

ASSESSMENT STUDY OF THE KNOWLEDGE, ATTITUDES AND PRACTICES OF NURSES IN ROMANIA REGARDING HAND HYGIENE AND HEALTHCARE-ASSOCIATED INFECTIONS

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INTRODUCTION

Healthcare-associated infections (HAIs) are adverse events of medical care, thus representing an important threat to patient safety. In this case, HAIs rates represent indicators of the quality, safety and satisfaction of the medical services provided to patients and also, of the outcomes of patient care.

Globally, HAIs affect a significant number of patients, between 5-15% in hospitals, and 9-37% in Intensive Care Units (ICUs) [1,2]. Fortunately, it was shown that approximately one third of HAIs are preventable, the results of hospitals with effective programs of surveillance and control of HAIs (including hand hygiene) indicating that the incidence of HAIs can be significantly reduced [3,4]. Moreover, research has shown that the rate of HAIs can be reduced by up to 70%, for example in the case of central venous catheters related infections and urinary tract infections, when medical staff members are aware of the risk of infections and apply effective methods for prevention and limitation of these complications [5].

Among the methods of infection prevention and control, the essential role of hand hygiene is universally recognized and it was already proven long time ago [6,7]. Hand hygiene represent any action of hand cleansing/hand decontamination and involves hand washing (when hands are visibly soiled) or hand rubbing (when hands are not soiled). Hand washing refers to the use of plain or antimicrobial soap and water, whereas hand rubbing involves the use of alcohol-based solutions [7,8]. Regarding hand rubbing with alcohol-based solutions, guidelines recommend frequent use of alcohol-based solutions in routine patient care [7,9].

Unfortunately, despite all the evidence on the usefulness and importance of hand hygiene, the medical staff's compliance with hand hygiene remains at very low levels, averaging around 40%, according to a systematic review,

INTRODUCTION. Healthcare-associated infections (HAIs) represent adverse events of medical care, an important threat to patient safety that affects a significant number of patients annually. Hand hygiene is universally recognized as being the most effective method of preventing and limiting HAIs. Nurses have a critical contribution in providing clean and safe care to patients and preventing HAIs.

METHODOLOGY. The nurses' knowledge level, attitudes and self-reported practices regarding hand hygiene and HAIs was evaluated by using an original questionnaire which was applied at the beginning of the National Conference of The Order of Nurses, Midwives and Medical Assistants in Romania which took place between September 13-14, 2018, in Bucharest. The applied questionnaire included 32 items in 3 sections with the following structure: (1) 8 items related to demographic and professional data; (2) 10 items for assessing the level of knowledge; and (3) 14 items for assessing self-reported attitudes and practices.

RESULTS. We analyzed the results of the assessment of the knowledge level, attitudes and self-reported practices of 576 Conference participants nurses who performed their professional activity in healthcare institutions in Romania. The analysis of the results obtained from assessing the knowledge showed that 16% (95%CI: 13.0-18.9) of the participants had a high level of knowledge (scores between 8 and 10), 58% (95%CI: 53.8-62.2) had a medium level (scores between 5 and 7) and 26% (95%CI: 22.4-29.7) a low level (scores lower than 5). The average score of the group was 5,51±2,07, reflecting an overall medium level of the group. Regarding the practice of workplace hand hygiene and the level of self-reported compliance, most participants (79% of them) declared high levels of compliance (at least 70-80%). The analysis of the answers to the items regarding the attitudes of the participants, which referred to the role of jewelry and nails in the occurrence and transmission of HAIs, the role and the importance of hand hygiene in HAIs prevention and the relationship between patient safety and HAIs prevention, showed an almost unanimous agreement with the statements that they contain (96%, 96% and 99%, respectively).

CONCLUSIONS. Nurses in Romania have an inadequate knowledge level regarding hand hygiene and HAIs, which could represent a cause of HAIs and a barrier to patient safety, have positive attitudes and overestimated self-reported practices. Future research is needed to assess the level of observed compliance and its relationship with the nurses' knowledge and attitudes in the field of hand hygiene and HAIs.

Keywords: nurses, knowledge, attitudes, practices, hand hygiene, healthcare-associated infections

which also shows different levels of compliance between professional categories: 48% for nurses and 32% for doctors, between hospital departments: 30-40% in ICUs 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 [10].

We thus know that the professional category, the type of department, as well as the moment of care can represent risk factors for the non-compliance with the hand hygiene of the medical staff. Thus, in the case of doctors, the ICUs and before the contact with the patient, the identified rates of compliance with hand hygiene are lower.

In this context, regarding nurses, as members of the healthcare team, they constitute the largest percentage of the healthcare professionals (HCP) and →

spend the most time with patients than other professionals. Moreover, although it is known that they have the greatest number of opportunities to come into contact with the patient, especially in the ICUs, where most procedures are performed by them, thus having an increased risk of non-compliance, especially in conditions of understaffing or overcrowding of patients, they have the best level of compliance of all categories of HCP, cleaning their hands much more often than other professionals [10-12].

Considering this, the focus of this year's 5 May World Health Organization (WHO) campaign: „*SAVE LIVES: Clean Your Hands - Nurses and Midwives, clean care is in your hands!*” is represented by the recognizing of the critical contribution that nurses and midwives have in providing clean and safe care to patients and preventing infections. In this regard, the WHO has developed the following calls for action both for nurses: „*Clean and safe care starts with you.*” and midwives: „*Your hands make all the difference for mothers and babies.*” [13]. Moreover, considering the fact that nurses and midwives play a central role in providing health services and meeting care needs of the patients, but also in order to celebrate the 200th anniversary of Florence Nightingale's birth, the 144th WHO Executive Board meeting held on 6 February 2019 designated 2020 *the International Year of the Nurse and the Midwife* [14].

Moreover, in addition to the risk factors that influence the compliance of the medical staff with hand hygiene, to which we referred in the text above, numerous causes have been identified that lead to non-compliance with hand hygiene by the medical staff: the high volume of work, insufficient staff, reduced accessibility to hand hygiene devices, reduced availability of hand hygiene resources, lack of knowledge, lack of education/training, reduced experience, lack of acknowledging the risk, misconceptions, rashes, lack of a role model, lack of feedback, lack of the institutional climate of safety culture, etc. [7,9].

To address these risk factors and causes of non-compliance, continuous efforts are made to identify effective and sustainable strategies for improving compliance with hand hygiene. Thus, numerous strategies have been developed to promote hand hygiene for medical staff: educational programs, providing feedback, awareness strategies, increasing the accessibility to hand hygiene devices, increasing the availability of hand hygiene products, the use of alcoholic solutions, etc. [7]. Each of these strategies can be effective, but in order to achieve long-lasting and the best results, the development of multimodal intervention strategies has proven to be much more useful, as they are more effective than single strategies, acting on more levels and on more risk factors/causes, and thus managing to positively influence the complex hand hygiene behavior of the medical staff [9]. One of the recommended multimodal strategies, with proven effectiveness for improving the hand hygiene practices and reducing HAIs, is the WHO multimodal strategy, which includes 5 components: (1) ensuring of system change, particularly access of HCP to alcohol-based hand rub at the point of patient care; (2) training and education of HCP; (3) monitoring of practices and provision of feedback on performance; (4) visual re-

mindings in the workplace; and (5) creation of a safety climate within the institution [7,15].

Moreover, in order to help the HCP in understanding, training, monitoring, and reporting hand hygiene, WHO developed the evidence-based concept, „*My five moments for hand hygiene*”, dedicated to promoting the 5 moments when hand hygiene is indicated: (1) before touching a patient, (2) before a/an clean/aseptic procedure, (3) after body fluid exposure risk, (4) after touching a patient and (5) after touching patient surroundings [16].

Within the multimodal strategies to improve compliance with hand hygiene, the educational component has inevitably proved to be an omnipresent integral part. This derives from the fact that knowledge is known to directly influence behavior and practice of medical staff, and one of the key factors in improving hand hygiene and HAIs control is to ensure that medical staff have an adequate level of knowledge about the role of hands in the causing and transmission of HAIs during patient care activities. Hence the important role of education, by providing the information needed to improve the level of knowledge, by facilitating awareness of the risk, by promoting the development of positive attitudes, and by the process of changing behaviors and improving the hand hygiene practice of HCP [7,9,17]. The importance of educational programs for HCP has been demonstrated by numerous researches, who have shown that the information and knowledge on hand hygiene acquired from the educational process positively influences both the hand hygiene practice of medical staff, increasing the level of compliance, as well as HAIs, significantly reducing their rate [18-20].

Thus, it is obvious that, the prevention and limitation of HAIs requires attention to three important components for the medical staff: knowledge, attitude, and practice. *Knowledge* represents the fact or condition of being learned, having information, knowing, understanding or being aware of something with familiarity gained through experience or study; it was defined as specific information on a subject or an intended behaviour [21]. *Attitudes* represent a way to be or behave, a position towards an event or a fact, a behavior that reflects a certain conception, a disposition; they were defined as a tendency of mind or relatively constant feeling toward a certain category of objects, people or situations [22]. Regarding hand hygiene, the literature has also shown that attitude is a significant predictor of the intention to perform hand hygiene [23]. *Practices* represent to do or perform (something) often, routinely, customarily, habitually, repeatedly in order to acquire or polish a skill or so as to become proficient; the practical application of theoretical knowledge. In terms of hand hygiene, the practices of medical staff can be assessed by self-report or direct observation, which is the gold standard in this field [24].

In this context, regarding the nurses' knowledge, attitudes and practices in the field of hand hygiene and HAIs, the studies showed that generally, they have an inadequate knowledge level, which needs to be improved and periodically updated, moderate attitudes and average practices, which could represent the causes of HAIs and barriers

to patient safety. Thus, a study conducted in Brazil showed that 86.52% of the nurses did not have full knowledge about hand hygiene [25], and a study conducted in 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 [26].

Sarani et al. conducted a study on 170 nurses and reported that 43% of the nurses had a low knowledge level, 37% had a moderate attitude regarding HAIs and 42% had an average practice [27]. Another study, conducted by Sodhi et al., showed that only 5% of the ICU nurses had an excellent level, 37% had a good level, 40% had an average level and 18% had a below-average level of knowledge regarding infection control practices (hand hygiene, standard precautions and transmission-based precautions, care bundles) [28].

Although internationally, the literature is quite rich in the field of assessment of knowledge, attitudes and practices of medical staff, including nurses, in terms of hand hygiene and HAIs, in our country the research in this field is very limited, especially regarding nurses [29].

The objectives of our study were: the assessment the Romanian nurses' knowledge, attitudes and self-reported practices regarding hand hygiene and HAIs; the reporting of the data obtained on hand hygiene best practices and recommendations in the field of infection prevention and control; the identification of the main causes that lead to non-compliance with hand hygiene by medical staff; the identification of the possible factors that could contribute to improving the hand hygiene practice of medical staff.

METHODOLOGY

The nurses' knowledge level, attitudes and self-reported practices regarding hand hygiene and HAIs was evaluated through a cross-sectional descriptive study with a prospective collection of data. The inclusion criteria were the profession of nurse and the participating in The National Conference of The Order of Nurses, Midwives and Medical Assistants in Romania (OAMGMAMR) which was organized by the OAMGMAMR Bucharest Branch and took place between September 13-14, 2018, in Bucharest. The participating in the Conference was optional, the nurses registering as participants based on a registration form.

In order to assess the knowledge, attitudes and self-reported practices regarding hand hygiene and HAIs of the nurses who participated in the National Conference, we used an original questionnaire which was applied at the beginning of the Conference. Of the 874 registered participants, 576 completed the questionnaire (65,90% response rate). The filling in of the questionnaires was voluntary and represented the agreement of the participants to participate in the research; the anonymity and confidentiality of data were also ensured.

The applied questionnaire was obtained after documenting and studying the literature and it included 32

items in 3 sections with the following structure: (1) 8 items related to demographic and professional data (age, gender, educational level, type of department, type of profession, professional experience, level of responsibility, professional degree); (2) 10 items for assessing the level of knowledge; and (3) 14 items for assessing self-reported attitudes and practices (5 items for attitudes, 8 items for practices and 1 item about the number of patients cared for in a shift).

The 10 items for assessing the level of knowledge had multiple variants of answer and only one correct answer. Each correct answer was scored with 1 point, the minimum possible score being 0 (low level - lack of knowledge) and the maximum possible score being 10 (high level - solid knowledge). The transposition of the scores into levels of knowledge was as follows: scores between 8 and 10 - a high level of knowledge; scores between 5 and 7 - a medium level of knowledge; scores lower than 5 - a low level of knowledge. The 5 items for assessing attitudes consisted of 3 dichotomous closed questions with only one possible answer (yes or no) and 2 open questions which asked respondents to identify 3 possible causes of non-compliance with hand hygiene and 3 possible factors that could contribute to improving the hand hygiene practice of medical staff. The 8 items for assessing self-reported practices had multiple variants of answer and only one possible answer.

All data were entered in SPSS 20.0 (IBM) for analysis. For demographics, descriptive statistics (frequencies and/or means) were calculated. For the questions assessing the level of knowledge an internal consistency analysis was performed, and, due to the good value of the Alpha-Cronbach coefficient (0.72), a knowledge general score was calculated for each respondent. Using the option of cut points for 3 equal groups, 3 categories of the respondents' level of knowledge were determined: high, medium and low. The relationships between the level of knowledge and other variables were investigated using correlations, the ANOVA or the Chi Square coefficient, depending on the type of variable correlated with the level of knowledge. For the questions regarding attitudes and practices, descriptive statistics (frequencies) were calculated (for the open questions, the descriptive statistics were calculated only after the answers were analyzed by two researchers, in order to reduce data to the main categories of answers).

RESULTS

We analyzed the results of the assessment of the knowledge level, attitudes and self-reported practices of 576 nurses who performed their professional activity in healthcare institutions in Romania: in hospitals (medical and surgical departments, ICUs, Operating Rooms - ORs, other departments) - 85% of the participants, or in other types of medical institutions (individual medical offices, dental office, laboratory, pharmacy, radiology, school medical offices, etc.) - 15% of the participants.

Ninety-one percent of participants were female and 9% male. Thirty-three percent of the participants had higher education degrees and 67% had secondary

Table 1. The average scores for the level of knowledge depending on the type of department in which nurses perform their professional activity

Type of department	Average score ± Standard deviation	ANOVA (p)
Medical departments	5.86 ± 2.00	F = 2.85 (p = 0.02)
Surgical departments	5.28 ± 1.92	
Intensive Care Units	6.17 ± 2.01	
Operating Rooms	6.00 ± 1.29	
Other departments	5.37 ± 2.31	

for in a shift (p = -0.129). It is a negative correlation - the higher the number of patients, the lower the level of knowledge.

Results related to the average scores for the level of knowledge, according to other demographic and professional characteristics (gender, type of department, type of profession, level of responsibility, professional degree) showed that the only significant differences between the different categories of respondents, in terms of level of knowledge about hand hygiene and HAIs, were recorded in respondents from hospitals, depending on the type of department in which they worked: nurses from ICUs and ORs had significantly higher average scores of knowledge (Table 1).

Also, the results regarding the average scores for the level of knowledge, depending on the participation in continuing medical education (CME) programs dedicated to the topics on hand hygiene and HAIs showed that there were no significant differences between respondents who participated in CME programs and those who did not participate, in terms of the level of knowledge: 5.81 ± 1.75, respectively 5.66 ± 1.80 (ANOVA test: F = 0.63, p = 0.42).

In terms of percentage of wrong answers, the first was item no. 2, 82% of the answers to this question being wrong (Table 2).

Table 2. The item with the most wrong answers

Item no.	Item
2	Which of the following methods of hand hygiene is more effective in preventing and limiting healthcare-associated infections, requires less time to perform, and is less irritating to medical staff hands? a. washing with soap and water b. disinfection with alcohol-based solutions c. there is no difference between the two methods mentioned above <i>Correct answer: b</i>

Table 3. The association between the level of compliance with hand hygiene and the availability of hand hygiene resources, the participation in CME programs on specific topics and the number of patients cared for in a shift

The association	Chi square (p)
The level of compliance - The availability of hand hygiene resources	4.02 (p = 0.04)*
The level of compliance - The participation in CME programs on specific topics	12.48 (p = 0.01)**
The level of compliance - The number of patients cared for in a shift	35.34 (p = 0.06)

*p<0.05; **p<0.01

education degrees. Regarding the level of responsibility, 71% of the participants had subordinate roles and 29% had leadership roles. The average age of the participants was 44.99 ± 8.74 years, the average professional experience being 20.23 ± 11.08 years.

The results regarding the level of knowledge in the field of hand hygiene and HAIs

The analysis of the results obtained from assessing the nurses' level of knowledge showed that 16% (95%CI: 13.0-18.9) of the participants had a high level of knowledge (scores between 8 and 10), 58% (95%CI: 53.8-62.2) had a medium level (scores between 5 and 7) and 26% (95%CI: 22.4-29.7) a low level (scores lower than 5). Also, the average score of the group was 5.51 ± 2.07, this reflecting an overall medium level of the group.

The analysis of the correlation coefficients between the level of knowledge and some demographic and professional characteristics (age, professional experience, educational level, the number of patients cared for in a shift) showed that the only significant correlation was between the level of knowledge and the number of patients cared

The results regarding the self-reported attitudes and practices in the field of hand hygiene and HAIs

The practices

Regarding the practice of workplace hand hygiene and the level of self-reported compliance with hand hygiene, most respondents (79% of them) declared high levels of compliance (at least 70-80%); moreover, 29% of them declared that they had 70-80% compliance with hand hygiene and 50% of them stated that they had 90-100% compliance with hand hygiene.

The analysis of the correlation between the level of compliance with hand hygiene and the level of knowledge showed that the correlation coefficient was small and insignificant (p = 0.032).

Considering that, in order to achieve adequate compliance with hand hygiene, it is important to meet several conditions (availability of hand hygiene resources, participation in CME programs, adequate number of patients to be cared for, etc.), we also analyzed the association between the level of compliance with hand hygiene and the number of patients cared for in a shift, availability of hand hygiene resources and participation in CME programs on specific topics (Table 3).

Table 4. The main causes that lead to non-compliance with hand hygiene by medical staff

No.	Category	Causes	Per-cent
1	Causes related to the particularities of the activities	- The large number of patients/maneuvers - Less time - Emergencies - Additional tasks/responsibilities	34%
2	Causes related to the management of the institution/ department	- Lack of staff - Discontinuity in the supply of hand hygiene products - Lack/insufficiency of hand hygiene products - Poor quality of hand hygiene products - Poor location of hand hygiene devices/ products (not at the point of care) - Lack of water	24%
3	The level of training/knowledge	- low level of knowledge - Lack/insufficiency of training	20%
4	Causes related to nurses	- Non-compliance with procedures - Lack of awareness - Wearing jewelry or long/false nails - Negligence/carelessness/indifference - Inattention	16%
5	Other causes	- Allergies to the substances used - Etc.	4%

Table 5. The possible factors that could contribute to improving the hand hygiene practice of the medical staff

No.	Category	Factors	Per-cent
1	Solutions related to work organization	- More staff - A smaller number of patients who need to be cared for by a nurse - A proper normalization of the activity - Granting the necessary time - The reduction of bureaucracy - Efficient organization of the activity - Compliance with procedures	36%
2	Solutions related to the supply of products for hand hygiene	- Providing hand hygiene products that are both quantitative and qualitative (solutions with adequate alcohol content, for ex.) - The positioning of hand hygiene products at the point of care (dispensers in each room, for ex.)	30%
3	Educational solutions	- Medical education/continuing education - Periodic trainings/information - Raising the level of risk awareness - Patient education	20%
4	Control and coercive measures	- Supervision/monitoring/control - Application of sanctions (including financial)	8%
5	Other solutions	- Promoting the importance of hand hygiene - Posters in visible places - Giving up wearing jewelry/long or false nails - Etc.	6%

The analysis of this association showed that the level of compliance with hand hygiene was significantly higher for respondents who had sufficient resources for workplace hand hygiene and among those who participated in courses/symposiums/conferences on specific topics.

In this context, the analysis of the answers to the items on these three aspects showed that regarding the ensuring of the necessary resources for hand hygiene by the institutions where they work, most respondents (84%) stated that they had sufficient resources to ensure proper hand hygiene in the institution/department where they performed their professional activity. Also, there was a large percentage of respondents (80%) with recent participation (in the

last year) in CME programs on topics related to hand hygiene and prevention of HAIs.

In terms of the average number of patients cared for in a shift, this was 20.74 ± 14.09 . Depending on the type of department in which nurses performed their professional activity, the average number of patients cared for in a shift was: 19 ± 11 patients in medical departments, 26 ± 13 patients in surgical departments, 8 ± 6 patients in ICUs and 24 ± 13 patients in other types of departments. The analysis of the association between the level of compliance with hand hygiene and the number of patients cared for in a shift did not show a significant relationship between these two variables (Table 3).

Also, an analysis of the answers to the items referring to the method of hand hygiene used routinely at the workplace, as well as to the items referring to the moment of care in which the indication of hand hygiene was most followed, was performed.

Regarding the preference for one of the two methods of hand hygiene, hand washing with soap and water or hand rubbing with alcohol-based solutions, the results showed that the method of hand hygiene most frequently used at workplace by 85% of the respondents was hand washing with soap and water. Only 15% of the respondents preferred hand rubbing with alcohol-based solutions. It is thus obvious that the most common method for hand hygiene for nurses who participated in the study was hand washing with soap and water. However, there was a important differentiation of this preference in the case of ICU nurses, only 56% of them preferring hand washing with soap and water and 44% preferring hand rubbing with alcohol-based solutions.

Concerning the answer to the question regarding the moment of care when they followed more the indication of hand hygiene, a higher percentage of respondents (58%) stated that they performed hand hygiene more frequently after the contact with the patient compared to 42% of respondents who reported that they performed hand hygiene more frequently before the contact with the patient.

Another aspect assessed in the questionnaire was related to the concern for promoting the importance of hand hygiene as a method of preventing and limiting HAIs, at the level of the management of the institution/department where the respondents performed their professional activity. According to them, in 93% of cases there was a concern for promoting the importance of hand hygiene as a method of preventing and limiting HAIs, at the level of the management of the institution/department where they performed their professional activity.

Also, in terms of knowing the percentage of HAIs in the institution/department where they worked, respectively the level of compliance with hand hygiene of the medical staff from the department where they worked, most respondents (72% and 74%, respectively) said that they knew the percentage of HAIs, at their workplace, as well as the percentage of performing hand hygiene maneuvers of the medical staff from the department where they worked.

The attitudes

The analysis of the answers to the 3 closed questions regarding the attitudes of the respondents, which referred to the role of jewelry and nails in the occurrence and transmission of HAIs, the role and the importance of hand hygiene in HAIs prevention and the relationship between patient safety and HAIs prevention, showed an almost unanimous agreement with the statements that they contain (96%, 96% and 99%, respectively).

Also, the answers to the 2 open questions regarding the attitudes of the respondents in the field of hand hygiene and HAIs were analyzed.

Thus, the answers of the respondents to the open question regarding the possible causes of non-compliance with hand

hygiene were grouped into 5 categories, which are presented in *Table 4*.

Also, the respondents' answers to the open question regarding the possible factors that could contribute to improving the hand hygiene practice of the medical staff were also grouped into 5 categories, which are presented in *Table 5*.

DISCUSSIONS AND CONCLUSIONS

The literature mentions that nurses generally have an inadequate level of knowledge of hand hygiene and HAIs [25-28]. Our study showed that only 16% of the nurses had a high level of knowledge (scores between 8 and 10), 58% having a medium level (scores between 5 and 7) and 26% a low level (scores lower than 5). We noticed that a quarter of nurses had a low level of knowledge, which could be an important risk factor for non-compliance with hand hygiene and cause of infections. Also, the average score of the group was $5,51 \pm 2,07$, this reflecting an overall medium level of knowledge, that may not be sufficient for a proper hand hygiene practice and an effective infection prevention activity. However, the average score of those who participated in CME programs was higher than that of those who did not participate: 5.81 ± 1.75 , respectively 5.66 ± 1.80 , even if it is not a significant difference.

Our study also showed a significant correlation between the level of knowledge and the number of patients cared for in a shift, that is a negative correlation - the higher the number of patients, the lower the level of knowledge. We can assume in this case that the standardization of work involving a smaller number of patients could increase the level of knowledge.

Also, our study showed that nurses from ICUs and ORs had significantly higher average scores of knowledge about hand hygiene and HAIs compared to those in other hospital departments (*Table 1*).

However, no significant correlation was identified between the level of knowledge and age, professional experience or educational level, gender, type of profession, level of responsibility or professional degree unlike the literature which cites the existence of correlations between the level of knowledge and some of these demographic or professional characteristics [7,9,27,28].

Regarding the practice of workplace hand hygiene and the level of self-reported compliance with hand hygiene, 29% of nurses declared that they had 70-80% compliance with hand hygiene and 50% of nurses stated that they had 90-100% compliance. Moreover, in the case of ICUs nurses, the percentage of those who declared 90-100% compliance was even higher (65%), an explanation for this could be the significantly higher level of their knowledge identified in this study. However, the analysis of the correlation between the level of compliance with hand hygiene and the level of knowledge showed that the correlation coefficient was small and insignificant, including in the case of ICUs nurses, who reported very high levels of compliance.

In this regard, considering that the observed compliance reported in the literature is about 40% [10], and in our study only 5% of respondents reported compliance

between 30-40% and only 14% of respondents reported compliance between 50-60%, we can speak in this case of an overestimation of one's own compliance reported by the nurses participating in the study.

Also, our study showed that the level of compliance with hand hygiene was significantly higher for nurses who had sufficient resources for workplace hand hygiene and among those who participated in courses/symposiums/conferences on specific topics (*Table 3*). These results are consistent with the literature emphasizing the importance of providing resources and education to improve compliance with hand hygiene [7,9]. Nurses' answers to open-ended questions about the causes of non-compliance and useful solutions to improve compliance also support the importance of resources and EMC. However, the analysis of the association between the level of compliance with hand hygiene and the number of patients cared for in a shift did not show a significant relationship between these two variables (*Table 3*), although it is known that workload and a large number of patients cared for are risk factors and causes of non-compliance with hand hygiene [7,9,10].

The hand hygiene method recommended for the routine use of the medical staff, both by international guidelines and by the legislation of our country, is hygienic hand disinfection by rubbing with alcohol-based solutions [7,9]. However, our study showed that the most common method of hand hygiene for nurses who participated in the study was hand washing with soap and water, 85% of them preferring this method. An explanation for this result could be the existence of a "traditional" misperception of the medical staff, in the sense that alcohol-based solutions are more irritating, which may actually come from a lack of specific knowledge about the benefits of using alcohol-based solutions (superior microbial efficiency, reduced time required and superior emollient protection). The justification of this explanation can come from the analysis of the respondents' answers to item no. 2 in the knowledge assessment section (regarding the efficiency, the time required and the causing of irritations by the two known methods of hand hygiene), where only 18% of the respondents answered correctly (*Table 2*). In support of this explanation comes the analysis of the answers to item no. 8, regarding the time required to perform hygienic hand disinfection by rubbing with alcohol-based solutions, which showed that 57% of respondents answered incorrectly.

We have a special situation in the case of ICU nurses, 44% of them preferring alcohol-based solutions, compared to only 15% in the case of the entire group of nurses. An explanation to this situation could be the significantly higher level of their knowledge identified in our study and their known high degree of training and specialization.

Also, in general, the literature mentions that the medical staff follow more closely the indication after coming into contact with the patient compared to the indication before the contact [10], the explanation being most likely the natural tendency of self-protection of the medical staff. Thus, the results of our study were consistent with the specialized literature, showing that a high percentage of nurses (58%) performed hand hygiene more frequently after the

who performed hand hygiene more frequently before the contact with the patient.

Our study also showed that there was in 93% of cases, a concern for promoting the importance of hand hygiene as a method of preventing and limiting HAIs, at the level of the management of the institution/department where nurses performed their professional activity. Also, in terms of knowing the percentage of HAIs in the institution/department where they worked, respectively the level of compliance with hand hygiene of the medical staff from the department where they worked, most respondents (72% and 74%, respectively) said that they knew the percentage of HAIs, at their workplace, as well as the percentage of performing hand hygiene maneuvers of the medical staff from the department where they worked. These results represent important positive aspects, because leadership and feedback are part of effective strategies to improve compliance with hand hygiene [7,9,15].

Here we can also talk about a limit of this study, because it would have been useful to complete the 2 items related to knowing the rate of compliance with hand hygiene and the rate of HAIs with "If so, what is this percentage?", to be compared with the percentages reported internationally.

The analysis of the answers to the 3 closed questions regarding the attitudes of the respondents, which referred to the role of jewelry and nails in the occurrence and transmission of HAIs, the role and the importance of hand hygiene in HAIs prevention and the relationship between patient safety and HAIs prevention, showed an almost unanimous agreement with the statements that they contain (96%, 96% and 99%, respectively). The nurses who participated in the study therefore had positive attitudes about hand hygiene and infection prevention. However, the existence of a good level of knowledge and positive attitudes is important; but just as important is their transposition into clinical practice to obtain improved compliance with hand hygiene and lower HAIs rates [7,9,26]. In this case, the question remains whether these positive attitudes of nurses are actually translated into practice and to what extent they lead to improved hand hygiene and reduced infections.

Thus, the respondents' answers to the 2 open questions regarding the possible causes of non-compliance with hand hygiene, which are presented in *Table 4*, and regarding the possible factors that could contribute to improving the hand hygiene practice of the medical staff, which are presented in *Table 5*, were consistent with the causes and strategies cited in literature [7,9,10,15]. We noticed here that among the main causes of non-compliance were the causes related to increased workload (the large number of patients, less time, the lack of staff - 34%), causes related to the availability and accessibility of hand hygiene products and devices (discontinuity in the supply of materials/solutions, poor location of solutions/devices - 24%), as well as the causes associated with education and training (low level of knowledge, lack/insufficiency of training - 20%). We also noticed that the order of ranking, as well as the share of percentages, were maintained in the case of factors that could help improve compliance, for each category of causes there was a category of solutions addressed to them (solutions related to work 30-40%

and only 14% of respondents reported compliance between 50-60%, we can speak in this case of an overestimation of one's own compliance reported by the nurses participating in the study.

Thus, given these results, strategies to improve compliance with hand hygiene developed at the level of medical institutions should consider reducing the workload of the medical staff, supplementing the medical staff, ensuring enough quantities of hand hygiene products and of good quality, ensuring good accessibility to hand hygiene devices, regular development of educational programs on hand hygiene and infection prevention and control, as well as monitoring and providing feedback on performance.

Moreover, knowing that, generally, nurses do not have adequate knowledge of hand hygiene and HAIs, and given their important role in this field and the importance of HAIs control, their continuing education and training are needed to improve their knowledge and attitudes in order to achieve appropriate behaviors and positive attitudes towards hand hygiene and HAIs prevention and control. However, in order to obtain an improved level of compliance with hand hygiene and achieve the ultimate goal of reducing HAIs rates, it is necessary to apply multimodal strategies that include educational interventions (very useful, effective, but not sufficient), but also organizational interventions at the level of institutional and system management (ensuring an adequate number of medical staff, ensuring sufficient and good quality resources, increasing

accessibility to hand hygiene products and devices, ensuring the availability of alcohol-based solutions, ensuring monitoring, feedback and institutional safety climate).

The information generated by this study will allow the identification of the knowledge gaps regarding hand hygiene and HAIs, and the problems related to the nurses' self-reported attitudes and practices of in this field, in order to develop and implement effective strategies to improve the clinical practice of hand hygiene and infection prevention.

In conclusion, we can say that nurses in Romania have an inadequate knowledge level regarding hand hygiene and HAIs, which could represent a cause of HAIs and barrier to patient safety, have positive attitudes and over-estimated self-reported practices. In this regard, future research is needed to assess the level of observed compliance with hand hygiene and its relationship with the knowledge and attitudes of nurses in the field of hand hygiene and HAIs, all the more so as the recent pandemic caused by SARS-CoV-2 has produced an additional awareness of the importance of hand hygiene among medical staff.

Acknowledgments

This study is to contribute towards a Doctor of General Medicine degree for the main author. The authors would like to thank the study participants, Mrs. Ilona Voicu for the support with the statistical analysis of the data and to Ms. Antonia Stroe for the support with the English revision of the manuscript.

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