UDC 004.942:615.32
DOI: https://doi.org/ 10.17721/3041-2323.2024.425-432

Andrii MALIAVA, Student
e-mail: andriy_m@knu.ua
Taras Shevchenko National University of Kyiv, Kyiv, Ukraine

USAGE OF INFORMATION SYSTEM IN SPHERE OF MEDICINE TO IMPROVE EFFICIENCY OF STERILIZATION PROCESSES

This article examines the critical role of sterilization in healthcare, emphasizing its importance in preventing Surgical Site Infections (SSIs), which are a leading cause of postoperative complications worldwide. It highlights the disparities in sterilization practices between Low and Middle-Income Countries (LMICs) and High-Income Countries (HICs) due to economic constraints and varying access to technology. The article explores the potential of developing a globally accessible information system for sterilization management, sponsored by the World Health Organization (WHO). Such a system could offer customizable, efficient solutions tailored to the resources of different healthcare facilities, enhancing patient safety, reducing SSIs, and positively affecting both global healthcare and economic outcomes. The long-term benefits include lower infection rates, reduced healthcare costs, and improved public trust in healthcare systems.

Keywords: ***sterilization, surgical site infections (SSIS), healthcare, low and middle-income countries (LMICS), high-income countries (HICS), world health organization (WHO), information systems, infection control, healthcare technology, patient safety, economic impact, global health, healthcare reforms.***

Background

Sterilization is the process of eliminating all forms of microbial life, including bacteria, viruses, fungi, and spores, from medical instruments and surfaces to ensure they are safe for use. It is a critical process in healthcare that is present in the surgical life cycle in each and every country in the world. When talking about surgery, sterilization is not a precaution but a necessity. Any fault or deviation from the strict requirements will probably result in a variety of dangerous situations that may lead to the death and severe injuries of a patient as well as a doctor. The importance of sterilization processes is confirmed by various healthcare organizations worldwide, including the World Health

Organization. They officially launched a course in 2020 divided into sterilization and decontamination of instruments and medical devices (World Health Organization).

Results

Problems that we are facing nowadays are usually connected to the quality of sterilization, which varies across countries, largely due to their economic status. Countries are often categorized into Low and Middle-Income-Countries (LMICs) and High-Income-Countries (HICs) based on their gross national income (GNI) per capita. The World Bank (table 1) defines Lower middle-income economies as those with a GNI per capita between $1,136 and $4,465; upper middle-income economies are those with a GNI per capita between $4,466 and $13,845; high-income economies are those with a GNI per capita of $13,846 or more, according to the World Bank Country and Lending Groups (The World Bank, n. d.1; n. d.2).

Table 1

Country category by GNI per capita
(The World Bank, n. d.1)

Country category	Minimum GNI per capita	Maximum GNI per capita
Low and Middle-Income-Countries	$1,136	$4,465
Middle-Income-Countries	$4,466	$13,845
High-Income-Countries	$13,846	–

LMICs frequently face challenges such as insufficient funding, which leads to outdated equipment, low-trained inexperienced staff, which negatively affects the quality of sterilization processes. Unlike LMICs, HICs typically allocate more resources to the research and development of high-efficient sterilization technologies, which results in lower surgical site infections (SSI). SSI are one of the most common and dangerous complications that arise from inadequate sterilization. That can cause the development of pathogens that infiltrate a surgical wound, causing inflammation, delayed healing, and, in severe cases,

sepsis or death. Surgical site infections are considered the reason for most postoperative deaths. Generally speaking, postoperative death is the third leading cause of death worldwide, accounting for 7.7% of global deaths in 2016 (Cura, 2023), which makes sterilization nowadays one of the most important.

Statement of the problem. Even in developed countries, like the United States, which is considered as a High Income country according to The World Bank: (The World Bank), SSI affects thousands of people each year (Cura, 2023). Despite achieved progress in the field of medical technology and sterilization, these infections remain a non-solved problem, underscoring the importance of continuous improvement of current sterilization practices. However, the current difference in efficiency of sterilization processes is clearly visible: infection rates in LMICs can reach as high as 70%, compared to 1.2%-5.2% in HICs, including the US (Cura, 2023).

Ukraine, according to the World Bank's 2024 data (The World Bank, n. d.), is classified as an Upper-Middle-Income Country (UMIC), which is still is a part of the LMIC group. The Ukrainian healthcare system underwent significant reforms in the last 5 years and became more transparent and digitalized, which positively impacted disease control efficiency, but still faces challenges typical of LMICs. These include underfunding and outdated medical equipment, especially in rural areas, leading to a heightened risk of hospital-acquired infections (HAIs) and SSIs. While urban hospitals in Ukraine may have access to modern sterilization technologies, the disparity between rural and urban healthcare facilities is more visible and often results in inconsistent sterilization practices.

Proposed solutions. Sterilization efficiency can be achieved through enhanced staff training and the adoption of advanced technologies; however, these improvements often result in increased costs that LMICs may struggle to afford. Implementing information systems is often a more cost-effective solution for enhancing sterilization practices in healthcare settings. These systems are typically less expensive than advanced sterilization technologies, making them more accessible to LMICs. Additionally, training staff to utilize information systems is generally more straightforward and less resource-intensive. As a result, information systems represent an affordable approach for LMICs to

enhance sterilization efficiency, ultimately contributing to better infection control.

Discussion and Conclusion

Challenges in developing global sterilization solutions. Currently, there are no widely available information systems specifically designed for sterilization processes that can be purchased by commercial hospitals or governments. While some private developments exist, they remain largely undisclosed as they are developed exclusively to meet the needs of the companies that requested them. The absence of accessible solutions creates a major gap in the healthcare market, especially for LMICs that face challenges with limited resources. Many hospitals in these countries lack the funding to invest in expensive, custom-made information systems designed for sterilization processes. This situation leaves healthcare providers in LMICs without the tools they need to effectively monitor and manage sterilization practices. As a result, hospitals in LMICs often struggle to maintain high standards of patient safety, and the risk of SSI remains high. Without affordable, ready-to-use solutions, these healthcare facilities are forced to rely on outdated sterilization technologies, which can further compromise the quality of care they provide.

Developing a single, ready-to-use information system for sterilization processes is a challenging task due to the diverse standards and requirements across different countries and private medical organizations. Each healthcare facility has its own specific needs based on factors like available resources, staff training, and local regulations. As a result, any effective system would need to function like a modular constructor, allowing organizations to customize their setup according to the resources they can provide and the capabilities of their staff. The system should intelligently adapt to these variations, determining the most efficient methods for sterilizing, accounting for, storing, and managing medical instruments.

Additionally, creating such a system poses significant challenges related to security. Since it involves handling sensitive personal information, including patient data, the system must meet very high security standards. This is essential not only to protect patient confidentiality but also to comply with various data protection regulations, such as the General Data Protection Regulation (GDPR)

(European Union, n. d.) in Europe, the Health Insurance Portability and Accountability Act (HIPAA) (U. S. Department of Health & Human Services, n. d.). in the United States, and the Personal Information Protection and Electronic Documents Act (PIPEDA) (Government of Canada, n. d.) in Canada. Each of these regulations imposes strict requirements regarding how personal data must be collected, stored, and processed, and non-compliance can result in severe penalties.

Because of the complexities of developing a single, ready-to-use information system, this requires global collaboration. It is difficult for any single country, even a highly developed one, to undertake such a comprehensive project alone due to the immense challenges of meeting various standards, security demands, and legal requirements across different regions. However, a solution could be found through the leadership of an international organization like the World Health Organization (WHO).

The WHO could play a game-changing role in sponsoring, organizing, and overseeing the development of such software. By providing financial support and bringing together experts from various fields – medical, technological, and legal – the WHO could ensure that the system is developed with maximum compatibility. A WHO initiative would help to establish universal standards for sterilization processes, while allowing the system to remain flexible enough to fulfill the specific requirements of individual countries and organizations. This modular approach would enable healthcare facilities to customize the software based on their resources, staffing, and regulatory environment.

Advantages of implementing information systems in sterilization. The development of such a system would have such a positive impact on sterilization processes and healthcare worldwide. For LMICs, the system would offer an affordable and scalable solution, allowing them to improve sterilization practices without the prohibitive costs of custom software development. It would enable healthcare facilities in LMICs to ensure compliance with best practices, reduce the risk of SSIs, and, as a result, enhance patient safety. This approach would help LMICs overcome the challenges of limited resources, outdated equipment, and insufficient staff training.

High-Income Countries would also benefit significantly from such a system. While many HICs already have advanced healthcare infrastructure,

a unified information system could streamline and enhance their existing sterilization processes. By adopting a globally recognized system, hospitals and healthcare networks could improve integration, enabling more consistent and efficient monitoring and management of sterilization procedures. Furthermore, by using a standardized system, HICs could avoid the high costs associated with developing, managing, and maintaining their own custom sterilization solutions. Instead of investing heavily in proprietary systems that may quickly become outdated or need continuous updates, healthcare providers could rely on a system developed and supported on a global scale.

Both LMICs and HICs would benefit greatly from the widespread implementation of this system. The reduction of SSIs would result in fewer postoperative complications, shorter hospital stays, and reduced healthcare costs for both governments and private healthcare providers. Additionally, it would help lower the global burden of antibiotic-resistant infections, as fewer patients would require treatment for preventable infections.

Moreover, by shortening recovery periods, this system would positively affect the economy, especially in LMICs. Patients would be able to return to work and daily activities sooner, reducing the economic strain on families and healthcare systems. This improvement in recovery time would have a direct impact on the economic development of LMICs, where prolonged hospital stays and the inability to work can severely affect livelihoods. By improving patient outcomes and increasing the overall safety of medical procedures, the software would also enhance public trust in healthcare systems worldwide.

Projected outcomes within the first year of implementation. In just one year, healthcare facilities could see a measurable reduction in SSIs, leading to fewer postoperative complications and a decrease in healthcare costs. The shorter recovery periods would start positively affecting workforce productivity, especially in Low and Middle-Income Countries, where a quicker recovery can have an immediate impact on economic growth and stability. Public trust in healthcare would also begin to rise as patient outcomes improved.

Projected outcomes within the ten years of implementation. Over the span of ten years, the cumulative benefits would be even more substantial. Both LMICs and HICs would see a significant reduction

in the global burden of antibiotic-resistant infections, as fewer patients would require antibiotics to prevent infections. The long-term cost savings from fewer infections, shorter hospital stays, and less need for custom sterilization solutions would benefit both governments and private healthcare providers. The economic growth driven by healthier populations and increased productivity would be particularly transformative for LMICs.

Longterm benefits of implementation. Over a lifetime, the system would lead to sustained improvements in global healthcare. By continuously evolving with new technologies and regulatory changes, the system would ensure that sterilization practices remain efficient and secure worldwide. This would result in higher overall patient safety, lower healthcare costs, and stronger public trust in healthcare systems. The long-term impact on global public health would be profound, with healthier populations contributing to more robust economies, particularly in developing nations.

References

Cura, M. (2023). *Instrument sterilization and surgical site infections in low and middle-income countries.* https://www.researchgate.net/publication/378165625_-Instrument_Sterilization_and_Surgical_Site_Infections_in_Low_and_Middle_Income_Countries

European Union. (n. d.). *General Data Protection Regulation.* https://gdpr.eu/

Government of Canada. (n. d.). *Personal Information Protection and Electronic Documents Act.* https://laws-lois.justice.gc.ca/eng/acts/p-8.6/index.html

The World Bank. (n. d.). *Data Ukraine information.* https://data.worldbank.org/country/ukraine

The World Bank. (n. d.1). *Middle income countries.* https://www.worldbank.org/en/country/mic/overview

The World Bank. (n. d.2). *World Bank country and lending groups.* https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

U. S. Department of Health & Human Services. (n. d.). *Health Insurance Portability and Accountability Act.* https://www.hhs.gov/hipaa/index.html

World Health Organization. (n. d.). *Decontamination and sterilization of medical devices.* https://openwho.org/courses/IPC-DECON-EN

Отримано редакцією журналу / Received: 17.09.24
Прорецензовано / Revised: 27.09.24
Схвалено до друку / Accepted: 01.10.24

Андрій МАЛЯВА, студ.
e-mail: andriy_m@knu.ua
Київський національний університет
імені Тараса Шевченка, Київ, Україна

ВИКОРИСТАННЯ ІНФОРМАЦІЙНОЇ СИСТЕМИ У СФЕРІ МЕДИЦИНИ ДЛЯ ПІДВИЩЕННЯ ЕФЕКТИВНОСТІ ПРОЦЕСІВ СТЕРИЛІЗАЦІЇ

Розглянуто критичну роль стерилізації у сфері охорони здоров'я, підкреслено її значення у запобіганні післяопераційним інфекціям (SSI), які є однією з основних причин ускладнень після хірургічних втручань у світі. Виконано аналіз розбіжностей у практиках стерилізації між країнами з низьким і середнім рівнем доходу (LMIC) і країнами з високим рівнем доходу (HIC), що зумовлено економічними обмеженнями та різним рівнем доступу до технологій. Досліджено потенціал створення глобально доступної інформаційної системи для управління стерилізацією, яку може підтримати Всесвітня організація охорони здоров'я (WHO). Така система може запропонувати ефективні й адаптивні рішення, враховуючи ресурси різних медичних установ, що сприятиме підвищенню безпеки пацієнтів, зменшенню випадків SSI та позитивному впливу на загальний стан охорони здоров'я та економіки у світі. Довгострокові переваги включають зниження рівня інфекцій, скорочення витрат на охорону здоров'я та підвищення довіри суспільства до медичних систем.

Ключові слова: ***стерилізація, післяопераційні інфекції (SSI), охорона здоров'я, країни з низьким і середнім рівнем доходу (LMIC), країни з високим рівнем доходу (HIC), Всесвітня організація охорони здоров'я (WHO), інформаційні системи, контроль інфекцій, медичні технології, безпека пацієнтів, економічний вплив, глобальне здоров'я, реформи охорони здоров'я.***

Автор заявляє про відсутність конфлікту інтересів. Спонсори не брали участі в розробленні дослідження; у зборі, аналізі чи інтерпретації даних; у написанні рукопису; в рішенні про публікацію результатів.

The author declares no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.