RESEARCH PAPER

Infection prevention and control standards and associated factors: Case study of the level of knowledge and practices among nurses in a Saudi Arabian hospital

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Summary

Introduction. *Healthcare-associated infection is a significant public health issue in both developed and developing countries. This study was performed to assess the knowledge and practices of infection prevention and control (IPC) of nurses working in a Saudi hospital, and to examine their associations with the nurses' sociodemographic characteristics and work/training experience.*

Methods. *A self-administered questionnaire survey was conducted with participation of male and female nurses of all nationalities who had direct contact with patients while providing healthcare services at King Abdulaziz Medical City-Riyadh (KAMC-R). Sociodemographic characteristics, and work/training experience were reported; IPC knowledge and practices were assessed by questionnaire. Data of 308 valid responses were analyzed. Percentage of correct responses to nine IPC knowledge questions and frequent adherence to 11 IPC practices were calculated. IPC knowledge and practice scores were developed by using principal component analyses; individual scores were classified into high/low level of knowledge or practices by the median of the scores. Logistic regression analysis was performed to evaluate associations between IPC knowledge or practice scores and sociodemographic or work/training variables.*

Results. *Majority of the participants were females (89.3%). Significant associations between high education level and high level of IPC knowledge (AOR = 2.72, 95% CI = 1.45-5.10) and practices (AOR = 3.66, 95% CI = 1.90-7.05) were observed, after controlling the influence of sociodemographic and work/training variables.*

Conclusion. *High scores for IPC knowledge and IPC practices were independently associated with nurses' high level of education, regardless of their nationality or previous working experience. Further studies to develop effective programs for IPC regardless of the nurses' educational attainment are recommended.*

Introduction

Healthcare-associated infection (HAI) is a significant public health issue around the world [1]. It affects both developed and developing countries [2]. About 5% to 10% of hospitalized patients in developed countries, and about 20% of patients in developing countries are affected by HAI [3]. Treatment of HAIs draws a lot from countries' budgets for healthcare; in the U.S., it costs 5 to 10 billion dollars annually to manage HAIs [4].

The World Health Organization (WHO) has created the term Infection Prevention and Control (IPC), for encouraging a scientific approach and practical solutions to prevent the harm accruing from HAI to patients and healthcare workers (HCWs) [5]. The Centers for Disease Control (CDC) established the concept of universal precautions (UPs) in 1987, and then, changed to standard precautions (SPs) in 1996 [6]. SPs are used when dealing with any patient, regardless of the diagnosis [7].

Studies have discussed IPC from different points of view. According to one reported study, assessment of the current levels of knowledge and practices of HCWs is the first step towards establishment of a successful IPC program [2]. Another study suggested that in order to increase the compliance level of HCWs towards IPC standards, the barriers need to be known and removed [8]. Another study has recommended periodic assessment of the knowledge levels for filling any gaps [9].

As a background to this study, Saudi Arabia has a total population of 34,218,169 persons, and is a high-income country [10]. The Saudi healthcare system has been ranked by the WHO as 26th from the top, out of 191 countries [11]. The nursing workforce in Saudi Arabia depends mainly on expatriate workers, who account for 62.6% of the entire workforce, and there are workers of over 44 nationalities in the Saudi health sector [10]. Saudi IPC is a young and rapidly growing speciality [12]. The most common types of HAIs in Saudi Arabia are pneumonia, urinary tract infection (UTI), and bloodstream infection. Approximately, 19.2% of HAIs in Saudi Arabia are reported to be device-associated [13]. WHO recently reported an outbreak of the Middle

East Respiratory Syndrome Coronavirus (MERS-CoV) in Saudi Arabia from October 1 to 30, 2019, which caused six deaths [14].

The Saudi Ministry of Health (MOH), at the current time, follows the healthcare 2020 vision, aimed at achieving the best possible health condition or health status for Saudi inhabitants [15]. This vision involves the establishment of an effective system by following appropriate and effective methods to estimate the risks and benefits of the methods employed [15].

This study was performed to assess the IPC knowledge and practices of nurses working in a Saudi hospital, and to examine their associations with the nurses' sociodemographic characteristics and work/training experience.

Methods

Study design and sampling

A cross-sectional self-reported questionnaire survey was conducted at King Abdulaziz Medical City-Riyadh (KAMC-R) between August 2 to September 5, 2019. The hospital follows the Joint Commission International (JCI) standards as the unifying standard for healthcare and practice [16]. According to the assumption of proportion of high level of IPC knowledge as 50%, degree of precision as 0.05, sample size for the study was calculated as 384. Nurses working at the following units of the hospital were invited to participate in the study, regardless of their gender and nationalities: medical unit, surgical unit, cardiac unit, emergency unit, labor and delivery unit, hemodialysis unit, intensive care unit, and ambulatory care center. Nurses who provided healthcare services and had direct contact with patients were included in the study sample. During the study period, 820 nurses participated in the survey; data of 803 valid responses were analyzed.

Data collection and instrument

The questionnaire was developed in English based on the WHO guidelines [17] and CDC guidelines [18]. Nurses in Saudi Arabia use English as a working language. By using multiple choice questions and a Likert scale for responses, sociodemographic characteristics, work/ training experiences, knowledge about IPC, and IPC practices of participated nurses were evaluated. To develop a questionnaire, a pilot questionnaire form was sent to two nurses and their views on the questionnaires were reflected to formulate words in the questionnaire.

The sociodemographic information included the gender, age, education, and nationality. Questions on work/training experiences included years of service, previous work experiences, experience in KAMC-R, and experience outside KAMC-R.

Nine questions were used to evaluate the subjects' knowledge on IPC, and 11 questions were used to evaluate the adherence to IPC practices by referencing WHO guidelines [17], CDC guidelines [18] and surveys conducted in other countries.

The survey instrument was pre-tested in a preliminary survey with 30 nurses from the same hospital prior to the start of the actual data collection process. Those nurses were excluded in the actual main data collection.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) version 22 software was used for the statistical analyses. The responses to nine individual questions about IPC knowledge were divided into correct or in-correct responses. The percentages of correct responses to individual questions were calculated. Adherence to IPC practices were evaluated based on self-reported responses on a Likert scale for frequencies (Always = 3; Sometimes = 2; Seldom = 1; Never = 0) to perform 11 practices. The percentages of the response of "always" for IPC practices and the means of the score for 11 practices were calculated.

To develop composite scores for IPC knowledge and IPC practices, individually, principal component analyses (PCA) were performed by using correct or in-correct answers to nine questions on IPC knowledge and self-reported frequencies of adherence to 11 IPC practices. The factor scores of the first component of IPC knowledge questions and the first component of IPC practices questions were used as the composite IPC knowledge score and the composite IPC practice score.

For further analysis to evaluate the associations between IPC knowledge or practices and the sociodemographic or work/training variables, the composite scores for IPC knowledge and practices were classified into high/ low level of knowledge or practice by the median of individual composite scores.

The associations between IPC knowledge or practice scores and sociodemographic characteristics or work/ training variables were evaluated by logistic regression analysis. Composite IPC knowledge score, high/low, was used as a dependent variable and its association with independent variables (sociodemographic characteristics and work/training experiences) were analyzed. Similar analysis using composite IPC practice score, high/low, as a dependent variable was also performed.

Ethical considerations

The study was conducted with the approval of the Tokyo Medical and Dental University Ethics Committee (M2018-310), and King Abdullah International Medical Research Center (SP19/406/R). The survey followed the principle of voluntary participation and informed consent for participation was obtained before answering to questions. They were informed that they were free to withdraw from the study at any time without any disadvantages accruing to them. Nurses who refused to participate in the survey were not included in the study. Those who were not directly involved in providing healthcare services to patients, such as nurse managers, were excluded from the study.

Table I. Infection prevention and control (IPC) knowledge and practices towards IPC of nurses working in a Saudi hospital (n = 308).

IPC knowledge		
Topics of questions	% of correct answers	
Hand hygiene	93.2	
Definition of standard precautions	54.5	
Rubbing of hands	84.4	
Five moments of hand hygiene	40.9	
Handling of personal protective equipment	71.1	
Handling of sharp objects	76.3	
Immunization for healthcare providers	41.2	
Respiratory hygiene	95.1	
Contact infection	95.5	
IPC practices		
Questions	% always practicing	IPC practices score* (Mean)
Performing hand hygiene before touching patients	95.8	2.96
Performing hand hygiene after touching patients	98.1	2.98
Performing hand hygiene before clean/aseptic procedure	97.1	2.97
Performing hand hygiene after touching the patient's surroundings	92.2	2.92
Performing hand hygiene after dealing with body fluids	98.7	2.99
Following the recommended time when hands washing	73.4	2.70
Following the recommended time when rubbing one's hands	81.5	2.80
Discarding sharp items into sharps containers immediately after use	98.4	2.98
Using suitable personal protective equipment before entering the patient's room	90.6	2.89
Looking up the required IPC information by oneself (using available resources)	64.6	2.58
Asking IPC team about the required IPC information, if needed	56.8	2.41
Overall Mean		2.83

* The score was calculated as: Always 3; Sometimes 2; Seldom 1; Never 0.

Results

Majority of the participated nurses were females (89.3%), and bachelor's/master's degree holders (81.2%). Most participants were 20 to 40 years of age (68.8%). Regarding working units and years of work at the hospitals, 22.4% were working in the medical unit; 76.6% served for less than 10 years in KAMC-R. Non-Saudi Arabian participants accounted for 78.3%; the nationalities were as follows: 55.5% Filipino, 14.3% Malaysian, 4.9% South African, 1.3% British, 0.6% Jordanian, 0.3% Slovakian, 0.3% Greek, 0.3% Korean, 0.3% Irish, and 0.3% Lebanese. 76.1% had prior work experience; 90.3% had received training about IPC at KAMC-R, and 89.6% were satisfied with the training they had received.

Table I shows the summary statistics of answers to individual questions pertaining to IPC knowledge and practices. The percentage of correct answers to individual IPC knowledge questions ranged from 40.9% to 95.5%, depending on the questions. For example, 40.9% of participants correctly chose the recommended 5 moments for hand hygiene, 71.1% of the participants chose correct answers for appropriate handling of personal protective equipment, and 95.1% of the participants chose correct answer for practices related to respiratory hygiene. The percentage of participants that answered "always" for the 11 individual questions pertaining to adherence to IPC practices ranged from

56.8% to 98.7%. 95.8% and 98.1% of the participants reported that they always ensure hand hygiene before and after touching patients, respectively; 98.4% always discarded sharp items into the containers for sharps immediately after use, and 64.6% always looked up information on IPC by themselves instead of contacting IPC department, when they need to seek information.

Table II shows the factor loading of the first factor based on PCA using IPC knowledge and practices. The results of PCA on IPC knowledge showed that even the first component, R^2, was 15.5% and representativeness of this component for overall IPC knowledge was limited. The results of PCA on IPC practices showed that the first component represented 29.1% of all variance, with a Cronbach alpha for the 11 items of 0.702.

Table III shows the distribution of high scores for IPC knowledge by the sociodemographic characteristics and work/training experiences of the nurses, and the results of logistic regression analysis showing the associations of high scores for IPC knowledge with the sociodemographic characteristics and work/training experiences of the nurses. Among the participants holding bachelor's or master's degrees, 55.2% had high scores for IPC knowledge, while only 34.5% of participants below a bachelor degree showed high scores for IPC knowledge. The percentages of high scores for IPC knowledge among those with and without previous work experience were 55.6% and 37.9%, respectively.

The unadjusted odds ratio (OR) showed that a high score

Table II. Factor loadings of principal component analysis of infection prevention and control (IPC) knowledge and practices.

IPC knowledge		
Item	Factor loading	Commonalities (R^2)
Hand hygiene	0.506	0.256
Definition of standard precautions	0.344	0.118
Rubbing of hands	0.132	0.017
Five moments of hand hygiene	0.443	0.197
Handling of personal protective equipment	0.253	0.063
Handling of sharp objects	0.540	0.291
Immunization for healthcare providers	0.425	0.181
Respiratory hygiene	0.521	0.272
Contact infection	-0.028	0.001

R^2 for component/factor: 15.5%; Cronbach alpha = 0.242.

IPC practices		
Item	Factor loading	Commonalities (R^2)
Performing hand hygiene before touching patients	0.597	0.356
Performing hand hygiene after touching patients	0.493	0.243
Performing hand hygiene before clean/aseptic procedure	0.483	0.233
Performing hand hygiene after touching the patient's surroundings	0.454	0.206
Performing hand hygiene after dealing with body fluids	0.459	0.211
Following the recommended time when hands washing	0.744	0.554
Following the recommended time when rubbing one's hands	0.671	0.450
Discarding sharp items into sharps containers immediately after use	0.356	0.127
Using suitable personal protective equipment before entering the patient's room	0.529	0.280
Looking up the required IPC information by oneself (using available resources)	0.497	0.247
Asking IPC team about the required IPC information, if needed	0.547	0.299

R^2 for component/factor: 29.1%; Cronbach alpha = 0.702.

for IPC knowledge was significantly associated with a high education level [OR = 2.34, 95% CI = 1.29-4.25], and previous work experience [OR = 2.05, 95% CI = 1.20-3.51], and negatively associated with the nurse being of Saudi Arabian nationality [OR = 0.57, 95% CI = 0.33-0.98]. After adjustments for all independent variables, only the variable of education level showed significant independent association with high IPC knowledge score: adjusted odds ratio (AOR) for high education level was (AOR = 2.72, 95% CI = 1.45-5.10).

Table IV shows the distribution of high scores for IPC practices by the sociodemographic characteristics and work/training experiences of the nurses, and the results of logistic regression analysis showing the association of high scores for IPC practices with the sociodemographic characteristics and work/training experiences of the nurses. Among the participants holding bachelor's or master's degrees, 51.6% showed high scores for IPC practices, while only 29.3% of participants below a bachelor degree showed high scores for IPC practices. The percentages of high scores for IPC practices among those with and without previous work experiences were 54.3% and 25.7%, respectively.

The unadjusted OR showed that a high score for IPC practices was significantly associated with a high age [OR = 2.16, 95% CI = 1.25-3.75], high education levels [OR = 2.57, 95% CI = 1.39-4.77], and previous work experience [OR = 3.44, 95% CI = 1.92-6.15], and negatively associated with the nurse being of Saudi Arabian nationality [OR = 0.27, 95% CI = 0.14-0.5]. After adjustments for all independent variables, only the variable of education level showed significant independent association with high IPC practice score: AOR for high education level was [AOR = 3.66, 95% CI = 1.9-7.05].

Discussion

The high percentage of female nurses among the study participants was consistent with the reported percentage of female workers in the Saudi nursing workforce (80.7%) [10]. The percentage of expatriate workers in the current study of 78.2% was higher than reported percentage of foreign workers in the Saudi nursing workforce (62.6%) [10].

More than half of the participants were Filipinos (55.5%). This reflects a report in 2011 by Kanchanachitra et al., which reported large number of international migration of Filipino nurses to Saudi Arabia, UAE, UK and USA, and referred the Philippines as one of the major countries for export of nurses [18].

The current study showed that nurses participated in the study had a high level of knowledge on hand hygiene, respiratory hygiene, contact infection, and rubbing of hands procedure, handling of personal protective equipment and handling of sharp objects; an intermediate

Table III. Distribution of high infection prevention and control (IPC) knowledge score and its association with sociodemographic characteristics and working/training experiences of nurses working in a Saudi hospital (n = 308).

Characteristics	n	High IPC knowledge score %	P*	OR (CI 95%)	P**	AOR (CI 95%)	P**
Sociodemographic characteristics							
Gender							
Female	275	49.5	0.062	Ref.		Ref.	
Male	33	66.7		2.04 (0.95-4.38)	0.066	1.65 (0.72-3.77)	0.237
Age (years)							
20-30	106	49.1	0.881	Ref.		Ref.	
31-40	106	50.9		1.08 (0.63-1.85)	0.784	0.77 (0.41-1.45)	0.426
41-50	80	55.0		1.27 (0.71-2.27)	0.422	0.66 (0.29-1.53)	0.335
>50	16	50.0		1.04 (0.36-2.97)	0.944	0.58 (0.15-2.19)	0.419
Highest completed education							
Below a bachelor degree	58	34.5	0.004	Ref.		Ref.	
Bachelor or Master degree	250	55.2		2.34 (1.29-4.25)	0.005	2.72 (1.45-5.10)	0.002
Nationality							
Non-Saudi Arabian	241	54.4	0.042	Ref.		Ref.	
Saudi Arabian	67	40.3		0.57 (0.33-0.98)	0.043	0.83 (0.30-2.24)	0.708
Working/training experience							
Participation in services (years)							
<10	236	49.2	0.172	Ref.		Ref.	
≥10	72	58.3		1.45 (0.85-2.47)	0.174	1.67 (0.80-3.49)	0.173
Previous working experience							
No	74	37.9	0.008	Ref.		Ref.	
Yes	234	55.6		2.05 (1.20-3.51)	0.008	2.0 (0.81-4.95)	0.133
Experience of training inside KAMC-R							
No	30	50.0	0.881	Ref.		Ref.	
Yes	278	51.4		1.06 (0.50-2.25)	0.881	1.06 (0.47-2.35)	0.895
Experience of training outside of KAMC-R							
No	190	53.2	0.407	Ref.		Ref.	
Yes	118	48.3		0.82 (0.52-1.30)	0.408	0.80 (0.48-1.33)	0.390
* Chi-square test; ** Logistic regression analysis; IPC: Infection prevention and control; KAMC-R: King Abdulaziz Medical City-Riyadh; OR: Odds Ratio; AOR: Adjusted Odds Ratio; Ref.: Reference							

level of knowledge on SP; knowledge below the average on the 5 moments of hand hygiene and immunization schedule or healthcare providers.

HAI is central to the provision of safe and high-quality healthcare, therefore, the related IPC policies and procedures should be adhered when dealing with patients as well as equipment. The IPC methods should ideally be applied to ensure that a sterile environment is provided.

With regards to the scores for IPC knowledge and practices developed by PCA, the score for IPC practices explained 29.1% of variance for the 11 variables and showed reasonable representation and consistencies; on the other hand, the IPC knowledge score only explained 15.5% of the variance for the 9 variables. Further studies are needed to develop a good indicator to reflect level of knowledge among HCWs in the context of Saudi Arabia. The results identified education level of the nurses as a significant independent factor related to high scores for both IPC knowledge and IPC practices. No significant associations of the scores were observed with previous work experience or experience of receiving training on IPC. These findings suggest that for nurses below a bachelor degree education, effective interventions to improve their knowledge of IPC and IPC practices are critically important.

The hospital had experienced an outbreak of MERS-CoV in 2015, and a special IPC program called "right care, right now" was implemented [16], however, the current results did not show any association of the scores for IPC knowledge or practices with experience of IPC training inside KAMC-R. Therefore, the impacts of in-hospital training programs need further investigation.

Saudi Arabia has announced the Saudi Vision 2030 for improving the delivery of services in all fields and sectors, including the health sector. The vision is aimed at improving the efficiency and effectiveness of the healthcare sector through the use of information technology and digital transformation [19]. Thus, for provision of training on IPC or IPC education sessions, use of modern information technology and digital sources is highly recommended.

Table IV. Distribution of high infection prevention and control (IPC) practices score and its association with sociodemographic characteristics and working/training experiences of nurses working in a Saudi hospital (n = 308).

Characteristics		High IPC practices score						
	n	%	p*	OR (CI 95%)	p**	AOR (CI 95%)	p**
Sociodemographic characteristics							
Gender							
Female	275	46.2	0.215	Ref.		Ref.	
Male	33	57.6		1.58 (0.76-3.28)	0.218	0.96 (0.43-2.16)	0.921
Age (years)							
20-30	106	35.8	0.032	Ref.		Ref.	
31-40	106	54.7		2.16 (1.25-3.75)	0.006	1.5 (0.78-2.85)	0.221
41-50	80	52.5		1.98 (1.09-3.57)	0.024	1.13 (0.49-2.64)	0.773
> 50	16	50.0		1.79 (0.62-5.15)	0.281	1.43 (0.37-5.56)	0.604
Highest completed education							
Below a bachelor degree	58	29.3	0.002	Ref.		Ref.	
Bachelor or Master degree	250	51.6		2.57 (1.39-4.77)	0.003	3.66 (1.90-7.05)	<0.001
Nationality							
Non-Saudi Arabian	241	53.9	< 0.001	Ref.		Ref.	
Saudi Arabian	67	23.9		0.27 (0.14-0.50)	<0.001	0.36 (0.13-1.03)	0.056
Working/training experience							
Participation in services (years)							
< 10	236	46.2	0.439	Ref.		Ref.	
> 10	72	51.4		1.23 (0.73-2.09)	0.439	1.02 (0.48-2.16)	0.954
Previous working experience							
No	74	25.7	< 0.001	Ref.		Ref.	
Yes	234	54.3		3.44 (1.92-6.15)	<0.001	1.79 (0.70-4.57)	0.223
Experience of training inside KAMC-R							
No	30	50.0	0.764	Ref.		Ref.	
Yes	278	47.1		0.89 (0.42-1.89)	0.764	1.04 (0.46-2.36)	0.918
Experience of training outside of KAMC-R							
No	190	47.4	0.988	Ref.		Ref.	
Yes	118	47.5		1.00 (0.63-1.59)	0.988	1.33 (0.79-2.26)	0.286

* Chi-square test; ** logistic regression analysis; IPC: Infection prevention and control; KAMC-R: King Abdulaziz Medical City-Riyadh; OR: Odds Ratio; AOR: Adjusted Odds Ratio; Ref.: Reference

Limitations

The study was designed as a cross-sectional study, which is not adequate to address causation. There could be potential reporting bias due to self-reporting of practices by the HCWs rather than observational or objective evaluation. Furthermore, there could have been potential sampling bias, as this survey was conducted at a single hospital run under unique system by the Ministry of National Guard Health Affairs, while Saudi Arabia is a big country with 13 administrative regions.

Conclusion

The study reported IPC knowledge and IPC practices of nurses working in a Saudi hospital. High scores for IPC knowledge and IPC practices were independently associated with a high level of education completed by the nurses, regardless of their nationality or previous working experiences. It is important to develop effective programs to improve IPC knowledge and compliance to recommended IPC practices, regardless of the level of education of nurses in the current workforce. Periodic conduct of an IPC awareness program for HCWs is also recommended.

Ethical approval

The study protocol was approved by the Tokyo Medical and Dental University Ethics Committee (M2018-310), and King Abdullah International Medical Research Center (SP19/406/R).

Acknowledgment

Conflicts of interest

The authors declare no conflicts of interest.

Authors' contributions

RSA and KN conceptualized and designed the study, RSA coordinated and managed the implementation of the survey and obtained data, RSA, KN, and SA analyzed and interpreted the results, and KS reviewed the analysis. RSA developed initial manuscript, and KN, SA, YT, NW and KS reviewed and revised the manuscript.

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