# Evaluation of the Nurses' Level of Knowledge Regarding Hand Hygiene and Healthcare-Associated Infections: A Survey

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**Abstract**
The level of knowledge on hand hygiene (HH) and healthcare-associated infections (HAI) directly influences the medical staff's practice of HH and the rate of HAI. Continuous Medical Education (CME) is an important way of improving knowledge, increasing HH compliance and reducing HAI rates. The aim of the study was to asses the nurses' knowledge regarding HH and HAI in order to identify their educational needs. From February to June 2018, a study was conducted, which included nurses participating in an educational program on HAI management that took place at the premises of The Order of Nurses, Midwives and Medical Assistants in Romania - Bucharest Branch. A questionnaire with 25 items from the following six specific areas: *HAI*, *HH*, *Disinfection and sterilization*, *Standard precautions and transmission-based precautions*, *Accidental exposure to biological products*, and *The management of medical waste* was used to assess the knowledge at the end of the educational program. A total of 236 nurses were included in the study. The average score of the group was 8.38+1.03. Three important specific areas where nurses encountered problems in identifying the right answer have been identified: *HAI*, *HH*, *Disinfection and sterilization*. Almost sixty-eight percentage of the nurses had inadequate knowledge (scores lower than 9) of HH and HAI prevention, and 39.0% of the nurses had an insufficient level of knowledge (scores lower than 8), which may be a potential barrier to HAI prevention. Identifying specific areas where nurses have knowledge deficits facilitates the development of a CME strategy centered on the nurses' educational needs.

**Keywords:** Nurses; Knowledge; Hand Hygiene; Healthcare-Associated Infections; Continuing Medical Education

## Introduction

Healthcare-associated infections (HAI) represent unwanted results of healthcare with important consequences on the patients' evolution like an increase in their suffering, an increase in the hospital stay, in the healthcare costs, in the morbidity and the mortality [1,2]. The percentage of hospitalized

patients affected by HAI is 5-15%, in Intensive Care Units (ICU) this percentage reaching values of 9-37% [3,4].

Ever since 1847, Ignaz Semmelweis showed that hospital-acquired infections are transmitted through the medical staff's hands and he proved that mortality associated with infections could be reduced when the medical staff takes proper measures regarding hand hygiene. However, although hand hygiene was shown to be the simplest, most efficient and proven method of HAI prevention, the rate of general compliance of the medical staff with hand hygiene is still at a very low level, an average of 38.7%, according to World Health Organization (WHO) [5]. In a systematic review from 2010 [6], Erasmus et al. reports an average rate of general compliance with hand hygiene of 40%, with differences between professional categories: 48% for nurses and 32% for doctors, between hospital departments: 30-40% in ICU and 50-60% in other units, and also between different moments of care: 21% before the contact with the patient and 47% after the contact with the patient.

The medical staff's compliance with hand hygiene represents a multifactorial aspect of the medical domain which requires both the existence of knowledge and also of adequate behavior. The factors influencing the hand hygiene behavior include both observed risk factors: the profession of doctor versus the profession of nurse, the ICU activity, a large number of patients, the use of gloves, etc. and also self-reported causes: rashes, reduced accessibility and availability, a high volume of work, insufficient staff, the lack of acknowledging the risk, lack of knowledge and education, reduced experience, etc. [5,7]. Therefore, the interventions for compliance improvement, especially the educational ones, can be explicitly addressed to different professional categories or units and can refer to specific domains that represent important barriers for an adequate practice of the medical staff's hand hygiene [7,8].

Indeed, the studies showed that information and knowledge about hand hygiene gained through the educational process positively influence the medical staff's hand hygiene practice [5,9], the educational programs being considered an essential component for the success of any infection control strategy [5]. It is evident that the impact of the educational programs is very important, the educational interventions having as a result the improvement of the staff's knowledge level, an increase in the medical staff's rate of compliance with hand hygiene, as well as a decrease in the HAI rate [10-13]. Taking this into account, more studies analyzed the efficiency of the educational programs on the nurses' knowledge, attitudes and practice regarding hand hygiene and HAI. For this purpose, the evaluation was performed after completing the educational program. For example, Ghezeljeh et al.'s study conducted in Iran showed that nurses in two experimental groups (one group with a multimodal educational program and another group with a traditional educational course) got significantly higher scores than the nurses in a control group (no education intervention) regarding hand hygiene knowledge, beliefs and practice [14]. Also, Allegranzi et al., in  Mali, Africa, demonstrated that a WHO multimodal educational program has significantly improved the medical staff's knowledge, including nurses' knowledge (p<0.05), as well as their compliance with hand hygiene from 8% to 21.8% (p<0.001) [15]. Moreover, another study from Turkey showed that training programs for nurses have to be applied individually and conducted periodically, and that the training methods must take into consideration the nurses' identified needs and that the final objectives have to be the transposing of the improved knowledge into daily practice and the changing of behaviors [16]. Thus, it was demonstrated that education has a positive impact on the medical staff's knowledge, attitudes and practice, but it is needed to develop a system of continuing education, with annual educational modules, taking into consideration the fact that the acquired knowledge fades over time, according to the authors of another study conducted in India [17].

In order to see what is the current basic level of the knowledge of the nurses in the field of hand hygiene and HAI, without following any form of training,  the studies showed that generally speaking, nurses have an inadequate knowledge level, which needs to be improved and periodically updated. For example, Derhun et al.'s study conducted in Brazil showed that 86.52% of the nurses did not have full knowledge about hand hygiene [18], and another study from Iran reported that 64.9% of the study participants, including nurses, had a moderate - good level of knowledge about hand hygiene, but only 32.1% of them had a moderate-good level of hand hygiene compliance [19]. Also, Sarani et al. study conducted in Iran showed that 43% of the 170 nurses included in the study had a low knowledge level, 42% had an average practice, and 37% had a moderate attitude regarding HAI

[20], and another study from India showed that only 5% of the nurses had an excellent level, 37% had a good level, 40% had an average level and 18% had a below-average level regarding infection control practice (hand hygiene, standard precautions and transmission-based precautions, care bundles) [21].

In Romania there are no research data regarding the nurses' level of knowledge of HAI and hand hygiene, as well as their hand hygiene practice.

The objective of our study was to assess the Romanian nurses' knowledge level regarding hand hygiene and HAI in order to identify their educational needs.

## Material and Method

The nurses' knowledge level regarding hand hygiene and HAI was evaluated by a cross-sectional study with retrospective collection of data. The results of the assessment of the knowledge level of the nurses who participated since February to June 2018 in an educational program on HAI management were anonymously analyzed.

The educational program was optional, the nurses registering as a participant on the basis of an request application. The registration decision was based on the need to obtain an evidence of participation in CME activities and on the purpose of improving the knowledge in the field of hand hygiene and HAI.

The curriculum of the educational program had six sections: *The surveillance, the prevention and the limiting of HAI, Hand hygiene, Disinfection and sterilization, Standard precautions and transmission-based precautions, The accidental exposure to biological products*, and *The management of medical waste.*

The Educational Program lasted for 10 hours (5 hours/a day) and consisted of a theoretical course of 8 hours (4 hours/a day) and a practical part of 2 hours (1 hour/a day), the practical component consisted of watching videos and performing practical hand hygiene demonstrations.

The educational program took place at the premises of The Order of Nurses, Midwives and Medical Assistants in Romania - Bucharest Branch (OAMGMAMR - Bucharest Branch), in rooms specially designed for the nurses' and midwives' continuing medical education (CME). OAMGMAMR is organized and has branches on a national and county level and, on the Bucharest level, respectively. OAMGMAMR works as a professional organization with, juridical personality, non-governmental, of public interest, apolitical, without patrimonial purpose, with responsibilities delegated by the state authority, having as an object of activity the control and supervision of the performing of the professions of nurse, midwife and medical assistant, respectively, as authorized liberal professions of public practice.

The inclusion criteria were: the profession of nurse and the performing of the professional activity in a public or private health-care institution in Bucharest (individual medicine offices, medical clinics, school medicine offices, pharmacy, laboratory, dental office, etc.) during the period of interest presented above.

In order to asses the knowledge of the nurses who participated in the educational program on the theme of HAI management, we used an original questionnaire with 25 items from six domains specific to HAI management, respectively the six sections of the curriculum: *HAI* (3 items), *Hand Hygiene* (8 items), *Disinfection and sterilization* (7 items), *Standard precautions and transmission-based precautions* (2 items), *The accidental exposure to biological products* (2 items), and *The management of medical waste* (3 items).

The questionnaire was applied at the end of the educational program.

The process of elaborating the questionnaire considered documentation, studying the specialized literature and covering the six sections of the curriculum of the educational program.

The 25 items had multiple variants of answers and only one correct answer. Each correct answer was scored with 0.4 points, the minimum possible score being 0 and maximum possible score being 10. The transposition of the scores into levels of knowledge was as follows: scores between 9 and 10 – a very good level of knowledge; scores between 8 and 9 – a medium level of knowledge; scores lower than 8 – an insufficient level of knowledge. Also, the scores lower than 9 were considered an inadequate level of knowledge.

All data were entered in SPSS 20.0 (IBM) for analysis. Each question was coded to correct and

incorrect, and, if a participant had two or more missing answers, it was not included in the final analysis. For each participant, a score was calculated by summing the number of correct answers, and multiplying it with 0.4, in order to obtain general scores from 0 (no correct answer) to 10 (all 25 correct answers). Using the option of cut points for 3 equal groups, 3 categories of level of knowledge of respondents were established: very good, medium and insufficient. These 3 categories were examined for percentage of participants. Also, mean and standard deviation was calculated for the general knowledge score. The association between the general score, age and professional experience was done with Person's method at a significance level of 5%, and the association between the general score and educational level, with Spearman's method at a significance level of 5%. The differences in scores among different places of work were evaluated with ANOVA test at a significance level of 5%. In order to evaluate the homogeneity of the group, the variability coefficient (standard deviation/mean x 100) was calculated.

## Results

We analyzed the results of the knowledge assessment for 236 nurses who perform their professional activity in health-care institutions in Bucharest: individual medicine offices - 23.4%, medical clinics - 33.2%, school medicine offices - 20.8%, as well as other types of medical institutions (pharmacy, laboratory, dental office, etc.) - 22.6%. Two-hundred and twenty-four participants were female and 12 participants were male. Only 5% of the nurses who participated in the study had higher education degrees, 95% of them having middle education degrees. The average age of the participants was 45.60±11.92 years, the average professional experience being 14.80±13.34 years.

The analysis of the results obtained from assessing the nurses' level of knowledge showed that 32.2% (95%CI: 26.7-38.1) of the participants had a very good level of knowledge (scores between 9 and 10), 28.8% (95%CI: 23.3-34.7) medium level (scores between 8 and 9) and 39.0% (95%CI: 33.1-44.9) a insufficient level (scores lower than 8). Moreover, the results show that 67.8% of the participants have an inadequate level of knowledge (the sum of the participants with a insufficient level and of those with a medium level of knowledge).

The average score of the group was 8.38+1.03, reflecting a generally medium level of knowledge. This correlated in a negative, but insignificant way, with age and professional experience of the participants (Table 1).

**Table 1.** The Correlation of the score obtained from assessing the nurses' level of knowledge with their age and professional experience

|  |  | Age (years) | Professional experience (years) |
|---|---|---|---|
| **Score** | Pearson Correlation | -0.033 | -0.072 |
|  | P-value (2-tailed) | 0.703 | 0.282 |
|  | n | 134 | 223 |

n = number of respondents

The analysis of the data showed that there were no significant differences between various participant categories depending on the type of institution where they perform their activities: nurses working in individual medicine offices – average score 8.43±0.95, medical clinics – average score 8.41±1.00, school medicine offices – average score 8.51±1.08, other types of medical institutions – average score 8.24±1.07 (ANOVA test: F=0.60, p=0.61).

Also, the analysis of the relation between the nurses' knowledge level and their educational level showed that there was a correlation coefficient, but it was low and insignificant (Spearman's correlation coefficient 0.064, p=0.406).

The variability coefficient was 12.33% (<15%), thus reflecting a low spread of the data. Therefore, we can say that the group is very homogenous from the point of view of knowledge. Also, the mean score was 8.38, representing a value significant enough to describe the knowledge level of the group.

Following the analysis of the results obtained by assessing the nurses' knowledge, we established that there were 3 important specific domains where nurses had problems in identifying the right

answer (more than 30% were wrong answers): *HAI*, *Hand hygiene* and *Disinfection and sterilization* (Table 2). The description of the items related to these 3 domains is presented in the Table 3.

**Table 2.** Domains where nurses had problems in identifying the right answer

| No. | Domain | Wrong answers (%) | 95% Confidence Intervals |
|-----|--------|-------------------|--------------------------|
| 1 | *Hand hygiene* | | |
| | - Item no. 2 | 40.2 | 34.3 – 46.6 |
| | - Item no. 11 | 32.2 | 26.7 – 38.1 |
| 2 | *HAI* | | |
| | - Item no. 14 | 38.5 | 32.2 – 44.9 |
| 3 | *Disinfection and sterilization* | | |
| | - Item no. 16 | 41.5 | 35.2 – 48.3 |

**Table 3.** Items where nurses had problems in identifying the right answer

| No. | Item no. | Item |
|-----|----------|------|
| 1 | 2 | Which of the following hand hygiene methods is the most efficient for preventing and limiting healthcare-associated infections and also the least irritating for the hands of the medical staff? <br> a. washing the hands with water and soap <br> b. disinfecting the hands with alcohol-based solutions <br> c. using both methods <br> Correct answer: b |
| 2 | 11 | Identify which of the following statements doesn't represent one of the 5 moments when hand hygiene is required: <br> a. before touching the patient <br> b. before aseptic interventions <br> c. before the contact with biological fluids <br> d. after finishing performing patient interventions <br> e. after touching the surfaces around the patient <br> Correct answer: c |
| 3 | 14 | Regarding healthcare-associated infections, identify which of the following statements is true: <br> a. healthcare-associated infections cannot be prevented <br> b. at least one third of the healthcare-associated infections can be prevented <br> c. all healthcare-associated infections can be prevented <br> Correct answer: b |
| 4 | 16 | The steps required for performing the disinfection of an object contaminated with biological products are: <br> a. cleaning, disinfecting, rinsing <br> b. disinfecting, cleaning, disinfecting, rinsing <br> c. washing, cleaning, disinfecting, rinsing <br> Correct answer: b |

**Discussion**

An essential factor in the improvement process of the medical staff's compliance with hand hygiene and infection control is to make sure that the medical staff has adequate knowledge about the role of hands in producing and transmitting HAI during the activity of caring patients. [10,22]. Our study showed that only 32.2% of the nurses had a very good level of knowledge. Instead, 67.8% of the participants had an inadequate level of knowledge, 39.0% having an insufficient level of knowledge and 28.8% having a medium level of knowledge, results that correspond with the reports of the specialty studies conducted in countries from Asia and South America [18-21]. Moreover, we can say that an inadequate level of knowledge can represent a potential barrier to preventing HAI in

medical practice. Taking into consideration the importance for the nurses to have adequate knowledge in the domain of infection prevention, as well as the insufficiency of the existence of a moderate knowledge level, it is necessary to have periodical medical education programs for the medical staff, just like specialty literature shows [23].

Also, our study identified 3 specific domains where nurses have a knowledge deficit (*HAI, Hand hygiene, Disinfection and sterilization*) (Table 2), and which could represent important limits for an adequate practice of hand hygiene and HAI prevention, aspects consistent with the literature and studies conducted in Brazil, Egypt and Italy [18,24,25]. The identification of these deficient domains facilitated the development of CME strategies corresponding with the identified educational needs and centered on the nurses' educational needs, according to the specialty literature [7,8]. This means the curriculum, the course content and the knowledge assessment questionnaire have to be periodically improved and updated, according to the identified educational needs and to the periodical updating of the international guidelines and specific regulations.

Regarding the items in the domain of *Standard precautions and transmission-based precautions*, they did not pose any particular problems to identifying the right answer, the percentage of wrong answers to these items being 21.2%. Similar results were obtained in the case of items from *The management of medical waste* domain, the percentage of wrong answers in this case being 22.1%. Concerning this aspect, the literature showed that generally, nurses have a(n) low/unacceptable knowledge level regarding the standard precautions for infection control and wearing protective equipment during clinical interventions [20,24].

As regards the items in the domain of *The accidental exposure to biological products*, they did not pose any problems in identifying the right answer. Instead, specialty literature, reports that, concerning the medical staff's knowledge and attitudes on the perception of the risk of accidental exposure, interventions like education, monitoring, improving the availability of the resources are necessary for the improvement of infection control in hospitals [26].

Concerning the existence of a correlation of the knowledge level with the nurses' age, professional experience or educational level, the results of the study did not show the existence of significant correlations. In this respect, some studies conducted in Italy showed as results the identification of significant correlations between the nurses' knowledge, attitudes and practice and their age, professional experience and educational level [27,28], the authors of these studies suggesting therefore that the interventions did not have to focus only on the predisposing factors (knowledge), but also on facilitating and strengthening factors (educational level, professional experience, etc.).

One of the limitations of our study was the fact this encompassed only nurses working in Bucharest, in individual medicine offices, medical clinics, school medicine offices, pharmacies, laboratories, dental offices etc, without encompassing nurses in hospitals. Moreover, we did not identify significant differences between the diverse participant categories, concerning the knowledge level, depending on the type of institution in which they work.

Another limitation of our study was the fact that the assessment of the nurses' knowledge was made only after finishing the educational program. In order to identify the effect of the educational intervention, a comparison of the knowledge level before and after attending the educational program would be useful.

Also, another limitation of the study and the educational program could be represented by the reduced length of time of the program (10 hours), which is insufficient for the nurses to assimilate enough knowledge about HAI management. This could also be an explanation for the inadequate level of knowledge of nurses in the context of post-training assessment. Taking into consideration the fact that HAI management plays an important role in the nurses' activities and their inadequate knowledge could represent a potential barrier to preventing HAI, it is necessary to extend the length of time of the educational program and to adapt the course curriculum according to the identified educational needs as well as for the nurses to participate periodically to courses dedicated to this field of interest.

Other explanations for the inadequate level of knowledge in the context of post-training assessment may be represented by resistance to change, low availability to learning and acceptance of new information and recommendations, the presence of misconceptions regarding certain aspects of hand hygiene, daily routine, lack of differentiation between the idealism of preventing all infections

and the reality of preventing only a certain percentage of them. Also, other explanations may be related to the presence of a different and limited set of knowledge specific to the activity of preventing infections at the time of participation in the educational program by the nurses, although these must be part of the standard set of knowledge of a nurse, as well as the different frequency of regular updating of specific knowledge at workplace as part of CME and specific infection prevention strategies.

Given the results of this study and the importance of education in this important area of infection prevention, we intend to develop the methodology for validating the questionnaire used in this study in order to use it in future studies.

However, we consider that our study provides useful information in the field of CME for nurses and underlines its importance in their professional activity. In this regard, the study is congruent with WHO recommendations [5], staff education being one of the five key components of the multimodal infection prevention strategy, in addition to system changes (infrastructure, equipment, resources), monitoring and feedback, reminders and campaigns, organizational culture of safety. Thus, the recommendations regarding the existence of an adequate level of specific knowledge and the periodic education of the medical staff are important, but these must be taken into account and applied in the framework of multimodal strategies for infections prevention and control: the increasing of staff number, the reducing of workload, the increasing of accessibility and availability for the equipment and materials, the providing of feedback, the using of innovative electronic devices, the developing of awareness campaigns, the provisioning of posters and reminder messages, etc.

In addition, the practical implication of this research derives from the identification of the knowledge deficit of the nurses in the field of hand hygiene and HAI, of the specific deficient domains, as well as of the educational need of the nurses, which allows the elaboration and implementation of effective educational strategies, but also the generalization of the obtained results. We are considering this issue, the more so as, in Romania, there are few researches regarding the knowledge of the medical staff in the field of hand hygiene and infection prevention, these being limited to a single professional category (dentists/medical students), so that future research is needed on this topic at all professional categories, with a specific aim towards the assessment of the knowledge and practices of the nurses, from all types of healthcare institutions, especially hospitals, as well as from as many regions of Romania.

## Conclusions

The existence of an inadequate nurses' knowledge level regarding HAI management, which may represent a barrier to HAI prevention, impose the necessity for the development of adequate educational strategies for the improvement of the nurses' knowledge in the domain of hand hygiene and HAI prevention, with the ultimate purpose of changing their professional behavior and providing clean and safe patient care.

## List of abbreviations

CME = Continuing Medical Education
HAI = Healthcare-associated infections
HH = Hand Hygiene
ICU = Intensive Care Unit
WHO = World Health Organization

## Conflict of Interest

The authors declare that they have no conflicts of interest.

**Authors' Contributions**

VN defined the aim of the research, the design of the experiment and led the study. MZ helped carry out the design of the experiment. DCM, CV and IMG reviewed the manuscript. All authors read and approved the final manuscript.

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**References**

1. Rosenthal VD, Maki DG, Jamulitrat S, Medeiros EA, Todi SK, Gomez DY, et al; INICC Members. International Nosocomial Infection Control Consortium (INICC) report, data summary for 2003-2008, issued June 2009. Am J Infect Control. 2010;38(2):95-104.e2.
2. Jarvis WR. Selected aspects of the socioeconomic impact of nosocomial infections: morbidity, mortality, cost, and prevention. Infect Control Hosp Epidemiol. 1996;17:552-7.
3. Allegranzi B, Bagheri Nejad S, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of endemic health care-associated infection in developing countries: systematic review and meta-analysis. Lancet. 2011;377:228-41.
4. Vincent JL. Nosocomial infections in adult intensive care units. Lancet. 2003;361:2068-77.
5. WHO Guidelines on Hand Hygiene in Health Care. Geneva, World Health Organization, 2009 (http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf).
6. Erasmus V, Daha TJ, Brug H, Richardus JH, Behrendt MD, Vos MC, et al. Systematic review of studies on compliance with hand hygiene guidelines in hospital care. Infect Control Hosp Epidemiol. 2010;31:283-94.
7. Boyce JM, Pittet D. Guideline for hand hygiene in health-care settings: recommendations of the healthcare infection control practices advisory committee and the HICPAC/SHEA/APIC/IDSA hand hygiene task force. Infect Control Hosp Epidemiol. 2002; 23[suppl]:S3-S40.
8. Pittet D, Mourouga P, Perneger TV, Members of the Infection Control Program. Compliance with handwashing in a teaching hospital. Ann Intern Med. 1999;130:126-30.
9. Wisniewski MF, Seijeoung K, Trick WE, Welbel SF. Effect of education on hand hygiene beliefs and practices: a 5-year program. Infect Control Hosp Epidemiol. 2007;28:88-91.
10. Mathai E, Allegranzi B, Seto WH, Chraiti MN, Sax H, Larson E, et al. Educating healthcare workers to optimal hand hygiene practices: addressing the need. Infection. 2010;38:349-56.
11. Lee TC, Moore C, Raboud JM, Muller MP, Green K, Tong A, et al. Impact of a mandatory infection control education program on nosocomial acquisition of methicillin-resistant Staphylococcus aureus. Infect Control Hosp Epidemiol. 2009;30:249-56.
12. Benton C. Hand hygiene: meeting the JCAHO safety goal: can compliance with CDC hand hygiene guidelines be improved by a surveillance and educational program?. Plast Surg Nurs. 2007;27:40-4.
13. Trick WE, Vernon MO, Welbel SF, Demarais P, Hayden MK, Weinstein RA. Multicenter intervention program to increase adherence to hand hygiene recommendations and glove use and to reduce the incidence of antimicrobial resistance. Infect Control Hosp Epidemiol. 2007;28:42-9.

14. Ghezeljeh TN, Abbasnejad Z, Rafii F, Haghani H. Effect of a multimodal training program and traditional lecture method on nurses' hand hygiene knowledge, belief, and practice: A brief report. Am J Infect Control. 2015;43:762-4.

15. Allegranzi B, Sax H, Bengaly L, Richet H, Minta DK, Chraiti MN, et al. Successful implementation of the World Health Organization hand hygiene improvement strategy in a referral hospital in Mali, Africa. Infect Control Hosp Epidemiol. 2010;31:133-41.

16. Dikici N, Ural O, Ertap F, Sumer S, Kara F. Training to prevent healthcare associated infections. The European Research Journal. 2015;1(3):94-105.

17. Suchitra JB, Lakshmi Devi N. Impact of education on knowledge, attitudes and practices among various categories of health care workers on nosocomial infections. Indian Journal of Medical Microbiology. 2007;25(3):181-7.

18. Derhun FM, de Souza VS, Costa MAR, Inoue KC, Matsuda LM. Knowledge of nursing professionals regarding hand hygiene. Cogitare Enferm. 2016;21(3):01-07.

19. Hosseinialhashemi M, Kermani FS, Palenik CJ, Pourasghari H, Askarian M. Knowledge, attitudes, and practices of health care personnel concerning hand hygiene in Shiraz University of Medical Sciences hospitals, 2013-2014. Am J Infect Control. 2015;43:1009-11.

20. Sarani H, Balouchi A, Masinaeinezhad N, Ebrahimitabs E. Knowledge, Attitude and Practice of Nurses about Standard Precautions for Hospital-Acquired Infection in Teaching Hospitals Affiliated to Zabol University of Medical Sciences (2014). Global Journal of Health Science. 2016;8(3):193-8.

21. Sodhi K, Shrivastavab A, Aryac M, Kumard M. Knowledge of infection control practices among intensive care nurses in a tertiary care hospital. Journal of Infection and Public Health. 2013;6:269-75.

22. Pittet D, Simon A, Hugonnet S, Pessoa-Silva CL, Sauvan V, Perneger TV. Hand hygiene among physicians: performance, beliefs, and perceptions. Ann Int Med. 2004;141:1-8.

23. Joukar F, Taherri Ezbarami Z. Nursing student and staff knowledge about nosocomial infection. Iranian Journal of Infectious Diseases and Tropical Medicine. 2007;12(37):83-6.

24. Eskander HG, Morsy WYM, Elfeky HAA. Intensive Care Nurses' Knowledge & Practices regarding Infection Control Standard Precautions at a Selected Egyptian Cancer Hospital. Journal of Education and Practice. 2013; 4(19):160-74.

25. Angelillo IF, Mazziotta A, Nicotera G. Nurses and hospital infection control: knowledge, attitudes and behaviour of Italian operating theatre staff. J Hospital Infect. 1999;42:105-12.

26. Stein AD, Makarawo TP, Ahmad MFR. A survey of doctors' and nurses' knowledge, attitudes and compliance with infection control guidelines in Birmingham teaching hospitals. J Hosp Infect. 2003;54:68-73.

27. Nobile CGA, Montuori P, Diaco E, Villari P. Healthcare personnel and hand decontamination in intensive care units: knowledge, attitudes, and behaviour in Italy. J Hosp Infect. 2002;51(3):226-32.

28. Sessa A, Di Giuseppe G, Albano L, Angelillo IF and for the Collaborative Working Group. An Investigation of Nurses' Knowledge, Attitudes, and Practices Regarding Disinfection Procedures in Italy. BMC Infectious Diseases. 2011;11:148(1-7).

29. Bobu L, Barlean L, Balcos C, Barlean M, Murariu A, Saveanu I. Level of knowledge concerning the prevention of infection transmission among dentists in Iasi, Romania. Romanian Journal of Oral Rehabilitation. 2019;11(1):52-58.

30. Balcoş C, Bobu L, Bosînceanu D, Bolat M, Stupu A, Nicolau A, et al. Hand hygiene practices for general medicine students in Iasi, Romania. Romanian Journal of Medical and Dental Education. 2019;8(8):57-63.