclers outside of their role in the operating room. Participants thought the greatest barrier to current OR recycling were lack of knowledge of recyclable materials and proper handling of materials, which could certainly be improved with increased labeling and training (Fig. 4). Commonly used items that are mistaken as non-recyclable were found to be clean blue OR towels, sterile soft polypropylene plastic wrapper for OR tools, sterile rigid plastic containers, plastic pour bottles, and electrocautery cords.

The attitudes of healthcare professionals are of particular importance in hospital waste management, and should be taken into consideration. Many studies have previously examined attitudes to waste management and recycling in healthcare.^{15,18,19,21} Tudor et al. demonstrated that hospital staff were more likely to perform sustainable waste management practices if they believed it was a major issue and were encouraged to conserve resources.¹⁸ Ultimately, healthcare professionals must understand the environmental and financial benefits of recycling if they are expected to actively engage in the process. Our data demonstrated that the survey participants are aware of the importance of recycling, but lack proper training and knowledge regarding the nuances of OR waste disposal. This issue is not limited to the United States, and research from other countries found participants in the study viewed inadequate information on how to properly recycle as one of the top barriers to recycling in the operating room.¹⁹ Educational waste management programs should address the numerous benefits of recycling in the operating room in addition to providing disposal training.

Although not tracked for the purpose of this study due to potential bias, our recycling survey of Mayo OR staff resulted in OR waste reduction and cost savings at a non-surveyed site. Future interventions may reveal significant cost savings in a hospital based setting. Our recycling improvement program was implemented at a surgery center outside of the Mayo Clinic system, with completely independent staff. Therefore, any bias from respondents after taking the survey was entirely removed during the intervention.

Although the intervention was relatively simple, consisting of a recycling training session and recycling signs in the OR, a positive impact was noted, with statistically significant cost savings of about 10% achieved after the intervention compared to the previous year's data. The extrapolation of these savings to a year's worth of time would result in about \$820 for the particular surgery center in the study, which is only three ORs in size. This seemingly small difference would be markedly larger for an actual hospital with many more ORs and beds, likely on the scale of thousands of dollars in saving. For instance, in the 122-OR Mayo Clinic hospital, similar reductions in sharps per OR would result in over \$33,000 of savings per year. This is excluding catheterization labs, general hospital wards, outpatient clinics, and other procedural areas of the hospital, where a similar process could be easily implemented. These results demonstrate that even relatively simple interventions can begin to make a difference in recycling habits within a hospital.

It is certainly important to consider the time and monetary investment associated with implementing changes in a hospital setting. Although the specific cost would vary between institutions, our study demonstrated a very minimal financial setback to initiate a recycling program. Many hospital ORs already have sharps containers and recycling bins in place, as well as established disposal protocols for each category of waste. The results of this study suggest that the main issue with improving recycling lies in training staff to correctly separate OR-generated waste materials. As most hospitals hold regular meetings and training sessions for quality improvement, implementing a waste disposal module is not

likely to create a significant burden. This small investment in OR recycling would repay itself through cost savings.

The authors are aware of the limitations of this study. In spite of the high response rate in the survey component, there are inherent limitations of this type of data collection. The participants who elected to respond to the survey may have produced biased results in favor of recycling attitudes and behaviors. The participants were mostly female nurses, given the high proportion of this demographic in the OR population. The survey was focused specifically in OR recycling, which could be different to other areas in the hospital where recycling is equally as important, such as the clinic, ward, minor treatment room and catheterization lab. Therefore, the conclusions drawn from this study were limited solely to the OR environment. The survey was only sent to employees in the Mayo Clinic system, whose recycling attitudes could differ at other hospital ORs.

Waste reduction cost savings were not as large in this study as some have previously reported. Other studies were performed on larger numbers of ORs with a broader focus on recycling including multiple types of OR waste. Given the high cost per pound in sharps waste, the data collection for this portion of the study was focused solely on reducing sharps container waste. Future large scale implementations with a longer follow-up may detect much greater cost savings.

Another limitation of our study is the dependence on OR staff attitudes and recycling behaviors. Considering the importance of this aspect in improving OR waste reduction, periodic feedback from OR staff could have helped to determine the success of recycling interventions. Additionally, the program consisted of only a single training session to OR staff. Having multiple education modules over a longer period of time may have produced greater cost savings. As the signs posted in our intervention only included the most commonly used materials in the OR, more comprehensive signs could further improve results.

Despite the mounting evidence that greening the OR is achievable and cost efficient, more evidence is needed to identify the widespread utility of these practices. Due to the variation between specialties in operating room waste production, further studies will need to investigate cost savings in individual specialties. Our data suggests an overall enthusiasm of healthcare personnel to recycle in the OR, but future research will be necessary to determine the effects of these changes on patient flow through the operating room and their applicability to other areas of the hospital, such as general medical and surgical wards, outpatient clinics and other procedural areas of the hospital, such as cardiac catheterization suites.

Conclusion

Survey respondents were receptive to possible improvements in hospital recycling. The biggest barrier to recycling in the OR was found to be lack of knowledge of recyclable materials and their proper handling. A recycling improvement program consisting of training sessions and educational material can significantly reduce sharps waste disposal cost.

Conflicts of interest

No conflicts of interest exist for this study for any of the

contributing authors. No funding was received in support of this study.

Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.amjsurg.2018.06.020>.

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