Healthcare-associated Infection Surveillance in Low- and Middle-income Countries: Challenges, Opportunities, and the Way Forward

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Abstract

With a substantial impact on patient morbidity and mortality, healthcare-associated infections (HAIs) are a significant public health concern. HAI surveillance plays a critical role in preventing and controlling these infections by providing accurate and timely data on the burden, trends, and risk factors associated with HAIs. In recent years, significant progress has been made in the development and implementation of HAI surveillance systems, both in high-income and low- and middle-income countries (LMICs). However, there are still many challenges that must be addressed, including resource limitations, lack of standardization, and data quality issues.

This review provides a comprehensive overview of HAI surveillance, including its history, evolution, methods, tools, strengths, limitations, challenges, and opportunities. It highlights the importance of international collaboration and partnerships in strengthening HAI surveillance systems, as well as the need for continued research and improvement in this area.

The findings of this review have important implications for policy and practice in HAI surveillance. They underscore the need for ongoing efforts to standardize and improve the quality of HAI surveillance data, as well as the importance of investing in emerging technologies and methods that can enhance the efficiency and accuracy of these systems. The review also highlights the critical role of international collaboration and partnerships in addressing the global burden of HAIs and provides recommendations for applying lessons learned from successful programs to other settings.

Keywords: Healthcare-associated infections surveillance, Healthcare-associated infections, International collaboration, Patient safety, Risk factors.

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Introduction

Infections that individuals contract while receiving healthcare treatments are known as healthcare-associated infections (HAIs). They can occur in any healthcare setting, including hospitals, long-term care facilities, and outpatient clinics.[1] HAIs pose a significant public health threat, with an estimated one in 31 hospitalized patients experiencing an HAI in the United States alone.[2] Long hospital stays, higher healthcare expenses, and even death are possible outcomes of these infections. Additionally, HAIs can contribute to the spread of antibiotic-resistant bacteria, making it more difficult to treat infections in the future.[3]

The burden of HAIs is particularly high in low- and middle-income countries (LMICs), where healthcare facilities may have limited resources, and infection prevention and control practices may be inadequate.[4] The World Health Organization (WHO) estimates that seven out of every 100 hospitalized patients in LMICs will acquire an HAI.[5]

Despite efforts to prevent and control HAIs, they continue to pose a significant challenge to healthcare systems worldwide. Effective surveillance of HAIs is critical to understanding the burden of these infections and implementing appropriate prevention and control measures.[6]

Methods

The Search Strategy and Criteria for Selecting Relevant Articles

For the review on HAI surveillance, a comprehensive search was conducted in PubMed, Embase, and Scopus databases.

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The search strategy included a combination of medical subject headings (MeSH) and keywords related to HAIs, surveillance, and epidemiology. They are as follows.

Medical Subject Headings (MeSH) Terms

- Healthcare-associated infections (HAI).
- Infection control.
- Disease surveillance.
- Cross-infection.
- Epidemiology.
- Nosocomial infections.
- Developing countries.

- Low-income countries.
- Middle-income countries.
- Communicable disease control.
- Public health.
- Surveillance systems.

Keywords

- Healthcare-associated infections (HAI).
- Hospital-acquired infections.
- Healthcare-associated infections (HAI) surveillance.
- Surveillance programs.
- Epidemiology of HAIs.
- Infection prevention.
- Low- and middle-income countries (LMICs).
- Challenges in HAI surveillance.
- Opportunities in HAI surveillance.
- Patient safety.
- Nosocomial infections.
- Cross-infection.
- Infectious disease control.
- Public health interventions.
- Developing world.
- Resource-limited settings.
- Healthcare quality improvement.
- Antibiotic resistance.

The search was limited to articles published in the last decade (2011–2021) and written in English.

The inclusion criteria for selecting relevant articles were as follows:

- The article must have reported on the surveillance of HAIs in healthcare settings.
- The study must have been conducted in LMICs.
- The study must have used a quantitative or mixed-methods design.
- The study must have reported on the prevalence, incidence, or risk factors of HAIs.

The exclusion criteria were as follows:

- Studies conducted in high-income countries.
- Studies that focused on a single type of HAI or a specific patient population.
- Studies that used a qualitative design.
- Studies that were not peer-reviewed articles.

CURRENT STATE OF HAI SURVEILLANCE

Review the History of HAI Surveillance and Its Evolution over Time

Healthcare-associated infections (HAIs) have been a significant public health issue for centuries. The earliest record of HAI surveillance dates back to the mid-1800s when Dr Ignaz Semmelweis discovered that handwashing with chlorinated lime could significantly reduce the incidence of puerperal fever in obstetric wards.[7] Since then, various surveillance systems and initiatives have been implemented to monitor and control HAIs.

In the early 1900s, efforts were made to establish standardized definitions and criteria for different types of infections, such as surgical site infections (SSIs) and urinary tract infections (UTIs).[8] In the 1950s, the United States Department of Health, Education, and Welfare (now the Department of Health and Human Services) began collecting data on hospital-acquired infections through its Hospital Infections Program.[9] This program was later expanded to include national surveillance of HAIs through the National Nosocomial Infections Surveillance (NNIS) system in 1970.[10]

Over time, HAI surveillance has evolved to include more comprehensive and sophisticated systems, such as the Centers for Disease Control and Prevention's (CDC) National Healthcare Safety Network (NHSN), which was launched in 2005.[11] NHSN provides standardized definitions, protocols, and data analysis tools for the surveillance of HAIs in different healthcare settings, including acute care hospitals, long-term care facilities, and outpatient dialysis centers.

In addition to national surveillance systems, many countries and organizations have established their own HAI surveillance programs, such as the European Centre for Disease Prevention and Control's (ECDC) surveillance network.[12] These programs not only monitor the incidence and prevalence of HAIs but also provide valuable data for guiding infection prevention and control efforts, evaluating interventions, and identifying trends and emerging issues.

The Various Methods and Tools Used for HAI Surveillance

Healthcare-associated infection (HAI) surveillance involves monitoring the incidence and prevalence of infections in healthcare facilities, as well as tracking risk factors, trends, and outcomes. There are several methods and tools used for HAI surveillance, including the following.

Patient chart review: This involves reviewing patient records to identify infections and collect data on relevant risk factors and outcomes. Chart review is a simple and cost-effective method that can be used in a variety of healthcare settings.[13]

Laboratory-based surveillance: This involves using laboratory data to identify patients with confirmed or suspected infections. This method can be automated and provides accurate and timely data on specific pathogens and antimicrobial resistance patterns.[14]

Electronic health record (EHR) surveillance: This involves using EHRs to identify infections and collect relevant data. EHR surveillance can be automated and provides real-time data on patient and facility-level trends and outcomes.[15]

Direct observation: This involves observing healthcare workers and patients to identify infection prevention and control practices. While it is resource-intensive and time-consuming, direct observation provides valuable data on behavior and practice patterns.[16]

Administrative data: This involves using billing and coding data to identify patients with infections and collect relevant data. Administrative data can be useful for large-scale surveillance but may not accurately capture all infections and risk factors.[17]

Apart from these methods, several tools and resources are available to support HAI surveillance, including standardized definitions and criteria, data analysis software, and reporting systems. These tools help to ensure consistency and comparability of data across facilities and regions and facilitate collaboration and communication between stakeholders.

The Strengths and Limitations of Current HAI Surveillance Systems

Healthcare-associated infection (HAI) surveillance systems have strengths and limitations that affect their ability to detect and

track HAIs accurately. Some of the strengths and limitations are discussed below.

Strengths

Standardization of surveillance criteria: Standardized surveillance criteria, such as the CDC's NHSN criteria, ensure consistency in HAI surveillance across facilities and regions.[18]

Ability to identify trends: HAI surveillance systems can identify trends in infection rates over time, allowing for the evaluation of prevention and control measures and the development of targeted interventions.[19]

Data collection efficiency: HAI surveillance systems can be automated and integrated into EHRs, reducing the burden of data collection on healthcare personnel.[20]

Identification of emerging pathogens: HAI surveillance systems can identify emerging pathogens and outbreaks, allowing for prompt response and control measures.[21]

Limitations

Underreporting: The issue of underreporting is a significant challenge faced by HAI surveillance systems, leading to an inaccurate estimation of the burden of HAIs. This poses a threat to patient safety and can impede efforts to implement effective infection control measures.[3]

Variability in surveillance methods: The lack of standardization in surveillance methods and definitions is a significant concern as it can hinder the comparability of HAI data between healthcare facilities and regions.[22]

Incomplete data: Incomplete data, such as missing information on risk factors and outcomes, can limit the usefulness of surveillance data for guiding prevention and control measures.[23]

Lack of data on community-acquired infections: Surveillance systems generally focus on HAIs but do not capture data on community-acquired infections, which can contribute to the burden of disease in healthcare settings.[24]

Despite these limitations, HAI surveillance systems play an essential role in monitoring and controlling the spread of infections in healthcare settings.

CHALLENGES IN HAI SURVEILLANCE

The Key Challenges in Implementing Effective HAI Surveillance

Effective surveillance is crucial for the prevention and control of HAIs. However, several challenges hinder the implementation of effective HAI surveillance programs in healthcare facilities, especially in LMICs.

One of the primary challenges is the lack of resources, including staff, funding, and infrastructure, which can limit the capacity to implement and sustain HAI surveillance programs.[25] Furthermore, the absence of standardization in surveillance methods and definitions of HAI can make it difficult to compare data across different settings.[26]

Data quality issues are another significant challenge that affects the accuracy and completeness of HAI surveillance data. Inadequate training and supervision of surveillance staff, incomplete medical records, and underreporting of HAI cases can lead to significant data quality issues.[27]

The complexity of HAI surveillance systems can be a barrier to effective implementation, particularly in settings with limited resources and expertise. This complexity includes the need for continuous data collection and analysis, feedback and communication of findings to healthcare providers, and interpretation and use of the data for decision-making.[28]

Addressing these challenges requires a concerted effort from policymakers, healthcare providers, and researchers to develop and implement standardized, cost-effective, and sustainable HAI surveillance programs. These programs must be adapted to the local context and resources, and include ongoing monitoring, evaluation, and improvement processes to ensure data quality and usefulness.[29]

The Impact of These Challenges on the Accuracy and Usefulness of HAI Surveillance Data

The challenges in implementing effective HAI surveillance systems can have a significant impact on the accuracy and usefulness of the data collected. One major issue is the lack of resources, which can lead to incomplete or inconsistent data collection, inaccurate data analysis, and incomplete reporting. As a result, surveillance data may not accurately reflect the true burden of HAIs in healthcare facilities.[30]

The lack of standardization in surveillance methods and definitions of HAI can make it difficult to compare data across different settings, which may lead to inconsistencies in data interpretation and difficulty in establishing national and international benchmarks for HAI prevention and control.[31]

Data quality issues, including inadequate training and supervision of surveillance staff, incomplete medical records, and underreporting of HAI cases, can also significantly impact the accuracy and usefulness of HAI surveillance data. Poor data quality can result in erroneous conclusions, misallocation of resources, and ineffective HAI prevention and control strategies.[32]

The complexity of HAI surveillance systems can be a barrier to effective implementation, especially in settings with limited resources and expertise. This complexity can lead to incomplete or inaccurate data collection, insufficient analysis, and inadequate feedback to healthcare providers.[28]

Addressing these challenges is critical to improving the accuracy and usefulness of HAI surveillance data, which is essential for developing effective prevention and control strategies.

OPPORTUNITIES FOR IMPROVING HAI SURVEILLANCE

The Emerging Technologies and Methods that could Enhance the Efficiency and Accuracy of HAI Surveillance

There are several emerging technologies and methods that have the potential to enhance the efficiency and accuracy of HAI surveillance.

One promising technology is the use of machine learning algorithms to analyze large amounts of data and identify patterns that may be indicative of HAIs.[33] Machine learning can also help to automate the process of data collection and analysis, reducing the burden on staff and improving the accuracy and timeliness of surveillance data. These tools can be used to analyze data from a variety of sources, including EHRs, laboratory reports, and clinical notes, and can help to identify cases that may have been missed by traditional surveillance methods.[34]

The use of genomics and molecular epidemiology has shown promise in improving the accuracy of HAI surveillance by providing more detailed information about the genetic makeup of bacterial and viral strains responsible for HAIs. This information can help to identify outbreaks and track the spread of infections within healthcare facilities.[35,36]

The use of mobile devices and wireless technologies can improve the efficiency and accuracy of HAI surveillance by enabling real-time data collection and analysis, as well as providing timely feedback to healthcare providers.[37]

The integration of HAI surveillance with other healthcare data systems, such as EHRs and prescription monitoring programs, can help to provide a more comprehensive view of patient health and identify potential risk factors for HAIs.[38]

One other emerging technology in the field of HAI surveillance is the use of EHRs and other digital data sources. EHRs can provide a wealth of clinical data that can be used to identify potential cases of HAIs, track patient movements within the healthcare facility, and monitor the use of antibiotics and other infection prevention measures. Several studies have demonstrated the effectiveness of using EHRs for HAI surveillance, particularly in identifying cases of central line-associated bloodstream infections (CLABSIs) and catheter-associated urinary tract infections (CAUTIs).[39,40]

However, it is important to note that these emerging technologies are not without their limitations and challenges. Issues such as data privacy and security, the need for specialized training and expertise, and the potential for bias and error must be carefully considered when implementing these tools in the context of HAI surveillance.[41]

The Importance of International Collaboration and Partnerships in Strengthening HAI Surveillance Systems

International collaboration and partnerships play a critical role in strengthening HAI surveillance systems, particularly in LMICs. LMICs often face challenges related to limited resources and infrastructure, which can hinder their ability to implement effective surveillance programs. Collaboration with international organizations, such as the WHO and the CDC, can provide much-needed technical expertise, training, and resources to support the development and implementation of HAI surveillance systems in these countries.[42,43]

International collaboration and partnerships can facilitate the sharing of data, information, and best practices across different regions and countries. This can help to identify global trends and emerging threats and inform the development of evidence-based policies and interventions to prevent and control HAIs.[44] Furthermore, partnerships between researchers, clinicians, and public health professionals can promote the development and validation of new surveillance tools and methods, as well as the generation of new knowledge and insights into the epidemiology and pathogenesis of HAIs.[45]

However, there are also challenges and barriers to international collaboration and partnerships in HAI surveillance. These include differences in healthcare systems, cultural norms, and resource availability, as well as issues related to data sharing and ownership, intellectual property, and ethics.[46] To address these challenges, it is important to establish clear and transparent governance mechanisms, communication channels, and mutual trust and respect between partners.[47]

International collaboration and partnerships are essential for improving the effectiveness and efficiency of HAI surveillance systems, and for promoting the global health security agenda.

CONCLUSION

The review of literature on the scenario of device-associated HAIs in LMICs revealed several key factors for the successful implementation of HAI surveillance programs. These include the development of a comprehensive surveillance system, involvement of stakeholders and interdisciplinary teams, capacity building through training and education, strong leadership and commitment, the use of standard protocols, data analysis, and feedback for continuous improvement, and the integration of HAI surveillance with infection prevention and control measures.

Areas for Future Research and Improvement in HAI Surveillance

There are several areas for future research and improvement in HAI surveillance identified in the reviewed literature. These include the following:

- Creating and implementing standardized HAI surveillance techniques in LMICs to improve data collection uniformity and comparability.
- Evaluation of the viability and efficacy of various laboratory-based surveillance, point prevalence surveys, and active surveillance strategies for HAI in LMICs.
- Investigation of the risk factors and determinants of HAIs in LMICs, such as environmental, patient, and healthcare-related factors.
- Identification of the burden of antimicrobial resistance (AMR) among HAIs in LMICs and the factors contributing to its emergence and spread.
- Exploration of innovative strategies and interventions for HAI prevention and control in LMICs, such as the use of probiotics, microbiome-based approaches, and behavioral interventions.
- Assessment of the economic impact of HAIs in LMICs, including the costs associated with prevention, diagnosis, and treatment, and the potential benefits of investing in HAI surveillance and control programs.

There is a need for more robust and comprehensive HAI surveillance systems in LMICs to better understand the burden and risk factors of these infections, guide appropriate interventions, and prevent the emergence and spread of antimicrobial resistance.

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