

Significance of Ongoing Training and Professional Development in Optimizing Healthcare-associated Infection Prevention and Control

Abstract

The employees who work in infection prevention and control (IPC) are very important in the field of health-care because they are committed to protecting patients, staff, and visitors from the risk of acquiring infections while in the hospital. The complexity of infection control in hospitals is always growing in tandem with the rapid developments that are being made in medical technology and practices. IPC personnel are required to maintain vigilance and continually improve their monitoring of the entire health-care process due to the ongoing development of IPC guidelines and regulations, the fluctuating infection risks, and the emergence of new infectious diseases. As a result, individuals involved in the prevention and control of infections in health-care settings absolutely need to participate in continual training and professional development. This review emphasizes the need of relevant professionals to engage in ongoing training and professional development to maintain their skills in the area of healthcare-associated infection control and prevention. Personnel working in IPC may more effectively react to newly discovered health risks and make certain that hospital infection (HI) management gets the appropriate attention if they have timely and in-depth awareness of best practices. They are better able to maintain their composure, react correctly, and deliver the most effective infection control and prevention techniques for the health-care system, all while increasing awareness about the significance of effective HI management.

Keywords: Healthcare-associated infection, ongoing training, professional development

Submitted: 30-Aug-2023

Revised: 17-Oct-2023

Accepted: 25-Oct-2023

Published: 02-Jul-2024

Introduction

Any infection that is acquired by patients while they are receiving medical treatment is referred to as a “Healthcare-Associated Infection” or “Hospital-acquired infection” (HAI). Other names for this condition include hospital infection (HI) and nosocomial infection. HAI refers to illnesses that were particularly picked up by patients while they were staying in the hospital.^[1] There are several subtypes of HAI that may be determined by characteristics such as the location of the infection, the kind of pathogen involved, and the time of infection. Infections that are caused by a catheter in the urinary system are known as catheter-associated urinary tract infections, hospital-acquired pneumonias (HAPs) are known as HAPs, bloodstream infections (BSIs) are known as BSIs, and surgical site infections are

known as SSIs.^[2] In addition, HAIs can be classified into two types based on the timing of infection: infections that occur during hospitalization or treatment within the hospital and postdischarge infections that relate to treatment received after discharge.^[3]

Globally, the incidence rates of HAI range from 3.5% to 12.0% in developed countries and from 5.7% to 19.1% in low-income and middle-income countries.^[4] According to the World Health Organization’s (WHO) first infection prevention and control (IPC) report, the Western Pacific Region, which includes China, has an approximate HAI incidence rate of 9%.^[5] Due to limited detection data in certain regions, the incidence of HAI in low-income and middle-income areas significantly exceeds the proportions.^[6] HAI represents a significant complication of modern medical therapy.^[7]

The WHO states that no country or health-care system, regardless of its

**Maojie Zhang^{1,2},
Shengwei Wu²,
Mohd Ismail
Ibrahim¹, Siti
Suraiya Md
Noor³, Wan Mohd
Zahiruddin Wan
Mohammad¹**

¹Department of Community Medicine, School of Medical Sciences, Health Campus, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia, ²Department of Infection Management, The First Affiliated Hospital of Guizhou Traditional Chinese Medicine University, Guiyang, China, ³Department of Medical Microbiology & Parasitology, School of Medical Sciences, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia

Address for correspondence:
Dr. Wan Mohd Zahiruddin Wan Mohammad,
Department of Community Medicine, School of Medical Sciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia.
E-mail: drzahir@usm.my

Access this article online

Website: www.jmssjournal.net

DOI: 10.4103/jmss.jmss_37_23

Quick Response Code:



How to cite this article: Zhang M, Wu S, Ibrahim MI, Noor SS, Mohammad WM. Significance of ongoing training and professional development in optimizing healthcare-associated infection prevention and control. *J Med Signals Sens* 2024;14:13.

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

complexity, can claim to be free of HAIs.^[5] HAI is a global population health issue accompanying various medical practices closely intertwined with health-care activities. The characteristics of HAI have also transformed with the advancement of diagnostic and treatment procedures, changes in medical facilities, and the evolution of medical technologies. Over the past century, medical professionals have increasingly emphasized the significance of HAI, leading to the implementation of HAI management practices worldwide to mitigate the economic and health damages caused by HAIs. One of the most effective approaches is cultivating and establishing management teams. However, implementing IPC measures is contingent upon health-care workers receiving adequate training and demonstrating competence.^[8]

The main contribution of this paper is as follows:

This article places a strong emphasis on the necessity of relevant individuals participating in ongoing training and professional development to keep their abilities current in the field of HAI control and prevention. If personnel working in IPC have timely and in-depth information on best practices, they may be able to respond more effectively to newly identified health concerns and ensure that HI management receives the right attention. In addition, they will be able to ensure that appropriate focus is paid to preventing and controlling infections.

They are better able to keep their cool, react appropriately, and provide the health-care system with the most effective infection control and prevention measures, all while raising awareness about the significance of successful HI management.

Impact and consequences of HAIs

HAIs exert a significant influence and pose a multitude of harms, affecting patients, health-care workers, and the broader community. HAIs contribute to additional morbidity and mortality,^[9] particularly among patients with compromised immune systems or underlying medical conditions.^[10] The WHO's World Alliance for Patient Safety has identified HAI as a global challenge, estimating that over 1.4 million individuals worldwide are afflicted with healthcare-acquired infections at any given time.^[11]

In the United States, the Centers for Disease Control and Prevention approximates that HAIs, caused by various microorganisms, including bacteria and fungi, are responsible for or contribute to 99,000 deaths annually.^[12] In Europe, where comprehensive hospital surveys have been conducted, Gram-negative infections account for two-thirds of the estimated 25,000 deaths yearly.^[13] The presence of antimicrobial resistance in many HAI types further complicates treatment. Notably, the annual economic burden in the UK alone is estimated to be ≤ 774 million, with BSIs and pneumonia emerging as the costliest HAI types per case.^[14] Numerous studies

underscore the significant economic implications of HAIs in health policies,^[15,16] underscoring their critical role in health and patient safety management.

HAI represents a prominent public health concern in China, generating an annual direct economic burden of \$1.5–\$2.3 billion.^[17] Xiangya Hospital, affiliated with Central South University, serves as the Business Management Center of the HAI Monitoring Network under the Ministry of Health. Through biennial cross-sectional surveys, the prevalence rate of HAI in China has been estimated to range from 3.22% to 5.22%.^[18] The HAI rate in Guizhou Province falls slightly below the national average, ranging from 2.24% to 2.31%.^[19,20] Nevertheless, there exist deficiencies in HAI infrastructure, including missing reports and detection data. Recent years, particularly in the aftermath of the COVID-19 pandemic, have witnessed a surge in HAI incidents in China, exposing challenges in the management, technological aspects, and execution of infection control measures.^[21] Consequently, there is an imperative to reinforce the implementation of laws, regulations, norms, standards, and system requirements pertaining to HAI management while also strengthening various prevention and control measures.

HAI prevention and management efforts should prioritize patients, health-care workers, and the wider community.^[22] Health-care workers themselves face the risk of acquiring HAIs, leading to absenteeism and diminished productivity. Moreover, infected health-care workers cannot provide care, leading to understaffing and patient treatment delays. In some instances, health-care workers may unknowingly propagate infections to other patients, perpetuating the transmission cycle.^[23] The community also experiences the far-reaching effects of HAIs^[24] including the spread of drug-resistant bacteria. The repeated exposure of bacteria to antibiotics fosters the development of drug resistance, amplifying the challenges in infection treatment.^[25] Consequently, health-care institutions must prioritize robust IPC measures to ensure the safety of all individuals involved in the healthcare system, whether patients, medical workers, or communities.

The findings of the article are applicable to a wide range of demographics, such as age, race, and ethnicity, as well as all genders of health-care workers and all socioeconomic classes of health-care professionals.

The findings of the article can be applied to a wide range of different types of health-care facilities, including but not limited to hospitals, ambulatory care centers, such as primary care clinics and urgent care centers, which are also a setting where HAIs can occur, and long-term care facilities, such as nursing homes and rehabilitation centers, are also a high-risk setting for HAIs. It is especially important that health-care professionals in hospitals are aware of the importance of preventing HAIs. Another type of environment in which HAIs

might develop is that of mental health centers. There is a significant contribution made by public health facilities, such as clinics and health departments, to the prevention and management of HAIs.

Necessity of HAI training

HAI training plays a crucial role in providing medical services and has garnered recognition within the medical community.^[26] The field of HI control encompasses diverse specialties and demands a high level of theoretical and practical knowledge. However, many medical schools have not established relevant courses and programs, leaving professionals and medical personnel with limited knowledge and skills in HI control upon assuming their positions. Consequently, conducting HAI training assumes excellent importance.^[27]

While education and training are interrelated, they are distinct processes. Education typically entails acquiring comprehensive knowledge and skills at the college or university level, whereas training focuses on acquiring job-specific knowledge and skills for practical applications.^[28] Several studies have demonstrated that medical staff trained in infection control adhere to recommended infection control practices.^[29,30] HAI management and prevention training ensures that health-care providers are proficient in IPC practices. This proficiency ultimately leads to improved patient outcomes, reduced HAIs, and a safer medical environment for health-care workers, shielding them from various infection risks.

The primary objective of HAI training is to prevent HAIs. Training should be conducted concurrently for HAI management personnel and clinical medical staff. The COVID-19 pandemic has exposed clinicians' deficiencies in knowledge and understanding of IPC, raising concerns about their preparedness in responding to such situations.^[31] Infection prevention training focuses on identifying and controlling the spread of infections, encompassing proper hand hygiene, correct usage of personal protective equipment (PPE), appropriate cleaning and disinfection of equipment and surfaces, and effective patient isolation procedures.^[32] Figure 1 shows the chain of infection. Infection control and contact tracing are meant to break the chain, preventing infection from spreading. Training should also guide antibiotic stewardship and epidemic management within the hospital setting. Implementing HAI training offers several advantages. First, it helps mitigate the risk of HAIs, reinforcing awareness and understanding of HAIs among medical staff, patients, and visitors while enhancing their level of attention.^[33] Second, it rapidly improves practitioners' familiarity with fundamental knowledge, skills, and regulatory compliance.^[34] Third, it facilitates the swift supplementation of IPC professionals, demonstrating unique advantages during disease outbreaks like the COVID-19 pandemic.^[35,36] Finally, it contributes to

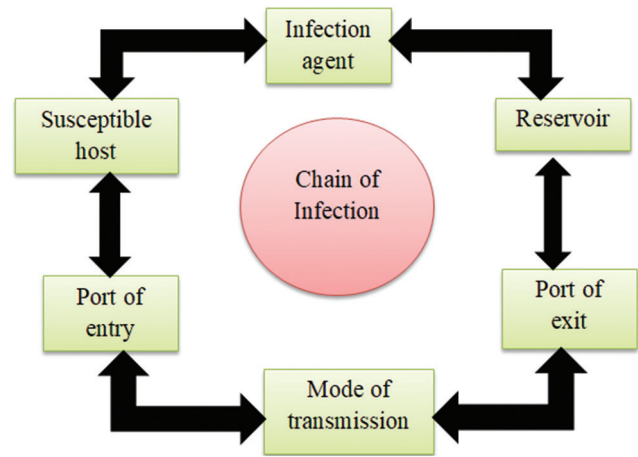


Figure 1: Chain of infections

overall improvements in medical quality within health-care institutions.^[37]

Simultaneously, it is vital to include personnel from all medical institutions as targets of HAI training, encompassing not only medical staff and patients but also logistics and maintenance personnel such as hospital cleaners.^[38] The significance of environmental service workers in HAI management should not be overlooked.^[39] A comprehensive training plan encompassing these stakeholders expands the reach of HAI training and assumes a more critical role in reducing the spread of infections within the health-care environment. Acknowledging the differences in practice and content between education and training is crucial, as this can lead to confusion and unsafe clinical practices among trainees, undermining clinicians' confidence.^[31] Therefore, training based on unified standards becomes vital in controlling the quality of training. Looking ahead, as global attention shifts to other emerging diseases, the development and expansion of existing training tools for HAI prevention and control to address these diseases become crucial in effectively enhancing the preparedness of countries and medical institutions for future infectious disease outbreaks.^[40]

Forms of HAI Training

HAI training encompasses various forms, each with its advantages and limitations. One of the most common forms is classroom-based training,^[8] also known as offline training, which follows a typical training mode used in other hospital specialties. In this form, a lecturer teaches infection control measures and procedures to medical staff. Classroom-based training ensures consistent information delivery and allows participants to ask questions and seek clarification, promoting interactive learning.^[41] However, scheduling training courses suitable for all employees can be challenging, particularly after the COVID-19 outbreak, as each employee has different roles and responsibilities, making offline training less suitable

in certain cases.^[42] Online training is another form of HAI training that provides flexibility regarding time and location. It can be tailored to the roles and responsibilities of individual staff members and is more cost-effective than classroom-based training.^[43] However, online training may lack the interactivity of classroom-based training, limiting the extent to which staff can actively participate and obtain comprehensive information. In addition, the monotony of video-based learning can be tiresome, dampening enthusiasm for self-study. Technical issues such as network instability and environmental noise can also impact the quality of online teaching, a common challenge faced by many institutions implementing online education.^[44]

Problem-based learning (PBL) is a pedagogical approach that emphasizes problem formulation and resolution, fostering communication and critical thinking skills among learners.^[45] It complements traditional training and teaching methods by encouraging interactive communication, autonomous exploration, and collaboration within small groups to solve problems.^[46] PBL is an effective method for enhancing students' problem-solving, analytical, and communication skills. Similar to the use of case studies, case-based learning (CBL) is a form of instruction that emphasizes the development of critical thinking skills through classroom discussion of real-world scenarios.^[47] As part of CBL, educators should seek out and analyze relevant examples, guide students in productive discussions, and help them structure their ideas. However, instructors often assume that students already have a firm grasp on essential subject matter and a foundation in relevant professional practices. For those with a specific amount of professional experience, this strategy works exceptionally well.

Simulation-based training has recently gained popularity as a form of HAI training.^[48] It involves creating a simulated environment where medical staff can learn infection control procedures and practice handling different situations.^[49] Simulation-based training provides a safe and controlled setting for medical staff to enhance their skills and build confidence in dealing with various scenarios.^[50] It improves the efficiency of HAI management and reduces medical costs.^[51] However, simulation-based training can be expensive and not feasible in all health-care settings. Nevertheless, studies have shown that simulation-based training enhances the training effect in infection prevention teaching, emphasizing the need for continuous innovation in this area.^[52]

Finally, ongoing HAI training provides guidance and feedback to medical staff on infection control procedures during their daily tasks. Ongoing training is essential for the continuous development and improvement of health-care quality. It supports the adaptation and growth of health-care professionals throughout their careers.^[53] There are several

forms of HAI training, each with its advantages and limitations. Choosing the appropriate training type based on the needs of medical institutions and employees is crucial. By providing practical HAI training, medical institutions can ensure that staff members have the knowledge and skills to prevent infection transmission, thus delivering safe, high-quality patient care.

Evaluation needs and effects of HAI training

There are specific gaps and differences in the knowledge and practical practice of preventing and controlling HAIs,^[54] so it is essential to do an excellent pretraining evaluation. The IPC training of nurses and doctors varies significantly from country to country, and the training content and type (e.g., standardized courses, education plans, and clinical experience) duration, evaluation, and accreditation/certification vary.^[55] It is vital for the early evaluation of cutting-edge information and advanced technology training in HAI management, and we hope to get more communication opportunities. The WHO report^[5] also mentioned that most IPC methods have mature guidelines for most methods, but the actual training programs available are often far from each other, and the actual training courses available are not many. Research on HAI training has shifted from macro-level topics such as "hospital infection management" and "hospital infection" to more detailed areas such as "disinfection," "prejob training," "cleaning personnel," and "interns."^[27] On the one hand, due to insufficient attention, on the other hand, the financial and human resources cannot provide sufficient training conditions. Therefore, the evaluation before training is critical in the face of the lack of training opportunities.

As mentioned in the WHO report,^[5] Kazakhstan has carried out a training practice based on a competency-based training current for IPC professionals, and the general health care force is under revision. It will incorporate identified best IPC training practices. This is a good practice and provides a good practice model for the needs assessment of HAI prevention and control training.

Little attention has been paid to how trainees can improve their knowledge and skills or change their attitudes and awareness through training.^[56] This requires the evaluation of the training effect. The evaluation index is used to measure the effectiveness of HAI training. These indexes are generally divided into two categories: process index and result index. The process index measures the extent to which health-care providers comply with best practices for infection prevention. For example, the process index can measure the percentage of medical staff washing hands before and after contacting patients.^[57] These indicators provide insight into training effectiveness by measuring how health-care providers implement the principles they have learned.

On the other hand, the outcome index measures the impact of training on the outcome of HAI in patients. For example, measure the infection rate related to medical treatment before and after training.^[58] On the other hand, feedback from medical staff or in-depth observation of infection prevention practices can help to identify areas where training can be improved and understand the subjective experience of medical staff.^[59] Medical institutions can use the above evaluation methods to evaluate the effectiveness of their training plans and make necessary adjustments to improve HAI prevention and control strategies and improve medication safety and quality.

Whether pretraining preparation, training process, or posttraining evaluation, it is a dynamic process of continuous improvement, which is also the purpose of ongoing training.

HAI Training: Conceptual Framework

Data sources and analysis methods

For the purpose of conducting research on the association between ongoing training and professional development and the incidence of HAIs, the following kinds of data sources could be utilized as sources of information:

Administrative data sets are compiled by a variety of organizations, including health-care facilities and government agencies. Patient demographics, medical history, procedures, and outcomes may all be recorded there.

Surveys are a common tool for researchers and health-care organizations to gather essential data. A health-care worker's knowledge, skills, attitudes, and behaviors can all be gathered with this instrument.

Observational data are collected by researchers shadowing health-care workers as they go about their normal workday. Potentially, it might be used to gather data on how doctors and health-care professionals actually do their jobs.

Any of the following sorts of analytic methodologies could be used to study the correlation between ongoing education and career development and the occurrence of HAIs:

Descriptive statistics can be used to characterize the data and identify recurring themes or other tendencies. Univariate analysis is one approach that can be used to explore the relationship between two variables. Univariate analysis could be used to study the correlation between the amount of training hours health-care workers have had and the prevalence of HAIs, for instance.

Using multivariate analysis, one can examine the connection between multiple variables while also accounting for and adjusting for any other influences on the relationship being studied. Researchers can use multivariate analysis to account for confounding variables such as health-care setting, patient population, and health-care provider's prior

experience when assessing whether or not training hours are correlated with HAI occurrence. This would ensure that the researchers accounted for every possible confounding factor.

To better understand the correlation between continuous professional development (CPD) and HAI occurrence, researchers might use a variety of data sources and analytical approaches. This allows for the researchers to make more informed conclusions. This information can be utilized to develop and put into practice strategies that are helpful in lowering the risk of HAIs.

Management and continuous improvement of HAI training

Continuous improvement and optimization of HAI training measures are crucial in enhancing infection prevention practices within hospitals and other medical institutions. Continuous improvement is an ongoing process that aims to identify and implement changes to improve the system's efficiency, effectiveness, and quality. Xiao's research, based on the analysis, design, development, implementation, evaluation (ADDIE) training design model, exemplifies a comprehensive training project that follows a systematic ADDIE.^[60] Regularly evaluating employees' knowledge and skills is crucial to improve HAI training continuously. This can be achieved through periodic testing, observation, and feedback. Identifying areas of weakness enables the provision of additional training to address these gaps. Continuous assessment and training ensure that employees possess the necessary knowledge and skills. Other studies^[61,62] have utilized the plan, do, check, act model to enhance training efficiency for midwives. These studies have provided scientific teaching plans, implementation schemes, inspection requirements, and result evaluation methods. Insights gained from these models serve as inspiration for improving HAI training. Continuous improvement efforts encompass regular evaluation of the training plan's effectiveness, identification of areas for improvement, and implementation of necessary changes to enhance the training's efficacy.

Figure 2 provides a conceptual framework for infection prevention service. The policy design, implementation tools, and monitoring and evaluation (M and E) are the three governance domains that are covered by the framework, which was conceived of as having a cyclical nature to allow for constant adjustments and improvements. M and E refers to M and E, which is an acronym for M and E. In addition to this, the framework addresses the three different governance spheres that are addressed by the framework. During our investigation, we made adjustments to the framework by including additional domains that Anderson's model lacked and by reorganizing existing domains into groups that were more internally consistent. These alterations were done to accommodate the findings of our investigation. These adjustments were made to take

into account the discoveries that were discovered by our team. In addition to a number of subdomains that may be categorized under the overarching word “surveillance,” we came up a brand new domain that we have designated as “international collaboration.” The following are some instances of subdomains that fall under this category: the development of warning systems for the early identification and reporting of newly emerging resistance; monitoring of hospital-acquired infections (HAI); surveillance of food items for antibiotic residues; surveillance networks at the regional and national levels; and cohesiveness with regard to Several diverse subject areas, such as “public awareness” and “education,” “antimicrobial stewardship” and “medicines regulation,” “AMR research” and “fostering R and D,” and so on, have all undergone reorganization.

Another crucial aspect of continuous improvement is staying updated on the latest policy requirements, cutting-edge research, and best practices in IPC.^[63,64] This necessitates continuous staff education and training on emerging infectious diseases, as well as new technologies and approaches for infection prevention. Regular training plan reviews and updates are vital to incorporate the latest

knowledge and best practices. With the persistent threat of infectious diseases such as COVID-19, it is more critical than ever to accurately evaluate and improve the training strategy for HAI within the medical environment.^[65]

Addressing past shortcomings in managing and continuously improving HAI training is crucial. Table 1 lists the key elements and learning practices for the evaluation of HI prevention. These include ensuring comprehensive coverage of training targets, encompassing all personnel working in medical institutions, as mentioned earlier. The following are the essential components and instructional procedures that should be followed while evaluating the effectiveness of infection control in hospitals:

1. To put together a list of well-defined goals and objectives. It includes the results of your evaluation and to consider increasing the number of patients who adhere to proper hand hygiene practices to lower the number of patients who get infections at surgical sites or achieve another goal.
2. Make sure to choose the appropriate techniques of assessment. The evaluation of infection prevention strategies in hospitals may be done in a variety of methods. Tracking the results of patients may also be done with the use of electronic health records.

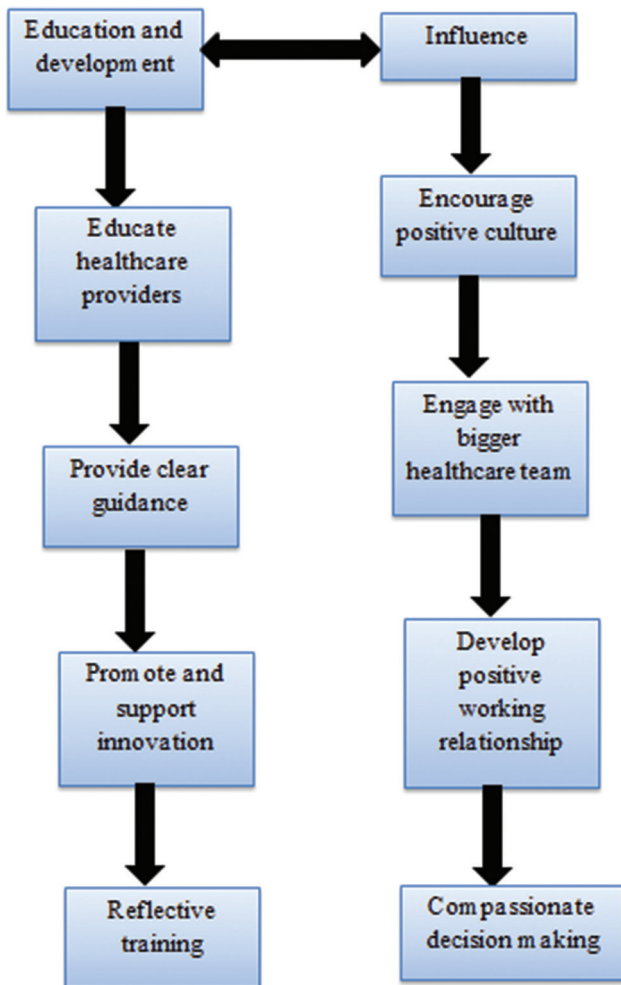


Figure 2: Conceptual framework of infection prevention service

Table 1: Key elements and learning practices for the evaluation of hospital infection prevention

Factors	Key elements
Expertise in one’s field and professional skill	Risk analysis and regular checks Planification and refurbishment of emergency location Conventions and norms Suggestions and comments Organising for uncertainty Direction and oversight Teaching of abilities Self-protection Health education
Capacity for normalization management	Reporting statistics Quality control Administration and control
Capacity for professional growth	Scientific investigations Occupational preparation Superior technical proficiency Knowledge of available data
Capacity for group cooperation	Attending to essentials Plan and execute training Integration of resources Collaboration
Behavior pattern	Stress resistance Commitment capability Persevere Capacity for decision-making Responsibility Capacity for change

The specific goals and objectives that you have set for yourself will be used to decide which evaluation strategies are the most suited for you to use

3. Acquire knowledge from a wide range of distinct sources. It is necessary to assemble data from a range of various sources when attempting to gain an accurate picture of the infection prevention plan at your hospital. It is essential that you collect data from patients, personnel working in health-care institutions, and managers at the facilities. Data from other sources, such as electronic health records, should also be gathered in addition to this information
4. Carry out an exhaustive investigation of the available data. Following the completion of the process in which you acquire all of your material, the following step is to study everything in great detail. This will be of assistance to you in deciding the components of the infection prevention strategy at your hospital that are operating effectively, as well as the areas in which it has space for advancement
5. Modify your strategy so that it takes into account the data. The findings of the evaluation will lead to enhancements being made to the infection prevention plan that is already in place at your institution. The information that you have gathered should serve as the foundation for these adjustments
6. Spread the word about the findings of your assessment. Everyone who has a stake in the outcome of your assessment has to be informed of the findings. Patients, health-care personnel, administrators, and members of the general public are all included here. By disseminating the findings of your assessment, not only will you be able to convince more people of the significance of infection prevention, but you will also be able to ensure that the infection prevention program at your hospital is functioning properly.

In addition, training content should extend beyond standard preventive measures to include hot topics related to HAIs, diagnosis of infected cases, prevention and control of multidrug-resistant bacteria, and the rational use of antimicrobial drugs. Finally, outdated research on training methods and systems should be gradually replaced with a sustainable, standardized, and systematic training approach that aligns with ongoing education's overarching goal.

Strategies for infection management: Digital health service

There are many different ways in which IPC may be improved with the use of digital health services.

Education and training on IPC practices may be provided to health-care professionals through the use of digital technologies, which can also be used to educate and teach health-care workers on IPC practices. This instruction might be delivered through a variety of channels, such as

through the use of interactive simulations, video lectures, or online classes. There is also the possibility of taking classes online.

Data about IPC practices, such as complying with requirements for hand hygiene, utilizing personal protection equipment, and keeping the surroundings clean, may be gathered using digital technology if the practitioner so chooses. Tracking and monitoring IPC practices are also possible to use for these instruments. It will be feasible, through the use of these figures, to decide which elements of IPC practices need more improvement.

The individuals in charge of making decisions about health-care might use digital technology to get additional help for their decision-making processes. For instance, digital technology may be used to identify patients who are at a high risk of developing a disease, monitor the spread of infection inside a health-care facility, and anticipate the impact of innovative IPC efforts.

The following is a sequence of steps that need to be followed to put into effect digital health solutions that make use of the pantheoretical framework. First things first, you need to put together a multidisciplinary team that includes medical experts, case managers, specialists in educational communications and technology/games for learning, behavioral scientists, data scientists, and health informaticians. The interdisciplinary team has to use a mixed-method approach (one that integrates qualitative and quantitative data) in the second stage of the process to determine the digital health strategy and wellness solution that will be the most effective. The gamification of a digital health service is not a one-size-fits-all strategy; rather, it is one of many different tactics that can possibly boost engagement and utilization of telemedicine and digital health solutions. The team can prepare and train the patient to accept and adhere to the digital solution. If the patient is not an ideal candidate for telemedicine or digital health, but the patient's medical care would be significantly improved with a digital solution, then the team can prepare and train the patient to accept and adhere to the digital solution. Third, familiarise patients with the new application using basic and user-friendly experience flows and interface components to elicit baseline adherence to treatment. This will help to ensure that patients get their prescribed medications. When patients have reached a level of familiarity with the course, the next step is to begin implementing it on a more permanent basis. There is a specific term for the procedure of "onboarding" new patients by use of digital apps. The use of onboarding quizzes and questionnaires is one method that has been effectively implemented to improve the early uptake of telemedicine and digital health solutions. This strategy has proven quite successful. The development of idiographic and personalized user phenotypes, as well as personalized interaction tactics, has the potential to significantly

improve the effectiveness of the use of these technologies. The fourth step is to continually monitor the patient's engagement behavior by continuously taking in data regarding the patient's biological and clinical, behavioral, provider, system, psychological, and environmental elements [Figure 3]. This phase also includes continuous data collection. Keeping a steady stream of data entries is one way to achieve this goal. Fifth, construct accurate and individualized algorithms (models of adherence) for each individual in the population using Artificial Intelligence and Machine Learning. The usage of cloud computing is often the most efficient way to complete this stage, especially when it comes to the management of large amounts of big data. The next step is to construct a personalized care support plan for each individual patient using mobile health solutions (nudges and education) and then to continue to fine-tune that plan throughout the patient's treatment. This process will take place utilizing mobile health solutions.

Impact of how professional development and ongoing education on HAIs

The following components make up the framework that shows how professional development and ongoing education impact the occurrence of HAIs. The purpose of this structure is to reduce the occurrence of such situations in the future.

Health-care professionals can grow in their expertise and knowledge through continuous education and training. As a result, there may be less chance of healthcare-associated infections (HAIs) due to stricter adherence to IPC protocols. Health-care practitioners must continue their education to stay current on IPC research and best practices. This helps guarantee they use cutting-edge HAI prevention methods. Continuous education and professional development can promote safety and quality in healthcare. This could lead to patient-centered care that reduces HAIs and improves patient satisfaction.

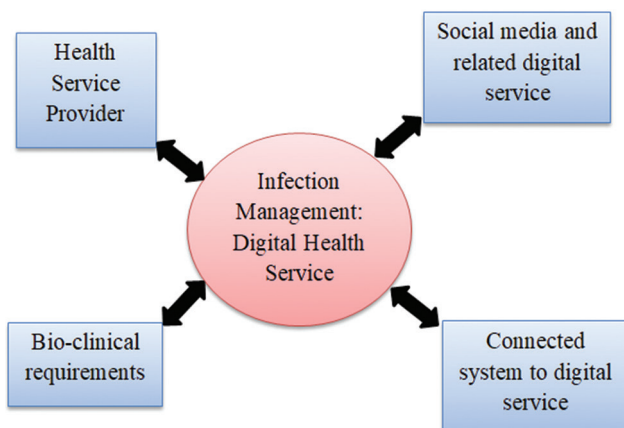


Figure 3: Infection management and digital health service

Benefits of Ongoing Training and Professional Development in HAI Prevention and Control

Emphasizing ongoing training in HAI prevention and control

One of the significant benefits of continuous IPC training is the reduction of HAIs.^[66] Research demonstrates that continuous IPC training helps medical staff adhere to best practices and understand their critical role in preventing the transmission of infections.^[67] Ibrahim^[68] recommends implementing a comprehensive, systematic, and continuous education plan, which holds great significance for applying HAI knowledge. In addition, with increased exposure to infection risks, employees gradually pay more attention to infection control and prevention during the medical process. Continuous IPC training aids medical staff in identifying potential risks and hazards that may contribute to the transmission of infections.^[67]

Professional development in HAI prevention and control

Professional development plays a crucial role in HAI prevention and control, encompassing providing resources, support for education, certification, and guidance. Health-care workers should receive education on fundamental principles, engage in ongoing education through seminars and conferences, pursue certification, seek guidance, and work within priority organizations. Continuing education and training are necessary to enhance medical staff's ability in IPC, including attending conferences, webinars, or seminars that provide updates on the latest research and best practices. In many countries, professional organizations like the Association for Professionals in Infection Control and Epidemiology offer educational opportunities for their members.^[69] Certification is another crucial aspect of professional development in HAI prevention and control. Certification validates that medical staff have acquired a certain level of knowledge and professional skills in this field. IPC professionals can obtain various certifications, such as the Certification in Infection Control and Epidemiology provided by The Certification Board of Infection Control and Epidemiology.^[70-72]

In China, the current imbalanced development of disciplines specializing in HI management highlights the need to strengthen training for relevant professionals in healthcare, public health, medical technology, and pharmacy in future endeavors.^[73] Moreover, most hospitals lack standardized management of HIs, face a shortage of professional talent, and exhibit significant disparities in the level of HI management across different medical institutions.^[73] Strengthening academic exchanges and communication with departments related to health supervision and disease control can foster consensus and unified standards, as well as enhance quality control measures and improve the efficiency of law enforcement

in HI management through initiatives such as mutual invitations to participate in training for knowledge and skills related to HI management, specialized lectures, and academic reports.

Improving job satisfaction and employee loyalty

Previously, the focus was primarily on implementing prevention and control measures for infectious diseases, with limited attention given to improving job satisfaction and employee loyalty. However, ensuring satisfaction and loyalty among staff in these departments can be challenging. Not all HAI management departments receive adequate attention and support from hospitals at all levels, resulting in issues concerning staffing composition and work levels. As full-time infection control personnel age, the infection management department is gradually perceived as the “elderly care department” of the hospital. Consequently, the department’s development is hindered by a lack of attention and understanding from other staff members, low income for full-time staff, a lack of self-worth, an unstable team structure, and other factors posing potential risks to medical safety.^[74] Figure 4 shows the impact assessment of health service needs. Hospital leaders often fail to provide clear communication and opportunities for professional development, which has a detrimental impact on employees.

Relating HAIs to continuing education and training

CPD and training can assist to reduce the occurrence of healthcare-associated infections (HAIs) by improving the knowledge and capabilities of health-care practitioners. HAIs are an acronym that stands for healthcare-associated infections.

Health-care professionals can learn and apply IPC rules through training and CPD. CPD is ongoing professional

development. This may prevent infectious disease spread and healthcare-associated infections (HAIs). New research and industry standards are released regularly in the IPC field, so it is crucial to stay current. CPD and training on IPC research and best practices may help health-care providers give the greatest treatment to their patients. This benefits patients and doctors. This could lead to patient-centric healthcare, reducing HAIs and improving patient satisfaction.

New Strategies for Ongoing Training and Professional Development

Interdisciplinary training

Interdisciplinary training plays a crucial role in bringing together professionals from different disciplines to collaborate toward a common goal.^[75] In the context of HAI management, an interdisciplinary training plan should involve professionals from various departments, including clinical medicine, nursing, microbiology, preventive medicine, and environmental services.^[76] The training plan aims to ensure that all staff members are knowledgeable about the latest infection control practices and programs, enabling them to prevent and manage HAIs collectively. There is a substantial amount of variation in the IPC training that is provided to nurses and physicians from one country to the next. Establishing an interdisciplinary regional training plan with common learning goals, standardized professional knowledge, and the assistance of national and international professional institutions might help to address the variability that is shown in IPC training for various professions.^[55]

The first thing that has to be done to create an inter-disciplinary training strategy for HAI management is to determine the relevant domains in which training is required. Every division may develop their own specialized training program according to these requirements. For instance, nursing personnel may be required to undergo training in the right practices for maintaining hand cleanliness as well as the usage of PPE. The employees in microbiology may need training on the processes for laboratory testing and the identification of pathogens. Training for environmental service staff on proper cleaning and disinfecting procedures for patient rooms and equipment might be beneficial. Training that is specialized to individual departments should be included in the strategy for interdisciplinary training, but training that emphasizes collaboration, and communication should also be included. When it comes to the prevention and management of HAIs, good communication and teamwork are very necessary. Because of this, staff members should be educated on how to communicate successfully with one another and recognize chances for collaborative efforts.

Hospital administrators must allocate the necessary resources and provide support to ensure that staff members

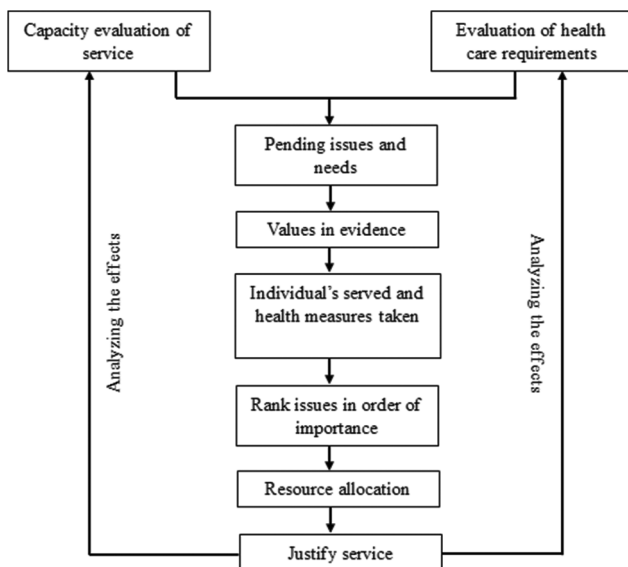


Figure 4: Impact assessment of health service needs

receive the required training and education. This view has been emphasized in several studies.^[8] Continuous education and updates are vital as infection control practices and protocols evolve. With the support of hospital leaders, interdisciplinary training programs can effectively reduce the incidence of HAIs and improve patient outcomes.

Enhancing professional development

There is significant room for improvement in the professional development of HAI prevention and control. In China, HI control has not been fully integrated into the formal curriculum of higher medical institutions and is not even included as a required course. As a result, the discipline of HI control has been significantly constrained, and its advancement necessitates continuous research and exploration. As IPC receive widespread attention globally, promoting the professional development of HI control management presents both opportunities and challenges.

One possible approach is establishing HAI control as a subsidiary discipline under public health and preventive medicine, integrating it into professional graduate education and referring to the clinical medicine professional training system to provide standardized training for professionals in HI control. The goal of establishing the discipline can be achieved by focusing on scientific research and talent development. Developing a professional training model that aligns with the discipline's growth would enable professionals to understand how to fulfill their duties, why they should do so, and what the future holds.^[77]

Illustration for practical use

The following are some particular examples for this work to put into practice:

It is possible for a hospital to design a training program on hand hygiene for all of the health-care professionals. Health-care professionals may have the opportunity to learn the most up-to-date recommendations for hand hygiene, view a demonstration of the correct techniques for doing so, and then put those techniques to the test in a simulated clinical setting as part of the training program.

Long-term care facilities can implement a program that trains all employees to recognize and respond appropriately to infection risks. The program may also include a review of the facility's IPC regulations and procedures in addition to instruction on specific IPC topics such as hand hygiene, aseptic technique, and environmental cleaning and disinfection. This might be included as part of the instruction.

The most recent findings from IPC research and the most successful treatment procedures can be disseminated to local medical practitioners through a program designed by a public health department. The most recent findings from HAI research can be dissected in the classroom, and

effective IPC interventions can be demonstrated in a variety of settings.

Conclusion

To effectively prevent and control infections, it is essential for HAI management employees to participate in ongoing training and professional development. HAI management professionals are very necessary to guarantee the safety of patients and cut down on HAIs. In order for them to successfully carry out their obligations, they need to have a wide range of information and skills under their belt. HAI management staff have the opportunity to improve their knowledge, get new skills, and remain current with the most recent guidelines and best practices by participating in ongoing training and professional development activities. Because of this, they are able to deploy enhanced procedures and technology, which ultimately results in better outcomes for patients and a lower incidence of HAIs. Training that is ongoing assists staff members in understanding the significance of infection control practices and maintaining a constant adherence to such practices.

Training programs that incorporate experts from a variety of departments and create teamwork while also promoting a common knowledge of IPC are called interdisciplinary training programs. By addressing the training requirements that are unique to individual departments and offering training in communication and cooperation, healthcare organizations may foster an environment that encourages effective collaboration and coordination in the management of HAIs. The incorporation of HI control into formal education curriculum, the establishment of HI control as a separate discipline, and the provision of standardised training for professionals are all required to enhance professional growth in the prevention and control of HAIs. By promoting research, talent development, and expanding the training model, the discipline can gain recognition and influence in the medical community.

Overall, HAI management personnel's continuous training and professional development improve their competence and enhance job satisfaction and loyalty. Health-care organizations need to allocate resources and support the ongoing education and development of their IPC personnel. By prioritizing training and professional development, health-care institutions can improve patient safety, quality of care, and overall IPC efforts.

Both health-care organizations and individual healthcare professionals may incur financial burdens as a result of the cost of continuous training and professional development. The cost of training could include things such as tuition, travel expenses, and wages that are missed throughout the process. The continuous training and professional development that is required of healthcare practitioners can be a time-consuming as well. There is a possibility that healthcare professionals will need to spend time away from

their regular jobs to participate in training programs or finish online training courses. There is often a wide range of quality among training programs. There is a possibility that certain programs do not successfully improve the knowledge and abilities of health-care workers.

It is possible that health-care professionals will not be able to put the knowledge and abilities they gain in their training programs into practice once they enter the workforce. This may be the result of a number of causes, including a deficiency in resources or assistance at their place of employment, or the variable requirements of their individual patients. Maintaining continual training and professional development programs over the course of time can be a challenging endeavor. It is possible that health-care organizations will not have the financial means to continue sponsoring training programs, and it is also possible that healthcare professionals will not be able to continue devoting the necessary amount of time to their participation in training programs.

Authors' contributions

MZ conceived the idea for this study and wrote the first draft of the manuscript. MZ discussed this publication with SW. SW, MII and SSMN provided assistance in manuscript writing. WMZWM provides assistance in the establishment of research ideas, manuscript writing, and revision comments stages. All authors revised the manuscript prior to submission. All authors read and approved the final manuscript.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

- Khan HA, Ahmad A, Mehboob R. Nosocomial infections and their control strategies. *Asian Pac J Trop Biomed* 2015;5:509-14.
- Boev C, Kiss E. Hospital-acquired infections: Current trends and prevention. *Crit Care Nurs Clin North Am* 2017;29:51-65.
- Sikora A, Zahra F. Nosocomial Infections. 2023. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023.
- Su C, Zhang Z, Zhao X, Peng H, Hong Y, Huang L, *et al.* Changes in prevalence of nosocomial infection pre- and post-COVID-19 pandemic from a tertiary hospital in China. *BMC Infect Dis* 2021;21:693.
- World Health Organization. Global Report on Infection Prevention and Control. Geneva: World Health Organization; 2022.
- World Health Organization. Report on the Burden of Endemic Health Care-Associated Infection Worldwide. Geneva: World Health Organization; 2011.
- Al-Tawfiq JA, Tambyah PA. Healthcare associated infections (HAI) perspectives. *J Infect Public Health* 2014;7:339-44.
- Qureshi M, Chughtai A, Seale H. Supporting the delivery of infection prevention and control training to healthcare workers: Insights from the sector. *Healthcare (Basel)* 2022;10:936.
- Trybou J, Spaepen E, Vermeulen B, Porrez L, Annemans L. Hospital-acquired infections in Belgian acute-care hospitals: Financial burden of disease and potential cost savings. *Acta Clin Belg* 2013;68:199-205.
- Collins AS. Preventing Health Care-Associated Infections. In: Patient Safety and Quality: An Evidence-Based Handbook for Nurses. Agency for Healthcare Research and Quality (US), Rockville (MD); 2008.
- Donaldson LJ, Fletcher MG. The WHO world alliance for patient safety: Towards the years of living less dangerously. *Med J Aust* 2006;184:S69-72.
- Liu JY, Dickter JK. Nosocomial infections: A history of hospital-acquired infections. *Gastrointest Endosc Clin N Am* 2020;30:637-52.
- Liu X, Zou N, Zhu D, Wang D. Influencing factors analysis and modeling of hospital-acquired infection in elderly patients. *J Comb Optim* 2019;37:248-70.
- Manoukian S, Stewart S, Graves N, Mason H, Robertson C, Kennedy S, *et al.* Bed-days and costs associated with the inpatient burden of healthcare-associated infection in the UK. *J Hosp Infect* 2021;114:43-50.
- Cumpat CM, Zouri M, Zouri N, Ferworn A. Managerial decision support system for evaluating the influence of nosocomial infections: A system dynamics approach. In: Proceedings of the 2019 2nd International Conference on Computers in Management and Business. New York, NY, USA: Association for Computing Machinery; 2019. p. 29-34.
- Gatto V, Scopetti M, La Russa R, Santurro A, Cipolloni L, Viola RV, *et al.* Advanced loss eventuality assessment and technical estimates: An integrated approach for management of healthcare-associated infections. *Curr Pharm Biotechnol* 2019;20:625-34.
- Sun B. Nosocomial infection in China: Management status and solutions. *Am J Infect Control* 2016;44:851-2.
- Wu A, Wen X, Li C, Ren N, Gong Ru, Huang X, *et al.* A survey report on the prevalence of hospital infections and cross-sectional antibiotic use in China in 2012. *Chin J Infect Control* 2014;13:8-15.
- You C, Cha Z, Li L, Luo G, Wang Q, Chen L, *et al.* A survey of hospital infection related indicators in various regions of Guizhou province in 2014. *Chin J Infect Control* 2016;15:821-4.
- Zhang M, Yang H, Xu Y, Mu X, Zhu Y, Wu Y, *et al.* Survey on the prevalence of hospital infection and community infection among hospitalized patients in medical institutions in Guizhou province in 2014. *Chin J Infect Control* 2017;16:23-7.
- Du Q, Zhang D, Hu W, Li X, Xia Q, Wen T, *et al.* Nosocomial infection of COVID-19: A new challenge for healthcare professionals (review). *Int J Mol Med* 2021;47:31.
- Haque M, McKimm J, Sartelli M, Dhingra S, Labricciosa FM, Islam S, *et al.* Strategies to prevent healthcare-associated infections: A narrative overview. *Risk Manag Healthc Policy* 2020;13:1765-80.
- Abbas M, Robalo Nunes T, Martischang R, Zingg W, Iten A, Pittet D, *et al.* Nosocomial transmission and outbreaks of coronavirus disease 2019: The need to protect both patients and healthcare workers. *Antimicrob Resist Infect Control* 2021;10:7.
- Higginson R. Infection control in the community. *Br J Community Nurs* 2018;23:590-5.
- van Duin D, Paterson DL. Multidrug-resistant bacteria in the community: An update. *Infect Dis Clin North Am* 2020;34:709-22.
- Macdonald AS, Loudon D, Wan S, Macduff C. Disentangling

- Complexity: A Visualisation-Led Tool for Healthcare Associated Infection Training. DRS Biennial Conference Series; 2016.
27. Ye Q, Xu Y, Lei Y, Deng M, Cheng Y. Visual analysis of research hotspots and frontiers in hospital infection training in China. *Chin J Infect Control* 2019;18:848-53.
 28. Qureshi MO, Chughtai AA, Seale H. Recommendations related to occupational infection prevention and control training to protect healthcare workers from infectious diseases: A scoping review of infection prevention and control guidelines. *BMC Health Serv Res* 2022;22:272.
 29. Alrubaiee GG, Baharom A, Faisal I, Shahar HK, Daud SM, Basaleem HO. Implementation of an educational module on nosocomial infection control measures: A randomised hospital-based trial. *BMC Nurs* 2021;20:33.
 30. Goyal M, Chaudhry D. Impact of educational and training programs on knowledge of healthcare students regarding nosocomial infections, standard precautions and hand hygiene: A study at tertiary care hospital. *Indian J Crit Care Med* 2019;23:227-31.
 31. Barratt R, Gilbert GL. Education and training in infection prevention and control: Exploring support for national standards. *Infect Dis Health* 2021;26:139-44.
 32. Jeihooni AK, Kashfi SH, Bahmandost M, Afzali Harsini P. Promoting preventive behaviors of nosocomial infections in nurses: The effect of an educational program based on health belief model. *Invest Educ Enferm* 2018;36:e09.
 33. Farotimi AA, Ajao EO, Nwozichi CU, Ademuyiwa IY. Effect of training on knowledge, perception and risk reduction regarding infection control among nurses in selected teaching hospitals in Nigeria. *Iran J Nurs Midwifery Res* 2018;23:471-7.
 34. Lobo D, Sams LM, and Fernandez SL. Correlation between health professionals' knowledge, attitude and practice about infection control measures. *Journal of Medical & Allied Sciences* 2019;9:26-31.
 35. Alsafi Z, Abbas AR, Hassan A, Ali MA. The coronavirus (COVID-19) pandemic: Adaptations in medical education. *Int J Surg* 2020;78:64-5.
 36. Ragazzoni L, Barco A, Echeverri L, Conti A, Linty M, Caviglia M, *et al.* Just-in-time training in a tertiary referral hospital during the COVID-19 pandemic in Italy. *Acad Med* 2021;96:336-9.
 37. Kong X, Zhu X, Zhang Y, Wu J. The application of plan, do, check, act (PDCA) quality management in reducing nosocomial infections in endoscopy rooms: It does work. *Int J Clin Pract* 2021;75:e14351.
 38. Gebreeyessus GD. Knowledge, attitude, and practices on occupational health and safety principles among cleaners: The case of Tikur Anbassa specialized referral hospital, Addis Ababa, Ethiopia. *Open Health* 2022;3:22-33.
 39. Thomas RE, Thomas BC, Lorenzetti D, Conly J. Hospital and long-term care facility environmental service workers' training, skills, activities and effectiveness in cleaning and disinfection: A systematic review. *J Hosp Infect* 2022;124:56-66.
 40. Soeters HM, Koivogui L, de Beer L, Johnson CY, Diaby D, Ouedraogo A, *et al.* Infection prevention and control training and capacity building during the Ebola epidemic in Guinea. *PLoS One* 2018;13:e0193291.
 41. Pei L and Wu H. Does online learning work better than offline learning in undergraduate medical education? A systematic review and meta-analysis. *Medical education online* 2019;24:1666538.
 42. Al Samaraee A. The impact of the COVID-19 pandemic on medical education. *Br J Hosp Med (Lond)* 2020;81:1-4.
 43. Vaskivska HO, Palamar SP, Kravtsova NV, Khodakivska OV. Transformation of the learning process in higher education institutions under the influence of the pandemic COVID-19. *Wiad Lek* 2021;74:1505-9.
 44. Huang Q, Su H, Zhang Y, Liu S, Liu Q, Jiang Y. Practice and experience in the teaching system of clinical pharmacy laboratory in the post-epidemic era: A review. *Medicine (Baltimore)* 2022;101:e32223.
 45. Strobel J, van Barneveld A. When is PBL more effective? A meta-synthesis of meta-analyses comparing PBL to conventional classrooms. *Interdiscip J Probl Based Learn* 2009;3:44-58.
 46. Luo Y, Hu H, Shao Y, Su Y, Li Q. The Application of PBL Teaching Method in Hospital Infection Training for ICU Intern Nurses *Nursing Research*; 2022.
 47. Zhao W, He L, Deng W, Zhu J, Su A, Zhang Y. The effectiveness of the combined problem-based learning (PBL) and case-based learning (CBL) teaching method in the clinical practical teaching of thyroid disease. *BMC Med Educ* 2020;20:381.
 48. Tan W, Ye Y, Yang Y, Chen Z, Yang X, Zhu C, *et al.* Whole-process emergency training of personal protective equipment helps healthcare workers against COVID-19: Design and effect. *J Occup Environ Med* 2020;62:420-3.
 49. Abualenain JT, Al-Alawi MM. Simulation-based training in Ebola personal protective equipment for healthcare workers: Experience from King Abdulaziz university hospital in Saudi Arabia. *J Infect Public Health* 2018;11:796-800.
 50. Marrs R, Horsley TL, Hackbarth D, Landon E. High consequence infectious diseases training using interprofessional simulation and TeamSTEPPS. *Am J Infect Control* 2020;48:615-20.
 51. Kang M, Nagaraj MB, Campbell KK, Nazareno IA, Scott DJ, Arocha D, *et al.* The role of simulation-based training in healthcare-associated infection (HAI) prevention. *Antimicrob Steward Healthc Epidemiol* 2022;2:e20.
 52. Cohen ER, Feinglass J, Barsuk JH, Barnard C, O'Donnell A, McGaghie WC, *et al.* Cost savings from reduced catheter-related bloodstream infection after simulation-based education for residents in a medical intensive care unit. *Simul Healthc* 2010;5:98-102.
 53. Radeva S. On-the-job training as a model for adapting to the working environment. *Knowl Int J* 2019;31:1609-14.
 54. Accardi R, Castaldi S, Marzullo A, Ronchi S, Laquintana D, Lusignani M. Prevention of healthcare associated infections: A descriptive study. *Ann Ig* 2017;29:101-15.
 55. Tsioutis C, Birgand G, Bathoorn E, Deptula A, Ten Horn L, Castro-Sánchez E, *et al.* Education and training programmes for infection prevention and control professionals: Mapping the current opportunities and local needs in European countries. *Antimicrob Resist Infect Control* 2020;9:183.
 56. Park M, Dlamini BB, Lee H, Jeong M, Giap TT, Jung J, *et al.* Factors influencing training transfer among infection control professionals participating in infectious disease training. *J Contin Educ Health Prof* 2023;43:21-7.
 57. Clancy C, Delungahawatta T, Dunne CP. Hand-hygiene-related clinical trials reported between 2014 and 2020: A comprehensive systematic review. *J Hosp Infect* 2021;111:6-26.
 58. Karabay M, Kaya G, Hafizoglu T, Karabay O. Effect of camera monitoring and feedback along with training on hospital infection rate in a neonatal intensive care unit. *Ann Clin Microbiol Antimicrob* 2019;18:35.
 59. Phan LT, Maita D, Mortiz DC, Weber R, Fritzen-Pedicini C, Bleasdale SC, *et al.* Personal protective equipment doffing practices of healthcare workers. *J Occup Environ Hyg* 2019;16:575-81.

60. Sun X, Ding M, Luo X, Kang B, Zhu Y, Xu Z, *et al.* A case study: A continuous improvement project of lecturing skills for clinical teachers in Chinese residency standardized training. *BMC Med Educ* 2022;22:265.
61. Jin H, Huang H, Dong W, Sun J, Liu A, Deng M, *et al.* Preliminary experience of a PDCA-cycle and quality management based training curriculum for rat liver transplantation. *J Surg Res* 2012;176:409-22.
62. Zhao M, Li H, Wang J, Chu L, Huang L, Li H. The effectiveness of motivation-guided PDCA cycle nursing for self-management ability and outcomes of patients with gestational diabetes mellitus. *Nursing Open* 2023;10:6509-16.
63. Gilbert GL, Kerridge I. Hospital infection control: Old problem – Evolving challenges. *Intern Med J* 2020;50:105-7.
64. Alyahya MS, Hijazi HH, Al Qudah J, AlShyab S, AlKhalidi W. Evaluation of infection prevention and control policies, procedures, and practices: An ethnographic study. *Am J Infect Control* 2018;46:1348-55.
65. Camputaro LA, Bello Quezada ME, Hoyos Arango WA, Bortoli RG, Ruiz Zelaya FA, Diaz Moreno MM, *et al.* Intensive competency-based training strategy in a National Hospital in times of Pandemic. *Medicine (Baltimore)* 2021;100:e27152.
66. Tomczyk S, Twyman A, de Kraker ME, Coutinho Rehse AP, Tartari E, Toledo JP, *et al.* The first WHO global survey on infection prevention and control in health-care facilities. *Lancet Infect Dis* 2022;22:845-56.
67. Cole J, Barnard E. The impact of the COVID-19 pandemic on healthcare acquired infections with multidrug resistant organisms. *Am J Infect Control* 2021;49:653-4.
68. Abumetteleq IS, Bayraktar N. Nurses' awareness on hospital acquired infection risks of the geriatric patients: A descriptive and cross-sectional study. *J Infect Dev Ctries* 2021;15:552-8.
69. Kalp EL, Harris JJ, Zawistowski G. Predictors of certification in infection prevention and control among infection preventionists: APIC Megasurvey findings. *Am J Infect Control* 2018;46:858-64.
70. Goss L, Volkman JC, Garcia-Houchins S, Sutton A, Glowicz J. A job analysis of knowledge and tasks for the certification in infection control and epidemiology examination. *Am J Infect Control* 2021;49:1561-3.
71. CIC(®) prep tools led by the new 'certification study guide': Updated 5th edition includes practical test preparation tools. *Am J Infect Control* 2014;42:1141.
72. Curchoe R, Fabrey L, LeBlanc M. The changing role of infection prevention practice as documented by the certification board of infection control and epidemiology practice analysis survey. *Am J Infect Control* 2008;36:241-9.
73. Yang Y, Huang X, Zhang H, Liu D, Yang H, Xian Y, *et al.* A survey report on the training status of provincial hospital infection training institutions nationwide. *Chin J Infect Control* 2016;15:659-64.
74. Min Q, Yang J, Gong X. The use of a three-in-one practice-management-innovation training model in the construction of an infection control team. *Risk Manag Healthc Policy* 2021;14:3403-9.
75. Nobile M, Agodi A, Barchitta M, Brusaferrò S, Castaldi S, D'Alessandro D, *et al.* The effectiveness of educational interventions in university training on hospital hygiene: Results of action research. *Ann Ig* 2018;30:111-20.
76. Emery RJ, Patlovich SJ, King KG, Lowe JM, Rios J. Assessing the established competency categories of the biosafety, infection prevention, and public health professions: A guide for addressing needed professional development training for the current and next pandemic. *Appl Biosaf* 2022;27:53-7.
77. He L, Liu D. The challenge and thinking of novel coronavirus pneumonia to modern hospital infection management. *Chin J Hosp Infect* 2020;30:1601-5.