Practical Model of Infection Prevention and Control in Intensive Care Units for Iran

Zahra Salehi[1], Esmaeil Mohammadnejad[2,3], Amir Aliramezani[4]

[1]Department of Medical-Surgical Nursing and Basic Sciences, School of Nursing and Midwifery, Iran University of Medical Sciences, Tehran, Iran

[2]Research center for Antibiotic Stewardship and Antimicrobial Resistance, Tehran University of Medical Sciences, Tehran, Iran

[3]Department of Medical-Surgical Nursing and Basic Sciences, School of Nursing and Midwifery, Tehran University of Medical Sciences, Tehran, Iran

[4]Department of Microbiology, Faculty of Biochemistry, Biophysics and Biotechnology, Jagiellonian University, Krakow 30-387, Poland

ABSTRACT	ARTICLE DETAILS
Background and Objectives: Nosocomial infections, especially in intensive care units as well as increased mortality and costs associated with them are considered as one of the major health problems in the communities so that successful control of them requires awareness on their problems in the hospitals and a precise planning. This study was conducted to "provide a model for prevention and control of nosocomial infections in intensive care units". **Methods and Materials**: This qualitative study was conducted through purposeful sampling strategy on 21 healthcare providers selected via purposive sampling from various medical subgroups, including: anesthesiologist, nurse manager, supervisors, faculty members, head nurses, and hospital managers. The data were collected using semi-structured interviews and conventional content analysis method was used for data analysis. In the second phase, a comparative study of the situation of our country and targeted countries was conducted and in the third phase a practical model is designed. **Results:** The results of qualitative content analysis using conventional approach in the field of staff's experiment regarding the model of prevention and control of nosocomial infections in intensive care units, revealed 3 main themes: "barriers (human factors, environmental factors, personal factors and complexity)", "facilitating factors (organizational, external and internal stimuli) ", and "concepts of the model (effectiveness of infection control training process in ICU, the systematic nature of the process of infection control, public hospital management, resource management and organizational leadership)". After a comparative study, the applied model of control and prevention of nosocomial infection in the ICU was designed with seven models, including standards (caring-curing and structural), monitoring and supervision, education and training, logistic resources, modern technologies, translation and knowledge transfer and evidence-based practice. **Conclusion:** Identifying the barriers and facilitating factors of nosocomial infection control and the use of especial measures in ICU promote the patient's safety and enhance the quality of care. Prevention of these infections requires a comprehensive and integrated controlling program. This model can be applied to resolve existing gaps and cause maximum integrity between the concepts. **KEYWORDS:** Intensive care units, Infection control, Nosocomial infections, Qualitative analysis	**Published On:** **28 January 2023** **Available on:** **https://ijmscr.org/**

INTRODUCTION

Medical measures and care, like any other economic, social and health activity, are associated with positive and sometimes unpleasant outcomes. Hospitals provide services in an organized, continuous and reliable manner(1, 2). If health is to be considered as the end product of treatment activities in an organization called a hospital, hospital-acquired infections (HAIs) should be regarded as a side effect

Corresponding Author: Esmaeil Mohammadnejad

and at the same time preventable. The HAIs have always been one of the major health problems as hospitals expand, increasing the risk of infection and mortality and therefore incurring high hospital costs by extending the duration of hospitalization(3-5).

According to the World Health Organization (WHO), the highest incidence rate of HAIs is in hospitals in the Eastern Mediterranean and Southeast Asia, and the lowest incidence rate is in the western Pacific and Europe(6). This figure has reached 11.8% in the Eastern Mediterranean and Southeast Asia. According to studies in some middle-income countries, about $ 8 billion in economic damage is estimated annually to address the problems associated with these HAIs. In another report, the incidence rate of HAIs was between 5-15% in the general wards and more than 50% in the intensive care unit (ICU)(3, 7).

The HAIs are important in three aspects: morbidity, mortality and hospital costs. On the other hand, each nosocomial infection adds 4.5 days to the duration of hospitalization and therefore imposes a significant cost on the hospital(8). The HAIs lead to mental stress, disability, morbidity and reduced quality of life in patients. About two million people in the United States experience HAIs each year, which cost more than $ 2 billion and are the 11th leading cause of death(9). Approximately 1% of these infections are fatal and about 4% are involved in patient mortality(10).

The problems of HAIs and their prevention strategies are influenced by factors such as the use of invasive methods, frequent changes in medical and surgical methods, changes in drug composition, antibiotic treatment, and the development of resistant microorganisms. Prevention and control of HAIs is an essential multi-sectoral and multi-dimensional issue (11). Scattered statistics from developing countries reflect the fact that the exact incidence rate of HAIs in such countries depends on many factors such as the number of hospital beds, the level of hospital referrals, whether or not they are trained, the presence or absence of control programs, the type of wards studied and the extent of facilities and financial adequacy for care programs(12).

The ICU patients are very vulnerable and more prone to infection due to general weakness caused by the disease, weakening of defense mechanisms and duration of f hospitalization, catheter placement and especially insertion of endotracheal tube and respirator into artificial ventilation, urinary catheterization and central vein. On the other hand, the HAI pathogens have become resistant to a variety of antibiotics and conventional therapies(13). Despite the fact that infectious and emerging diseases such as HIV/AIDS, TB , Hepatitis and Covid-19 are important problems and their management must be up to date (14-16). In the medical center, programs and models should be designed to control infectious diseases, especially in ICU.

Infection control as a major responsibility should be considered increasingly by the medical staff in particular(17). Considering the principle of preference of prevention over treatment, prevention of these infections is undoubtedly the most effective, least expensive and most desirable method of control. Today's activities in the field of infection control are considered as one of the basic indicators of the quality of patient care and vital components of hospital management(18). Nurses, as the largest members of the treatment team(19), play an important role in the spread, prevention and control of infection, and are a key component in the management and control of HAIs(20).Considering the above cases and the incidence of HAIs in the intensive care wards, the present study was performed with the aim of "analyzing the process and presenting a model for infection prevention and control in the intensive care units of hospitals".

MATERIALS AND METHODS

The present study is a qualitative research using content analysis method, which was conducted by purposeful sampling among 21 members of the medical staff from all groups (anesthesiologist, head of department, supervisor, faculty members, head nurse and manager) through semi-structured interviews. Data were analyzed by contractual content analysis. In the second phase, a comparative study was conducted between the situation of our country, Iran, and the target countries. The third phase is related to the design of the applied model. In this study, 21 people participated and 23 interviews were conducted with them in total. The majority (57.1%) of the participants in this study was female and 42.8% were in the age range of 36-45 years. The first participant was a Master of Science (M.Sc.) in Nursing and Supervisor for HAI control, who volunteered to participate in the interview. A total of 14 interviews - two ICU presidents, five specialists, two infection control supervisors, four with a bachelor's degree in nursing, one hospital administrator, and one university infection control expert - were conducted during outside of normal business hours as agreed by both parties. In the present study, the research context of medical staff in different cities of Iran was based on inclusion criteria. The environment chosen for the interview was based on the participants' wishes, so that all the interviews were conducted in a safe, secluded and trusted place according to the participants' wishes. Inclusion criteria were at least one year of work experience in the intensive care unit, one year of management experience in centers with ICUs. The semi-structured interviews were employed in this study.

A) Semi-structured interviews and contractual content analysis of data

To reach the goal, content analysis was recruited by examining existing texts and documents for the field. The purpose of quantitative and qualitative data analysis is to organize, provide structure and extract meaning from research data. Throughout the research process where bulk data is collected, exclusive reporting of all data is not the main goal which is a very long task(21). Contractual content analysis method was performed to analyze the data(3). To

achieve data immersion, researchers listened to the interviews several times, handwritten and typed them verbatim, and reviewed the typed text several times. Subsequently, in order to extract the codes, the data were read verbatim, and the highlighted words of the text were identified, and the coding was carried out by writing notes in the margins of the text. Preliminary coding was performed using the participants' own words and the researcher's perceptions of the statements. By coding, the semantic unit was extracted from the statements of the participants. Then, the codes were classified based on similarities and differences, and compared to obtain the main classes. The eight steps of qualitative content analysis are as follows: prepare the data, specify the semantic unit, develop the classes and coding map, test the coding map in a sample text, codify the whole text, evaluate the coding consistency, draw your own conclusions from the coded data, and report the methods and findings.

B) Comparative study of the situation in Iran and other countries
The present study was conducted by descriptive-comparative design using the George F. Brady method. Comparative study is a practice in which two or more phenomena are put together and their differences and similarities are analyzed. Data collection tools in this study were number of hospital beds per population, training courses, staff status (number of staff per bed and patient), physical structure, process (Infection Control Committee), guideline used for intensive care unit and incidence rate of HAIs. Accordingly, for each case, Iran was compared with other countries for commonalities and differences.

C) Presenting a model of infection prevention and control in the intensive care units of hospitals
The Walker and Avant approach was used in model design. According to this model, structures and processes related to the control and prevention of HAIs were identified. Since the model design was based on a selection of results from a content analysis study, the three-step strategy of Walker and Avant(22) is a suitable method for this purpose. This section contains the theory, model processing method, assumptions, key concepts, model objectives, and model strategies or operational steps.

RERSULTS
A qualitative study identified inhibiting and facilitating factors. The facilitating factors in the control and prevention of HAIs include organizational, external, and internal stimuli. The inhibiting factors included human, environmental, individual and complexity factors. Finally, the model concepts were identified (Table 1).

Table 1. Concepts of HAI control and prevention model in intensive care units

Main classes	Sub-classes
Efficiency of the infection control training process in the intensive care unit	Proper educational management
	Trainer efficiency
	Codified infection control training program
	Taking advantage of the trainees
Systematization of infection control processes	Implementation of strategies for standards
	Efficiency of infection control system
	Complete supervision and monitoring over the infection control process
General management of hospitals	Coordination of related wards in hospitals
	Providing favourable physical conditions
	Improvement of human resources
Resource management	Funding
	Insufficient equipment and resources
	Supply of efficient manpower
Organizational leadership	Providing sufficient motivation to work in the intensive care unit
	Updating the knowledge, attitude and skills of medical staff
	Involving all team members in the infection control process
	Setting infection control goals in coordination with the team

STRUCTURE AND COMPONENTS OF THE MODEL
After studying the content analysis, comparative study, operational model of control and prevention of HAI in the ICU was extracted with seven concepts of standards (care-treatment and structural), monitoring & supervision, training & education, logistics resources, new technology, knowledge translation and transfer (research on infection control), and evidence-based practice (EBP) (Figure 1-4).

In-service training, design and development of graduate courses, electronic courses and short-term courses

Education&Training

logestic Resource

Vaccination of medical staff, provision of hospital facilities, standard precautions, effective interaction of sections, staff culture, communication with public health and other services

Care-treatment: antibiotic therapy, antimicrobial stewardship, screening of patients, microbial resistance, reduction of invasive measures, hand washing

Standards

Structural: ventilation, isolation room, design of hospital wards, disinfection space

Anti-microbial cloths, intelligence robot infection tracker

New Technology

Monitoring & Supervision

Infection control committee, establishment of infection prevention and control (IPC) system, clinical audit, compilation and operational indicators

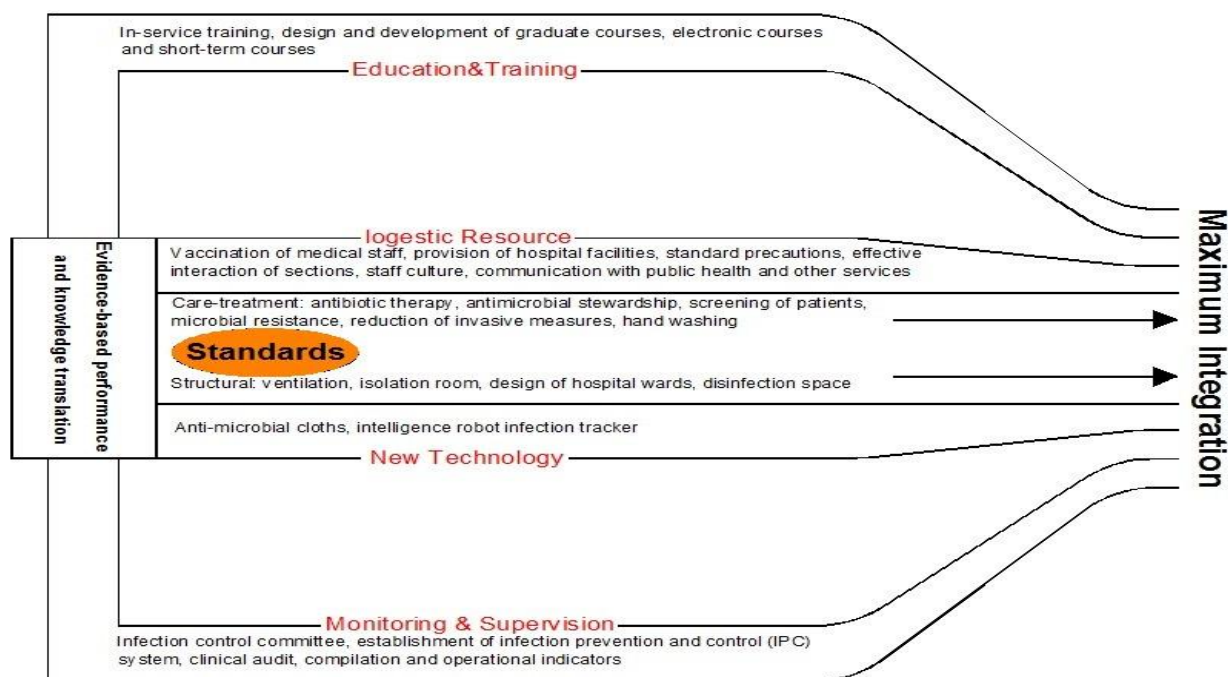Evidence-based performance and knowledge translation

Maximum Integration

Figure 1-4. Applied model of control and prevention of hospital-acquired infections in the intensive care unit

DESCRIPTION OF THE DESIGNED MODEL

Knowledge translation and transfer and Evidence-based practice will be the theoretical basis of the model, i.e. monitoring and supervision, standards, education and training, new technology and logistics resources should be based on Knowledge translation and transfer and Evidence-based practice. The foundation of the main route to be implemented in the control and prevention of HAI in the ICU is standards, which is considered as the central channel. The main focus of the standards can be implemented through education and training, monitoring and supervision. Standards must be implemented and operational, which requires education and training, monitoring and supervision in line with standards. Standards are static and dynamic in nature, and are revising, developing and changing, which will be dynamic with the support of two important logistics resources and important new technologies that will strengthen the standards. There is no end to infection control, but given that in the current situation these items are not integrated with each other, it is designed to have the most coordination and integration.

ASSUMPTIONS

Theory begins with a number of assumptions that have been experimentally tested or validated by previous theories or research. The assumptions of this model are as follows.
The changing nature of medical science makes evidence-based practice inevitable. HAI control and prevention standards are dynamic, and monitoring, control, education and training are necessary to implement the standards.

THE OBJECTIVES OF THIS MODEL INCLUDE

Improving the monitoring system and evaluating the quality of services provided and improving HAI control indicators and patient safety

Optimizing the medical centers using the information of patient care and safety system and at-risk staff (treatment team)

Designing and conducting applied research and exploiting the results according to the available facilities and resources

Improving knowledge, ability to use information technology and documentation to increase the efficiency and quality of medical care in infection control

Improving meta-competencies, self-learning and continuous professional growth via existing facilities by strengthening and practicing self-assessment skills

Planning and implementing persistent education of medical staff based on advances and the latest developments and technology in infection control

Monitoring and evaluating the provision of medical services based on national, regional and international care standards

DISCUSSION

Knowledge translation was expressed as a theoretical concept of the applied model of HAI control and prevention. In today's age of information economics, knowledge is a valuable resource. Therefore, creating, organizing, saving and applying knowledge are considered essential for organizations because the production of goods and services has become highly knowledge-oriented in today's world(23). The importance of knowledge transfer and the use of research results for healthcare decision makers is increasing in developed and developing countries. On the other hand, low-income countries face many challenges in applying knowledge due to lack of resources(24, 25).

Evidence-based activity relies on research data suggestions that form the basis for selecting a particular action and the results and outcomes that are likely to be expected.(26, 27). The purpose of this method is to apply the latest research findings aim at providing quality care. Nursing decisions about patient care depend on the best solutions available to the nurse through experience or research findings(28). Evidence-based approach to nursing is the skills learned for students and clinical instructors that require a great deal of intellectual curiosity to understand and receive the facts of the work. Evidence-based care is a problem-solving approach in healthcare delivery, which combines the best results of patient care studies and information with clinical expertise, as well as patient desires and values. It makes effective decisions, avoiding the provision of care in a habitual and repetitive manner, facilitating the provision of different care and the ability of healthcare workers to maintain and promote the health of patients and their families(29). Numerous studies show that evidence-based practice has a direct effect on the control and prevention of HAI and guideline writing. There is reportedly insufficient knowledge and attitude about evidence-based practice(30). Other results indicate that clinical experiences, pathophysiological arguments, and process-based opinions may not be sufficient in care settings. Medical staff should learn to use critical thinking skills and evidence-based methods to make clinical decisions and increase the quality and cost-effectiveness of care(31).

The results of content analysis demonstrated that a strong step can be taken in controlling and preventing HAIs by effectively changing the training process, continuous and systematic implementation of infection control processes along with resource management in hospitals, efficient and up-to-date planning in controlling and preventing HAIs through monitoring and evaluation(32-34). The comparative study showed that despite the existence of clinical guidelines and specific standards from the World Health Organization (WHO) and the Center for Disease Control and Prevention (CDC), it is less operational and practical due to problems in infrastructure and attitudes. The existing physical structures for the ICU and the medical staff are inadequate in terms of up-to-date infection control training contents; the rate of diagnosis and report of HAI in our country is much lower than in other countries(35-37). Applying this practical model of infection control and prevention can fill the existing gaps. Planning and supervision, combined with education and training, can lead to the emergence of maximum integration between wards and related organizations in medical centers.The limitation of the study was coordination with the participants according to their working conditions, which was solved by conducting half of the interviews with the agreement of both parties during non-office hours.

Future studies are suggested to form a think tank with the aim of establishing an integrated structure and system in different parts of institutions and organs, instructions and regulations, reviewing programs, recording and collecting, monitoring and analyzing information and determining new indicators, continuous education and research based on indicators in the field of infection control, designing HAI control and prevention tools in the ICU. Future studies are also proposed to develop a plan and indicators to improve the comprehensive registration and assessment plan for HAIs and the status of equipment and materials in the field of infection control in pilot hospitals and to develop an audit method. The mechanism of encouraging and introducing top hospitals and strong support of university presidents and strengthening HAI control committees are recommended as the only solutions to strengthen the HAI care system and prevent antibiotic resistance and antimicrobial stewardship.

CONCLUSION

Monitoring and control of nosocomial infections are now a global priority, with the aim of minimizing infections in addition to reducing mortality, shortening hospital stays, and significantly declining treatment costs. All health groups can play an active role in preventing and controlling these infections. Identifying the causes of hospital-acquired infections and applying measures in the intensive care unit will improve safety and increase the quality of treatment. Prevention of these infections requires a comprehensive and continuously controlled program to play an important role as a proper health behavior in controlling and treating most of the challenges of the intensive care units.

Source of Support: Nil

Conflict of Interest: Nil

REFERENCES

I. Darvishpoor K, Rezaei Manesh MR. Prevalence of nosocomial infections and microbial causes in Torbat heydariyeh 9dey educational and clinical hospital in 2012 and 2013. Iranian Journal of Medical Microbiology. 2016;10(1):93-6.

II. Mobaien AR, Amirhasani S, Nekoei A, Moghimbeigi E, Nekoei B. Study of nosocomial urinary tract infections in the ICUs of Hamadan Besat and Ekbatan Hospitals during the 1387-89 Period. J Adv Med Biomed Res. 2012;20(79):94-102.

III. Mohammadnejad E, Abbaszadeh A, Soori H, Afhami S .Prevention and control of nosocomial infections proceeding in intensive care units: A content analysis study. Acta Medica Mediterranea. 2016;32:1295.

IV. Shakib P, Lavakhamseh H, Mohammadi B. The prevalence of nosocomial infection in ICU, Besat Hospital ,Sanandaj City, Iran. 2014.

V. Trubiano JA, Padiglione AA. Nosocomial infections in the intensive care unit. Anaesthesia & Intensive Care Medicine. 2015;16(12):598-602.

VI.   Amini M, Sanjary L, Vasei M, Alavi S. Frequency evaluation of the nosocomial infections and related factors in Mostafa Khomeini Hospital" ICU" based on" NNI" system. JAUMS. 2009;7(1):9-14.

VII.   Allah-Bakhshian A, Moghaddasian S, Zamanzadeh V, Parvan K, Allah-Bakhshian M. Knowledge, attitude, and practice of ICU nurses about nosocomial infections control in teaching hospitals of Tabriz. Iran journal of nursing. 2010;23(64):17-28.

VIII. Dehghani K, Nasiriani K, Mousavi T. Investigating intensive care unit nurses' performance and its adjusting with standard. SSU_Journals. 2014;21(6):808-15.

IX.   Kalantarzadeh M, Mohammadnejad E, Ehsani SR, Tamizi Z. Knowledge and practice of nurses about the control and prevention of nosocomial infections in emergency departments. Archives of clinical infectious diseases. 2014;9(4).(

X.   Bagheri P. The review systematic and meta analysis of prevalence and causes of nosocomial infection in Iran. Iranian Journal of Medical Microbiology. 2015;8(4):1-12.

XI.   Ding J-G, Sun Q-F, Li K-C, Zheng M-H, Miao X-H, Ni W, et al. Retrospective analysis of nosocomial infections in the intensive care unit of a tertiary hospital in China during 2003 and 2007. BMC infectious diseases. 2009;9(1):1-6.

XII.   Majumdar SS, Padiglione AA. Nosocomial infections in the intensive care unit. Anaesthesia & intensive care medicine. 2012;13(5):204-8.

XIII. Chandramathi K, Padmavathi P, Rajeswari S. Hypertonic Saline Nebulized Suctioning for Tracheostomy Patients. International Journal of Nursing Critical Care. 2019;5(2):9-15.

XIV.   Rabirad N, Nejad EM, Hadizadeh MR, Begjan J, Ehsani SR. The prevalence of TB in HIV patients and risk factor with frequent referral (Iran, 2009-10). Iranian Red Crescent Medical Journal. 2013;15(1):58.

XV.   Mohammad Nejad E, Jafari S, Mahmoodi M, Begjani J, Roghayyeh Ehsani S, Rabirad N. Hepatitis B virus antibody levels in high-risk health care workers. Hepat Mon. 2011 ;11(8):662-3.

XVI.   Abdollahi A. Comparison of patient-collected and lab technician-collected nasopharyngeal and oropharyngeal swabs for detection of COVID-19 by RT-PCR. Iranian journal of pathology. 2020;15(4):313.

XVII. Ghadmgahi F ,Zighaimat F, Ebadi A, Houshmand A. Knowledge, attitude and self-efficacy of nursing staffs in hospital infections control. Journal Mil Med. 2011;13(3):167-72.

XVIII. Bikmorady A, Mardani D, Soltanian A, Khatiban M. The impact of educational evidence-based hand washing program on knowledge, attitude, and adherence of intensive care unit nurses. Scientific Journal of Hamadan Nursing & Midwifery Faculty. 2013;21:5-13.

XIX.   Cheraghi MA, Nejad EM, Begjani J, Rabirad N, Ehsani SR, Kaji MA. Knowledgeand attitudes of nurses regarding HIV/AIDS (Tehran–2010). Iran J Clin Infect Dis. 2011;6(3):121-3.

XX.   Ehsani SR, Mohammadnejad E, Hadizadeh MR, Mozaffari J, Ranjbaran S, Deljo R, et al. Epidemiology of needle sticks and sharp injuries among nurses in an Iranian teaching hospital. Archives of Clinical Infectious Diseases. 2012;8(1):27-30.

XXI.   Neuendorf KA, Kumar A. Content analysis. The international encyclopedia of political communication. 2015:1-10.

XXII. Walker LO, Avant KC. Strategies for theory construction in nursing: Pearson/Prentice Hall Upper Saddle River, NJ; 2005.

XXIII. Bailey RR. Modeling the Epidemiologic and Economic Impacts of Nosocomial Infection Prevention Strategies: University of Pittsburgh; 2011.

XXIV. Siron S, Dagenais C, Ridde V. What research tells us about knowledge transfer strategies to improve public health in low-income countries: a scoping review. International journal of public health. 2015;60(7):849-63.

XXV.   Bull S, Roberts N, Parker M. Views of ethical best practices in sharing individual-level data from medical and public health research: A systematic scoping review. Journal of Empirical Research on Human Research Ethics. 2015;10(3):225-38.

XXVI. Titler MG. The evidence for evidence-based practice implementation. Patient safety and quality: An evidence-based handbook for nurses. 2008.

XXVII. Kvernbekk T. The concept of evidence in evidence-based practice. Educational Theory. 2011;61(5):515-32.

XXVIII. Curtis K, Fry M, Shaban RZ, Considine J. Translating research findings to clinical nursing practice. Journal of clinical nursing. 2017;26(5-6):862-72.

XXIX. Tingen MS, Burnett AH, Murchison RB, Zhu H. The importance of nursing research. Journal of Nursing Education. 2009;48(3):167-70.

XXX.   Collins AS. Preventing health care–associated infections. Patient safety and quality: An evidence-based handbook for nurses. 2008.

XXXI. Van Graan AC, Williams MJ, Koen MP. Professional nurses' understanding of clinical judgement: A contextual inquiry. health sa gesondheid. 2016;21:280-93.

XXXII. Pratt R, Pellowe C, Wilson J, Loveday H, Harper P, Jones S, et al. epic2: National evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. Journal of Hospital infection. 2007;65:S1-S59.

XXXIII. .Loveday HP, Wilson JA, Pratt RJ, Golsorkhi M, Tingle A, Bak A, et al. epic3: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. Journal of Hospital infection. 2014;86:S1-S70.

XXXIV. Mehta Y, Gupta A, Todi S, Myatra S, Samaddar D, Patil V, et al .Guidelines for prevention of hospital acquired infections. Indian journal of critical care medicine: peer-reviewed, official publication of Indian Society of Critical Care Medicine. 2014;18(3):149.

XXXV. McKibben L, Horan T, Tokars JI, Fowler G, Cardo DM, Pearson ML, et al. Guidance on public reporting of healthcare-associated infections: recommendations of the Healthcare Infection Control Practices Advisory Committee. American journal of infection control. 2005;33(4):217-26.

XXXVI. Allegranzi B, Pittet D. Role of hand hygiene in healthcare-associated infection prevention. Journal of Hospital infection. 2009;73(4):305-15.

XXXVII. Haque M, Sartelli M, McKimm J, Bakar MA. Health care-associated infections–an overview. Infection and drug resistance. 2018;11:2321.