

Evaluating Outcomes of Education on Waste Management in the Hospital Setting

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EVALUATING OUTCOMES OF EDUCATION ON WASTE MANAGEMENT IN THE
HOSPITAL SETTING

by

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A thesis submitted in partial fulfillment of the requirements
for the Honors in the Major Program in the College of Nursing
and in the Burnett Honors College
at the University of Central Florida
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ABSTRACT

With advancements in healthcare, we continue to find new needs that must be addressed. Hospitals generate a substantial amount of medical waste, and proper disposal is important for patient and staff safety, environmental protection, and cost efficiency. A series of studies show there is a need for further education on hospital waste management policies. This thesis aims to evaluate education interventions to improve knowledge and healthcare waste disposal practices. This literature review was conducted using multiple databases, including MedLINE, CINAHL, GreenFILE, Google Scholar, EBSCOhost, and NCBI, to find qualifying research articles in the English language from 2005-2018. Key terms for the searches were: education, training, waste, disposal, healthcare, medical, reduction, hospital, pound, and kilogram. Results demonstrate that further education on hospital waste management has the potential to reduce waste, improve disposal and segregation, and reduce costs. However, the lack of consistency in the research, literature, and educational interventions all pose as limitations. Hospitals have the potential to benefit from improved waste management practices by enhancing patient care, reducing waste, saving costs on waste disposal, and protecting the environment.

DEDICATION

For Scott, Tracey, and Carson,
who have continued to encourage and love
me through all my endeavors.

For Royce, who has continued
to show me love and support.

For my professors at UCF, College of Nursing,
who have generously shared
their nursing knowledge with me and my peers.

For my patients, who continue
to inspire and encourage me.

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INTRODUCTION

Disposable supplies and equipment have allowed for a more affordable and safer healthcare setting; reducing the cost of equipment and maintenance, reducing infection, complications, and length of hospital stays (Collins, 2008). However, the current practice of single-use items and their disposal in healthcare has become costly and wasteful in a different manner (Campion, N., et al., 2015). The generation of waste requires instructions for disposal to maintain safety, limit transmission of infections, and environmental protection (World Health Organization, n.d.). Hospitals create a significant amount of waste, and the World Health Organization (2018), estimates that nearly 85% of that waste is nonhazardous. In addition to nonhazardous waste there are other forms which include hazardous waste, sharps waste, pharmaceutical waste, and recyclable waste. These types of waste are generated from medication administration, dressing changes, medical procedures, and routine daily care. This thesis will focus on improving disposal with educational interventions on waste management of these various types of waste created in the hospital setting.

Waste management policies and procedures are implemented to maintain patient safety, dispose of waste in a cost-effective manner and protect the environment (Stonemetz, J., et al., 2011). Health care waste, such as nonhazardous, hazardous, sharps, pharmaceuticals, and recyclables, created in the hospital setting requires staff education on waste management for proper disposal.

What are the different types of hospital waste?

Healthcare waste includes all the waste generated through medical activities, including diagnostic procedures and preventative, curative, or palliative treatments. (World Health Organization, n.d.). Waste is broken down into the following categories: non-risk healthcare waste (recyclable, biodegradable, and other non-risk waste), healthcare waste requiring special attention (human anatomical waste, sharps waste, and pharmaceutical waste), and infectious healthcare waste. 75-90% of all waste generated is non-risk healthcare waste (World Health Organization, n.d.).

The distinction between the different types of waste is important for understanding waste management. Recyclable waste includes paper, cardboard, and non-contaminated plastics, metal, or glass which can be recycled (World Health Organization, n.d.). Other nonhazardous waste includes items that cannot be recycled or are not biodegradable (food items), these are items like gloves and masks. Sharps are considered objects and materials that pose a potential risk of injury and infection due to their ability to puncture or cut (World Health Organization, n.d.). Standard items include needles and scissors. Sharps are considered one of the most hazardous wastes generated by a healthcare facility (World Health Organization, n.d.). Pharmaceutical waste includes a wide range of chemicals varying from disinfectants to medications (World Health Organization, n.d.). Infectious or hazardous waste has the potential of transmitting infectious agents to humans or animals (World Health Organization, n.d.).

These varying types of waste requires different disposal methods for the safety and protection of both patients and medical professionals. The different types of waste are collected and sorted into color coded bags or containers, depending on the hospital policy. For example, sharps are disposed of into a hard-sided, puncture resistant sharps box, so the needles cannot

penetrate and cause injury. Pharmaceutical waste is placed into a container, usually found in the medication room, so it can be disposed of according to regulations (International Committee of the Red Cross, 2011). Each type of waste has set costs associated with its disposal, yet these costs can fluctuate (Martin et al., 2017).

Many supplies are needed for the routine care of patients and require proper segregation into these main categories. Research has found that used and unused supplies of all types of waste are not always disposed of properly, and education on proper waste segregation can help (Johnson, K. M., et al., 2013). Interventions used to improve waste disposal and reduce waste include increasing awareness and education among staff on proper waste management (Johnston, 2017). Studies previously conducted surveyed nurses and hospital staff assessing their knowledge on waste disposal and segregation; results showed there is a need for further education (Kirshnan, Deamani, & Jayalakshmi, 2015). According to Krishnan, Devamani, and Jayalakshmi (2015), pre-test scores on proper waste management practices revealed a need for education. The same study found that post-test scores improved with education along with waste management practices, which showed a reduction in waste and improved disposal techniques (Krishnan et al., 2015). Providing hospital workers education on waste management practices and procedures has the potential to improve waste disposal, reduce waste, improve patient care, and save cost.

A researcher synthesized the benefit of continuing education in the nursing practice, and it was concluded that further education increased nurse's confidence and self-awareness, and improved knowledge (Wood, 1997). Relating to patient care, with additional education, nurses experienced improved communication skills, enhanced individual care, and increased research

centered general practice (Wood, 1997). From this, we can hypothesize that further educating nurses regarding patient supply waste and proper disposal could reduce nurse's contribution to improperly disposed of hazardous, nonhazardous, pharmaceutical, sharps, and recyclable waste. There are multiple opportunities within the healthcare setting for further education about waste, whether it be research opportunities, recommended lectures, or studies provided by the hospital. For example, a recent study reduced waste in the critical care setting through education focused on increasing supply waste awareness via emails, photographs, posters, and hospital newsletters (Morrow et al., 2013). Nurses may not realize the significance of properly sorting the various types of waste they generate, but with increased awareness and education, they may be more conscientious about gathering, using, and disposing of supplies in their practice.

Another study found that an educational intervention for doctors, nurses, and paramedics on biomedical waste management significantly improved waste management knowledge and practice (Krishnan et al., 2015). Nurses were provided education on the significance of supply waste and how it impacts not only patients, but also staff and unit organizations. The results showed an approximate \$15 reduction per discharge in unused patient supply waste (Johnston, 2017).

There are multiple ways in which waste is generated throughout a hospital stay including but not limited to: medical procedures, wound management, medication administration, routine care, and after/upon discharge. Improving education on waste management may benefit patients, hospitals, and the environment (Stonemetz et al., 2011). Additionally, there appears to be a general movement by consumers towards the use of more sustainable products, as evidenced by fair trade clothing, hybrid cars, and reusable non-plastic bags for groceries and other stores (Web

Ecoists, n.d.). Understanding the outcomes of how providing education on waste management has reduced healthcare waste and cost is worth evaluating and implementing into hospital systems because of the potential benefit. For example, a study conducted in Spain shows that educational programs reduced hospital waste expenses by 26.3%, or €125,205 (Mosquera et al., 2015).

The 21st century is not the first time in the history of nursing where the correlation between a patient's medical care, medical supplies, the environment, and waste has been made. Florence Nightingale, the founder of modern nursing, is known for many accomplishments but especially her Environmental Theory (Fee & Garafolo, 2010). She provides a background to the introduction of medical supplies, waste, the environment, and the impact all three have on patient care (Fee & Garafolo, 2010). According to Kamau (2015), this theory states “nurses manipulate and mediate the environment to put the patient in the best condition for nature to act upon” (para. 1). The environment is continually evolving, requiring nurses to adapt to improve patient care. Nightingale developed this theory when caring for wounded soldiers during the Crimean War; she hypothesized more soldiers were dying from infections due to their environment rather than battle wounds (Fee & Garafolo, 2010). Her findings resulted in enhanced sanitation techniques on reusable equipment and supplies to reduce infection and improve patient care. With advancements in science and technology, hospital equipment has continued to develop and progress; disposable equipment and supplies were a significant development to reduce infection and cost while enhancing convenience (Campion, 2015). This thesis is a continuation of Nightingale's theory that a patient's treatment is directly impacted by their environment, including the supplies used for treatment and the waste generated from those supplies. Better

waste management practices are consistent with Nightingale's theory of the environment in that reducing waste provides a cleaner environment that allow for more time and money for better patient care

PROBLEM

The problem associated with the various types of medical waste is the improper or lack of knowledge regarding proper disposal methods and significant of waste management (Martin et al., 2017). This can lead to a variety of other challenges that have an overall negative impact on patient care and their environment. Improper disposal methods can result in infections, injuries, contamination, and unnecessary expenses (Stonemetz et al., 2011).

PURPOSE

The purpose of this literature review is to evaluate the outcome of education as an intervention on hospital waste management. Improving awareness and education on waste management procedures and policies have previously been implemented in studies to improve waste disposal. This literature review will summarize findings of previous research to evaluate how implementing education as an intervention can reduce waste and save costs in the hospital setting. The interventions will be evaluated by weight of waste generated, actual or projected cost reduction in supply waste, change in quantity, amount, or weight of hospital waste.

METHODS

The literature review focused on educational interventions on waste management practices in the hospital setting. Educational interventions varied from presentations, seminars, informative emails, posters, and flipcharts. Databases searched include: Cumulative Index to Nursing and Allied Health Literature (CINAHL), EBSCOhost databases, Google Scholar, GreenFILE, National Center for Biotechnology Information (NCBI) and Medical Literature on-line (Medline).

Key terms searched included educat* or train* or program or curriculum, waste, disposal or segregation or separation, hospital or healthcare or “health care” or medical, improve or reduc* or minimize, weight or pound* or “lb” or kilogram* or “kg.” Articles were further limited by publication date, 2005-present, written in the English language, providing education as an intervention, if the study occurred in the hospital setting, and provided statistical analysis of results. Appendix A shows the consort diagram for articles meeting the criteria. Appendix B shows the data table of included articles summarizing the study and the key findings.

RESULTS

Key terms searched were educat* or train* or program or curriculum, waste, disposal or segregation or separation, hospital or healthcare or “health care” or medical, improve or reduc* or minimize, weight or pound* or “lb” or kilogram* or “kg” in the databases CINAHL, MEDLINE, and GreenFILE databases resulted in a total of 75 articles. The search was then limited to English and articles published from 2005 to 2018, resulting in 57 qualifying articles. Articles not included were focused on dental offices, long term care settings, and waste management of metals. Articles were further eliminated if they did not include an educational intervention, did not statistically analyze findings, or occurred outside of the hospital setting. 53 articles were eliminated, resulting in four qualifying articles.

Each of the articles evaluated how educating staff on waste management can reduce waste and improve waste disposal, as well as evaluated their findings with statistical analysis. Three articles found a decrease in waste and improved disposal techniques, while one article found nonsignificant results (Stonemetz et al, 2011). All of the articles used varying techniques of providing education on waste management.

Table 1: Summary of Outcomes on Waste Management after Educational Intervention	
Outcome of Educational Intervention on Different Types of Waste	Supportive Article
Increased recycling	(Martin et al., 2017), (Mosquera et al., 2014)
Decreased pharmaceutical waste	(Mosquera et al., 2014)
Decreased regulated medical, including infectious or biohazardous waste	(Johnson et al., 2013), (Martin et al., 2017), (Mosquera et al., 2014)
Decreased municipal/non-risk waste	(Martin et al., 2017)
Decreased sharps waste	(Martin et al., 2017)

Cost savings on waste disposal	(Johnson et al., 2013), (Martin et al., 2017), (Stonemetz et al., 2011)
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Table 2: Summary of Educational Intervention Types and Supporting Articles	
Educational Intervention	Supportive Article
Seminar Lecture/Presentation	(Johnson et al., 2013), (Martin et al., 2017), (Mosquera et al., 2014),
Poster	(Johnson et al., 2013), (Martin et al., 2017), (Stonemetz et al., 2011)
Email	(Martin et al., 2017)
Small group sessions	(Martin et al., 2017), (Mosquera et al., 2014), (Stonemetz et al., 2011)

Martin et al. (2017), conducted an educational intervention study at Harborview Medical Center in Washington State, the hospital had 413 beds and 24 operating rooms, the study was conducted from March 2013 to April 2014 and was implemented in 16 surgical suites managing adult, pediatric, outpatient, and trauma cases. The goal was to optimally sort waste material in the operating room and divert waste streams to maximize low-cost disposal of items like recyclables (Martin et al., 2017). Lean Six Sigma, a common method used to identify a problem, determine, and implement a solution, was used. Four types of waste streams were identified: solid waste, regulated medical waste (RMW), also referred to as biohazardous or infectious waste, pharmaceutical waste, and recyclable waste. Ten focus groups were conducted to obtain attitudes, barriers, and motivation regarding waste management (Martin et al., 2017). Then a survey was distributed over an email operating room staff, nurses, technicians, anesthesiologists, CRNSAs, and surgeons, to assess baseline knowledge of waste management. Results from the survey and focus groups resulted in the need for an area for anesthesiologists to separate waste, clear signage was posted, and an education program was implemented (Martin et al., 2017). The

educational program included live interactive presentations, small group sessions focusing on change and concerns, and formal seminar sessions discussed proper waste separation for all OR staff (Martin et al., 2017). Pre-intervention, waste was gathered and weighed in kilograms daily, number of waste bags were counted each day in the different waste streams, sharps containers were counted over a two-week period; and the pharmaceutical waste stream was not calculated in the baseline data because no system was available (Martin et al., 2017). Post-educational intervention, daily weights and number of bags for each waste category were collected during two consecutive weeks. 20 weeks post-intervention a survey was distributed to assess knowledge and obtain feedback.

Martin et al. (2017), found the daily weight significantly decreased after the intervention period ($p < .01$), which equated to a 12% reduction in waste weight. Additionally, regulated medical waste decreased by 59%, no p value was provided. Sharps disposal containers were downgraded from 15.2 L to 7.6 L sized puncture resistant containers, pre-intervention period sharps containers were replaced every 10 days and weighed approximately 4.5 kg, during the intervention period the smaller sized sharps containers were replaced approximately every ten days and weighed 2 kg, indicating a greater than 50% reduction (Martin et al., 2017). After the educational interventional the amount in sharps containers decreased because non-sharps materials were no longer being placed in the sharps container (Martin et al., 2017). However, the sharps waste reduction was not supported with a p value. Meanwhile, the weight of recyclable waste had a significant ($p < 0.1$) increase from a mean of (0.89 +/- 0.50 kg per operating room per day) pre-intervention to (1.06 +/- 0.55 kg per operating room per day) post-intervention (Martin

et al., 2017). This was a positive outcome indicating the educational interventions resulted in improved waste management practices.

The study conducted a knowledge assessment about waste management which demonstrated significant improvement. During the pre-intervention period 143 users returned the survey and after the intervention period 164 completed the questionnaire (Martin et al., 2017). The biggest knowledge gain revealed empty glass bottles/vials need not to be disposed of in the sharps container but can be recycled (Martin et al., 2017). This study anticipated savings would derive from a reduction of regulated medical waste, solid waste, and sharps waste while increasing amounts of recyclable waste (Martin et al., 2017).

In another study, Mosquera et al. (2014), conducted a quasi-experimental study in a 382-bed hospital in Spain. The purpose was to assess the impact of regulated medical waste segregation after a training intervention on advanced medical waste management (Mosquera et al., 2014). The training was conducted over a nine-month period in 2010. The educational intervention included 24 half-hour sessions, one for each hospital department, the staff were exposed to the training once (Mosquera et al., 2014). In addition to the department trainings, a ten-hour advanced healthcare waste management course was provided, and 455 hospital employees participated in the study (Mosquera et al., 2014). After the educational intervention was delivered, infectious, chemical, pharmaceutical, and general solid wastes were collected and weighed daily. The pre-intervention period was from March 2009-February 2010, the post-intervention period was from December 2010-November 2011. Mosquera et al. (2014), concluded their educational interventions significantly ($p=.003$) increased recycling of paper and cardboard (9,983.33 +/- 1,544.49 kg monthly average) pre-intervention weight to (11,752.20 +/-

2,136.68 kg monthly average) post-intervention, and a significant ($p=.000$) increase in recycled plastic was found after creating the plastic recycling (0 kg monthly average) pre-intervention to (1,330.91 +/- 343.67 kg monthly average) post-intervention (Mosquera et al., 2014). However, a nonsignificant ($p=.110$) increase in recycled glass occurred (Mosquera et al., 2014). Researchers concluded this decrease was because the hospital experienced a transition from glass to plastic containers for some solutions.

Mosquera et al. (2014), found a significant ($p=.000$) total decrease in monthly infectious waste from (11,631.08 +/- 1,507.01 kg) pre-intervention to (5,945.64 +/- 587.39 kg) post-intervention. Genotoxic and pharmaceutical waste also showed a significant ($p=.000$) reduction from (609.60 +/- 53.51 kg) pre-intervention to (422.53 +/- 40.37 kg) post-intervention (Mosquera et al., 2014). Researchers did not experience a significant ($p=.995$) decrease in monthly general waste (80,658.33 +/- 6,718.37 kg) pre-intervention and (80,646.37 +/- 7,006.56 kg) post-intervention (Mosquera et al., 2014). The study did not experience a significant ($p=.440$) decrease in chemical waste (666.10 +/- 365.07 kg) pre-intervention to (744.53 +/- 236.19 kg) post-intervention (Mosquera et al., 2014). The savings in weight equaled €125,205, a 26.3% reduction in costs. Although the researchers only saw a 6% reduction in overall volume, they noted the cost savings and improvement in waste segregation (Mosquera et al., 2014).

Johnson et al. (2013), conducted a two-phase study in a 299-bed hospital in El Salvador, that has approximately 1,000 employees and 592 staff participated in the training. The objectives of this study were to assess hospital needs regarding waste management, evaluate staff's knowledge, and determine and provide a solution and evaluate improvements of healthcare waste management (Johnson et al., 2013). The first part of the study was an observational cross-

sectional study of waste containers and the second part was a quasi-experimental with pre- and post-training questionnaire (Johnson et al., 2013). Education included PowerPoint presentations for 20 or more people. Flip charts were used for groups with a maximum of five people and remained on each hospital unit. All sessions lasted approximately 20 minutes (Johnson et al., 2015). It found the hospital saved a significant ($p < .001$) amount, \$2,772.57 per month on biohazardous waste disposal during August-December 2011 following an educational intervention (Johnson et al., 2013). During those same months, they found a significant ($p < .001$) decrease in kilograms of waste produced per month, a decrease from (7,778.5 kg/month) pre-intervention to (3,795.9 kg/month) post-intervention, or (0.86 kg/bed/day) pre-intervention to (0.42 kg/bed/day) post-intervention (Johnson et al., 2013). Additionally, a one-year post-intervention test was conducted revealing that staff exemplified significant ($p = .012$) improved knowledge on proper waste segregation; the pre-education score was 89.53 and one-year post-education was 98.64 (Johnson et al., 2013).

Stonemetz et al. (2011), this study was conducted in an academic medical hospital during January 2007-December 2008. The purpose of this study was to assess waste disposal in surgical suites and use an improvement plan to decrease both cost and volume of regulated medical waste (Stonemetz et al., 2011). The educational intervention involved an improvement plan of clarifying guidelines to properly segregate waste into appropriate disposal containers, identify areas requiring additional receptacles, design and post clear signage and educational posters, and develop an educational plan for all staff (Stonemetz et al., 2011). Stonemetz et al. (2011), did not find a statistically significant ($p = .39$) reduction in the amount of waste after the educational intervention, but there was a decrease from 1.3 billion pounds in January of 2007 to 1.1 billion

pounds of waste in December 2008 (1,241,561 +/- 79,861 lb/month) (Stonemetz et al., 2001). Overall, the average cost of regulated medical waste decreased from (\$151,442 +/- 4,195 per month) pre-intervention to (\$127,441 +/- 3,208 per month) post-intervention with 95% CI 12,662-35,240 (Stonemetz et al., 2011). Additionally, they noted a savings of \$576,024 for the institution due to the reduction in regulated medical waste (Stonemetz et al., 2011).

The cited research articles listed in Table 1 identify areas that demonstrated improvement after providing education on waste disposal and waste management. Table 2 identifies the varying types of educational interventions and the supporting articles. All the articles discussed improved segregation techniques even if the statistical analysis was not found to be significant. Three of the four articles provided a significant reduction in regulated medical waste. This literature review of these articles shows the potential to reduce waste and save cost through educational intervention on waste management.

DISCUSSION

The findings of this research conclude providing education on waste management can benefit waste disposal, improve safety, and save costs. Hospitals that implemented different types of education have experienced improved waste management using various educational interventions. The introduction of educational interventions is significant for both nurses and patients. The most significant findings from the research were environmental benefits of proper waste disposal, reduction in hospital waste expenses, and improved safety. These benefits directly provide nurses with more resources such as time, money, and a better work environment.

The impact of medical waste on the environment is considerably one of the most pressing issues regarding improper waste management. Strong correlations have been made between Latin American countries having severe cholera epidemics and hospitals treating cholera patients and practicing uncontrolled release of sewage (World Health Organization, n.d.). Pathogenic microorganisms, which can cause hepatitis or HIV, have varying abilities to remain infectious when exposed to the environment (World Health Organization, n.d.). However, rodents and insects have the ability to transmit some pathogenic organisms. Research has shown that non-hazardous healthcare associated waste is approximately equally as dangerous as domestic waste, in regard to containing pathogenic microorganisms. However, the potential spread of dangerous organisms through insects and rodents becomes increasingly concerning when waste is mismanaged (World Health Organization, n.d.). The spread of dangerous microorganism is only one of the ways waste management was studied and analyzed.

Two of the studies were conducted within the United States, one was in El Salvador and one in Spain. In the US, nurses are required to complete continued education. Hospital systems waste management is included in hospital orientations in the United States (PROMEDICA, n.d.). No information could be located as to whether waste management is part of the US's continuing education program. If waste management isn't included in the annual content hospitals should consider implementing it to improve waste management and save cost. The two studies conducted outside the US demonstrated improvements on multiple departments, developing countries should consider implementing education on waste management on units with signs, interactive teaching, and formal lectures.

The two studies conducted in the United State focused specifically on waste management within operating rooms. This demonstrates there is a need for further education regarding waste management in operating rooms more so than other hospital units. In the operating room, clear posters and signage proved to be effective in improving waste management (Martin et al., 2017). Operating rooms produce a large amount of the hospitals overall waste, as much as 20-30% (Booth, 2015). Sources of waste produced by the operating rooms differ from other units because of the need to maintain sterile fields and infection prevention (Booth, 2015). Often surgical kits or trays come prepackaged, and not all the items are used, and they become waste. Implementing a recycling program in the operating room can help to reduce waste, increase, recycling, and save costs (Martin et al., 2017). In the hospital many health professionals are involved in patient care, but this is especially true in the operating room. These medical professionals and their responsibilities to patient care and waste management extend beyond the operating room and into other areas of the hospital as well.

All individuals exposed to hazardous healthcare waste are potentially at risk when in contact with waste that has not been properly managed. Nurses, patients, doctors, transporters, and individuals outside of the hospital are also at risk. Examples of infections caused by improperly managed health care waste include but are not limited to salmonella, the measles virus, herpesvirus, human immunodeficiency virus (HIV), Ebola, and hepatitis (World Health Organization, n. d.). The biggest way nurses can improve patient care by practicing proper waste management is from providing improved safety by reducing spread of infection and reducing needlestick injuries (World Health Organization, n. d.). This is demonstrated by educational interventions on waste management limiting the spread of infectious organisms and reducing accidental needle stick injuries on patients (World Health Organization, n. d.). The World Health Organization (n. d.), states the primary concern is infections caused by needle injuries, which often contain blood. In the USA, June 1994, the Center for Disease Control and Prevention recognize 39 occupational transmission cases of HIV, 32 of which occurred from needle-stick injuries (World Health Organization, n. d.). Proper disposal of sharps is a high priority is waste management.

Chemical and pharmaceutical waste are also to be disposed of properly. If not, individuals are at risk for burns, poisoning, and intoxications (World Health Organization, n. d.). If proper waste management practices are not maintained, there can be adverse effects within and outside of the hospital setting.

In conclusion, varying forms of education were found to be effective in the different settings studied. This demonstrates that delivering education is vital to improving waste management. Johnson et al. (2013), conducted a knowledge survey one-year post-intervention.

The scores showed a statistically significant improvement, demonstrating that educational interventions have long-term benefits (Johnson et al., 2013). The improved waste management can help to save costs. Regulated medical waste requires additional disposal expenses, therefore, reducing regulated medical waste and increasing other waste forms helps to reduce these expenses (Stonemetz et al., 2011). Improved waste management can reduce injuries and limit the spread of infectious agents. It is essential for healthcare professionals to be educated on proper waste management to promote safety and reduce costs. Continued study of this topic will help both nurses and educators to better understand what type of education and training they need to effectively implement better waste management practices, and how hospitals, nurses, and patients will all benefit. Not only does the research analyzed show the potential benefits of proper waste management, it also addresses the current and future risks of improper waste management. Improper waste management can be directly associated with increased risks for both patients and nurses. It is a nurse's responsibility to be a patient advocate, and therefore it is their responsibility to do everything in their power to eliminate a potentially harmful environment from dangerous waste that has been negligently disposed of.

IMPLICATIONS FOR NURSING

Nurses are on the forefront for much of the waste produced and disposed of in hospitals throughout patient care. Adequate training and knowledge on waste management is part of a nurse's role in providing safe patient care and promoting health.

Implementing waste reduction programs in hospitals would impact nurse's daily patient care practice, specifically through time with patients, decreased contamination and infection, and increased efficiency. This gives nurses the opportunity to set an example for patients and other medical professionals to practice honest and effective care-taking within their fields. To do this effectively, nurses need to work alongside other health care professionals to improve waste management practices throughout the entire hospital.

Developing an educational intervention can begin by creating a healthcare waste management team. The team can include members from environmental services, infection prevention nurses, sustainability leaders, and nurse educators. The objectives of the healthcare team should be to provide further education on waste management practices and the significance relating to cost, environmental protection, and health safety. Hospitals have several units that may have varying waste management needs. Therefore, when creating the healthcare waste management team, objectives should remain similar but realize units may have varying needs.

Once a waste management team has been formed, an assessment of the nurses and nursing assistants should be performed before an educational intervention is delivered. One study provided a survey to learn about nurse's perception and opinions regarding waste management (Martin et al., 2017). The survey should provide questions regarding current practices and ask

how nurses best learn. After the unit survey has been completed, an observation should be made to survey practices on the floor. Once these observations have been made, an educational intervention plan can be created that works best for each unit.

A variety of educational interventions can be implemented, such as: presentations, lectures, interactive games, posters, emails, signage, or brochures. Studies have proven to be effective in improving waste management with a variety of educational interventions with varying times, delivered over a period from weeks to months. If the unit is experiencing difficulty finding motivation for improvement incentives may be offered. Incentives help to encourage staff to make change (Smart CEO, n. d.). Educational interventions should be delivered regularly for at least one month, once a week. After the education is delivered a post - intervention survey should be administered as well as a post-intervention for observations.

The two educational intervention studies conducted in the United States addressed a need for improved education among waste management in the operative setting. One specific example of this is recycling in operating rooms. Hypothetically, if a recycling program isn't currently practiced in the operating room, this can be implemented as a starter program. The waste management team can work together to create a recycling program. Initially, the team can deliver education on recycling waste to nurses, techs, surgeons, physicians, and anesthesiologist about the importance of recycle, cost savings, and beneficial environmental impact (Martin et al., 2017). The recycling program can gather clean plastic, paper, cardboard, and glass for recycling. Separate bins would be appointed for the items. Clear signage and poster can be placed to encourage, remind, and reinforce knowledge of recycling procedures. If a recycle program has

already been implemented, further education can be delivered to help increase the amount of recycled waste.

Additionally, staff can be incentivized with food, money, or other small goods to encourage recycling practices. Creating competition between operating rooms or other units might help motivate and encourage staff to improve recycling practices. Operating room staff can practice real-time recycling, as equipment is prepared for surgery, it can be a staff member's responsibility to properly dispose of waste in the correlating recycling bin. Operating rooms produce a large amount of waste but with education, recycling opportunities, and more initiatives improved waste management can happen in the operating room (Martin et al., 2017). Operating room recycling is only one small example of potentially improved waste management. Several health professionals can contribute towards improved waste management practices.

The studies analyzed involved nurses among other health professionals and hospital employees. This indicates that waste management is interdisciplinary. Therefore, these implications are relevant to all individuals involved in hospital waste. Of the four studies, two were conducted in the United States and two in developing countries. This shows that there is a global need for improved waste management. All four articles demonstrated a need for improved waste management and benefits from educational interventions. The articles were conducted on different hospital units, critical care, adult, pediatric, and surgical operating rooms. The diversity of the units can lead to improvements on many different units if educational interventions on waste management are provided. The variations in hospital personnel, countries, and units studied implies that waste management has a significant impact in the hospital setting and needs to be addressed on a larger scale.

Another practical implication of better waste management refers to the disposal of sharps. Martin et al. (2017), found decreased amount of sharps waste after reducing the size of puncture resistant sharps containers from 15.2 L to 7.6 L. This reduction implies that non-sharp waste was being disposed of in sharp boxes. Sharps are costlier to dispose of because of their dangerous nature and risk for injuries. Reducing the size of sharps waste containers can encourage staff members to manage other waste forms because of the limited space instead of using the convenience of the sharps box (Martin et al., 2017). Maintaining proper sharps disposal methods also reduces the risk of sharps injuries for both nurses, patients, and staff responsible for transporting waste (World Health Organization, n. d.).

In conclusion, improved waste management can reduce the spread of infection and limit injuries both inside and outside of the hospital setting. Effective waste management can promote cost efficiency, as it is more expensive to manage some wastes more than others. With this knowledge, we can deliver the educational interventions on waste management that research has demonstrated a need for. Floor nurses, nurse educators, environmental services, and sustainability leaders can come together to create healthcare teams dedicated to waste management and recycling to promote cost efficiency, reduce waste, and improved safety.

LIMITATIONS

Multiple limitations were discovered in the process of completing this literature review. When searching databases, it was found that several research studies have been conducted. The first limitation is: few articles used education as an intervention and even fewer statistically analyzed their findings. The second limitation is that other studies only measured the change in amount of waste overtime without implementing education. This resulted in a lack of consistency between studies. Furthermore, different hospitals in different countries worldwide have varying processes of waste disposal resulting in discrepancies among differing practices and outcomes. The articles used in this thesis review worldwide practices as there was not enough data on practices in hospitals in the US, which is the third limitation of this analysis. The final limitation is: none of the articles implemented in this literature used the same educational intervention. This makes it difficult to apply the interventions to other hospital systems. The limitations listed above demonstrate the need for further research and to help define areas of focus for future studies.

Further research should be conducted with an emphasis on educational intervention. Specifics should include type, definitions of waste, setting, time span, duration, and content. This will help research to be reproducible and applicable. Further research should more closely examine recycling because current research shows its significance in waste reduction. The last recommendation for further research would be to explore waste management practices for home health.

SUMMARY

The purpose of this literature review was to evaluate the effectiveness of education on waste management policies and procedures. Overall, the findings of this literature review suggest that education has the potential to improve medical waste disposal and in turn reduce waste and save cost. Three articles reviewed support the thesis that there is a relationship between education on waste management and waste reduction. In researching this, it was also discovered that there is a connection between waste management, the environment, waste expenses, and safety practices. The benefit of this research is that implementing educational interventions has additional benefits beyond waste management. Further research would benefit future hospitals nurses, patients, and the environment through proper waste management practices.

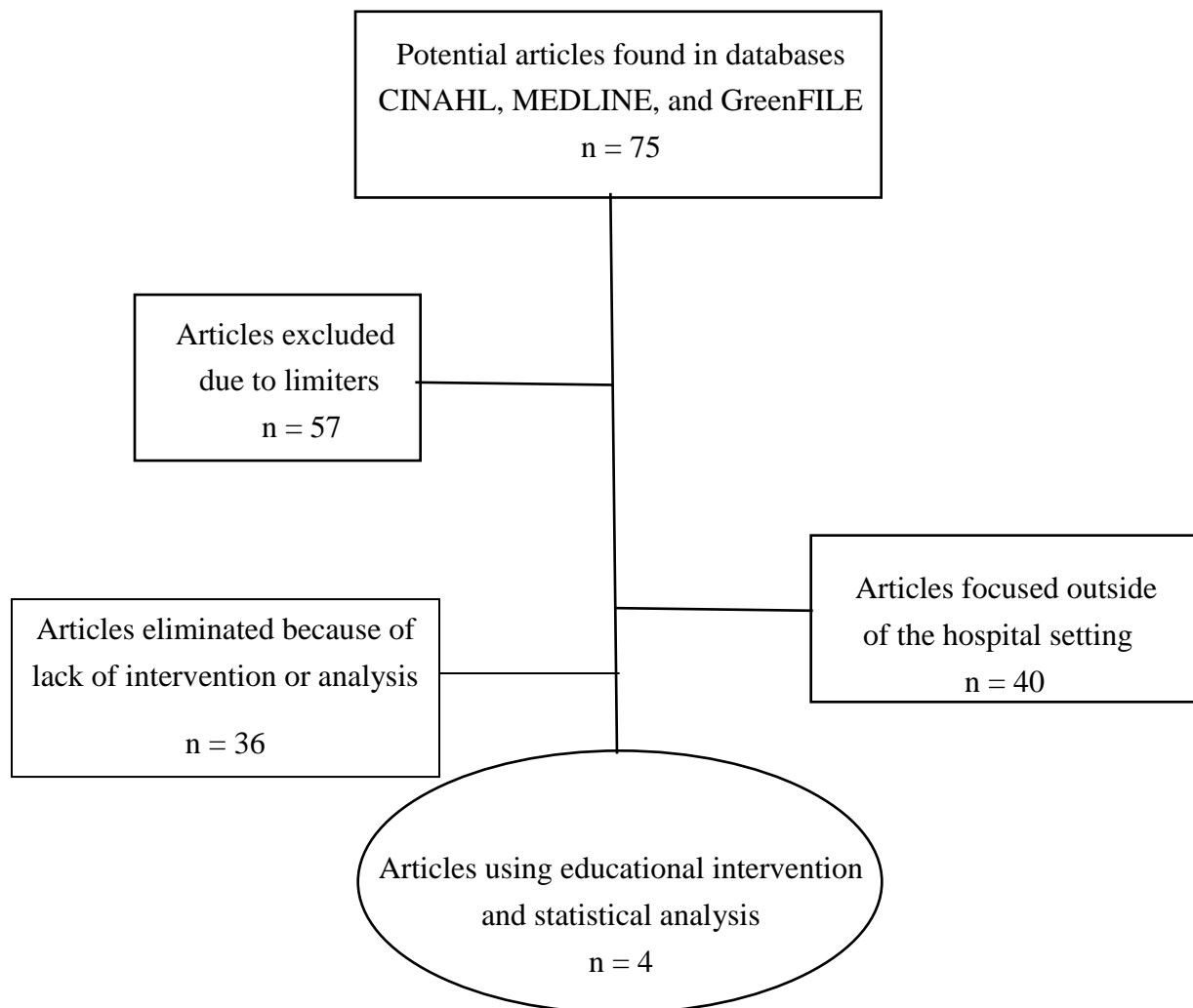
APPENDIX A

CONSORT DIAGRAM

Figure 1: Consort Diagram

Key terms searched: education, training, curriculum, intervention, waste, RMW, municipal waste, biohazard, disposal, recycle, hospital, healthcare, medical, weight, pound, kilogram, or cost

Limiters: English language, peer-reviewed articles, published prior to 2005



APPENDIX B

TABLE OF EVIDENCE OF REVIEWED LITERATURE

Table 3: Table of Evidence of Reviewed Literature

Article Title	Evaluation of an education and training intervention to reduce health care waste in a tertiary hospital in Spain
Design	Quasi-experimental intervention study
Year	2014
Population/Location	382 bed hospital, including acute medical surgical and intensive care units
Intervention	Training over 9-month period; 24 training session of half an hour each in different clinical areas. Additionally, a course on advanced health care waste management (10 hours) was completed. 455 people were involved.
Purpose	The aim of the training was to assess correct segregation of different waste streams. Posters were also used.
Key Findings	A significant decrease in waste production after educational intervention. A statistically significant decrease in volume. Recycling of paper cardboard, and plastic were significantly increased. A 6.2% reduction in the monthly average waste volume which equates to a cost savings of 125,205 Euros.
Implications	Strong employee involvement improves waste segregation and waste reduction. Improper management of healthcare waste poses a risk to patient, healthcare workers, the community, and the environment.
Citation	Mosquera, M., Andrés-Prado, M. J., Rodríguez-Caravaca, G., Latasa, P., & Mosquera, M. E.G. (2014). Evaluation of an education and training intervention to reduce health care waste in a tertiary hospital in Spain. <i>American Journal of Infection Control</i> , 42(8), 894-897. doi:10.1016/j.ajic.2014.04.013

Article Title	Improving waste segregation while reducing costs in a tertiary-care hospital in a lower-middle-income country in Central America
Design	Two types of studies were conducted: the first was an observational, cross-sectional study. The second was a quasi-experimental study with pre and post training questionnaire.
Year	2013
Population/Location	299 beds, and employees nearly 1000 people. 39 healthcare waste educational sessions
Intervention	Training the hospital staff with PowerPoint presentation and flipcharts. Each provided instruction on the types of hospital waste and its disposal. The PowerPoint was for educating large audiences (greater than 20 people) and the flipchart was targeted for smaller groups (less than or equal to 5 people). Length of education sessions was 20 minutes. Staff training was provided on each unit. A questionnaire was developed to determine if staff placed item in the proper waste container, both pre- and post-intervention.
Purpose	To evaluate and improve health care waste practices in El Salvador.
Key Findings	Post training found that the hospital spent an average of \$2,771.57 US dollars less on biohazardous waste disposal during the 5 post-intervention months. During the same period the amount of waste in kilograms decreased by 48%, a decrease from 0.86 kg/bed/day to 0.42 kg/bed/day.
Implications	Better segregation of biohazardous waste and important savings can be obtained by healthcare waste management education of hospital staff.
Citation	Johnson, K. M., González, M. L., Duñas L., Gamero, M., Relyea, G., Luque, L. E., & Caniza, M. A. (2013). Improving waste segregation while reducing costs in a tertiary-care hospital in a lower-middle-income country in Central America. <i>Waste Management & Research</i> , 31(7) 733-738. doi: 10.1177/0734242X13488192

Article Title	Reduction of regulated medical waste using lean sigma results in financial gains for hospital
Design	<i>Not clearly defined</i>
Year	2011
Population/Location	Operating room and post anesthesia care units of a large, urban academic medical center from January 2007 to December 2008.
Intervention	Clarification of the guidelines for regulated medical waste vs municipal trash, identification of areas needing additional receptacle bins, designing and posting clear signage for receptacles and educational posters, developing an educational plan for staff.
Purpose	To assess waste disposal process in surgical suites and to decrease the volume and costs of regulated medical waste.
Key Findings	At baseline the institution produced 15 million pounds of trash per year, an annual cost of US\$3 million. During the study period the change in total waste was not statistically significant (1.6 million lb in January 2007 and 1.1 million lb in December 2008). Overall, the average regulated medical waste in the baseline period was 618,130 +/- 17,122 lb pound per month compared to 520, +/- 13,093 lb pound per month during the study period. The project reduced regulated medical waste in main surgical suites and save the institution \$576,024 during a 24-month period.
Implications	It is necessary for all hospital staff to have knowledge and understanding of waste management practices to reduce waste, save costs, and benefit the environment.
Citation	Stonemetz, J., Pham, J. C., Necochea A. J., McGready, J., Hody, R. E., & Martinez, E. A. (2011). Reduction of regulated medical waste using lean sigma results in financial gains for hospital. <i>Anesthesiology Clinics</i> , 29, 145-152. doi: 10.1016/j.anclin.2010.11.007

Article Title	An initiative to optimize waste streams in the operating room: RECYcling in the operating room (RECOR) project
Design	<i>Not clearly defined</i>
Year	2013-2014
Population/Location	413 bed hospital with 24 Operation Rooms in Washington State, US
Intervention	Educating the staff through modules, printed materials, posters, and in-services. Additionally, posting metrics of success once the buy-in period was complete. Compared the daily weights of solid waste, regulated medical waste, and recyclable waste between the 2-week baseline period and the 2-week implementation period.
Purpose	To optimally sort waste material in the operating room (OR) environment and divert waste such that streams of low-cost disposal, including recyclable material, could be maximized.
Key Findings	During the intervention period daily weight of solid waste decreased by 12% in 16 ORs evaluated, along with the number of solid waste bags. Regulated medical waste decreased in weight by 59% along with the amount of regulated medical waste bags. The weight of recyclable waste increased by 19%, with a 45% increase in recyclable bags used. Greater than 50% reduction in sharps waste was also obtained during the intervention period. A significant improvement in knowledge was also found.
Implications	Successful implementation of Lean Six Sigma method and how anesthesia providers can take a leadership role in designing and managing a process improvement project aimed at reducing hospital waste.
Citation	Martin, D. M., Yanez, N. D., & Treggiaria, M. M. (2017). An initiative to optimize waste streams in the operating room: RECYcling in the operating room (RECOR) project. <i>American Association of Nurse Anesthetists</i> , 85(2), 108-112. Retrieved from https://ohsu.pure.elsevier.com/en/publications/an-initiative-to-optimize-waste-streams-in-the-operating-room-rec

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