IMPORTANCE OF INFECTION CONTROL IN INCREASING PATIENT SAFETY AND PREVENTING INFECTIONS DURING HEALTHCARE (literature review)

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https://doi.org/10.35339/ic.2025.12.2.krg

ABSTRACT

Background. Today, the topic of combating Healthcare-Associated Infections (HAIs) is becoming increasingly relevant. The World Health Organization has developed the concept of Infection Prevention and Control (IPC), which is a key component of quality control and patient safety in hospitals.

Aim. To analyze modern methods of infection prevention and the role of healthcare workers in the effective implementation of infection control measures, according to the data of modern literature sources.

Materials and Methods. We analyzed the literature on prevention of hospital-acquired infections, as well as the importance of infection control in improving patient safety, the role of medical staff in the provision of medical care. The search for scientific information was carried out using the scientific databases Scopus, PubMed, Web of Science, Google Scholar.

Results & Conclusions. Hospital-acquired infections are a serious public health problem associated with increased patient morbidity and mortality, as well as an economic burden on healthcare systems. Approximately 10% of hospitalized patients in high-income countries are affected by HAIs. Infection control is defined as a set of effective organizational, preventive and anti-epidemic measures aimed at preventing the occurrence and spread of healthcare-associated infections. Healthcare workers play an important role in the effective implementation of infection control measures. The use of Personal Protective Equipment (PPE), hand hygiene, environmental cleaning, screening and isolation, sterilization and disinfection, surveillance and reporting, vaccination and the introduction of innovative technologies in hospital infection control are important elements of the prevention and control of HAIs. Hospital infection control is essential to protect patients, healthcare workers and the wider community from HAIs. These measures are important to protect patients, healthcare workers and all society.

Keywords: *hand hygiene, healthcare-associated infections, infection prevention.*

Introduction

Today, methods and means of combating Healthcare-Associated Infections (HAIs) are in high demand due to the growing need in this area. Therefore, there is an urgent need to implement mechanisms for assessing the quality of care provided in this area [1]. The World Health Organization (WHO) has developed the concept of Infection Prevention and Control (IPC), which is a key component of quality control and patient safety in hospitals. Preventing healthcare-associated infections and reducing the transmission of infections are the main goals of IPC [2].

The term "Infection Control" (IC) is defined as a set of effective organizational, preventive and anti-epidemic measures aimed at preventing the occurrence and spread of HAIs based on the results of epidemiological diagnosis. Implementation of the infection control system transfers the main focus of the fight against HAIs to each specific hospital, where staff set goals and determine methods to achieve them, constantly collect data for internal assessment of the situation with HAIs, and shortcomings are considered as flaws in the infection control system implemented in a given hospital, not a specific person [3; 4].

Healthcare workers play an important role in the effective implementation of infection control

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measures [5]. Hospital infection control practices should be implemented in hospitals to reduce the adverse effects of HAIs [6]. The use of Personal Protective Equipment (PPE) and good hand hygiene are important elements of HAI prevention and control [7]. The first important step in establishing an effective infection control program is to identify the knowledge, approaches and methods currently available to healthcare staff regarding infection control [8].

Aim

To analyze modern methods of infection prevention and the role of healthcare professionals in the effective implementation of infection control measures, according to the data of modern literature sources.

Results

The term HAI covers a number of infections that a patient can contract during a hospital stay for pathology other than the infection in question [9]. Collectively, these infections pose a serious public health problem associated with increased patient morbidity and mortality, as well as an economic burden on healthcare systems [10]. Approximately 10% of hospitalized patients in high-income countries are affected by HAIs. Developing countries report significantly higher incidence rates (in some cases, more than 25% of all hospitalized infections) [11]. In Europe, the prevalence of HAIs ranges from 4.6% to 9.3% [12]. The financial costs associated with HAIs are estimated to be between US$28 billion and US$45 billion [13]. In the UK, in 2016–2017, public hospitals recorded more than 650,000 HAIs among 13.8 million inpatients, including 22,800 deaths [14]. According to Stewart S. et al., HAIs can lead to a 7.8-day increase in the length of a patient's hospital stay, with an average of 30 days for patients with a HAIs and 3 days for patients without HAIs. The authors of the study concluded that a 10% reduction in the incidence of AMI could free up to 5800 bed days [15]. It is estimated that in 2016–2017, the NHS spent almost £2.1 billion on the treatment of HAIs [14].

The causes of HAIs are also well understood and are mainly related to the transmission of potentially pathogenic microbes from patient to healthcare worker (HCP), which is often associated with contamination of surrounding or adjacent surfaces (e.g. equipment, clothing, sanitary utensils) [16–18]. Efforts to reduce the risk of such transmission have largely focused on Hand Hygiene (HH) [19], as reflected in the World Health Organization's 2009 "5 Moments for Hand Hygiene" document [20].

It should be noted that hand hygiene in Emergency Departments (ED) cannot be significantly improved [21–23]. This is a particularly challenging task, as in most developed countries, the emergency department is the main point of access to life-saving care for critically ill or injured patients [24]. In contrast to inpatient departments, the environment and practices of the ED reflect the increased complexity associated with critically ill or polytrauma patients and overcrowding, which are factors that contribute to the relatively low levels of compliance observed. In particular, Muller M.P. et al. [22] reported that overcrowding in wards contributed to lower levels of hand hygiene compliance in ICU. Paradoxically, the high frequency of invasive procedures performed in ICU provides an opportunity to improve hand hygiene compliance and reduce the rate of HAIs [22].

Nurses can reduce the risk of infection and colonization by using evidence-based aseptic practices that reduce the introduction of endogenous and exogenous microorganisms through invasive medical devices. Appropriate use of personal protective equipment and good hand hygiene are paramount to reducing the risk of exogenous transmission of infection to a susceptible patient. For example, microorganisms have been found in the environment, as well as on surfaces surrounding the patient, and on portable medical equipment used in the ward [25].

Proper donning and doffing of Personal Protective Equipment (PPE) by healthcare staff, followed by hand hygiene, will reduce transient microbial burdens that can be transmitted to themselves or others. Good asepsis and infection control practices have been shown to reduce the spread of microorganisms between patients, prevent re-transmission, which can lead to outbreaks among multiple patients or establish a hospital-endemic flora in the healthcare environment [26].

An important component of the infection control program is a set of preventive and anti-epidemic measures, which includes [27; 28]:

- optimization of measures to combat and prevent HAIs with different routes of transmission;
- rationalization of the basic principles of hospital hygiene, including the implementation of measures that can be generally described as "clean hands";
- improving the effectiveness of disinfection and sterilization measures, maximizing the use of

disposable medical instruments and equipment, and epidemically safe disposal of medical waste.

Surgical Site Infections (SSIs) (formerly referred to as wound infections) are recorded when a postoperative infection occurs within 30 days of surgery (or, in the case of implant surgery, a deep organ/cavity infection that develops within 90 days of surgery). IDHI is the most common complication in postoperative surgical patients, associated with significant morbidity, high mortality and financial burden for national budgets and individual patients [28; 29]. The type of surgery determines the proportion of IDHI. [2–36]% of patients develop IDHI, with the highest risk of developing this complication in orthopedic patients, followed by patients undergoing cardiac and intra-abdominal surgery [12]. Approximately 25% of patients with SSI develop severe sepsis and shock and are transferred to intensive care [15; 30].

Numerous domestic and foreign researchers point to the importance of implementing the IR system to improve the quality and safety of medical care in hospitals [31–33]. In particular, Marra A.R. [34] emphasizes that changing the behavior of medical staff, namely active participation in preventive anti-infective measures, helps to reduce morbidity and mortality from ventilator-associated pneumonia and central venous catheter-related bloodstream infections.

The results of a study conducted in US hospitals show that general recommendations for the prevention of HAIs, based on training of medical staff in hand hygiene before and after any procedure or patient contact, are very effective. They reduce the incidence of catheter-associated urinary tract infections by 38%, ventilator-associated pneumonia by 8%, and surgical site infections by 7% [35]. A study in Malaysia suggests that simple infection control measures, such as hand sanitization with alcohol-based disinfectant, can help prevent HAIs and save a significant number of lives, reduce morbidity and minimize healthcare costs.

Direct or indirect contact with people and contact with contaminated materials are the two main ways in which infectious diseases are transmitted from one person to another [36]. Infection control programs have become standard practice in hospital settings [37; 38]. Healthcare professionals, infection control experts, health authorities and patients are concerned about HAIs [39]. All of them are affected by the transmission of infectious organisms in healthcare facilities [40].

The first important step in establishing an effective infection control program is to identify the knowledge, approaches and methods currently available to healthcare staff regarding infection control [8]. Insufficient funding for healthcare in general, the inability of facilities to implement effective preventive measures and insufficient training of healthcare workers, especially nurses, are just some of the global health constraints that affect infection prevention [41].

Every healthcare worker should practice infection control as it is one of their medical functions [42]. In various healthcare organizations, infection control procedures reduce the incidence of HAIs and, as a result, are now standard practice in most healthcare centers in developed countries [43]. To achieve positive changes in healthcare, it is important to recognize the dangers and limitations associated with emerging infectious diseases and assess how they will affect existing infection control practices [44].

Infection control is essential to minimize the occurrence and spread of HAIs in healthcare facilities. Common factors contributing to the occurrence of a HAI include many elements, including:

- patient susceptibility due to a weakened immune system;
- widespread use of invasive procedures leading to antimicrobial resistance;
- inadequate hand hygiene among healthcare workers;
- contaminated medical equipment and suboptimal environmental hygiene [12].

In addition, non-compliance with proper sterilization methods, overcrowding and insufficient implementation of standard infection control protocols all contribute to the spread of HAIs [45].

The Resolution of the Cabinet of Ministers of Ukraine No.376 on April 21, 2023, amended the List of ensuring the proper level of healthcare services under the contract with the National Health Service of Ukraine [46]. The list was supplemented with minimum requirements for infection prevention, infection control, counteraction to the spread of antimicrobial-resistant pathogens and the quality of bacteriological tests. Accordingly, the contracting of healthcare facilities for 2024 under the medical guarantees program was carried out taking into account these requirements [46].

The role of nurses in infection prevention

Preventing infections is a core responsibility of nurses, who also play a key role in patient education and ensuring that all elements of their nursing practice are based on the latest scientific knowledge. As patients' caregivers, nurses are uniquely

positioned to drive change and raise standards of care. Nurses can use several methods to provide a safe environment for patients. The most important nursing action for infection prevention is handwashing, which is a powerful tool in the nursing arsenal [47–49]. When working with biological fluids, nurses should use PPE. They can provide a safe environment for patients in addition to performing bedside care. This tactic helps the facility identify ways to improve the system and prevent future problems [50–52].

Key approaches and strategies to ensure infection control in hospitals

Maintaining infection control in hospitals is essential for the protection of patients, healthcare staff and visitors [48; 53]. The best methods and tactics for ensuring infection control in hospitals are:

Hand hygiene

Hand hygiene is the most obvious, verifiable and effective measure of infectious control [25; 54; 55] and is essential for preventing and limiting the spread of infection [49; 56; 57]. According to numerous studies conducted at the current stage of medical development, as well as on the basis of historical experience, it has been proven that the hands of medical personnel are the main factor in the transmission of infectious diseases. Thorough hand washing is one of the best methods to prevent the spread of infection. Healthcare workers should wash their hands frequently [58]. Posters with images promoting the importance of hand hygiene should be placed near sinks and antiseptic supplies [59]. According to the WHO "Five Moments" model, healthcare workers should perform hand hygiene before and after touching a patient, after risk of contact with a bodily fluid, before performing a clean or aseptic procedure, and after touching the patient's surrounding objects or belongings [60].

The prevalence of HAIs can be significantly reduced if everyone practices good hand hygiene [51].

Personal protective equipment

To stop the spread of infectious organisms while caring for patients, healthcare workers should wear proper PPE, such as gloves, gowns, masks and eye protection [61]. PPE acts as a barrier between healthcare personnel and potentially infectious materials [62]. Proper wearing and disposal of PPE is essential for safety, and the use of PPE requires proper training, adherence to protocols, and regular evaluation of infection control practices [7; 63].

Cleaning the environment

To stop the transmission of diseases, hospital rooms, equipment and surfaces need to be cleaned and disinfected regularly [64; 65]. The use of appropriate disinfectants and detergents helps prevent cross-contamination [66]. By maintaining a clean and hygienic environment, hospitals can create a safer environment for patients, contributing to their recovery and well-being [67; 68].

Screening and isolation

To prevent the spread of infection to other patients, people infected with MultiDrug-Resistant Organisms (MDROs) should be identified through screening and isolation [69; 70]. Hospitals usually have protocols in place to screen patients on admission. Isolation measures are used to separate patients with known or suspected infectious diseases from others to prevent the spread of infection [71].

Education and training

To ensure that healthcare staff is up-to-date with best practices, they should receive ongoing education and training on infection prevention, including an understanding of the infection chain, transmission routes and prevention strategies. Training should include the implementation of standard precautions, which are the basic infection prevention measures used for all patients [72].

Sterilization and disinfection

To prevent the transmission of infections, all medical equipment, especially reusable equipment, should be sterilized or disinfected before use. Sterilization is typically used for critical medical equipment that comes into contact with sterile body tissue. Disinfection is the process of reducing the number of microorganisms on surfaces, instruments, or in the environment to a level that is considered safe [9; 73; 74].

Surveillance and reporting

Outbreaks of infectious diseases should be detected and reported, and appropriate control measures should be implemented in hospitals [58; 75]. A functioning surveillance system is forward-looking, accurately identifies the risk group and predicts the outcome of infection control efforts [76; 77]. Reporting is the process of communicating surveillance data to the relevant authorities or organizations responsible for monitoring and regulating infection control practices [78].

Vaccination

Healthcare workers must be vaccinated against infectious diseases to stop the transmission of disease. Vaccination of healthcare workers is essential to protect their health and prevent the ac-

quisition and spread of infections. Vaccination methods include both routine and emergency procedures [7; 78; 79].

Technology innovation in hospital infection control

Improvements in hospital infection control have been driven largely by technology and innovation.

Ultraviolet (UV) disinfection systems

Ultraviolet light kills bacteria and viruses by exposing them to ultraviolet radiation. UV disinfection systems are used in hospitals to disinfect patient rooms, operating theatres and other areas where infectious organisms may be present. These systems use UV lamps to reduce the risk of HAIs [80].

Electronic monitoring of hand hygiene

One of the best strategies for stopping the spread of infection in hospitals is to maintain good hand hygiene. This technology can help hospitals identify areas of poor hand hygiene compliance and improve overall compliance. Electronic hand hygiene monitoring systems use sensors to track when healthcare staff enter and leave patient rooms and can track whether they wash their hands or use hand sanitizer [54; 77].

Antimicrobial surfaces

In hospitals, bed rails and door handles are two frequently touched objects that can harbor bacteria and viruses. Antimicrobial surfaces are designed to kill viruses and bacteria as soon as they are touched, reducing the chance of infection transmission. Usually copper or silver is used, which have antibacterial properties [50; 73].

Improved air filtration systems

In healthcare facilities, especially in areas such as operating theatres and intensive care units, infections can spread through the air. Modern air filtration systems can remove germs and viruses, as well as other airborne particles. These systems can reduce the risk of airborne infection [77].

Electronic patient monitoring

By using electronic patient monitoring systems to track vital signs and other medical data, healthcare providers can identify patients who may be at risk of infection. When a patient's condition changes, these systems can notify the relevant healthcare providers, allowing for earlier intervention and reducing the risk of infection [40].

Difficulties in implementing effective infection control in hospitals

The transition to new practices may be met with reluctance or hesitation by healthcare workers, stemming from comfort and familiarity with established procedures. Accepting change in healthcare facilities can be challenging and requires extensive training and support mechanisms. Providing detailed education, demonstration and ongoing guidance is crucial to facilitate a smooth transition and ensure effective implementation of new infection control measures.

Effective infection control depends to a large extent on the availability of adequate resources. These cover a range of needs, such as sufficient PPE, access to high quality cleaning products, financial support for maintenance and procurement, and well educated staff [39]. Ensuring strict cleaning protocols, adequate isolation measures and strict adherence to infection control practices are crucial in managing the constant high flow of patients and visitors [81]. A single and standardized approach cannot effectively meet the diverse needs of patients with different medical problems. Adapting infection control measures to specific conditions is becoming a challenge. Implementation of a flexible approach is essential for full infection control in healthcare facilities [66].

Establishing robust communication strategies and encouraging interdisciplinary collaboration are crucial to ensure cohesive infection control efforts [25; 72]. Without adequate education and ongoing training programs, healthcare workers may lack the skills and knowledge to accurately implement preventive measures. Investing in comprehensive training initiatives and continuing education programs is crucial to ensure that healthcare workers have the knowledge they need to effectively control infections [81]. Despite the efforts of healthcare professionals to educate and encourage patients to follow infection control practices, individual behavior and attitudes towards these practices may vary. Educating patients, clearly communicating the importance of these measures and creating an enabling environment for compliance are important strategies to reduce the risk of patient behavior in spreading infection in healthcare settings [72].

Enforcement and monitoring

Hospital infection control measures designed to stop the spread of infectious diseases among patients, healthcare workers and visitors must be accompanied by compliance and monitoring to be effective, continually updated and reviewed, and based on current evidence-based guidelines [48; 61]. All hospital staff should be trained in infection prevention. Continuous education, multiple training sessions, reminders and feedback on compliance with these guidelines are essential [81; 82].

Open communication with patients, visitors and healthcare professionals can help identify areas for improvement and promote compliance with infection control protocols [83]. By effectively implementing and monitoring infection control measures, hospitals can help prevent the spread of infectious diseases and protect the health of patients, healthcare workers and visitors [84].

The future of hospital infection control

Hospitals are using Artificial Intelligence (AI) and Machine Learning (ML) to proactively detect and contain the spread of infections. AI-based systems monitor staff compliance with hand hygiene rules and detect infections on surfaces, alerting staff to the need for timely intervention [50]. Telemedicine has become a vital tool in the fight against infections, allowing for remote consultations and monitoring. Healthcare workers can remotely receive education and training on infection prevention methods, reducing the risk of infection transmission in healthcare facilities [47; 68].

Hospitals are exploring advanced sanitation techniques such as ultraviolet light, electrostatic spraying and hydrogen peroxide vapor to effectively clean surfaces and equipment. These technologies not only increase cleaning efficiency, but also significantly reduce the need for large amounts of labor, thereby optimizing costs [84]. Environmental monitoring systems provide real-time data on factors such as temperature, humidity and air quality that affect infection control [83]. Antibiotic stewardship programs are critical to preventing the development of infection-resistant infections.

Hospitals are developing comprehensive antimicrobial stewardship initiatives to optimize antibiotic use, thereby reducing the risk of antibiotic-resistant infections [62; 66]. Hospitals are integrating infection control into broader patient safety programs, recognizing its critical role in overall patient safety. Prioritizing infection prevention, early detection and rapid response to outbreaks within these programs is essential for effective control [62]. Hospitals promote collaboration to combat the spread of infections, recognizing that infection control is a shared responsibility.

This involves sharing best practices, information and resources between healthcare facilities. Formalized collaboration and networks are likely to contribute to infection prevention in the future [74]. Providing patients with knowledge about infection prevention methods makes a significant contribution to reducing the incidence of HAIs [79; 85].

Conclusions

Hospital infection control is essential for protecting patients, healthcare workers and the wider community from HAIs. The complexity of the challenges, from high patient turnover to the diversity of patient conditions, underscores the need for robust strategies. These strategies include best practices such as strict hand hygiene, PPE, environmental cleaning, surveillance, and innovative technologies such as artificial intelligence and UV disinfection systems. Overcoming the challenges requires resource allocation, effective communication, continuous education and patient participation.

The future of infection control lies in the adoption of advanced technologies, integrating infection control into patient safety initiatives, encouraging collaboration and empowering patients. Ultimately, by actively involving patients in their own care, promoting education and awareness, a culture of infection prevention can be developed, leading to a safer healthcare environment for all. As hospitals evolve, these trends and opportunities will shape the future of infection control, emphasizing a proactive commitment to patient safety and well-being.

DECLARATIONS:

Disclosure Statement

The authors have no potential conflicts of interest to disclosure, including specific financial interests, relationships, and/or affiliations relevant to the subject matter or materials included.

Statement of Ethics

The authors have no ethical conflicts to disclosure.

Data Transparency

The data can be requested from the authors.

Funding Sources

There are no external sources of funding.

Consent for publication

All authors give their consent to publication.

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Received: 14 Mar 2025
Accepted: 01 Apr 2025
Published: 01 Apr 2025

Cite in Vancouver style as: Krasovska KO, Globina NI. Importance of infection control in increasing patient safety and preventing infections during healthcare (literature review). Inter Collegas. 2025;12(2):64-74. https://doi.org/10.35339/ic.2025.12.2.krg

Archived: https://doi.org/10.5281/zenodo.17502096