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Healthcare-associated Infection in Neonatal Intensive Care Units: What is the Role of Nurses' Knowledge and Practice?

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Abstract

Background: **Healthcare-associated infections (HAIs) constitute a global health problem. It is considered one of the leading causes of morbidity and mortality, with a longer duration of hospital stay. Knowledge and practice of healthcare workers are two pillars of infection control.** ***Aim:*** **To assess the knowledge and practice of NICU nursing staff regarding infection control measures.** ***Methods:*** **This is a descriptive cross-sectional study that included 100 nurses from the working staff inside the neonatal intensive care units in 3 Egyptian hospitals. We used a self-administered questionnaire to detect the level of knowledge of nurses regarding infection control, and an observational checklist to help accurate judgment of their real practice. A scoring system was developed and a score of less than 65% was considered an inadequate practice.** ***Results:*** **The mean knowledge score was 105.5 ± 7.38 points, where 67% of the participants had a satisfactory level of knowledge while; the mean practice score was 37.56 ± 1.98 points, where 40% of the participants had a satisfactory practice level. There was a significant positive correlation between the knowledge of the studied sample and their practice in regard to infection control measures. The unavailability of suitable equipment was the most frequent barrier that hinders following instructions of infection control measures inside the NICU (98%) followed by a shortage of nurses (74%) and overwhelming tasks (72%).** ***Conclusion:*** **Nurses had unsatisfactory practice despite their satisfactory knowledge. The main barrier was the shortage of the proper equipments followed by the overwhelming tasks.**

Keywords: *KAP, NICU, neonatal safety, infection control, Healthcare-associated infections*

Introduction

Healthcare-associated infection (HAI) is defined as an infection occurring in a patient during the process of care in a hospital or other healthcare facility that was not manifested or incubating at the time of admission. This includes infections acquired in the hospital and any other setting where patients receive health care and may appear even after discharge[(1)]. It is a major contributor to higher morbidity and mortality rates as well as longer intensive care unit (ICU) stays, making it a global health issue., increased severity of the underlying illness, increased utilization of devices for

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monitoring and treatment, increased cost of treatment in both developed and developing countries and impairment of the quality of patient's and family's life[2]. According to the world health organization report on the burden of endemic healthcare-associated infection worldwide in 2011, 46.4% of European countries reported to the European national surveillance system that more than 4 million patients were affected by HAI in Europe, and 1.7 million affected patients in the USA. Incidence of HAIs in the developing countries was 2-3-fold higher than in high-income countries and 13 times higher than the USA. Available data revealed surgical site infection (SSI) to be 11.8 per 100 patients[3]. There are several risk factors in neonatal intensive care unit (NICU), including the knowledge and attitude of healthcare personnel regarding infection control measures, invasive procedures, length of stay, low birth weight, and early contact with parents. All these factors can trigger a higher proliferation ofHAI , impairing the recovery and the quality of life of the newborn[4]. Unfortunately, all these factors are present altogether in a lot of our NICUs in Egypt. Newborns hospitalized in NICU are at risk of HAIs because of their physiologic instability, exposure to invasive procedures and devices, and broad-spectrum antibiotics. Overcrowding and poor staffing ratios are other main contributors[5]. it is possible to significantly reduce the rate of HAI through effective infection and prevention control[6]. Hospitals and NICUs that comply with best practice guidelines on infection prevention and control have extremely low rates of HAIs[7]. The responsibility of infection control applies to everybody working and visiting the NICU including staff (physicians and nurses), administrators, coworkers, and parents. The role of nurses is extremely important in preventing the hazards and sequels of HAI and protecting patients, themselves, and other healthcare personnel from acquiring infection[8]. Standard precautions are based on the premise that all patients are potentially infectious, even when asymptomatic, and that the same safe standard of practice should be used routinely with all patients to prevent exposure to blood, body fluids, secretions, excretions, mucous membranes, non-intact skin or soiled items and to prevent the spread of microorganisms[9].This study aimed to assess the knowledge (their information), attitude (are they convinced) and pra,ctice (what they actually do) of NICU nursing staff towards basic elements of infection control standard precautions. The results of the research will help us to determine whether the NICU nursing staff needs special training program for infection control or not.

Subjects and Methods

This is a cross-sectional observational study performed in the NICUs of Suez Canal University hospital, El-Matariya teaching hospital, and Atfal-Misr hospital. A sample of 100 nurses was included from the nursing staff working inside the previously mentioned hospitals (30 nurses from Suez Canal University Hospitals, 30 nurses from Atfal-Misr Hospital, and 40 nurses from El-Matariya Teaching Hospital). Nurses were selected by systematic random sampling technique from a list involving names of all the nurses in each NICU. The study was approved by ethics committee of the Faculty of Medicine, Suez Canal University. An informed consent was obtained from all nurses before inclusion in the study.

Methods

Two tools were used in this study: 1- a self-administered questionnaire and 2- an ob-

servational checklist. The self-administered questionnaire was designed to detect the level of knowledge and attitude of nursing staff regarding infection control. It consists of 2 sections; section I: included the socio-demographic data of the nursing staff like age, gender, professional qualifications, educational level, years of experience in NICU, and attended workshops and training programs (6 questions), and section II: questions to assess the knowledge regarding infection control measures in the Arabic language. The questionnaire included 32 questions covering all items of standard precautions based on the questionnaire used in the Ayed et al study[9]. Scoring system of the questionnaire: one point was given to the right answer and zero to the wrong answer. Scores less than 65% were considered to have inadequate knowledge about infection control in NICU and those who got 65-100% are adequate. The observational checklist was employed to help accurate judgment on the real practice of nursing staff and was based. it was adopted from Rochwani and Sharma study[10]. It was categorized under 9 main items with 60 subtitles related to the following: (personal hygiene, personal protective equipment, hand hygiene, suction of respiratory tract, I.V. infusion therapy, chest tube care, sharp devices, and waste disposal). Each item was observed as done or not done. Scoring system of observational checklist: one point was given to each item done and zero point was given to item not done. Scores less than 65% were considered as inadequate practices and level 65-100% were adequate. The observation was made by the researchers through observing the nurses while working in their area of practice 3 times at different intervals for each nurse. The observation was made for 2 weeks for each NICU. Reliability testing was applied to all questions to confirm their consistency.

Statistical Analysis

The Statistical Package for Social Science (SPSS) software version 20 for data capture and statistical analysis was used. Mean and standard deviation was estimated for each continuous variable. ANOVA, Student t-test, and chi-square test (χ^2) were used to assess the statistical difference between variables, each test according to the type of variable. P-value < .05 was used as the level of statistical significance

Results

The present study was designed as a cross-sectional observational study that included 100 female nurses from the nursing staff working inside the neonatal intensive care units in Suez Canal University Hospital, El-Matariya Teaching Hospital and Atfal-Misr Hospital. The mean age of the participants was 28.08 ± 5.27 years; 46% of them graduated from the health technical institute while 30% were enrolled in the nursing college. In addition, one-third of the nurses had participated in a previous infection control course, and 84% of the participants had received Hepatitis B and/or Influenza vaccination (Table 1). We divided the responses of the studied nurses regarding each item related to their knowledge about the infection control measures into satisfactory and unsatisfactory answers. It was found that domains with the highest level of satisfactory answers were the definition of the infection, other standard precautions including non-touch technique and respiratory hygiene, as well as sterilization and disinfection domains with satisfactory levels of 85%, 83% and 77%, respectively. Generally, 67% of the participants were found to have a satisfactory level of knowledge, while only 40 % of the participants were found to have a satisfactory

practice (Table 2). It was found that there was a statistically significant difference in the knowledge score about infection control measures among different levels of education, years of work experience, and history of infection control courses attendance. On applying a post hoc test, we found that nurses who graduated from high nursing school had significantly higher knowledge scores than those who graduated from the health technical institute (p<0.001). Moreover, nurses with working years' experience less than 5 years had statistically significantly lower knowledge scores than those who have experience from (5 – 10) or >10 yrs. (p<0.001) (Table 3).

Table 1: Baseline characteristics of the studied sample

Variables	n=100
Age, mean ± SD	28.08 ± 5.27
Level of education, n (%)	
Nursing College (high study 4 years)	30 (30)
Health Technical Institute (high study 2 years)	46 (46)
High nursing school (basic study 3 years)	24 (24)
Experience duration, n (%)	
< 5 years	51 (51)
5-10 years	32 (32)
> 10 years	17 (17)
Previous infection control courses, n (%)	
No	67 (67)
Yes	33 (33)
< 3 courses	28 (28)
3-6 courses	5 (5)
> 6 courses	0 (0)
Vaccinated, n (%)	
No	16 (16)
Yes	84 (84)
Hepatitis B only	63 (63)
Influenza only	9 (9)
Both	12 (12)

Data are presented as mean ± SD or frequency (%)

Regarding nurses' practice, the post hoc test revealed that nurses graduated from high nursing school had significantly higher practice score than those graduated from the health technical institute (p=0.03). Moreover, nurses with working years' experience less than 5 years had statistically significant lower practice score than those who have experience from (5 – 10) or > 10 years (p<0.001) (Table 4). There was significant positive correlation between age of the participants and their knowledge score about infection control measures (r=0.818) (p<0.001) as well as their practice score (r=0.783) (p<0.001). Additionally, there was significant positive correlation between the knowledge of the studied sample and their practice regarding the infection control measures (r=0.925) (p<0.001). (Figure 1).

Table 2: Frequency distribution of the studied nurses as regard to their satisfactory levels of knowledge and Practice (n=100)				
Infection control related to	**Satisfactory**		**Unsatisfactory**	
	N	**%**	**N**	**%**
Infection (definition, mode of transmission)	85	85	15	15
Nosocomial infection	60	60	40	40
Sharp devices and needle stick injuries	70	70	30	30
Body fluids spillage, linen management, and waste disposal	65	65	35	35
Hand hygiene	62	62	38	38
Personal protective equipment	64	64	36	36
Sterilization and disinfection	77	77	23	23
Other standard precautions	83	83	17	17
Total knowledge score (mean ± SD 105.50 ± 7.38)	67	67	33	33
Total Practice score (mean ± SD 37.56 ± 1.98)	40	40	60	60

N.B. other standard precautions include non-touch technique and respiratory hygiene

Table 3. Association between baseline characteristics of studied sample and their knowledge about infection control measures		
Variables	**Knowledge score about infection control measures** mean ± SD	**p-value**
Level of education		
Nursing College	105.07 ± 6.49	**0.002** [a]
Health Technical Institute	103.7 ± 7.42 [α]	
High nursing school	109.5 ± 7.06	
Experience duration		
< 5 years	99.61 ± 2.56	**<0.001** [a]
5-10 years	110.5 ± 5.4 [β]	
> 10 years	113.76 ± 5.14 [β]	
Previous infection control courses		
No	100.96 ± 3.38	**<0.001** [b]
Yes	114.73 ± 3.7	
Vaccinated		
No	104.88 ± 4.95	0.73 [b]
Yes	105.62 ± 7.77	

[a] *P values are based on as Kruskal Wallis test. Statistical significance at P < 0.05*

[b] *P values are based on as Mann-Whiney test. Statistical significance at P < 0.05*

Multivariable linear regression analysis was used to assess predictors of satisfactory knowledge and practice scores and revealed that the best-fitting predictors for the knowledge score about infection control measures among participant nurses were age (p=0.028), level of education (p=0.024), years of experience (p=0.044) and attending previous courses (p<0.001). This indicates that for every one-year increase in age, there is increase in knowledge score by 0.276 points. Meanwhile, there is an increase by 1.82 points in knowledge score of nurses who were graduated from high nursing school compared to those graduated from nursing college.

Moreover, there is an increase by 8.949 points in knowledge score of nurses who had had previous courses compared to those did not have any courses before (Table 5). While the most significant predictor of satisfactory practice was attending previous courses as there was significant increase by 3.056 points in the practice score compared to those who did not have any courses before (p<0.001). Moreover, for every one unit increase in the nurses' knowledge score, their practice score increases by 0.231 points (p<0.001) (Table 6). Assessing the barriers that hinder following the instructions of infection control measures inside the NICU revealed that unavailability of suitable equipment was the most frequent barrier (98%) followed by shortage of nurses' number (74%), overwhelming tasks (72%), and time shortage (47%).

Discussion

HAIs represents a major global safety concern for both patients and healthcare professionals. HAIs include occupational infections among facility staff. These infections often caused by multi-resistant pathogens and can result in prolonged hospital stay, potential disability, excess costs, and sometimes death[1]. The burden of HAIs is already substantial in developed countries, where it affects from 5-15% of hospitalized patients in regular wards and as many as 50% or more of patients in intensive care units (ICUs).

Table 4 Association between baseline characteristics of studied population and their practice regarding infection control measures

Variables	Practice score regarding infection control measures mean ± SD	p-value
Level of education, n (%)		
Nursing College	37.47 ± 1.8	**0.035** [a]
Health Technical Institute	37.22 ± 1.91 [α]	
High nursing school	38.33 ± 2.2	
Experience duration, n (%)		
< 5 years	36.18 ± 0.68	**<0.001** [a]
5-10 years	38.66 ± 1.77 [β]	
> 10 years	39.65 ± 1.9 [β]	
Previous infection control courses, n (%)		
No	36.31 ± 0.61	**<0.001** [b]
Yes	40.09 ± 1.23	
Vaccinated, n (%)		
No	37.31 ± 1.35	0.43 [b]
Yes	37.61 ± 2.08	

[a] *P values are based on as Kruskal Wallis test. Statistical significance at P < 0.05*

[b] *P values are based on as Mann-Whiney test. Statistical significance at P < 0.05*

In developing countries, the magnitude of the problem remains underestimated or even unknown largely because HAI diagnosis is complex and surveillance activities to guide interventions require expertise and resources[11]. Surveillance systems exist in some developed countries and provide regular reports on national trends of endemic HAIs. This is not the case in most developing countries because of social and

healthcare system deficiencies that are aggravated by economic problems. Additionally, overcrowding and understaffing in hospitals result in inadequate infection control practices, and lack of infection control policies, guidelines and trained professionals also adds to the extent of the problem[3]. The present study was designed to assess the knowledge and attitude regarding infection control measures among 100 NICU nursing staff from 3 hospitals. The results showed that the mean knowledge score was 105.5 ± 7.38 points, where 67% of the participants had satisfactory level of knowledge. On the other hand, mean practice score of the nurses was 37.56 ± 1.98 points, where 40% of the participants had satisfactory practice level. These results showed the size of the infection control problem. This also could be an indication of the existing contrast between knowledge and practice, which reflects the need for linking knowledge to practical aspects in teaching infection control measures as mentioned in another study[12]. The result of this study was consistent with several research that revealed that healthcare workers had good knowledge about infection control measures. As found by a study done in College of Nursing, King Saudi University, Kingdom of Saudi Arabia; authors reported that the majority of the studied nurses had good knowledge about infection control measures, but they showed lack of practice in hand washing and using gloving which are the most significant items to prevent transmission of infection[13].

Table 5. Multivariable linear regression analysis of determinants of Knowledge score about infection control measures

Predictors	Unstandardized Coefficients		Standardized Coefficients	(95% CI)	*p*-value
	B	Std. Error	Beta		
(Constant)	92.263	2.994			**<0.001***
Age	0.276	0.123	0.197	0.031 – 0.520	**0.028***
Level of education					
High nursing school vs. Nursing College	1.827	0.794	0.106	0.250 – 3.404	**0.024***
Health Technical Institute *vs.* Nursing College	0.596	0.601	0.040	-0.598 – 1.789	0.324
Experience duration					
> 10 years vs. < 5 years	3.612	1.772	0.185	0.094 – 7.130	**0.044***
5-10 years vs. < 5 years	3.801	1.024	0.242	1.767 – 5.836	**<0.001***
Previous courses					
Present *vs.* absent	8.949	0.733	0.573	7.495 – 10.404	**<0.001***

*ANOVA<0.001, R^2= 0.88; * Statistical significance at P < 0.05*

However, these results were different from those reported by Soliman[14] who stated that most of the nurses had poor knowledge regarding standard precautions. This is due to lack of awareness, training, and education of nurses. In the present study, it was found that nurses had satisfactory knowledge about hand washing (62%), personal protective equipment's such as gloves (64%). In agreement with our results, Salem reported that (78.3%) of nurses had fair knowledge of hand washing. Moreover, nurses' knowledge about gloving, disinfection and discarding were good (71.7%, 63.3%, and 93.3%, respectively). Generally, 60% of the nurses had good knowledge and 51.7% had poor practice about infection control measures[13]. It was found that there was a significant positive correlation between level of education and their knowledge score about infection control measures. On applying post

hoc test, we found that nurses graduated from nursing college had significantly higher knowledge score than those graduated from the health technical institute. Similarly, a study in Palestine reported that there were Significant statistical differences between mean knowledge scores and both gender and qualification. They also revealed that nurses who had master degree displayed higher mean knowledge scores as compared to the other two groups (diploma & bachelor). However, they reported that no significant statistical differences were found between mean knowledge scores and years of experience, training course or level of education[9]. This controversy in results shows that it is not very clear whether the educational level affects the nurse's knowledge or not. But most of the studies approve those higher levels of education positively increase knowledge of nurses about infection control. In the current study, we found that there was a significant positive correlation between age of the participants and their knowledge score about infection control measures. It was obvious that the older the nurse, the more qualified she becomes. On the other hand, a study done in Teaching Hospitals affiliated to Zabol University of Medical Sciences in Iran, found that the variables of age, work experience, and level of education did not establish a significant relationship with the knowledge and attitude of nurses[15]. This controversy in results may be explained by looking at the mean age of the studied samples in these studies. The mean age in Sarani et al.[15] was 41± 1.13 while in our study it was 28.08 ± 5.27. This means that most of the nurses in the former study had enough experience so the increase in age did not improve their knowledge or practice significantly. While in our study, most of nurses who are fresh graduates have little experience. Their experience increases significantly by their increase in age. This is supported by many studies that confirm that years of experience is an important factor that affect nurses' knowledge and practice[17].

Table 6: Multivariable linear regression analysis of determinants of practice score regarding infection control measures

Predictors	Unstandardized Coefficients		Standardized Coefficients	(95% CI)	p-value
	B	Std. Error	Beta		
(Constant)	34.369	0.946			**<0.001***
Age	0.071	0.039	0.188	-0.007 – 0.148	0.073
Level of education					
High nursing school Vs Nursing College	0.030	0.251	0.007	-0.468 – 0.529	0.905
Health Technical Institute Vs Nursing College	0.109	0.190	0.027	-0.269 – 0.486	0.569
Experience duration					
> 10 years Vs < 5 years	0.503	0.560	0.096	-0.609 – 1.614	0.372
5-10 years Vs < 5 years	0.186	0.324	0.044	-0.457 – 0.829	0.566
Previous courses					
Present Vs absent	3.056	0.232	0.729	2.596 – 3.516	**<0.001***
Knowledge score	0.231	0.023	0.860	0.186 – 0.276	**<0.001***

*ANOVA<0.001, R^2= 0.927, * Statistical significance at P < 0.05*

In our study we found that the best-fitting predictors for the knowledge score about infection control measures among participant nurses were age, level of education,

years of experience and attending previous courses. Similarly, a study done on nurses on University of Jordan, Amman found that age, level of education, and gender were the best fitting predictors for knowledge about infection control measures[17].

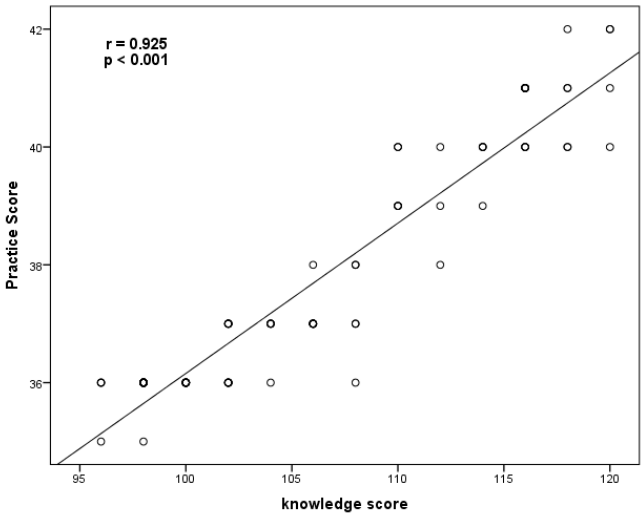

Figure 1: Correlation between knowledge and practice of infection control measures

This indicates the importance of educational levels and years of experience in improving the knowledge of nurses. We also found that nurses who had previous courses had significantly an increase by 3.056 points in their practice score compared to those who did not have any courses before. Moreover, for every one-unit increase in the nurses' knowledge score, their practice score increases by 0.231 points. These results reflect how training courses can improve the knowledge and practice of nurses regarding infection control measures. This is similar to results found by Abd-Elhamid et al. who concluded that the implementation of health educational program had improved nurse's knowledge and practice regarding infection[18]. There was also significant correlation between knowledge and practice of infection control measures but knowing the infection control measures does not mean that nurses will practice them usually due to many barriers. We also found many barriers to following instructions of infection control measures such as unavailability of suitable equipment, shortage of numbers of nurses, overwhelming work tasks and time shortage. These results are similar to the results found by Travers et al. who indicated that there are five key themes emerged as perceived barriers to effective infection prevention and control for certified nursing assistants: 1) inability to understand patients; 2) lack of trained nurses; 3) per-diem/part-time staff; 4) overwhelming work tasks and, 5) time shortage[19].

Conclusions

Despite of having satisfactory knowledge, nurses had unsatisfactory practice regarding infection control measures. The unavailability of suitable equipment followed by the overwhelming tasks were the most frequent barriers that hinders following instructions of infection control measures inside NICUs.

Conflicts of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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