

Factors Hindering Compliance of Critical Care Nurses With Isolation Precautions

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Background: Nosocomial infection (NI) is one of the most frequent adverse events threatening patients' safety worldwide and presents a challenge for all health personnel that resulting in longer hospital/ Intensive care unit (ICU) stay, more utilization of resources, more unnecessary suffering for patients and their families.

Objective: To assess critical care nurses' compliance with isolation precautions and determine the factors that hinder their compliance with these precautions.

Research design: A descriptive research design was used to conduct this study.

Setting: This study was conducted in seven ICUs in the Alexandria Main University Hospital, namely: General ICU "unit I", General ICU "unit II", General ICU "unit III", Medical ICU, Respiratory ICU, Neurosurgery ICU and Emergency anesthesia ICU.

Results: 100% of the study nurses agree that understaffing and unavailability of places for patient isolation were the most hindering factors for non-compliance with isolation precautions followed by lack of knowledge, lack of training and lack of managerial support by 93.3%. Moreover, 78% of them agree that lack of subjective norms and unavailability and inadequacy of equipment and supplies.

Conclusion: Factors that hinder nurses' compliance with isolation precautions include understaffing, workload, lack of knowledge, lack of training, lack of managerial support and subjective norms and unavailability of equipment and supplies were the most hindering factors.

Keyword: Factors, Compliance, Nurses, Isolation precautions.

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I. Introduction

The burden of NI increases frequently in developed countries, where it affects from 5% to 15% of hospitalized patients in regular wards and as many as 50% or more of patients in ICUs. The European Centre for Disease Control also estimated that 4.1 million patients per year develop NIs within the European Union as a result of health care, and that 37,000 deaths result annually due to such infections⁽¹⁾. The risk of acquiring NI is especially significant in the ICUs. Approximately 30% of ICU patients are affected by one or more episodes of NIs. Among those are immune-compromised, extremes of age, colonized with microorganisms, admitted with severe illnesses and complex comorbidities. In addition, ICU environment provides ideal conditions for microorganisms to be transmitted between those who receive and give care^(2,3). Nurses who represent the largest group of healthcare professionals are likely to be exposed to microorganisms during their daily practice. As part of their role, they have a professional and moral obligation to follow scientifically accepted isolation precautions to prevent disease transmission amongst critically ill patients or among patients and healthcare professionals. Moreover, they should make sure that their knowledge and skills regarding infection control and prevention are up-to-date and their practice is safe and competent⁽⁴⁾.

Compliance of critical care nurses with isolation precautions has been recognized as being an efficient means to prevent and control NIs within the ICU. Such measures not only protect the patients, but also healthcare workers and the environment. Nosocomial infection or healthcare-associated infection or hospital-acquired infection is one of the most common types of infections. It is acquired during patient stay in a hospital or in other health care settings, manifests only after 48 hours of stay, and not present or incubating at the time of admission. It may involve not only patients but also any one comes in contact with the hospital including staff members, visitors, workers...etc. It can range from simple, uncomplicated infection to major, life-threatening infection⁽⁹⁾. One fourth of nosocomial infections involve patients in ICUs, and nearly 70% are due to microorganisms that are resistant to one or more antibiotics. Four types of ICU-acquired infections account for more than 80% of all nosocomial infections and include urinary tract infections, surgical site infection, respiratory tract infections and blood stream infection⁽¹⁰⁾. Chain of infection is a term used to describe

the process by which infection can occur. Infection occurs only with the presence of the basic elements leading to its occurrence. These elements are infectious agent, susceptible host, portal of exit, mode of transmission and portal of entry on which all precautions and measures used to prevent and control infection are based⁽⁹⁾.

After investigating the serious outcomes of NI and its risk factors, critical care nurses are obliged to protect critically ill patient against acquiring infection. Therefore, they have to share the responsibility in better prevention and appropriate treatment, targeted surveillance programs and subsequent initiation of the appropriate infection control measures, hopefully resulting in lower infection rates, morbidity, mortality and substantial savings for the hospital budget⁽³⁾. Nurses have a basic role in the prevention phase of infection control. They are assigned to prepare, administer the vaccine, which is an agent prepared biologically to improve the immunity to a particular disease⁽¹¹⁾.

Nurses also should be alert to the emergence of antibiotic resistant pathogens. That is attributed to prolonged hospitalizations, higher antibiotic costs and the need to develop new antimicrobial agents. The overall national costs of antimicrobial resistance have been estimated to be between 10 million and 30 billion dollars annually⁽¹²⁾. Another study of Abd-Elmonsef, et al (2014)⁽¹³⁾ in Medical/Surgical ICU of Emergency Hospital at Tanta University revealed that multi-drug resistant organisms accounting 92.68% of the isolated organisms. The highest resistance (68.29%), was against the third generation cephalosporins followed by sulphamethoxazole (63.41%), and the least was against imipenem (12.2%). While, oxacillin resistance was 60% among the gram-positive isolates and no resistance was detected against vancomycin (0%).

The starting point of a good program for infection control is the basic surveillance in which nurses play a significant role in calculating the infection rate after a valid case finding. Then the provided data is used to convince the organization and the clinical team to take serious steps toward the expenditure of significant resources to improve the infection control practices, which in turn, decrease the rate of infection and its related morbidity, mortality and economic burden. Surveillance activities include monitoring cultures results, antimicrobial use, evidence of infection, and screening for evidence of colonization with particular pathogens⁽¹⁴⁾.

Isolation precautions are designed to prevent and control transmission of highly transmissible pathogens. Isolation precautions are directed primarily at interruption of the transmission phase of infection. Transmission of infection in the ICU can occur through direct skin (mucosa) to skin contact and so direct physical transfer of microorganisms from one patient to another. Indirect contact also can occur via contaminated hands of a healthcare provider or via contaminated surfaces (contact transmission)⁽¹⁵⁾.

Two-tier approach described in the CDC update of isolation precautions which is the most cost-effective, simple way to control and prevent transmission of infections, and therefore should be utilized all the time. It is a collection of prudent precautions recommended by the CDC personnel and a panel of outside experts. These precautions may be modified as necessary for an individual hospital⁽¹⁶⁾. The first tier (standard precautions) is designed to protect patients, healthcare workers, trainees and visitors against acquiring infection and to care for all patients all times whatever the diagnosis or presumed infectious status and to reduce the risk of transmission of organisms from both recognized and unrecognized sources of infection in hospitals. It includes hand hygiene, personal protective equipment (PPE), gloving, mask and eye goggles, gowning, medications storage and preparation, safe injection practices, handling sharps, medical equipment and instruments, equipment reprocessing cycle, handling and disposal of linens, waste management, cleaning of spillages of blood and body fluids, respiratory hygiene and cough etiquette. The second tier (Transmission-based precautions) designed for patients with known infection or suspected to be infected with highly transmissible and epidemiologically important pathogens spread by droplet or airborne modes or by contact with skin or contaminated surfaces, each according to its mode of transmission^(9,17).

In order to achieve the desired goal of infection prevention and control, stakeholders should establish clear organizational structure at all levels of healthcare system. It should determine responsibilities of all the working personnel starting from employee responsible for organizational support to employee who provide direct care to patients. Three keystones needed to ensure the success of this program. First, the availability of a written and clear policy describes the indications and procedures of isolation. Secondly, successful implementation of the procedures through clear objectives and staff education. Thirdly, monitoring compliance of health care workers with isolation precaution in a continuous improvement program⁽¹⁸⁾.

Multiple studies had been done to assess nurses' compliance with infection control measures. For instance, Ramadan (2016)⁽¹⁹⁾ assessed compliance of critical care nurses with standard precautions and reported the following. Nurses' compliance with performing hand hygiene was 6% before touching patients, 50% when touching blood and body fluids, and 36% after removing gloves. And 84% of nurses complied with using gloves for touching blood and body fluids, while 66% of nurses complied with wearing gloves when touching contaminated items, but only 36% of them complied with changing gloves between different patients and the vast majority of nurses complied with needles and other sharps handling recommendations.

Nurses must be aware of the problem of nosocomial infection and its consequences on the health of all personnel coming in contact with the healthcare settings. World Health Organization fact sheet (2010)

concluded that the prevalence rate of NIs in the developed countries varies between 3.5% to 12% with annual financial cost approximately 7 billion dollars in Europe and 6.5 million dollars in US. While in developing countries, the prevalence rate varies between 5.7% to 19.1% with a huge financial cost. So we have to apply the necessary measures (Isolation precautions) to prevent and control the spread of these infections and save the additional financial costs⁽²⁰⁾.

Significance of the study

Despite the clarity and simplicity of the isolation precautions, recent and widely publicized documents reported that compliance of nurses with these precautions is poor. There are clear gaps between "what is recommended" and "what is practiced" regarding NIs prevention. This poor compliance reflects the gap between what nurses know and what they are practicing^(3,5). Furthermore, although nurses' non-compliance is well documented, relatively little is known about why nurses fail to follow isolation precautions. Surveys of nurses' compliance suggest that many factors hinder nurses to comply with isolation precautions. Three different sets of factors were identified as being challenges in implementing isolation precautions. First, individual factors which reflect nurses' beliefs and attitude toward isolation precautions. Secondly, organizational factors which comprise support of nurses by stakeholders to comply with the precautions while the third and last set is directly for environmental factors that comprise conditions affecting work status. A better understanding of these factors is needed to improve compliance rate⁽⁶⁻⁸⁾.

The aim of this study:

- Assess compliance of critical care nurses with isolation precautions.
- Determine factors hindering compliance of critical care nurses with isolation precautions.

Research question:

- Do the critical care nurses comply with isolation precautions?
- What are the factors that hinder compliance of critical care nurses with isolation precautions?

II. Material And Methods

Material:

Research design:

A descriptive research design was used in this study.

Setting:

This study was conducted in seven ICUs in the Alexandria Main University Hospital, namely: General ICU "unit I" with a staff capacity of 22 nurses, General ICU "unit II" with a staff capacity of 12 nurses, General ICU "unit III" with a staff capacity of 15 nurses, Medical ICU with a staff capacity of 17 nurses, Respiratory ICU with a staff capacity of 12 nurses, Neurosurgery ICU with a staff capacity of 12 nurses and Emergency anesthesia ICU with a staff capacity of 10 nurses.

Subjects:

Convenient sample of 90 bedside nurses who are working in the previously mentioned settings were included in this study.

Inclusion criteria:

- Nurses who provide direct care to isolated patients.
- Nurses (male or female) with at least one year of ICU working experience.

Tool:

Two tools were used in this study. These tools were developed by the researcher after reviewing the relevant literature⁽²¹⁻²⁷⁾.

Tool one: Nurses' Isolation Precautions Compliance Checklist

This tool was developed by the researcher after reviewing the relevant literature⁽²¹⁻²⁷⁾ to assess the compliance of critical care nurses with isolation precautions. It consists of a list of isolation precautions during hand hygiene, using of PPE, patient placement, patient transport, patient care equipment, disposable patient care items, respiratory hygiene/cough etiquette, handling linen and laundry, management of sharps, safe injection practices, disinfection of blood /body fluid spills, therapeutic activities with the patient and family visits that were observed by the researcher using a three-point likert scale, a score of 2 was allotted to correct & complete, score of 1 for correct and incomplete and score of 0 for incorrect or not done. A nurse score of 70% or more was considered compliant, and who scored less than 70% was considered non-compliant.

In addition, socio-demographic data of the nurses as age, sex, qualifications, years of ICU working experience, previous infection control program attended, history of previous exposure to an infection and previously given vaccines were obtained.

Tool two: Factors Hindering Critical Care Nurses Compliance with Isolation Precautions Structured Interview Schedule

This tool was developed by the researcher after reviewing the relevant literature⁽²¹⁻²⁷⁾ based on the Health Belief Model (HBM) to study the factors that hinder compliance of critical care nurses with isolation precautions. It consists of questions about HBM six constructs; perceived susceptibility consists of 5 statements, perceived severity consists of 5 statements, perceived benefits consists of 6 statements, perceived barriers consists of 15 barriers, cues to action consists of 7 statements and self-efficacy consists of 4 statements. It was scored based on three-points likert scale system, a score of 3 was allotted for agree, score of 2 was allotted for neutral and score of 1 was allotted for disagree.

Methods

Data collection:

- An official letter was obtained from the Faculty of Nursing, Alexandria University to the administrative authority of the main university hospital to conduct the study.
- A written approval was obtained from the hospital administrative authority to conduct the study.
- Two Tools were developed by the researcher after reviewing the relevant literature.
- The study tools were tested for content validity by four experts in the field of critical care nursing (two professors, one lecturer and infection control nurse) and one in the field of critical care medicine (professor). Modifications were done accordingly in the observational checklist to start each statement with a verb and tool two translated to an Arabic form to ensure consistency while interviewing nurses.
- Tool two was validated after translation to Arabic by four experts in the field of critical care nursing (two professors, one lecturer and infection control nurse) and one in the field of critical care medicine (professor).
- Reliability of the developed tools were tested using Cronbach's coefficient alpha test and they were reliable.
- A pilot study was carried out on 10 % of the nurses to evaluate feasibility and applicability of the research tools and necessary modifications were done accordingly.

Data were be collected as follows:

- Nurses' practice of isolation precautions were observed by the researcher twice in two shifts (morning and evening) while they are providing care for patients in need for contact isolation (MRSA, hepatitis C, hepatitis B, AIDS, Tuberculosis, scabies) or droplet isolation (MRSA, Haemophilus influenza type b, Neisseria meningitides, Mumps) or airborne isolation (TB, Meningitis, SARS, Measles) using tool one.
- The observed isolation precautions were hand hygiene, gloving, masking, gowning and precautions concerning safe injection, patient placement, patient care equipment and instruments, disposable patient care items, linen and laundry, sharps, and family visits.
- Regarding hand hygiene, gloving, masking and gowning procedures, procedural checklists were used to observe their practice and they were scored as correct and complete or correct and incomplete or incorrect or not-done.
- The rest of the precautions were checked directly in the research tool one without procedural checklists and they were scored as correct& complete or correct and incomplete or incorrect or not-done.
- Nurses who achieved a score of 70% or more of the available opportunities to practice a single precaution were considered compliant with that precaution, while nurses who achieved a score of less than 70% were considered non-compliant.
- Some precautions' opportunities couldn't be applied to certain patients. So they were checked as not-applicable and their scores were discounted from the total scores of the precautions.
- The observed nurses were unaware of the fact that they were being observed since the awareness of the observation could affect their practice resulting in false data and incorrect results.
- Upon completion of the observation of all nurses during their practice, the researcher interviewed each observed nurse individually during the break time using the Arabic form of tool two for about 15 minutes to respond to HBM constructs' statements. The answers were recorded immediately by the researcher.
- Data were coded and transformed into specially designed form to be suitable for computer entry process.

Statistical analysis of the data:

- Data were described using mean and standard deviation. Significance of the results was judged at 5% level. The used tests were:

1. McNemar-Bowker and Marginal Homogeneity Test used to analyze the significance between the first and second observation of isolation precautions statistically.
2. Student t-test for normally distributed quantitative variables, to find a relationship between nurses' compliance with isolation precautions and nurses' characteristics for different studied groups.
3. F-test (ANOVA) for normally distributed quantitative variables, to find a relationship between nurses' compliance with isolation precautions and nurses' characteristics for different studied groups.

Ethical considerations:

- Informed oral consent was obtained from each nurse before participation in the study. The consent includes the aim of the study, potential benefits, risks and discomforts from participation and the right to refuse participation in the study was emphasized to subjects.
- The anonymity, privacy of the nurses and confidentiality of the collected data were assured.

III. Results

Table (I) shows characteristics of the studied nurses. It was found that more than half (58.9%) of the studied nurses were in the age group of 30 years to less than 40 years old while 8.95% of them were in the age group of 40 years to 50 years old and the majority of them (93.3%) were female. Concerning their qualifications, more than half of them (54.4%) had diplomat in nursing and only 13.3% had a bachelor degree in nursing. As regard to working experience in the ICU, 37.8% of nurses had 10 years to less than 15 years of experience while only 7.8% had more than 20 years of experience. Moreover, the majority (97.8%) of the nurses had one year to less than five years of experience outside the ICU. On the other hand, 20% of the nurses attended lectures in infection control; only 5.6% of them had finished a full course in infection control and 73.3% of the studied sample was vaccinated against HBV.

Table (I): Distribution of the studied nurses according to their characteristics:

<i>Nurses characteristics</i>	<i>No. (90)</i>	<i>%</i>
Age		
20 - <30 years	29	32.2
30 - <40 years	53	58.9
40 - 50 years	8	8.9
Sex		
Male	6	6.7
Female	84	93.3
Qualification		
Diplomat	49	54.4
Technical	29	32.2
Bachelor	12	13.3
ICU work experience		
1 - <5 years	16	17.8
5 - <10 years	16	17.8
10 - <15 years	34	37.8
15 - 20 years	17	18.9
> 20 years	7	7.8
Previous work experience		
1 - <5 years	88	97.8
5 - <10 years	2	2.2
Attendance to an infection control program		
No	72	80.0
Yes	18	20.0
If yes, extent of learning (n = 18)		
Full course in infection control	1	5.6
Intermittent lectures	17	94.4
Previously given vaccines (Hepatitis B vaccine)		
Yes	66	73.3
No	24	26.7

Table (II) illustrates the studied nurses' compliance with all isolation precautions. This table shows that the majority (98.9%) of the studied nurses were non-compliant with hand washing opportunities in both observations as well as all of them (100%) were non-compliant also with hand disinfection opportunities. On the other hand, 40%, 73.3% and 98.9% of the studied nurses were non-compliant with donning/ doffing gloves, mask and gown opportunities respectively.

As for safe patient placement, all the studied nurses (100%) were non-compliant with safe placement of the infected patients. On the other hand, 80% of the nurses were compliant with safe injection practices. Regarding safe reprocessing of patient care equipment and instruments, the majority (73.3%) of nurses were non-compliant, whereas 53.3% of them were found to be compliant with precautions specific to disposable patient-care items. Moreover, this table illustrates that all the studied nurses (100%) were found to be non-compliant with safe handling of linen and laundry. More than two thirds of the nurses (66.7%) had safe disposal of sharps. Finally, it can be noted that all the studied nurses were non-compliant with precautions specific to family visits.

Table (II): Frequency distribution of the studied nurses according to their compliance level with isolation precautions

Isolation precautions	1 st observation				2 nd observation				Average of the two observations			
	Compliant ≥70%		Non-compliant <70%		Compliant ≥70%		Non-compliant <70%		Compliant ≥70%		Non-compliant <70%	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Hand washing	1	1.1	89	98.9	7	7.8	83	92.2	1	1.1	89	98.9
Hand disinfection	7	7.8	83	92.2	12	13.3	78	86.7	0	0.0	90	100
Donning/ doffing gloves	60	66.7	30	33.3	54	60.0	36	40.0	54	60.0	36	40.0
Donning/ doffing mask	24	26.7	66	73.3	24	28.6	60	71.4	24	26.7	66	73.3
Donning/ doffing gown	1	1.2	83	98.8	1	1.1	89	98.9	1	1.1	89	98.9
Safe patient placement	0	0.0	90	100.0	0	0.0	90	100.0	0	0.0	90	100
Safe injection practices	72	80.0	18	20.0	66	73.3	24	26.7	72	80.0	18	20.0
Safe reprocessing of patient care equipment and instruments	24	26.7	66	73.3	30	33.3	60	66.7	24	26.7	66	73.3
Disposable patient care items	66	73.3	24	26.7	54	60.0	36	40.0	48	53.3	42	46.7
Linen and laundry	0	0.0	90	100.0	0	0.0	90	100.0	0	0.0	90	100
Safe disposal of sharps	36	40.0	54	60.0	36	40.0	54	60.0	30	33.3	60	66.7
Family visits	0	0.0	90	100.0	0	0.0	90	100.0	0	0.0	90	100.0

Table (III) illustrates critical care nurses' perception of factors hindering their compliance with isolation precautions. This table shows that 100% of the study nurses agree that understaffing and unavailability of places for patient isolation were the most hindering factors for non-compliance with isolation precautions followed by lack of knowledge, lack of training and lack of managerial support by 93.3%. Moreover, 78% of them agree that lack of subjective norms and unavailability and inadequacy of equipment and supplies were considered among their factors for non-compliance with isolation precautions. Furthermore, 80%, 73.3%, 40%, 33.3% and 33.3% of nurses respectively agree that emergency situations, workload, time constraints, forgetfulness and psychological factors were also reasons for non-compliance with isolation precautions. In addition, intention, belief, attitude and self-efficacy were considered hindering factors by 13.3% of nurses as well as perceiving susceptibility, severity and cues to action by 6.7% of nurses.

Table (III): Descriptive analysis of the studied nurses according to factors hindering their compliance with isolation precautions (n = 90)

Factors	N=90			
	Affecting factors		Non-affecting factors	
	No.	%	No.	%
Individual factors				
Not-perceiving their susceptibility to infection	6	6.6%	84	93.3
Not-perceiving severity of infection	6	6.6%	84	93.3
Not-perceiving benefits of compliance with isolation precautions	0	0.0	90	100.0
Intention not to adhere to isolation precautions	12	13.3%	78	86.7
Wrong belief	12	13.3%	78	86.7
Wrong attitude	12	13.3%	78	86.7
Psychologically uncomfortable with isolation precautions	30	33.3%	60	66.7
Lack of knowledge	84	93.3%	6	6.7
Lack of training	84	93.3%	6	6.7
Forgetfulness	30	33.3%	60	66.7
Organizational factors				
Workload	66	73.3%	24	26.7
Understaffing	90	100%	0	0.0
Lack of managerial support	84	93.3%	6	6.7

Lack of subjective norms	78	86.6%	12	13.3
Environmental factors				
Emergency situations	72	80%	18	20.0
Time constraints	36	40%	54	60.0
Unavailability and inadequacy of supplies	78	86.6%	12	13.3
Unavailability of places	90	100%	0	0.0
Knowing cues to action	6	6.6%	84	93.3
Self-efficacy in applying precautions	12	13.3%	78	86.7

Table (IV) presents the relationship between nurses' compliance with isolation precautions and their age, sex and qualifications. This table reveals that there is a statistical significant difference between nurses' age and their compliance with hand hygiene, hand disinfection, wearing mask, wearing gown, safe disposal of linen and laundry and safe management of sharps (P= 0.001, <0.001, 0.030, 0.035, <0.001 and 0.005) respectively, indicating a higher mean compliance score among nurses having from 40 to 50 years old. Furthermore, a statistical significant difference were found between nurses' sex and their compliance with hand washing, hand disinfection, wearing gown, reprocessing of patient care equipment and instruments, and safe management of sharps (P= <0.001, <0.001, <0.001, <0.001 and <0.001) respectively, revealing a higher mean compliance score with female nurses than males. A statistical significant difference was also found between nurses' qualifications and hand washing, hand disinfection, wearing mask, wearing gown, safe reprocessing of patient-care equipment and instruments, safe disposal of linen and laundry and safe management of sharps (P= <0.001, <0.001, 0.001, <0.001, 0.012, <0.001 and <0.001) respectively, indicating a higher mean compliance score for graduate nurses with a bachelor degree.

Table (IV): Relationship between nurses' compliance with isolation precautions and their age, sex and qualifications. (n = 90)

Nurses' characteristics	Areas of non-compliance with isolation precautions							
	Hand washing (n = 89)	Hand disinfection (n = 90)	Wearing mask (n = 66)	Wearing gown (n = 89)	Patient placement (n = 90)	Reprocessing of patient care equipment and instruments (n = 66)	Linen and laundry (n = 90)	Management of sharps (n = 60)
	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.
Age								
20 - <30 years	26.51 ± 21.54	12.38 ± 6.03	31.90 ± 19.07	8.62 ± 19.22	19.66 ± 1.86	48.26 ± 9.0	26.72 ± 6.02	
30 - <40 years	39.58 ± 17.88	20.72 ± 14.02	32.50 ± 15.26	21.70 ± 25.02	20.0 ± 0.0	50.0 ± 14.06	28.11 ± 6.59	49.57 ± 11.32
40 - 50 years	51.30 ± 7.69	37.50 ± 8.29	50.0 ± 0.0	24.29 ± 11.34	20.0 ± 0.0	60.0	40.0 ± 2.67	40.0 ± 12.46 62.50
F (p)	7.070 (0.001*)	15.374 (<0.001*)	3.697 (0.030*)	3.487 (0.035*)	1.053 (0.353)	0.497 (0.611)	15.083 (<0.001*)	5.855 (0.005*)
Sex								
Male	4.17 ± 0.0	8.50 ± 0.0	33.75 ± 17.87	0.0 ± 0.0	18.33 ± 4.08	35.0 ± 0.0	28.63 ± 7.34	37.50 ± 0.0
Female	38.56 ± 18.57	20.31 ± 13.48	37.50 ± 0.0	18.92 ± 23.48	20.0 ± 0.0	51.0 ± 12.10	30.0 ± 0.0	45.83 ± 13.30
T (p)	16.878 (<0.001*)	8.031 (<0.001*)	1.625 (0.109)	7.340 (<0.001*)	1.000 (0.363)	10.242 (<0.001*)	1.710 (0.091)	4.604 (<0.001*)
Qualifications								
Nursing school	27.26 ± 13.14	11.30 ± 5.48	27.70 ± 18.67	6.53 ± 16.65	20.0 ± 0.0	46.43 ± 11.70	24.08 ± 5.37	
Institute of nursing	39.81 ± 20.64	27.88 ± 13.87	40.22 ± 10.63	24.14 ± 23.23	19.66 ± 1.86	53.33 ± 13.50	32.76 ± 3.92	41.07 ± 11.14
Bachelor of nursing	66.86 ± 2.18	32.92 ± 11.80	50.0 ± 0.0	50.0 ± 0.0	20.0 ± 0.0	60.0 ± 0.0	37.92 ± 3.34	50.0 ± 13.06 62.50 ± 0.0
F (p)	31.045 (<0.001*)	38.980 (<0.001*)	8.157 (0.001*)	28.437 (<0.001*)	1.053 (0.353)	4.779 (0.012*)	57.123 (<0.001*)	11.400 (<0.001*)

F, p: F and p values for ANOVA test, t, p: t and p values for Student t-test, *: Statistically significant at p ≤ 0.05.

Table (V) presents the relationship between nurses' compliance with isolation precautions and their ICU working experience and previous working experience. This table illustrates a statistical significant difference between nurses' ICU working experience and their compliance with hand disinfection and safe disposal of linen and laundry (P= <0.001 and <0.001) respectively, indicating the higher mean compliance score

among nurses with ICU working experience more than 20 years. As for previous working experience, a statistical significant difference was found between nurses' previous working experience and their compliance with safe management of sharps ($P = <0.001$), indicating a higher mean compliance score among nurses with previous working experience from 5 to less than 10 years.

Table (V): Relationship between nurses' compliance with isolation precautions and their ICU working experience and previous working experience. (n = 90)

Nurses' characteristics	Areas of non-compliance with isolation precautions							
	Hand washing (n = 89)	Hand disinfection (n = 90)	Wearing mask (n = 66)	Wearing gown (n = 89)	Patient placement (n = 90)	Reprocessing of patient care equipment and instruments (n = 66)	Linen and laundry (n = 90)	Management of sharps (n = 60)
	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.
ICU work experience								
1 - <5 years	25.39 ± 26.56	11.69 ± 6.44	35.94 ± 18.75	12.50 ± 22.36	19.38 ± 2.50	46.15 ± 11.39	27.50 ± 6.32	
5 - <10 years	35.29 ± 20.57	19.88 ± 14.74	30.77 ± 20.80	15.63 ± 23.94	20.0 ± 0.0	48.0 ± 10.33	27.19 ± 8.16	
10 - <15 years	37.32 ± 17.46	19.0 ± 11.69	35.0 ± 14.40	19.12 ± 24.66	20.0 ± 0.0	50.74 ± 12.99	27.65 ± 6.30	46.09 ± 10.92
15 - 20 years	40.93 ± 17.13	19.29 ± 14.60	25.0 ± 13.69	20.59 ± 25.36	20.0 ± 0.0	51.25 ± 13.84	28.53 ± 5.23	48.96 ± 11.25
> 20 years	48.40 ± 0.0	39.71 ± 5.86	50.0 ± 0.0	20.0 ± 0.0	20.0 ± 0.0	-	40.71 ± 1.89	43.45 ± 14.59
								42.05 ± 14.0
F(p)	2.119(0.086)	6.810(<0.001*)	2.475(0.054)	0.336(0.853)	1.165(0.332)	0.546(0.652)	6.988(<0.001*)	0.702(0.555)
Previous work experience								
1 - <5 years	35.93 ± 19.83	19.52 ± 13.50	33.98 ± 17.18	17.47 ± 23.09	19.89 ± 1.07	49.38 ± 12.55	28.64 ± 7.14	
5 - <10 years	50.0 ± 26.52	19.50 ± 3.54	37.50 ± 17.68	25.0 ± 35.36	20.0 ± 0.0	55.0 ± 7.07	32.50 ± 3.54	44.40 ± 12.65
								62.50 ± 0.0
t(p)	0.988(0.326)	0.002(0.998)	0.285(0.777)	0.452(0.652)	0.150(0.881)	0.627(0.533)	0.760(0.449)	10.902(<0.001*)

F,p: F and p values for ANOVA test, t, p: t and p values for Student t-test, *: Statistically significant at $p \leq 0.05$

Table (VI) presents the relationship between nurses' compliance with isolation precautions and their attendance to an infection control program, previous exposure to infection and previously given Hepatitis B vaccine. This table illustrates a statistical significant difference between attendance of nurses to an infection control program and their compliance with hand washing, hand disinfection, wearing gown, safe reprocessing of equipment and instruments, safe disposal of linen and laundry and safe management of sharps ($P = <0.001, 0.008, 0.003, <0.001, 0.001$ and <0.001) respectively, indicating a higher mean score compliance with nurses who attended to an infection control program lectures. In addition, it can be seen that there is a significant statistical difference between previously given vaccines and management of sharps ($P = 0.032$), indicating a higher mean compliance score between nurses who didn't receive vaccines previously.

Table (VI): Relationship between nurses' compliance with isolation precautions and their attendance to an infection control program, previous exposure to infection and previously given Hepatitis B vaccine (n = 90)

Nurses' characteristics	Areas of non-compliance with isolation precautions							
	Hand washing (n = 89)	Hand disinfection (n = 90)	Wearing mask (n = 66)	Wearing gown (n = 89)	Patient placement (n = 90)	Reprocessing of patient care equipment and instruments (n = 66)	Linen and laundry (n = 90)	Management of sharps (n = 60)
	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.
Attendance to an infection control program								
Yes	54.29 ± 9.95	26.94 ± 15.32	34.72 ± 16.59	32.35 ± 24.63	20.0 ± 0.0	51.50 ± 11.29	33.61 ± 5.37	
No	31.98 ± 19.31	17.67 ± 12.23	31.25 ± 19.58	14.17 ± 21.54	19.86 ± 1.18	30.0 ± 0.0	27.50 ± 6.97	45.83 ± 13.30 37.50 ± 0.0
T (p)	6.726 (<0.001*)	2.732 (0.008*)	0.635 (0.528)	3.046 (0.003*)	0.498 (0.620)	14.756 (<0.001*)	3.466 (0.001*)	4.604 (<0.001*)
Previously given Hepatitis B vaccine								
Yes	36.17 ± 16.62	18.58 ± 12.44	37.50 ± 15.12	14.92 ± 21.80	20.0 ± 0.0	48.75 ± 12.57	28.71 ± 7.61	
No	36.46 ± 27.36	22.13 ± 15.56	28.13 ± 18.89	25.0 ± 25.54	19.58 ± 2.04	51.67 ± 12.13	28.75 ± 5.57	42.86 ± 13.28 50.0 ± 10.50
T (p)	0.061 (0.951)	1.117 (0.267)	2.211 (0.031*)	1.716 (0.095)	1.000 (0.328)	0.847 (0.400)	0.026 (0.980)	2.223 (0.032*)

t, p: t and p values for Student t-test, *: Statistically significant at p ≤ 0.05

IV. Discussion

Nosocomial infections are unintended, undesirable, and intolerable events that endanger ICU patients' safety in terms of increased morbidity, length of stay and an economic burden on the healthcare system. At any time, NI affects between 15-40% of patients admitted to the critical care units in developed countries. The risk is two to twenty times higher in developing countries⁽²⁸⁾. Although isolation precautions were officially recommended, the present study concluded that critical care nurses' compliance with most isolation precautions was low, which in turn predispose the critically ill patients to more risks and thus more unnecessary suffering and costs. Hence, it was necessary to study the factors that hinder their compliance with isolation precautions.

The barriers and obstacles in implementation of isolation precautions are present in all hospitals with different magnitudes, especially in resource limited countries. The present study by interviewing critical care nurses was aimed to collect the ideas of people responsible for implementation of isolation precautions. Moreover, the use of HBM as a theoretical framework to explain why nurses non-compliant with isolation precautions and offers the ability for comparison among similar studies a variety. With the available evidence, hindering factors are easy to determine.

In relation to individual factors, lack of knowledge and training were the highly ranked individual factors hindering nurses' compliance. This may be due to the limited lectures in the field of infection control and most nurses had not received further training on how to apply isolation precautions within their units. This is congruent with the results of Kim, et al (2015)⁽²⁹⁾ and Dioso (2014)⁽³⁰⁾ who stated that nurses didn't know the exact concept of isolation precautions and had confused isolation precautions with general infection control practices. As well, Liu, et al (2014)⁽³¹⁾ reported that many nurses felt that their level of training was below what it should be in their current profession and they were not adequately trained on the correct use of PPE due to lack of a standard practice about the nature and effectiveness of the trainings on isolation precautions in our country. On the contrary, Erden et al., (2015)⁽³²⁾ studied factors hindering compliance of nurses with infection control practices and concluded that nurses' trainings given did not affect their compliance with isolation precautions. Although the related literature includes a number of studies indicating insufficient knowledge of health care personnel and nurses about universal precautions, continuing education and performance feedback are reported.

As for factors of forgetfulness and psychological factors (discomfort, fitting and losing dexterity), one third of the current study nurses forgot to wear PPE and they didn't wear PPE because they were always unfit and they felt uncomfortable while wearing them. Also they said that they lost their skill of palpating a vein or artery with gloves. This is similar to the results of Peponis, et al (2017)⁽³³⁾ and Akagbo, et al (2017)⁽⁷⁾ who stated that

most nurses forgot to wear PPE especially with workload and results of Efstathiou, et al (2011)⁽³⁴⁾ and Luo, et al (2010)⁽²²⁾ who stated that they feel uncomfortable and lose their dexterity while wearing PPE long time.

Regarding factors of intention not to comply, false belief and wrong attitude toward isolation precautions, a small number of nurses in the current study agreed that they are hindering factors. This may be due to lack of supervision, lack of knowledge, physicians' non-compliance and feeling safe with vaccinations. This is congruent with Al-hussami, et al (2013)⁽³⁵⁾ and Michinov, et al (2016)⁽³⁶⁾ results who stated that negative attitude toward precautions and resistance to change even with available supplies were factors for nurses' non-compliance.

Also, it was disturbing that the majority of nurses were non-compliant with most isolation precautions although all of them reported perceiving benefits of these precautions and most reported perceiving severity of infection and their susceptibility to it. These percentages may be the result of daily work with infected patients and the seen effect of infection on patients' health. This is in contrast to the results of Adeleke, et al (2012)⁽²³⁾ who stated that health care workers didn't perceive that they are susceptible to acquire TB outside the TB sections so they didn't wear PPE but they comply once they are in the TB diagnosed room.

Concerning organizational factors, understaffing was reported as a hindering factor by all nurses in the current study, giving a rationale that most nurses viewing isolation precautions as an extra assignment and usually work unwillingly especially in case of understaffing. This is in line with Sadule-Rios, et al (2017)⁽³⁷⁾ and Nderitu, et al (2015)⁽³⁸⁾ results who stated that understaffing was always a problem for nurses' non-compliance in the intensive care units.

Lack of managerial support and lack of subjective norms were reported as hindering factors by most nurses in the current study. This may be attributed to a great gap between supervisors and employees, absence of feedback from both colleagues and supervisors, unavailability of written policy and colleagues' non-compliance. This is in keeping with the results of Kim, et al (2015)⁽²⁹⁾ who stated nurses didn't use the recommended precautions because their supervisors and colleagues didn't and Hessels, et al (2016)⁽³⁹⁾ results who attributes health care workers non-compliance to lack of managerial support and unsafe working climate.

As regards workload, three quarters of the current study nurses considered workload a hindering factor for non-compliance with isolation precautions. This may be due to understaffing, more assigned complicated cases and lack of time. Similarly, Nmadu, et al (2016)⁽⁴⁰⁾ stated that nurses were usually too busy to protect themselves against contact with infected patients because of high patient load and inadequate manpower to cope with it. Moreover, Luo, et al (2010)⁽²²⁾ revealed that nurses were too busy to use PPE while working with infected patients.

Environmental factors which are inherent to the ICU environment were investigated. Unavailability of places to isolate infected patients or cohorting them was reported as the most hindering factor by all the current study nurses. This is due to the limited space of the Main University Hospital and the impossibility of monitoring critically ill patients with closed curtains especially with substantive understaffing. Followed by a factor of unavailability and inadequacy of equipment and supplies that was reported by most nurses in the current study, giving a rationale of limited resources and storage of such equipment and supplies far from where nursing care is provided. This is in agreement with Holmen, et al (2017)⁽⁴¹⁾ and Efstathiou, et al (2011)⁽³⁴⁾ results who concluded that the insufficient number of masks, gloves, gowns, soap and alcohol hand rub stations were significantly a highly ranked factor for non-compliance with hand hygiene.

As regards factor of emergency situations, almost all nurses in the current study described emergency situation as a major obstacle in following precautions. They said that they ration their time to provide care instead of taking time to wear PPE, despite the fact that this may expose them to microorganisms. Efstathiou, et al (2011)⁽³⁴⁾ findings revealed that actual working conditions as emergencies negatively influence the adherence to standard precautions. Another environmental factor perceived as a barrier by less than half of the current study nurses was time constraints. Nurses always said that they have many things to do with patients and there is no time to follow isolation precautions every time they contact patients. This is similar to Barker, et al (2017)⁽⁴²⁾ study, in which nurses stated that time burden is a reason for non-compliance with isolation precautions. In addition, Cutter, et al (2012)⁽⁴³⁾ stated that nurses failed to adopt precautions consistently due to time constraints.

Concerning Nurses' self-efficacy in applying isolation precautions, a small percentage of them stated that it is difficult to change the way we were trained and practicing after so many years, even if they know that it is not correct. This is in agreement with the results of Youssef, et al (2018)⁽⁴⁴⁾ who stated that the culture of nurses is not receptive to changing practice. Finally, almost all nurses in the current study reported that they don't know cues to action as the majority knew that their compliance will be improved if they got infected, were properly trained and knowledgeable about isolation precautions, received support and positive feedback from supervisors and colleagues or found equipment and supplies always available. Cheung, et al (2015)⁽⁴⁵⁾ also agreed that nurses know well what should be done to enhance their compliance with infection control practices. In ranking of factors from the most hindering to the least, understaffing and unavailability of places constitute the most hindering factors followed by lack of knowledge, training and managerial support. On the other hand,

perceiving benefits, perceiving susceptibility, perceiving severity constitute the least hindering factors for non-compliance with isolation precautions.

V. Conclusion

Critical care nurses were compliant with donning and doffing gloves, safe injection practices and safe management of disposable patient-care items, but they were non-compliant with the rest of the observed precautions. Regarding factors that hinder nurses' compliance with isolation precautions, understaffing, workload, lack of knowledge, lack of training, lack of managerial support and subjective norms and unavailability of equipment and supplies were the most hindering factors. On the other hand, factors of intention, belief, attitude, perception and self-efficacy were the least hindering factors.

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