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Surgical Site Infections: Causes and Implication On Healthcare Systems and Patients in Low Resource Countries

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ABSTRACT

Surgical site infections (SSI) are a leading cause of complications and mortality in patients admitted to hospitals in low resource countries. These infections are largely a result of a lack of proper sterilization. Sterilization requires high heat and pressure typically provided by gas powered autoclaves that may not be readily available. Unclean surgical equipment leads to growth of bacteria leading to infections in patients. This paper examines the cause and effect of sterilization and SSI and implications in terms of financial and health burden on healthcare systems and patients. Finally, the paper provides an alternative solution in the form of solar powered autoclaves, that is fast catching on in low resource countries.

Surgical Site Infections (SSI)

Health issues primarily consist of Surgical Site Infections (SSI), infections as a result of surgery and occurs in the part of the body where the surgery was performed, caused by a lack of sterilization of surgical and other medical equipment, including needles (Pierre et al., 2000). Without knowing the implications of Surgical Site Infections, understanding the urgency for a different method of sterilization is arduous.

SSIs are a leading cause of mortality and morbidity in low resources and off-grid areas. According to Song et al. (2014), researchers in the Department of Biomedical Engineering at Carnegie Mellon University, “surgical site infections (SSI) are currently a major cause of morbidity and mortality in low-resource areas” (p. 1).

Lack of Resources for Sterilization

Currently, gas-powered autoclaves, gas fueled machines that use heat and pressure to clean, are the method of sterilization in low-resource countries such as India as well as various countries in Africa. However, off-grid areas, areas without electricity, do not have the funding for gas nor do they have enough gas to power their autoclaves, causing them to abandon sterilization completely. How does a lack of sterilization deteriorate the health and well-being of the people in low resource areas? This poses not only major health issues, but financial issues for patients as well as hospitals (Shepard, 2013). According to Schuler et al. (2012), engineers at Brown and Rice University, the price of gas is too expensive for these off-grid areas in South Asia and Africa to afford to power their gas autoclaves. They have the equipment to sterilize, but without the gas, their medical equipment and instruments are left unclean and increase the risk of SSIs.

Sterilization and SSI

A lack of sterilization and clean water can especially raise the risk for bacterial SSIs. Lucy et al. (2017) assert, "Four [bacterial] organisms were responsible for causation of SSIs among this cohort. *Klebsiella pneumoniae* caused 50% of the SSIs followed by *Staphylococcus aureus* at 27.8% and *E. coli* and *Pseudomonas* shared 11.1% each" (p. 3). These bacterial infections grow in the patients' bodies after surgery, raising mortality and morbidity. Because these SSIs are caused by bacterial growth, patients require antibiotics as well as longer stays in the hospitals, increasing patients' hospital costs.

The lack of proper sterilization in low resource, off-grid areas causes Surgical Site Infections. According to Pierre et al. (2017), researchers at universities in France and Africa, nurses and doctors are forced to reuse dirty needles due to the lack of resources and the shortage of fuel to power autoclaves for sterilization. Without access to sterilization, the risk of SSI stays consistently high posing a risk for the population. Lucy et al. (2017), researchers at the Mbarara University of Science and Technology, found a large majority of SSI patients had contaminated, partially contaminated, and dirty wounds. The state of the surgical wounds in SSI patients demonstrates the lack of sterility in these areas in Africa and South Asia. Without sterilization, the mortality and morbidity rates will continue to remain high. According to Chu et al. (2014), researchers in the Department of Surgery at Harvard Medical School and University of California, San Francisco, a lack of sterilization increases the risk of infection in Caesarean Sections in Sub-Saharan Africa. Without sterilization, the morbidity and mortality rates increase due to diseases involved with contaminated wounds. Surgical operations performed using contaminated instruments have been proven to cause SSIs.

The residents of these off-grid areas go to the hospital for normal surgical procedures, but end up with the burden of SSIs. According to Dillon et al. (2011), researchers at Penn State and other colleges in Pennsylvania, general and vascular surgery patients in Africa have a high chance of developing SSIs due to the nature of their surgeries. If the method of sterilization in these off-grid areas does not improve, more and more patients will continue to suffer the burden of SSIs. Lucy et al. (2017) report, "overall SSI incidence was 16.4%: 5.9% superficial and 47.1% deep and organ space SSIs each" (p. 1). A large portion of SSI incidence was in organs, increasing the chance of death. Because there is a lack of sterilization, every patient getting surgery in these areas has an increased risk of death due to SSIs on top of the chance of death from the actual procedure.

SSI and Financial Burden On Patients and Healthcare Systems

SSIs create a financial burden on both the patients and their families. According to Sullivan et al. (2017), doctors at Beth Israel Deaconess Medical Center, SSIs are the third most costly infection due to readmission, increased length of stay, and the cost of antibiotics. Because of the lack of sterilization caused by a lack of resources to sterilize, patients are burdened with hefty medical costs to pay for treatment of SSIs. According to Gupta et al. (2017), researchers at Beth Israel Deaconess Medical Center, additional hospital costs brought on by SSIs range from $3,000 to $40,000. Without proper sterilization, patients continue to be burdened by not only the SSI itself, but the cost of the infection, raising their financial and emotional toll.

SSI patients take up a large portion of already low resource hospitals' resources. According to Song et al. (2014), the hospitals and clinics in low resource and off-grid areas, not only lack sterilization and electricity, but also lack funding for fuel and treatments. Without enough money, these areas lack the resources to tend to any patient, let alone SSI patients.

Shepard (2013), a researcher at Johns Hopkins University and Stanford Clinic, argues patients with SSIs not only require antibiotics in addition to preoperative antibiotics, but also require more time in the Intensive Care Unit (ICU). Patients with SSIs have their own financial burdens, but also cause financial stress on already low resource hospitals. According to Chu et al. (2014), the length of stay for women with a Caesarean section without an SSI was 7 days as opposed to women with SSIs staying for as long as 21 days. Additionally, due to SSI patients taking up a lot of the hospitals' resources, they face financial drawbacks.

Shepard (2013), declares hospitals lose millions of dollars due to SSI patients due to length of stay in ICUs and regular hospital beds. Each patient that comes into a hospital provides money and revenue, but the longer a patient stays the less room there is for a new patient with a new procedure. According to Dillon et al. (2011), hospitals have to pay for additional antibiotics to accommodate SSI patients. Not only do hospitals lose revenue due to lack of patients, they also lose more money due to the lack of resources and needing to pay to have those resources such as antibiotics supplied to their clinics.

Discussion

As a resolution to this, Schuler et al. (2012) propose the switch to solar sterilization, a method of sterilization that requires only the sun to power as well as lower costs in the long run. The fuel shortage in addition to the cost of gas is no longer a factor with the implementation of solar-powered sterilization. It is now in the hands of the government to fund the upfront fee for this improved method of sterilization that would allow the residents in these countries to live a life of higher quality.

Conclusion

Ultimately, the lack of sterilization in low-resource countries and off-grid areas deteriorates the health and well-being of the people living there. Patients not only go through the pain of SSIs, but they also endure a financial and emotional toll. Additionally, already low resource hospitals continue to have their supplies depleted and money wasted on issues easily fixed by changing the method of sterilization.

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References

Boltz, M. M., Hollenbeak, C. S., Julian, K. G., Ortenzi, G., & Dillon, P. W. (2011). *Hospital costs associated with surgical site infections in general and vascular surgery patients*. https://pubmed.ncbi.nlm.nih.gov/28410761/.

This peer-reviewed article is about vascular and general surgery patients developing Surgical Site Infections due to lack of sterilization. This supports my research that lack of sterilization and contaminated wounds leads to SSIs.

Chu, K., Maine, R., & Trelles, M. (2014, October 31). *Cesarean section surgical site infections in sub-Saharan Africa: a multi-country study from Medecins Sans Frontieres*. World journal of surgery. https://pubmed.ncbi.nlm.nih.gov/25358418/.

This article outlines how women with c-sections in Sub-Saharan Africa get infected with SSIs due to a lack of sterilization. It also outlines the ways SSI patients deplete resources from already low-resource hospitals.

Dhankher, A., Drake, G., Haytko, J., Patel, Y., Sidoti, C., & Song, G. (2014). *A Solar Sterilization and*

Distillation Unit for Water in Resource-Poor Settings. IEEE XPLORE. https://ieeexplore.ieee.org/document/6970324.

This peer-reviewed article is about the technology and feasibility of solar-powered sterilization. This supports my research because it shows that the current method, gas-powered, is not effective enough to be safe or ethical to keep.

Dicko, M., Jacquet, B., Pierre, L., Kone, S., Ganivet, S., & Oni, A. Q. O. (2000). *Safety of immunization injections in Africa: not simply a ...* ResearchGate. https://www.researchgate.net/publication/12573598_Safety_of_immunization_injections_in_Africa_Not_simply_a_problem_of_logistics.

This article is about the lack of sterilization for needles. It outlines the fact that they reuse needles even if they are dirty. This supports my research that lack of sterilization is unethical.

Kaseman, T., Boubour, J., & Schuler, D. A. (2012). *Validation of the efficacy of a solar-thermal powered autoclave system for off-grid medical instrument wet sterilization*. The American journal of tropical medicine and hygiene. https://www.astmh.org/search?searchtext=Validation+of+the+Efficacy+of+a+Solar-Ther mal+Powered+Autoclave+System+for+Off-Grid++Medical+Instrument+Wet+Sterilizatio n&searchmode=anyword.

This article is about how solar autoclaves are a cheaper, more effective option for sterilization. It outlines the problems with gas autoclaves and argues why solar autoclaves are better. This supports my research that the current method of sterilization, gas-powered, is unethical.

Lubega, A., Joel, B., & Justina Lucy, N. (2017, January 12). *Incidence and Etiology of Surgical Site Infections among Emergency Postoperative Patients in Mbarara Regional Referral Hospital, South Western Uganda.* Surgery Research and Practice. https://www.hindawi.com/journals/srp/2017/6365172/.

This peer-reviewed article is about the etiology of SSIs. The article addresses that SSIs are prominent off-grid areas without the means of powering their autoclaves. It supports my research because it discusses the role of a lack of sterilization in low resource areas in patients developing SSIs.

Shepard, J. (2013, October 1). *Financial Impact of Surgical Site Infections*. JAMA Surgery. https://jamanetwork.com/journals/jamasurgery/fullarticle/1730490.

This article is about the financial burden of SSIs on hospitals. It is the hospital's perspective on the impact of SSIs. This supports my research that the current method of sterilization is not enough, and that a lack of proper sterilization is unethical.

Sullivan, E., Gupta, A., Cook, C. H., Khan, F., Cherian, T., & Arenal, J. J. (2017, May 1). *Cost and Consequences of Surgical Site Infections: A Call to Arms*. Mary Ann Liebert, Inc., publishers. https://www.liebertpub.com/doi/10.1089/sur.2017.072.

This article is about the financial burden of SSIs on patients. It is a patient's perspective of the costs and how high the cost of treatment for SSIs are. This supports my research that the financial burden is too great to be ethical.