

NOSOCOMIAL INFECTION CONTROL IN HEALTHCARE ENVIRONMENTS: A SYSTEMATIC REVIEW

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Abstract

HAIs are hospital-acquired infections that can worsen the patient's illness, prolong the length of hospital stay, increase the cost of care, increase the family's economic burden, and indicate a decline in the quality of health services. The purpose of this paper is to obtain an overview of the efforts that have been made in the context of controlling nosocomial infections in the health care environment. This research is a systematic literature review (systematic review) of various research results sourced from various electronic databases using the Flow chart of the literature search process approach (PRISMA 2009). The number of articles that are in accordance with the research objectives are 17 articles, then a review is carried out. The results showed that the most common causes of HAIs were the lack of adherence to handwashing by health care workers, and the lack of supervision of infection prevention and control. So it is necessary to make efforts in the form of increasing knowledge, attitudes, and skills of health care workers continuously through training and supervision programs by the hospital infection control team. The conclusion is that HAIs control is not an easy process, because it requires awareness of all components in its implementation. Therefore, it is recommended that hospitals always provide training programs, demonstrations and strict supervision of the implementation of infection control.

Keywords: HAIs (healthcare-associated infections), nosocomial infections, infection control.

INTRODUCTION

The healthcare environment significantly supports the health improvement process of individuals undergoing treatment. The healthcare environment is a meeting place for patients, providers, visitors, and the surrounding community. These interactions can lead to the spread of disease if not supported by good and sanitary environmental conditions (Ministry of Health, 2022).

Healthcare requires healthcare workers who can provide safe care, so these efforts begin with education (Husna, Novayelinda & Woferst, 2021). Full student involvement in nursing care can foster interdependence among healthcare providers. According to Anindya, Wahyuni, and Mudjianto (2018), healthcare workers such as doctors and nurses, including nursing students, physician assistants, and medical students, contribute to improving and reducing pathogen transmission through patient contact.

Nosocomial pathogens can be transmitted from person to person, through contaminated food and water, infected individuals, or contaminated skin or contact with healthcare workers. Accidental exposure to opportunistic environmental or airborne pathogens can cause infections with significant morbidity and/or mortality. Lack of adherence to established standards and guidelines (such as the use of personal protective equipment, handwashing procedures, and disinfectant use) can have detrimental effects on both patients and healthcare workers (Zhang, Fang, Zhang, et al., 2020). One effect that can occur due to non-compliance is nosocomial infection (Mahdizadeh, Tavakoly, & Sarpooshi, 2021).

Nosocomial infections are infections acquired/associated with hospitals, currently known as healthcare-associated infections (HAIs). The global prevalence of HAIs reaches 9%, or approximately 1.40 million hospitalized patients worldwide are affected by nosocomial infections. The WHO released a global report on infection prevention and control, which found that in low- and middle-income countries, 15 out of every 100 people visiting healthcare facilities will experience a nosocomial infection. The prevalence of HAIs is highest in the Eastern Mediterranean and Southeast Asia, at 11.80% and 10%, respectively, while in Europe and the Western Pacific it is 7.70% and 9%, respectively (WHO, 2022).

HAIs occurring in healthcare settings can impact various aspects of life. The impact on patients can include worsening their illness, prolonging hospital stays, increasing treatment costs, and increasing the economic burden on families (Li, Li, Zhang, et al., 2022). The impact on healthcare providers can indicate poor quality healthcare and weak infection control management.

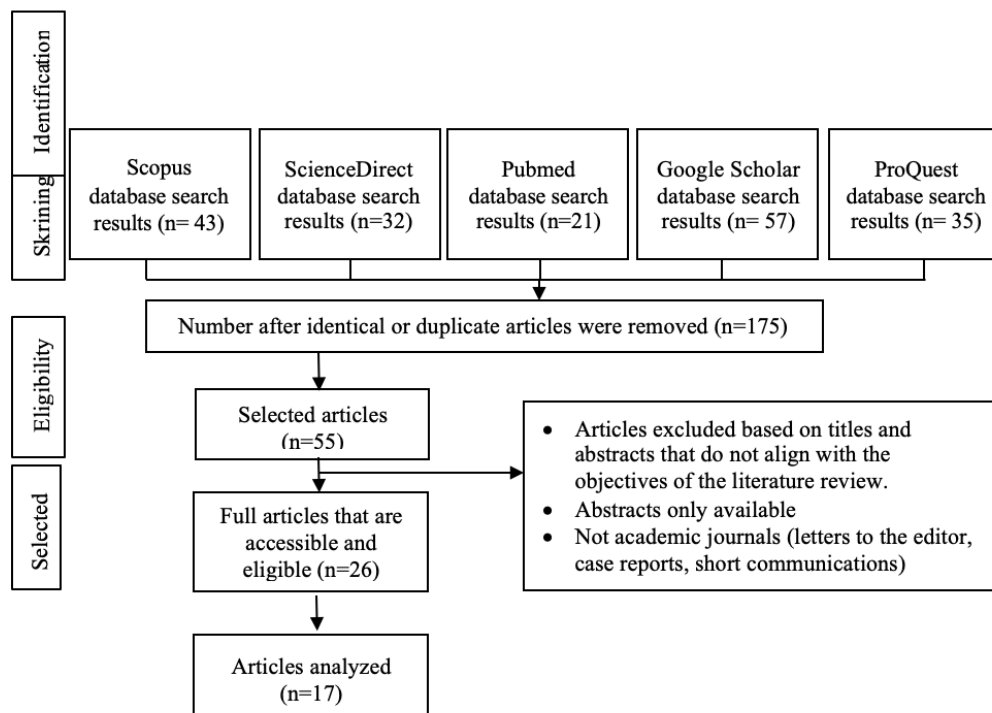
Based on this description, the author is interested in conducting a systematic review of infection control in healthcare settings. The purpose of this paper is to obtain an overview of the efforts that have been made to control nosocomial infections in healthcare settings. The research results reviewed will be linked to their benefits for infection control in healthcare settings.

RESEARCH METHODS

This research is a systematic literature review of various research findings sourced from various electronic databases. The literature search was conducted online using databases such as ScienceDirect, Scopus, Pubmed, ProQuest, Clinicalkey for nursing, and Google Scholar. The keywords used in the reference search were healthcare-associated infections, hospital-acquired infections, nosocomial infection, and infection control. The reference search was limited to the years 2018 to 2023. The author's article selection process is depicted in Scheme 1

RESEARCH RESULTS

Seventeen research articles were selected that met the objectives of this paper. The selected studies were then extracted and tabulated using a table containing the author(s), year of publication, country of study, study design, sample size and participant characteristics, and results (Table 1).



Scheme 1: Flow chart of the literature search process (PRISMA 2009).

Table 1. Results of literature review

Researcher, title, journal, year	Problems	Population, method	Results
Ramayanti, Semiarty, R., dan Lestari. “Analisis Pelaksanaan Program Pencegahan Dan Pengendalian Infeksi Nosokomial di RSUD Pasaman Barat” Jurnal Kesehatan Andalas. 2019; 8(3)	This study aims to analyze the implementation of the PPI program through a descriptive policy study with a qualitative approach.	Data collection was carried out through interviews, FGDs, document reviews and observations.	Research results revealed that there were obstacles to the implementation of PPI at West Pasaman Regional Hospital after being analyzed using a systems approach. The input constraints were human resources, funding, and facilities, while the process constraints were suboptimal implementation because some officers still did not follow Standard Operating Procedures (SOPs).
Riani, dan Syafriani. “Hubungan Antara Motivasi Dengan Kepatuhan Perawat Melaksanakan <i>Handhygiene</i> Sebagai Tindakan Pencegahan Infeksi Nosokomial Di Ruang Rawat Inap”. Jurnal Ners Volume 3 Nomor 2 Tahun 2019 Hal 49-59.	Nosocomial infections in a hospital in Pekanbaru reached 6.55% in 2018. Nurses' motivation and compliance with hand hygiene practices only reached around 56.3%.	The research design used was cross-sectional, with the population and sample being all inpatient nurses.	There is a significant relationship between motivation and nurses' compliance in implementing six-step hand hygiene in five moments as a measure to prevent nosocomial infections in hospital inpatient rooms.
Anindya, Wahyuni, dan Mudjiyanto. “Pengetahuan Petugas Surveilans Tentang Identifikasi <i>Healthcare-</i>	Nurses' knowledge in identifying healthcare-associated infections (HAIs) is needed to facilitate the implementation of surveillance and the	This study aims to describe the knowledge of HAIs surveillance officers. This study is a descriptive observational study with a cross-sectional design.	Most nurses experienced increased knowledge in identifying HAIs, were able to enter data, were able to convert data entry into tables, and after training, most of the treatment rooms had started to use epi info to record HAIs data.

Researcher, title, journal, year	Problems	Population, method	Results
<i>Associated Infections</i> di Surabaya” Jurnal Berkala Epidemiologi Vol 6 No 2 2018 130-138	application of surveillance data collection.		
Alrubaiee, G.G., Baharom, A., Faisal, I., Shahar, H.K., Daud, S.M., and Basale, H.O. Yaman <i>Implementation of an educational module on nosocomial infection control measures: a randomised hospital-based trial.</i> BMC Nursing (2021) 20:33	Previous cross-sectional studies have reported limited knowledge and practice among nurses regarding nosocomial infection (NI) control. Although healthcare institutions offer numerous in- service training courses to address the problem, the three-year nursing education program at these institutions is insufficient to equip nurses with the skills to manage NI.	This study aimed to evaluate the implementation of an educational module on NI control measures among Yemeni nurses. A single-blind, randomized, hospital-based trial was conducted involving 540 nurses assigned to two intervention groups and a waitlist group. Intervention Group 1 received a 20-hour face-to-face training course spread over six weeks and a hard copy of the module, while Intervention Group 2 received only a hard copy of the module (no training). In contrast, the waitlist group received nothing during the data collection period.	The results of data collection and analysis showed a statistically significant difference in the mean knowledge score between the intervention groups detected immediately after the intervention with a mean difference (MD) of 4.31 ($P < 0.001$) and 3 months after the end of the intervention. intervention (MD = 4.48, $P < 0.001$) compared to the waiting list group. Similarly, the results showed a statistically significant difference in the mean practice score between the intervention group immediately after the intervention (MD = 2.74, $P < 0.001$) and 3 months after the intervention (MD = 2.46, $P < 0.001$) compared to the waiting list group. Intervention-1 (face-to-face training + modules) was more effective than intervention-2 (modules only) in improving the knowledge and skills of Yemeni nurses.

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Mahdizadeh, S.M., Tavakoly, B.S., Sany, Sarpooshi, D.R., Jafari, A., & Mahdizadeh, M. Iran <i>Predictors of preventive behavior of nosocomial infections in nursing staff: a structural equation model based on the social cognitive theory</i> BMC Health Services Research (2021) 21:1187	The occurrence of nosocomial infections remains a health threat to patients and hospital staff. This study applies social cognitive theory to predict the determinants of nosocomial infection control behavior among hospital nursing staff.	A cross-sectional study was used. The sample size was 280 nurses and nursing assistants. The sampling technique used was random sampling from intensive care wards, including the CCU, ICU, NICU, and dialysis, at a teaching hospital in Mashhad, Iran, in 2020. The research instrument was a 5-point Likert-scale questionnaire based on the constructs of social cognitive theory.	The results showed that nosocomial infection prevention behavior was directly influenced by self-regulation, outcome expectations, and construct barriers. The highest effect was related to the self-regulation structure, with a p value of <0.001. Considering that self-regulation, outcome expectations, and barriers significantly influence the adherence to nosocomial infection prevention behavior among nursing staff. It is recommended that policymakers and planners try to reduce barriers, strengthen behavioral motivation, and empower nursing staff by teaching self-regulation.
Zhang, C.Q., Fang, Y.R., Zhang, Y.R., Hagger, M.S., & Hamilton, K. Hongkong <i>Predicting Hand Washing and Sleep Hygiene Behaviors among College Students: Test of an Integrated Social-Cognition Model</i> Int. J. Environ. Res. Public Health (2020) 17:1209	Handwashing and sleep hygiene are two important health behaviors. The purpose of this study was to identify students' motivation and willingness to practice handwashing and sleep hygiene, based on an integrated behavioral model combining the Theory of Planned Behavior (TPB) and the Health Action Process Approach (HAPA).	Using a prospective design, college students (N = 1106) completed a survey assessing the motivational constructs of action self-efficacy, attitudes, subjective norms, perceived behavioral control, intentions, and handwashing and sleep hygiene behaviors.	The results showed significant direct effects of attitude, subjective norm, and perceived behavioral control on intention; a significant direct effect of action self-efficacy on maintenance self-efficacy; and a significant direct effect of maintenance self-efficacy on action planning and coping planning. The current findings suggest that college students' handwashing and sleep hygiene behaviors are a function of motivational and volitional factors. The findings also

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			suggest that the TPB and HAPA pathways may differ for these two health behaviors.
Abalkhail, A., Al Imam, M.H., Elmosaad, Y.M., Jaber, M.F., Al Hosis, K., Alhumaydhi, F.A., Alslamah, T., Alamer, A., & Mahmud, I. Saudi Arabia <i>Knowledge, Attitude and Practice of Standard Infection Control Precautions among Health-Care Workers in a University Hospital in Qassim, Saudi Arabia: A Cross Sectional Survey</i> Int. J. Environ. Res. Public Health 2021, 18, 11831	Hospital-acquired infections (HAIs) contribute to increased length of hospital stay, higher mortality, and higher healthcare costs. HAIs prevention and control are important public health issues. This study assessed knowledge, attitudes, and practices of standard infection control precautions among healthcare workers in Qassim, Saudi Arabia.	This study employed an online survey method with healthcare workers using a structured questionnaire. Predictors of KAP (Knowledge, Attitude, and Practice) were investigated using multivariate logistic regression analysis and independent sample t-tests. The sample size was 213 healthcare workers.	The results suggest that organizing training schedules for healthcare workers may be useful in improving their knowledge of standard infection control precautions and is also expected to facilitate positive attitudes and practices.
Husna, N., Novayelinda, R., & Woferst, R. An overview of the efforts by professional students of the nursing faculty of riau	This study aims to determine the description of the efforts of Professional students of the Faculty of Nursing, University of Riau towards	This is a quantitative research study with a descriptive design. Sample selection used a purposive sampling method with inclusion criteria.	Professional students of the Faculty of Nursing, University of Riau have a percentage of prevention efforts ranging from 85.3% to 11.9% for phlebitis in pediatric patients.

Researcher, title, journal, year	Problems	Population, method	Results
university to prevent phlebitis in pediatric patients Jurnal Ilmu Keperawatan (2021) 9: 2	preventing phlebitis in pediatric patients.		
Pratiwi, V., & Yarmaliza Identifikasi perilaku perawat dalam pencegahan infeksi nosokomial di ruang rawat inap RSUD Cut Nyak Dhien Kabupaten Aceh Barat. Jurnal Jurnakemas (2022) Vol. 2: 2	Nurses are among the healthcare workers most vulnerable to nosocomial infections, as they work 24/7 in hospitals. Nurses' behavior in preventing nosocomial infections is influenced by several factors, including their knowledge, attitudes, and motivation.	This was a quantitative cross- sectional study. The sample consisted of 76 inpatient nurses at Cut Nyak Dhien Regional Hospital. Data analysis used univariate and bivariate analyses.	The study found a relationship between nurses' knowledge and motivation in preventing nosocomial infections. It is recommended that institutions increase their commitment to preventing nosocomial infections in hospitals, particularly in inpatient wards, by improving nurses' knowledge, prevention, and control. This will allow for continued growth, particularly in providing new insights into nosocomial infection control.
Trisnawati, N.L., Krisnawati, M.S., & Damayanti, M.R. Gambaran Pelaksanaan Pencegahan Infeksi Nosokomial Pada Perawat di Ruang HCU Dan Rawat Inap Rumah Sakit X Di Bali Jurnal BIMIKI (2018) Vol. 6:1; 11-19	Nosocomial infections are a serious problem facing hospitals because they have significant impacts. The incidence of nosocomial infections can be related to the care provided by nurses in hospitals.	This study used a descriptive analytical design with a cross- sectional approach. Respondents consisted of 30 nurses in the intensive care unit (HCU) and inpatient units, selected using a simple random sampling technique. Data collection was conducted by completing a questionnaire on knowledge and	The results of the study showed that nurses in the HCU Room had good knowledge (53.3%), positive attitudes (93.3%) and moderate actions (46.7%), while in the inpatient room it was found that nurses had good knowledge (53.3%), positive attitudes (86.7%) and moderate actions (33.3%) related to the implementation of nosocomial infection prevention. Researchers suggest that nurses working in the HCU room and inpatient room can

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Researcher, title, journal, year	Problems	Population, method	Results
		attitudes, as well as observing nursing actions.	implement nosocomial infection prevention measures properly in accordance with hospital standard operating procedures to prevent cross-infection.
Dewi, I.P., Adawiyah, W.R., & Rujito, L. Analisis Tingkat Kepatuhan Pemakaian Alat Pelindung Diri Mahasiswa Profesi Dokter Gigi Di Rumah Sakit Gigi Dan Mulut Unsoed Jurnal Ekonomi, Bisnis dan Akuntansi (JEBA) Volume 21 No 4 Tahun 2019	Healthcare workers in hospitals are at high risk of contracting diseases that could threaten their health and safety while working. These workers include medical students who are practicing in hospitals.	This research method was quantitative and employed a cross-sectional approach. The aim was to determine factors related to compliance with the use of personal protective equipment among dental students. A simple random sampling method was used to select 111 students. Data collection used questionnaires and observation sheets.	The results showed a correlation between age and compliance with PPE use ($p = 0.001$). There was no correlation between length of service and compliance with PPE use ($p = 0.74$). There was a correlation between knowledge and compliance with PPE use ($p = 0.008$). There was a correlation between attitudes toward compliance with PPE use ($p = 0.001$). There was a correlation between facility availability and compliance with PPE use ($p = 0.000$). There was a correlation between training on compliance with PPE use ($p = 0.003$). There was a correlation between control and compliance with PPE use ($p = 0.001$). Dental students' compliance with personal protective equipment (PPE) use still needs to be improved through regular outreach and supervision to protect professional students from the risk of infection transmission in hospitals.

Researcher, title, journal, year	Problems	Population, method	Results
Arruum D, Novieastari E, Gayatri D, Ayu NMS. The Factors Impacting Nurses Awareness on Prevention Healthcare-Associated Infections: A Systematic Review Macedonian Journal of Medical Sciences. 2021 Oct 07; 9(F):595-600.	Healthcare-Associated Infections (HAIs) are a significant cause of illness and death, and nurses are the healthcare workers who have the most frequent contact with patients, therefore nurses need to have adequate knowledge and awareness.	A systematic review was conducted using data collection sources including ProQuest, ScienceDirect, PubMed, and Google Scholar from 2011 to 2020. The English language guidelines for review were used, using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement. Data were obtained through questionnaire surveys, direct observation, and self-reports from 4,329 nurses, meeting 12 inclusion criteria.	The study results showed that a significant number of nurses lacked acceptable levels of knowledge and practice, despite positive attitudes. Hand hygiene and other personal protective equipment (PPE) are essential for nurses and other healthcare workers to prevent hospital infections. Nurses had low levels of knowledge, with higher positive attitudes and low adherence to practice. Nurses need to have the correct knowledge, attitudes, and guidelines. Standard Operating Procedures (SOPs) are crucial for patient safety management, and nurses need adequate training to raise awareness.
Lien LT, Johansson E, Lan PT, Chuc TK, Thoa NT, Hoa NQ, <i>et al.</i> A potential way to decrease the know-do gap in hospital infection control in Vietnam: Providing specific figures on healthcare-associated infections to the hospital staff can “wake them up” to change their behaviour. <i>Int J Environ Res Public Health</i> . 2018;15(7):1549.	Adequate infection control plays a key role in preventing healthcare-associated infections (HAIs).	This study aimed to explore staff perceptions of hospital infection control in rural and urban hospitals in Vietnam. Individual interviews were conducted with hospital managers, and focus group discussions (FGDs) were conducted separately with doctors, nurses, and cleaning staff. An interview guide, including discussion points on HAIs, hand hygiene, and	Generally, staff have knowledge of hospital infection control, but they are unaware of the situation in their own hospitals, and infection control practices in hospitals remain poor. Reported challenges in infection control include lack of resources, poor awareness, and patient overload. A key theme emerged: Making data on HAIs available to healthcare workers can increase their awareness and motivate them to put their existing knowledge into

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		healthcare waste management, was used. Content analysis was used for analysis.	practice, thereby closing the knowledge gap in infection control.
Lobo D, Sams L, Fernandez S. Correlation between health professional knowledge, attitude and practice about infection control measures. <i>J Med Allied Sci.</i> 2019;9(1):26.	Infection control measures are recommended to prevent infection transmission in hospitals. However, their implementation depends on the knowledge and attitudes of healthcare workers (HCWs).	A cross-sectional study was conducted among healthcare workers at A.J. Hospital and Research Centre, Mangaluru. A total of 80 staff nurses were selected through purposive sampling from the medical, surgical, and orthopedic wards. Data were collected through a self-administered structured questionnaire that assessed knowledge and adherence to practices and attitudes regarding infection control measures.	This study describes healthcare workers' knowledge and adherence to practices, as well as attitudes regarding infection control measures. There was a linear correlation between knowledge and attitudes, and between knowledge scores and practice scores. Overall, there was no correlation between individual attitude and practice scores.
Daulay FC, Sudiro S, Amirah A. Management analysis of infection prevention: Nurses' compliance in implementing hand hygiene in the inventories of rantauprapat hospital.	Prevention and control of nosocomial infections in hospitals is crucial because the incidence of nosocomial infections reflects the quality of hospital services. The risk of infection in hospitals can be minimized through planning, implementation, guidance, education and	This study aims to analyze the impact of infection control management on nurses' compliance with hand hygiene in the inpatient ward at Rantauprapat Regional Hospital. Method: An analytical survey with a cross-sectional design was used.	The results of the study indicate a relationship between infection control prevention management and nurse compliance with hand hygiene in inpatient wards, with a chi-square test result of $p = 0.0001$. The most dominant variable influencing nurse compliance with hand hygiene was supervision, as it had the largest regression coefficient (B) of 2.444, with Exp (B).

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J Sci Res Med Biol Sci. 2021;2(1):42-9.	training, monitoring, and evaluation.	The study population consisted of 64 nurses working in the inpatient ward. Data collection was conducted using purposive sampling.	Based on the results of the study, it can be concluded that routine supervision and training are the most effective options in infection control prevention management.
Li P, Li Y, Zhang Y, Bao J, Yuan R, Lan H, Sun M. Economic burden attributable to healthcare associated infections in tertiary public hospitals of Central China: a multi-centre case control study <i>Epidemiology and Infection</i> (2022) 150, e155, 1–7.	Healthcare-associated infections (HAIs) are a major cause of morbidity, mortality, and costs, which vary widely by region and hospital.	A sample of 2,976 patients in 10 hospitals was enrolled, and the incidence rate of HAI was	The per capita economic losses caused by HAIs are significant, primarily from pharmaceutical costs. Furthermore, the economic losses caused by device- associated infections and hospital- acquired multidrug-resistant bacteria are two to four times greater than those caused by controls. The burden of HAIs is substantial, and opportunities to alleviate this burden exist in several areas, including strengthening antibiotic stewardship and implementing effective HAI prevention regimens for patients.

DISCUSSION

Several research findings reviewed in this paper were adapted to develop a safety-based infection control model.

Hand hygiene is recognized as a crucial step in preventing healthcare-associated infections. Healthcare workers' handwashing awareness is a fundamental behavior in preventing cross-infection (Pratiwi & Yarmaliza, 2022). However, compliance with standard operating procedures (SOPs) is only 36%. Low compliance primarily concerns the technical details of handwashing (Riani & Syafriani, 2019).

Dewi, Adawiyah, & Rujito (2019) stated that knowledge and skills in using PPE, implementing SOPs, and washing hands before procedures are factors associated with nosocomial infections. Implementation of PPE use is suboptimal because some staff still do not follow Standard Operating Procedures (SOPs) (Ramayanti, Semiarty, & Lestari, 2019).

HAIs occurring during hospitalization impact length of stay, disability, and economic burden (Li P, Li Y, Zhang Y, et al., 2022). HAIs also burden the healthcare system in terms of costs to payers and providers, and inefficiencies in hospital capacity and operations. Infected patients and healthcare providers suffer consequences such as reduced quality of life and sometimes death. HAIs can be prevented by appropriate healthcare worker behavior and adherence to evidence-based infection prevention procedures and guidelines (Lobo, Sams, & Fernandez, 2019).

Educational programs to improve hand hygiene compliance and knowledge for healthcare workers using a role model training approach have had a significant impact on behavioral change (Pratiwi & Yarmaliza, 2022; Lobo, et al., 2019). One approach that can be used is the use of training modules and direct mentoring on nosocomial infection prevention (Alrubaiee, Baharom, & Faisal, 2021).

Motivation also has a significant relationship with nurses' compliance with the six-step, five-moment hand hygiene protocol as a preventive measure for nosocomial infections in hospital inpatient wards (Riani, 2019). This finding aligns with the statement that adapting the World Health Organization's (WHO) Five Moments for Hand Hygiene Guidelines can reduce HAIs in hospitals (Daulay, Sudiro & Amirah, 2021).

HAIs can also be controlled through continuous monitoring and enforcement of specific infection control SOPs (Arruum, Novieastari, Gayatri, & Ayu, 2021). Furthermore, a training schedule for healthcare workers is also useful for improving knowledge, attitudes, and positive practices regarding standard infection prevention and control measures (Abalkhail, Al Imam, & Elmosaad, 2021).

Oversight of HAIs prevention and control implementation is not as easy as imagined. Implementation constraints exist, which are analyzed using a systems approach. Input constraints include human resources, funding, and facilities, while process constraints involve suboptimal implementation because some staff still do not follow standard operating procedures (Ramayanti, 2019). If hospitals and policymakers choose to rely on administrative data for HAIs, oversight, continuous improvement of algorithms, and validation are crucial (Lien, Johansson, Lan, et al., 2018).

One effort to control HAIs is through ongoing monitoring and training of healthcare workers. Alrubaiee (2021) found that interventions involving face-to-face training and modules were more effective than those providing modules alone in improving nurses' knowledge and skills.

CONCLUSION

HAIs impact length of stay, disability, and the economic burden on patients and healthcare workers in hospitals. Therefore, efforts to prevent and control HAIs are necessary. This effort is carried out by improving nurses' knowledge, attitudes, and skills through education and training. Furthermore, the hospital infection control team will monitor and continuously improve the implementation of HAIs prevention and control.

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