Repurposing Surgical Instrument Waste Stream of UVA Health Medical Center

Analysis of the Success of UCLA Health Reusable Isolation Gown Pilot Program

A Thesis Prospectus
In STS 4500
Presented to
The Faculty of the
School of Engineering and Applied Science
University of Virginia
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Biomedical Engineering

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December 6, 2023

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

Combating the increase in landfill waste has been one of the foremost environmental problems of the past decade. Specifically, healthcare is the second most wasteful industry in the United States behind the food industry, accounting for an average of about 5 million tons of waste per year, or about 14,000 tons per day (Wen, 2023; "Waste Reduction—Sustainability | UCLA Health", n.d.). Looking forward, hospital waste output is unlikely to decrease without drastic changes to the current supply chains, as the vast majority of healthcare products are single-use, disposable items made of plastic, metal, and glass. These disposable products currently have no recycling procedures in place, with nearly all items being discarded in landfills after use, adding the immense amount of total waste produced each year across the country. Therefore, the implementation of practical solutions that reuse materials is vital to the reduction of overall waste output.

In order to reduce the waste output of the University of Virginia (UVA) Health Medical Center, I will target one of the largest contributors of total hospital waste: the operating room. Therefore, I propose a redesign of the stainless steel operating room surgical tool waste stream in order to create injection molds for additive manufacturing processes. The waste stream redesign will improve on the current process, where surgical instruments are discarded after use, by providing them with a secondary use, which will reduce overall hospital waste output. This technical project requires several steps, as the surgical instruments must be collected, sanitized, melted down, and formed into molds. Due to its complexity, the process involves many different entities and groups that must work together for successful implementation, all of whom have different priorities and values. To examine the social mechanisms that lead to effective integration of technological development, I will utilize the science, technology, and society

(STS) framework of social construction of technology (SCOT) to analyze the successful implementation of reusable hospital isolation gowns at the University of California, Los Angeles (UCLA) Health Medical Center. Specifically, I will examine how the alignment of relevant stakeholder groups in the hospital system and broader scope contributed to the adoption and success of this change. In order to address the sociotechnical challenge of reducing waste output, modifications need to be made on both ends of the waste stream, as upstream changes switching to reusable materials must be implemented as well as downstream repurposing of waste. Therefore, using insights gained from understanding the social factors that contributed to the success of the isolation gown program, I will then work to leverage those same ideas to ensure that my technical project design aligns with the views of all relevant stakeholders and properly reduces downstream waste, as well as propose upstream changes to the current waste stream to make it more sustainable.

Technical Project Proposal

Operation procedures are one of the largest contributing factors to healthcare waste, with operating rooms producing 20 to 30 percent of total hospital waste output across the country (Plisko et al., 2015). The healthcare industry has also been one of the fastest growing industries in recent years, which has contributed to a substantial increase in healthcare landfill contribution (Kenny & Priyadarshini, 2021). This surge in healthcare waste is further exacerbated by hospitals, such as the UVA Health Medical Center, switching from reusable surgical instruments to disposable alternatives.

The UVA Medical Center previously used high-grade German stainless steel surgical instruments that could be sterilized and reused for years without needing replaced. The process included collecting surgical tools after a procedure and using an autoclave to decontaminate the instruments before redistributing them to be used again. However, this practice was abandoned, as the hospital switched to using cheaper, lower quality instruments that rust when attempted to wash, resulting in them being discarded after only a single use. There is no current process in place for recycling disposable surgical instruments, as it is deemed more cost-efficient to simply replace them after each use. The acceptance of the decision to switch to disposable medical supplies also exacerbates greenhouse gas emissions. Healthcare systems already account for nearly 8% of the nation's carbon emissions, but if more single-use items are used, that figure will only increase and cause further damage to the environment (Pichler et al., 2019). Therefore, development of a protocol for reusing disposable surgical tools for a practical purpose is necessary to decrease hospital waste output.

The goal of the technical project is to design a process for recycling used stainless steel surgical tools and remanufacturing them into injection molds for three-dimensional model fabrication. The project is broken down into four major components that need to be implemented, from the collection of used instruments to the construction of injection molds. The first step is to complete a comprehensive lifecycle analysis and quantification of the UVA Health disposable surgical tool waste stream. Then, a robust decontamination protocol must be implemented to clean the surgical tools, as they are deemed a hazardous waste product by the Environmental Protection Agency (EPA) upon existing the surgical suite ("Model Guidelines for State Medical Waste Management", n.d.). Therefore, bacteria and pathogen tests must be conducted after decontamination to examine the efficacy of the sterilization process and ensure that all surgical waste is safe for repurposing. The next step will be to refine and melt the surgical tools. With the refinement process, the chemical composition of the stainless steel will be tested for its chromium content, which determines the strength and durability of the metal (Kropschot & Doebrich, 2010). In October 2023 the United States Food and Drug Administration (FDA) released Import Alert 76-01, a warning about imported disposable surgical instruments, citing that "the quality of the instruments appear to fall below that which they were represented to possess. Documented analysis revealed great variability in chromium content" ("Import Alert 76-01", 2023). Therefore, upon melting, the steel must be analyzed for its chemical composition to ensure that a chromium content of 12-18% is achieved for adequate durability and strength (Modak, 2023). Finally, the injection mold design must be produced from the stainless steel and assembled. This process will be validated by the creation of a model using the mold and analyzing the scale of precision as well as the efficiency of the overall process in its ease of use for and accessibility for users.

STS Project

In 2012, the University of California, Las Angeles (UCLA) introduced a pilot program at its Ronald Reagan Medical Center that swapped the disposable isolation gowns used in its liver transplant and liver intensive care unit (ICU) with reusable alternatives (Trinka, n.d.). Prior to implementing the change, the liver transplant unit used over 1,000 disposable gowns each day and the entire health system purchased 2.6 million gowns each year, producing 234 tons of landfill waste annually (Trinka, n.d.). However, the new isolation gowns could be washed and worn again, with a typical lifespan between 75 and 100 uses. The circular lifecycle of the reusable gowns led to a net decrease in per-use gown cost, including resources and labor required for washing. It was reported that the program resulted in a 53% annual savings in total gown expenditure (Trinka, n.d.). This pilot program was deemed such a success by hospital administrators that it was then implemented across all UCLA Health facilities, with complete compliance reported in 2015 (Trinka, n.d.). Since its first introduction, the utilization of reusable isolation gowns has generated a total savings of $3.9 million, as well as reducing hospital waste output by over 1,180 tons (Trinka, n.d.).

While the success of the reusable isolation gown program is often attributed the UCLA administrators who enacted its implementation, this fails to take into account the perspectives and ideas held by various groups, such as the doctors, nurses, hospital waste management, patients, and members of a wider community that contributed to its effective implementation. Instead of focusing merely on a single positive alteration to the reusable gowns, a complete redesign was undertaken, where changes were made to make them more effective, more practical, and less environmentally impactful. Each individual stakeholder group contributed to the final design in some significant way, either through physical design suggestions or simply by shared values. Therefore, the final design that was accepted was socially constructed as a result of the perspectives of each stakeholder group.

I argue that it was due to the alignment of all relevant stakeholder perspectives on societal and logistical ideas that the UCLA Health reusable isolation gown pilot program was successfully implemented, so I will draw upon the STS concept of SCOT to frame my analysis of the project. The principle of SCOT is based on the idea that technological change is influenced by a variety of social factors, including the unique views of relevant social groups. Central to this this framework is the notion that innovation has interpretive flexibility, in that objects are interpreted differently by each specific social group (Johnson, n.d.). Therefore, I will utilize interpretive flexibility to explore the perspectives of each relevant group with interest in the design of hospital isolation gowns to explore how views of each group contributed to the successful adoption of reusable gowns to replace the previous disposable design. The evidence I will utilize to support my argument will be taken from a number of sources, including news articles, studies of the efficacy and environmental impact of the gowns, interviews with hospital administrators, and feedback from users in the hospital system.

Conclusion

As the healthcare industry in the United States continues to grow, its expansion contributes to the propagation of landfill waste from hospital systems. Therefore, it becomes increasingly important that efforts are undertaken to limit waste output and redesign products or waste streams to allow for items to be recycled in a meaningful manner. The technical project proposed aims to limit hospital waste output by creating a process that utilizes disposable stainless steel surgical instruments to create injection molds for additive manufacturing. The STS research project is intended to analyze the successful implementation of a program at the UCLA Health Medical Center that swapped single-use isolation gowns for a reusable alternative. This will be accomplished using SCOT to evaluate the perspectives of all relevant social groups in the hospital, and how the ideas of each group combined to form the new design so that it best supports the values of all stakeholders. The insights gained from exploring stakeholder values in a hospital setting can then be applied to the technical product to ensure that the design is both effective for use and meaningful in terms of addressing sustainability. The combined results of the technical design and STS project will serve as a complete analysis of the socio-technical challenge of reducing hospital waste by examining the factors behind product supply decisions, as well as provide a framework for future conservation work in a hospital setting.

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