Wasting No Time: Implementation and the Climate Impact of a Solid Waste Stream Process Intervention in a Large Academic Emergency Department

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INTRODUCTION

Climate change is one of the most critical issues facing our planet, and healthcare systems play a major role in generating the greenhouse gases that lead to accelerated climate change.[1] In fact, healthcare is responsible for 10% of all greenhouse gas emission in the United States[2] and generates 4.3 million tons of waste annually.[3] Moreover, the emergence of the COVID-19 pandemic has created myriad challenges including the increased production of biomedical waste.[4]

Meaningful solutions to reduce the impact of human activity on climate change must include efforts by healthcare systems to reduce waste and decrease the production of greenhouse gases. In particular, biohazard waste, also known as regulated medical waste (RMW), requires autoclaving and shredding and results in up to fifteen times as much greenhouse gas equivalents emitted as compared to regular solid waste.[5,6] In addition, RMW processing is seven times more costly to healthcare systems as compared to regular solid waste processing.

RMW is typically defined as items saturated in blood or potentially infectious bodily fluids, sharps, and syringes and is generally collected in red biohazard bags and sharps containers. RMW comprises just a fraction of all waste produced within a medical system, yet idiosyncratic institutional practices (such as the sole use of red bags for all medical waste disposal) can adversely affect the environment at a disproportionate level. In order to mitigate this particular problem in the Emergency Department (ED) at Rhode Island Hospital (RIH), a multi-disciplinary departmental "Green Team" planned and implemented a pilot intervention, i.e., the introduction of a regular solid waste disposal "clear bag" option with accompanying educational efforts and materials on proper waste sorting.

Similar efforts have been successful in other healthcare settings: Inova Fairfax Hospital saved nearly $200,000 in annual waste disposal fees through better segregation of waste and a concerted effort to educate and engage staff;[7] a study by Garcia et al. reported a 2-million pound decrease in biohazard waste with a corresponding savings of $696,000 in annual costs through a similar hospital-wide initiative at Brookdale University Hospital and Medical Center.[8] However, we are not aware of initiatives that have been specific to the ED – this may be due to the positioning of the ED as a unique and high-risk environment with respect to waste disposal, given the nature of its clinical operations and associated challenges.

Figure 1. Regulated medical waste and tan regular solid waste bins.

In this context, the Green Team aimed to decrease its ED greenhouse gas footprint as well as operational costs by introducing new tan waste bins with clear bags for regular solid waste disposal (alongside the existing red waste bins and red bags for biohazard waste, **Figure 1**). In addition, educational materials were created and disseminated to ED staff by the Green Team to promote proper waste disposal one month prior to rollout of the project. In parallel with these processes, the team planned and conducted an objective analysis of the environmental impact and fiscal savings of this change within the ED. This manuscript describes the project's design, conduct, findings, and measured impact.

METHODS

Baseline Analysis

Green Team members met with institutional personnel, including environmental service staff to understand the existing waste stream processes. After meetings and direct observation, the project team conducted a baseline analysis by weighing the ED waste stream (comprising RMW and regular solid waste) over 7 days and then 14 days at two time points prior to implementation of the project's pilot intervention.

Education

To ensure that all ED technicians, nurses, advanced practice providers (APPs) and physicians understood proper disposal processes as well as the implications of correct waste

disposal, the Green Team created educational materials for distribution. The Green Team developed posters to be placed on waste bins and in utility rooms, as well as slide shows with a brief overview of the planned intervention to display at education sessions. All materials were reviewed and approved by the institution's department of infection control. In-person education sessions were held at faculty meetings, resident conferences, APP meetings, and nursing and technician huddles; emails detailing the project were sent to all staff. Education sessions were also held with all environmental services staff who were briefed on waste disposal process updates as well as how to report RMW that was erroneously discarded in the regular solid waste stream (solid waste within the RMW stream was not reported). Instances of incorrect disposal of RMW were reported via an online reporting form for review by the Green Team and the institutional safety officer.

The multi-disciplinary composition of the Green Team facilitated staff buy-in and adherence to the new waste stream process. Dissemination of project goals and new waste disposal guidelines to staff began one month prior to implementation of the new process.

Project Solid Waste Stream Process Intervention

One month following the second baseline weighing, 105 tan bins with clear bags were added to ED patient rooms and areas (**Figure 1**). (Pre-existing tan bins which had been lined with red bags received clear bags.) Laminated signs reminding staff of appropriate waste disposal guidelines were affixed to the lids of the tan bins within patient rooms (**Figure 2**). A third ED waste stream weighing (for RMW only) was completed over a 3-week intervention period. (**Figure 3**)

Figure 2. Educational poster attached to tan bins placed in the ED for regular solid waste handling.

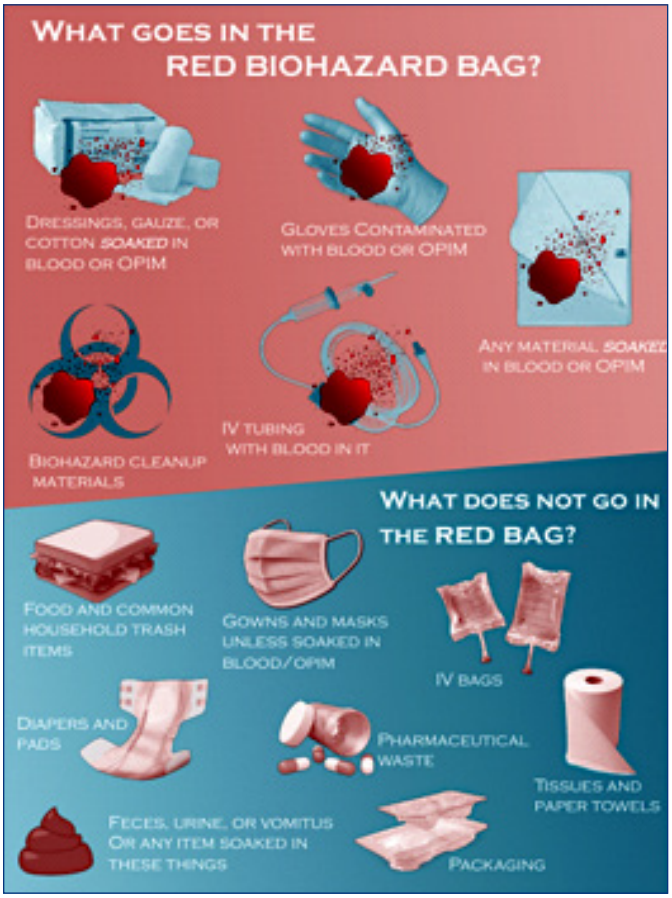
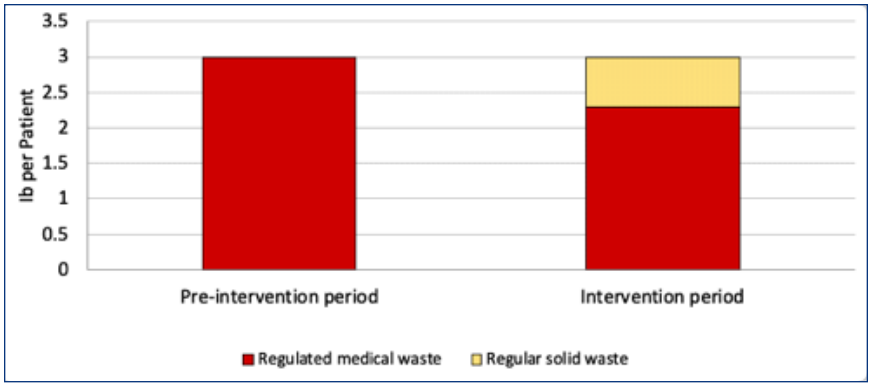


Figure 3. ED waste weights (lbs) per patient before and during introduction of a solid waste stream process intervention.



Data Analysis

Daily ED red bag weights for the pre-intervention period (RMW and regular solid waste) and for the intervention period (RMW only) were calculated with correction for ED census (patients who left prior to full medical evaluation were excluded from the census). Given that no interventions were implemented to change provider behaviors or institutional processes with respect to medical care and the resultant waste, the quantity of overall, total census-adjusted ED daily waste was presumed to remain the same, such that any red bag weight reductions in the intervention period were ascribed to the diversion of regular solid waste into the new clear bags and tan bins. A one-sided t-test was employed to compare the pre-intervention and intervention periods' red bag weights.

Greenhouse gas equivalents were calculated using the M+WasteCare Calculator.[5] The calculator used the amounts of pollutants in each step of the disposal process and converted them to carbon dioxide equivalents (greenhouse gas equivalents). Emissions factors were used for all calculations, including waste transportation to landfill and emissions associated with the landfill. The difference in greenhouse gas equivalent tons per year (TPY) for autoclaved RMW vs regular solid waste was calculated and applied to the observed and annual projected reductions (based on the

2020 ED census) in RMW production. RMW was classified as autoclaved on-site prior to being landfilled. Cost savings were estimated using the reduction in daily ED red bag waste weights between the two periods and with adjustment for accompanying increase in solid waste processing costs.

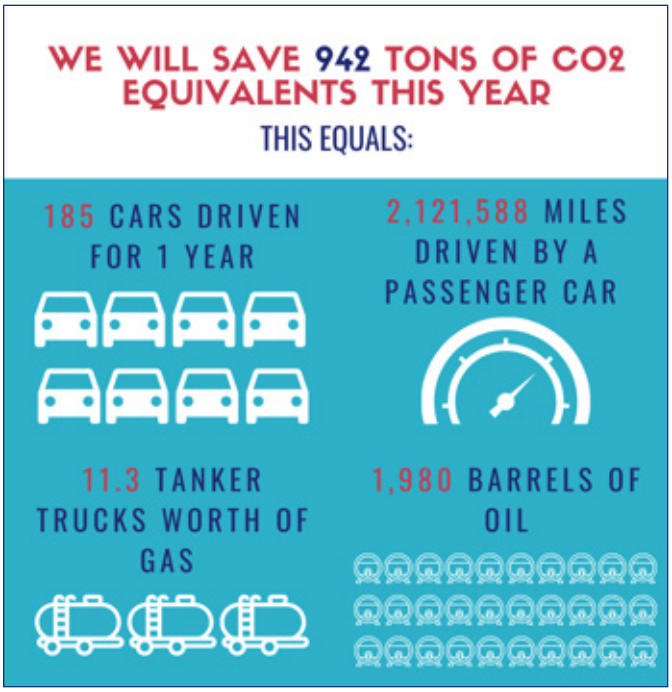
RESULTS

During the pre-intervention measurement periods, the average red bag waste produced per ED patient was 3.0 lbs (95% CI 2.5-3.5). Over the intervention period, the average red bag waste produced per ED patient was 2.3 lbs (95% CI 1.8-2.8, p=0.02), resulting in a net 0.7 lb reduction in biohazard waste per ED patient. Assuming no change in overall waste production per patient, regular solid waste constituted 23.3% of all waste generated during the intervention period. Using the 2020 ED census of 84,221 encounters, the projected annual RIH ED diversion of biohazard waste for 2021 will be 62,323 lbs (31.2 tons). The projected reduction in ED waste greenhouse gas equivalents is 942 TPY; the projected savings in ED waste processing costs is $11,841 per year. As of three months after the intervention period, there were no reported incidents of RMW within the regular solid waste stream.

DISCUSSION

Institution of a regular solid waste stream within a large academic ED resulted in significant reductions in greenhouse gas emissions. Projections indicate that in just the subsequent year, emissions prevented will be equivalent to over 2 million miles driven by a passenger car, 1,980 barrels of oil, or over 11 tanker trucks worth of gas (**Figures 4**).[10] Furthermore, the project's pilot intervention was found to be fiscally beneficial for the hospital system, with return on investment from start-up costs reached within nine months.

Figure 4. Educational poster distributed after institution of the solid waste stream process intervention to inform employees of the project's impact.



While the 23% reduction in actual RMW by the intervention represents a significant decrease for our ED, waste audits of other EDs suggest room for improvement. For example, a recent waste audit of a large academic ED in Boston demonstrated RMW was 10.7% total waste[9], and a similar audit of a community ED in Rhode Island found just 3% RMW. We expect greenhouse gas savings to improve over time with continued education and institutional adoption of eco-friendly waste disposal practices.

Limitations

Given the process by which hospital waste is measured at our institution, it was not possible to isolate and weigh only the regular solid waste component. Thus, calculations assumed the same total generation of waste on a per-patient basis. A formal waste audit was not performed to calculate the proportions of appropriate waste versus inappropriate waste within the RMW stream – a formal audit of the RMW stream in the future would allow for tailored education and further interventions to continue to reduce RMW generated.

Due to the architectural configuration and operational layout of the ED, certain patient care areas such as the 12-bed critical care patient space were not included in the project – there is significant healthcare waste produced in this area, and there exists the potential for substantial additional greenhouse gas reductions and cost savings. Future research will examine the amount and type of waste generated from this area as well as potential interventions to reduce impact.

The M+WasteCare calculator[5] uses known formulas for carbon and other pollutant generation from medical waste. Variables added to the calculator include distance to landfills, type and frequency of waste transport. There may be slight variations in the actual amount of greenhouse gases produced based on these variables. However, because the variables were constant across the measured periods, the impact of the intervention should not have been affected.

CONCLUSIONS

Proper sorting of RMW and regular solid waste within EDs represents a straightforward, economical, and impactful environmental intervention. While risk to the healthcare system exists in the form of waste misclassification, from this intervention, this appears to be minimal and outweighed by the advantages. In light of the COVID-19 pandemic and the related increase in biomedical waste, conscientious disposal practices will be even more important to the environmental sustainability of our healthcare systems.

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Acknowledgment

The authors acknowledge the multidisciplinary members of the Anderson Emergency Department Green Team for their pivotal role in designing and implementing this project.

The authors also acknowledge Ananya Suram for her design and creation of Figure 4.

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