UNIVERSITI PUTRA MALAYSIA

EFFECTIVENESS OF A NOSOCOMIAL INFECTION CONTROL EDUCATION MODULE ON KNOWLEDGE AND PRACTICE AMONG NURSES IN PUBLIC HOSPITALS IN AZA'AL REGION, YEMEN

GAMIL GHALEB AHMED NASR

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By

GAMIL GHALEB AHMED NASR

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Doctor of Philosophy

June 2018

DEDICATION

This work is dedicated to my beloved dad and mom who always give me unending support and unconditional love. Arwa, you are my best friend and lovely wife forever. Daughters (Ghaida & Ghadeer) and sons (Abdulrahman & Abdulmalak) you are the light of my life. I couldn't have made it without you. I hope you realize how I love and proud of all of you.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

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Chairman : Anisah binti Baharom, PhD
Faculty : Medicine and Health Sciences

Introduction: The incidence of nosocomial infection is high in Middle East countries (11.8%), including in Yemen (34%). Good knowledge and practices on infection control measures are important for nurses' adherence to infection control measures, However, Yemeni nurses seem to have lack of knowledge and practices regarding nosocomial infection control measures. Previous study by Sherah showed that only 7.2% and 3.4% of the nurses had a good level of knowledge and practices, respectively. Education and training of nurses are important components of an infection control program. Therefore, the aim of this study was to develop, implement and evaluate the effectiveness of a nosocomial infection control educational module on knowledge and practice among nurses in public hospitals in Aza'al Region in Yemen.

Method: A Single-blinded randomized hospital-based trial design was used in this study. Eight public hospitals were randomized to intervention-1 (face-to-face intervention + module), intervention-2 (module only) and waitlist group (no intervention). The study was conducted in three phases: (1) developing the module and instrument and baseline pre-intervention evaluation, (2) implementing the intervention and (3) module evaluation. Delivery of the module was based on Situated Learning Theory (SLT). A pre-validated questionnaire was used to collect the data on demographic characteristics, knowledge and practice of nosocomial infections. Data of knowledge and practice were collected at three points of time, i.e. baseline, immediately after the intervention and 3-months post-intervention. Statistical Package for Social Sciences (IBMSPSS), version 21.0 was used for data analysis. A P-value of less than 0.05 level (two-tailed) with 95% confidence interval was considered significant. General Estimating Equations (GEE) was used to measure between and within-groups differences over time.

Results: The results of the current study showed that at baseline, most of the participants (69%) had poor knowledge and more than two third of them (77%) had poor level of practices. There was significant association between the degree of previous in-service training in NIs control measures and the nurses' knowledge (*P*=0.004).

The results from the comparison between the immediately post-intervention and the three-month post-intervention showed a significant increase in the mean score of knowledge among those who received the intervention-1 (face-to-face intervention + module) and the intervention-2 (module only) as compared to the waitlist group (P<0.001). Likewise, the results showed a significant increase in the mean score of practice among those who received the intervention-1 (face-to-face intervention + module) (P<0.001), but no significant improvement of the immediately post-intervention (P=0.06) was found among those who received the intervention-2 (module only). Although it was statistically significant at the three-month post-intervention (*P*=0.02), it was not clinically meaningful because it was =0.11%. Furthermore, the knowledge and practice scores achieved from the immediately post-intervention sustained over the three-month post-intervention.

Conclusion: The findings of the current study indicate that the intervention-1 (face-to-face intervention + module) was more effective than the intervention-2 (module only) in improving knowledge and practices of Yemeni nurses regarding nosocomial infection control measures. In-service training courses to upgrade and refresh nurses' knowledge and practices about infection control measures are recommended at a regular basis at least six monthly.

Key words: Yemeni nurses, knowledge, practice, nosocomial infections, education intervention.

Abstrak tesis ini dikemukan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KEBERKESANAN MODUL PENDIDIKAN DAN PRAKTICAL UNTUK MENGAWAL JANGKITAN NOSOKOMIAL DALAM KALANGAN JURURAWAT DI HOSPITAL AWAM DALAM WILAYAH AZA'AL, YEMEN

Oleh

GAMIL GHALEB AHMED NASR

Jun 2018

Pengerusi : Anisah binti Baharom, PhD
Fakulti : Perubatan dan Sains Kesihatan

Pendahuluan: Insiden mengenai jangkitan nosokomial adalah tinggi di negara-negara Timur Tengah (11.8%), termasuk di Yaman (34%). Pengetahuan dan latihan yang baik mengenai langkah-langkah untuk mengawal jangkitan adalah penting untuk kecekapan jururawat demi mengawal jangkitan noskomial. Walau bagaimanapun, jururawat di Yemeni kurang pengetahuan dan pendedahan mengenai langkah kawalan jangkitan nosokomial. Kajian terdahulu yang dilakukan oleh Sherah menunjukkan bahawa hanya 7.2% dan 3.4% jururawat mempunyai tahap pengetahuan dan latihan yang baik. Pendidikan dan latihan yang diberikan kepada jururawat adalah satu komponen yang penting dalam program kawalan jangkitan. Oleh itu, matlamat kajian ini dilaksanakan adalah untuk membangun, melaksana dan menilai tahap keberkesanan modul pendidikan dan latihan untuk mengawal jangkitan nosokomial dalam kalangan jururawat di hospital awam di Wilayah Aza'al di Yaman.

Kaedah: Kaedah percubaan secara rawak berasaskan hospital digunakan dalam kajian ini. Lapan hospital awam dipilih secara rawak untuk kumpulan interrvensi-1 (bersemuka + modul), intervensi-2 (modul sahaja) dan kumpulan senarai menunggu (tiada intervensi). Kajian ini dijalankan dalam tiga fasa: (1) membangunkan modul dan kaedah dan penilaian pra-intervensi. (2) melaksanakan intervensi dan (3) penilaian modul. Perlaksanaan modul adalah berdasarkan pada Teori Pembelajaran Situasi (SLT). Kajian soal selidik digunakan untuk mengumpul data mengenai ciri demografi, pengetahuan dan latihan yang dilaporkan mengenai jangkitan nosokomial. Data mengenai pengetahuan dan latihan yang dilaporkan telah dikumpulkan, iaitu garis dasar, sebaik sahaja selepas intervensi dan intervensi selepas 3 bulan. Pakej Statistik untuk Sains Sosial (IBMSPSS), versi 21.0 digunakan untuk menganalisis data. Nilai P kurang daripada 0.05 (two-tailed) dengan selang keyakinan 95% dianggap penting.

Persamaan Anggaran Am (GEE) digunakan untuk mengukur perbezaan antara dan dalam kumpulan dari semasa ke semasa.

Hasil Kajian: Keputusan kajian semasa pada dasarnya, menunjukkan bahawa kebanyakan peserta (69%) mempunyai pengetahuan yang kurang baik dan lebih separuh daripada mereka (77%) mempunyai tahap latihan yang rendah pada peringkat awal. Terdapat persamaan yang ketara di antara tahap latihan dalam perkhidmatan untuk langkah kawalan NI dengan pengetahuan jururawat (P=0.004).

Keputusan daripada perbandingan antara intervensi dengan segera dan intervensi selepas tiga bulan menunjukkan peningkatan yang signifikan dalam skor min pengetahuan bagi mereka yang menerima intervensi-1 (bersemuka + modul) dan intervensi-2 (modul sahaja) berbanding dengan kumpulan senarai menunggu (P<0.001). Begitu juga, keputusan menunjukkan peningkatan yang signifikan dalam skor min latihan dalam kalangan mereka yang menerima intervensi-1 (bersemuka + modul) (P<0.001), tetapi tiada penambahbaikan yang signifikan terhadap intervensi (P=0.06) dalam kalangan mereka yang menerima intervensi-2 (modul sahaja). Walaupun ia signifikan pada intervensi selepas tiga bulan (P = 0.02), tetapi ia tidak berkesan secara klinikal kerana ia adalah =0.11%. Selain itu, skor pengetahuan dan latihan yang dicapai dari intervensi segera itu terus kekal selama tiga bulan selepas intervensi.

Kesimpulan: Hasil kajian semasa menunjukkan bahawa intervensi-1 (bersemuka + modul) lebih berkesan daripada hanya menggunakan intervensi-2 (modul sahaja), hal ini dapat meningkatkan pengetahuan dan latihan bagi jururawat di Yaman mengenai langkah-langkah kawalan jangkitan. Kursus latihan dalam perkhidmatan untuk meningkatkan pengetahuan dan latihan bagi jururawat mengenai langkah-langkah kawalan jangkitan disyorkan dilakukan secara berkala sekurang-kurangnya setiap enam bulan.

Kata kunci: Jururawat di Yemeni, pengetahuan, latihan, jangkitan nosokomial, intervensi pendidikan.

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I certify that a Thesis Examination Committee has met on 7 June 2018 to conduct the final examination of Gamil Ghaleb Ahmed Nasr on his thesis entitled "Effectiveness of a Nosocomial Infection Control Education Module on Knowledge and Practice among Nurses in Public Hospitals in Aza'al Region, Yemen" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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LIST OF ABBREVIATIONS

ABHR	Alcohol-Based Hand Rub.
AP	Additional Precaution.
CAUTI	Catheter-associated urinary tract infection.
CDC	Centers for Disease Control and Prevention.
CLABSI	Catheter line-associated blood stream infection.
CVI	Content Validity Index.
EFA	Exploratory factor analysis.
FA	Factor analysis.
GCC's	Gulf Cooperation Council States.
HBV	Hepatitis B virus.
HCV	Hepatitis C virus.
HCWs	Healthcare workers.
HH	Hand hygiene.
HIHS	High Institute for Health Sciences.
HIV	Human Immunodeficiency Virus.
HSV	Herpes Simplex Virus.
IBMSPSS	Statistical Package for Social Sciences.
ICU	Intensive Care Unit.
I-CVI	Item Content Validity Index.
IP	Infection Prevention.
IPC	Infection Prevention and Control.
KAP	Knowledge, Attitudes, and Practices.
KMO	Kaiser-Mayer-Olkin.
MoPH&P	Ministry of Public Health and Population
MRSA	Methicillin Resistant Staphylococcus aureus.
NIs	Nosocomial infections.
NNIS	National Infection Surveillance.

PCRA	Point of Care Risk Assessment.
PPE	Personal protective equipment.
RSV	Respiratory Syncytial Virus
S-CVI	Scale Content Validity Index.
SLT	Situated-Learning Theory
SP	Standard Precaution.
SSI	Surgical site infection.
U.S.	The United States.
UPM	Universiti Putra Malaysia.
VAP	Ventilator-associated pneumonia.
VRE	Vancomycin Resistant Enterococci.
WHO	World Health Organization.

CHAPTER 1

INTRODUCTION

1.1 Background

Nosocomial infections (NIs) are new infections that occur among patients after at least 48 hours from their admission to hospital. This type of infection is not present or incubating at the time of admission into the hospital, but is usually acquired during the process of receiving medical care (Ducel, Fabry, & Nicolle, 2002). NIs can also appear within ten days after discharge (Collins, 2008) or within 30 days after a surgical operation (Horan, Andrus, & Dudeck, 2008).

NIs occur as a result of the individual's adverse reaction to an infectious pathogen or its toxins (Bereket et al., 2012). It can be either endemic or epidemic. While endemic infections are more common, epidemic infections occur only during the outbreak. Epidemic infection is defined as an abnormal increase of infection rate above the baseline level. It also might be mild or severe with the incidence of 5-10 % (Ducel et al., 2002; Mayhall, 2012). Its prevalence rate greatly varies from one country to another (WHO, 2010a; Pourakbari et al., 2012; Gupta et al., 2014). Such considerable variation of NIs prevalence rate is referred to differences in case mix, different case definitions used, using different data collection methods and variations in the interval in which data are collected (Humphreys & Smyth, 2006; Ozer et al., 2010).

Generally, the prevalence rate of NIs was reported to range between 3.0 and 20.7 % (Samuel et al., 2010; Mayhall, 2012). The estimated prevalence rate in high-income countries was also found between 3.5 and 12 %, whilst it was between 5.7 and 19.1 % in low- and middle-income countries (Pittet et al., 2008; WHO, 2010b, 2013). However, the highest prevalence rate was in the Eastern Mediterranean Region 11.8%, which confirms that NIs are a growing challenge to the quality of healthcare services in the region (WHO, 2010b).

Fundamentally, all hospitalised patients are at risk to acquire NIs at any given time during the treatment process, but there are some factors that predispose patients for different kinds of NIs in the hospital or any health care setting. These predisposing factors are usually associated with either a decreased susceptible host defence or an increased risk factor for colonization (Collins, 2008) and can be divided into five groups. The first group comprises patient condition-related factors, including patient's age (Inci et al., 2016), nutrition (Cevik et al., 2005), some habits, diabetes (Karkhane et al., 2016) and chronic lung disease (Sheng et al., 2007). The second group refers to severity disease process-related factors such as in the case of surgery (Ott et al., 2013), burns (Wibbenmeyer et al., 2010) and trauma (Al Otaibi & Al-Hulaily, 2012). The third group includes invasive procedures related factors, such as surgical drainage (Ott et al., 2013), urinary catheterization, tracheostomy (Erayman et al., 2016), lavage and

gavage intubation (Suner et al., 2015) and intravenous cannulation (Tahir Siddique & Waheed). The fourth group involves treatment-related factors, such as blood transfusion (Fukuda, 2016), parenteral nutrition (Netto et al., 2017), some medications (Wang & Wang, 2016), current antimicrobial drugs (Dantas et al., 2014), and patient's position (Sternal, Franek, & Pieńkus, 2014).The fifth group of factors involves poor infrastructure, inadequate environmental hygienic conditions and waste disposal, insufficient equipment, understaffing, overcrowding, poor knowledge and application of basic infection control measures as well as absence of local and national guidelines and policies (WHO, 2013).

Nurses as a majority (>50%) of the national HCWs in many countries (WHO, 2011) represent the heart of the health care system (Tvedt et al., 2012). They are responsible for providing medications, dressing, sterilization, and disinfection. They are also involved in more contact with patients than other HCWs. Therefore, nurses are more exposed to various NIs (Saini, Nagarajan, & Sarma, 2005; Buerhaus, Auerbach, & Staiger, 2007; Shinde & Mohite, 2014). They play a vital role in transmitting NIs, and their compliance with infection control measures seems to be necessary for preventing and controlling NIs. Similarly, the HCWs in general and nurses, in particular, are also at high risk for acquiring NIs as they spend more time with patients and they are exposed to body fluid and contaminated instruments during providing care and moving among patients (Endalafer, Gebre-Selassie, & Kotiso, 2010).

Hence, nurses' knowledge of NIs control measures is important as the basis for making any positive behavioural changes. Awareness leads to knowledge, which in turn brings actions. Therefore, nurses should be aware of how to prevent transmission of NIs, and they be knowledgeable of its potential risk to the patients, other staff as well as visitors. Otherwise, the lack of knowledge and practices among nurses as a majority and first health care provider is a crucial problem because it aggravates the issue of NIs transmission and increases the prevalence rate in the hospitals. Previous studies have documented that nurses' lack of knowledge about NIs and their shortage of skill in using personal protective devices result in noncompliance with infection control measures (Motamed et al., 2006; Amin & Al Wehedy, 2009). Consequently, this increases the incidence of NI among patients and HCWs (Ducel et al., 2002; Wu, 2007).

Moreover, nurses' lack of knowledge and practices of infection control measures represents one of the most challenging barriers to prevention and control of infection (Amin & Al Wehedy, 2009). It results in non-compliance with infection control measures while providing care to patients, thus increasing the prevalence rate of NIs. (Pittet et al., 2000; Stein, Makarawo, & Ahmad, 2003; Duerink et al., 2006). For example, Pittet et al. (2000) examined the effectiveness of a hospital-based programme in improving compliance of HCWs (including nurses) with hand hygiene. The results revealed that the overall compliance significantly increased from 47.6% to 66.2% ($P<0.001$) and the prevalence rate of NIs decreased from 16.9% to 9.9% ($P<0.001$). Nurses' insufficient knowledge could be due to their inability to understand applicable materials while joining health care programs, their failure to understand

particular policies and procedures of a given hospital and inability to understand how to use advanced medical equipment (Wong, 1998).

Accordingly, improving nurses' knowledge and practices in regard to infection control measures is an essential part of any training program that strives to decrease the prevalence rate of NIs. For instance, any infection control program at any hospital should aim to protect the HCWs, the patients and the visitors by a cost-effective way (Zack et al., 2002; Warren et al., 2003). From a hospital's management perspective, these can be attained through providing education on infection control measures as a constant and important need to strengthen the knowledge and practices and improve compliance among the HCW's, thus decreasing the NIs rate.

Many previous studies have documented the important role of nursing education and in-service training in improving nurses' knowledge and practices related to NIs. These studies stated that providing infection control education on a regular basis to nurses improved their knowledge and practices and reduced the incidence of NIs to a great extent as it was effective in informing and convincing the nurses that infection control measures are important and hence it ensures their compliance (Kim et al., 2001; Yeung, 2007; Fashafsheh et al., 2015). For instance, the study by Nguyen, Nguyen, and Jones (2008) revealed that the incidence of NIs reduced from 13.1% to 2.1% (84%) after conducting a hand hygiene educational program. This reduction in the incidence of NIs rate indicates a significant difference with (χ^2=116.58, P =0.001).

Based on the results of previous studies carried out in neighbouring countries such as Kuwait and Saudi Arabia, the levels of nurses' knowledge and practices were relatively poor. El-Sol and Badaw (2017) conducted a study to evaluate the effectiveness of an educational module in improving nurses' knowledge and practice in prevention of central-line associated blood stream infection in Kuwait. The findings revealed that the mean total knowledge and practice scores were (5.09±76 & 5.91±0.93), respectively. Amin and Al Wehedy (2009) assessed the healthcare workers' knowledge regarding Standard Precautions in Saudi Arabia. The result showed that the mean total knowledge score was (27.8±5.9). Similarly, Sherah (2015) and Gawad (2017) evaluated knowledge and practice of the health care workers (including nurses) on Standard Precautions in Sana'a City, Yemen. Sherah' study showed that only 7.2% and 3.4 of the nurses had a good level of knowledge and practice, respectively on Standard Precautions, while Gawad's study revealed that the majority of nurses (63.8%) had poor knowledge. Therefore, upgrading nurses' knowledge and practices on infection prevention and control is vital to enhance nurses' clinical competence and improve quality of patient services.

Furthermore, the application of learning theories will increase the effectiveness of an educational intervention in improving nurses' knowledge and practices. One of the theories of learning which was identified to be appropriate for this study is the Situated Learning Theory. It focuses on learner-centred learning by engaging learners in cooperative and participative learning. The main focus of this theory is improving the

learners' problem-solving skills, adherence to life-long learning and critical thinking ability (Mann, 2011).

1.2 Problem statement

NIs are recognized as one of the most critical public health problems worldwide. World Health Organization (WHO) estimated that almost 5% to 10% of admitted patients to the critical care units acquire at least one infection. Furthermore, the WHO reported that among the 19 million patients who are admitted to hospitals around the world, 9 million are infected by NIs and almost 1 million patients die annually. The WHO also stated that the Eastern Mediterranean Region has the highest prevalence rate of NIs, 11.8 %, and the risk of such infection is aggravated two to 20 times and can exceed 25% in developing countries (WHO, 2010b).

In Yemen, the prevalence rate of surgical site infection (SSI) increased from 8 % in 2001 (Noman et al., 2001) to 34 % in 2013 (Nasser et al., 2013). The reasons behind this drastic increase in SSI are probably the lack of infection control attributable to the unstable socio-political situation in the country during these years (2001-2013), the effects of rapid population growth, the increasing health care demand which affected the health sector and led to deterioration in the provision of health services and the lack of training among health care workers (WHO, 2006; MoPH&P, 2010). Obviously, the rate of NIs in Yemen appeared to have been increasing over the years, and it is becoming extremely high when compared with the rate in Saudi Arabia (12.9 %) as a neighbour country (Abdel-Fattah, 2008), or with other countries such as Mali and Ethiopia where the NI rates were 10.2% and 10.9%, respectively (Togo et al., 2010) and (Mulu et al., 2012).

Nurses represent more than fifty percent of the national health care workers in most countries (WHO, 2011). They have an important role in transmitting NIs and increasing the incidence rate as they have contact with patients for a long time more than any other HCWs (Pittet et al., 2006; Kamunge, 2013). Some previous studies revealed that nurses contaminate their hands during performing daily direct patient care activities such as taking vital signs, moving patients and touching the patients' body (e.g. dressing, given intravascular catheter care and caring of respiratory tract), or even the patients' surroundings (Rogues et al., 2007; Collins, 2008; WHO, 2009). According to the WHO, about 70% of HCWs contaminate their hands or gloves by direct contact with patient and patient's surroundings during caring for patients with vancomycin-resistant enterococci (VRE). Nurses' responsibilities in providing safe health care services expand continuously, particularly with the advances in medical technology. Thus, improving their knowledge and practices on infection prevention and control are vital for enhance nurses' clinical competence and improve quality of patient services.

In spite of the fact that nursing education programs involve courses and instructional approaches that include ways aimed at preparing nurses who are able to cope with infection control issues, a three-year nursing curriculum in Yemeni is specifying four

theoretical hours as well as six practical hours only for infection prevention and control. This hours covers topics of hand washing, disinfection and methods of sterilization (High Institute of Health Sciences, 2006). Based on curriculum of nursing three years academic system 2006-2007 (Appendix P), these topics are not studying as a specific education unit on infection prevention and control but are included within the fundamentals of nursing which are usually studied in the second semester of the first academic year. Indicate these topics are not integrated in one course with a standard outline and specific objectives to ensure that delivery of such topics and attaining the intended outcomes is unified. Further, ten hours implies that nurses have a very minimal exposure to topics and knowledge about infection control measures during their three-year diploma program.

Another side of the problem is that Yemeni nurses are not subjected to in-service training on infection control measures while they engage in their professional work at public hospitals. This is due to the lack of written policy for in-service training and refresher courses that obligate employed nurses to take specific credit points per year in infection control education as it is in some other countries (Al-Sayaghi, 2011). For instance, in Taiwan, the policy for staff in-service training and education obligates all registered nurses to take five credit points per year of infection control education and training while they are employed in a hospital (Wu, Gardner, & Chang, 2010). Therefore, Yemeni employed nurses are unlikely to attend an in-service education relevant to infection control measures at the hospital due to the absence of such obligations.

Yemeni nurses seem to have lack of knowledge regarding nosocomial infection control measures, only 7.2% of them were reported to have good level of knowledge (Sherah, 2015). Another a study by Gawad (2017) found that 22.4% of nurses had good knowledge regarding Standard Precautions. Recently, Alwaber (2018) conducted a study to assess nurses' knowledge of needlestick injury preventive measures in Sana'a city hospitals in Yemen. The author found about 27% of Yemeni nurses had good knowledge on preventing needlestick injury. Accordingly, Yemeni nurses have poor knowledge on infection control measures.

Previous studies in different countries such Iran, Saudi Arabia and Yemen indicated that transmission of NIs could be attributed to insufficient knowledge and practices among HCWs (Motamed et al., 2006; Amin & Al Wehedy, 2009; Gawad, 2017). The authors stated that poor knowledge regarding infection control measures lead to non-compliance of the healthcare workers and increase the risk of NIs transmission. Thus, nurses need to improve their knowledge that may contribute to improve their compliance and reducing transmission of NIs. Further, educating Yemen nurses would improve their understanding of the importance of applying nosocomial infection control measures and its role in preventing such infection. This is currently needed by Yemeni hospitals and is consistent with the intention of the Ministry of Public Health and Population to prepare these hospitals for accreditation.

Likewise, Yemeni nurses seem to have poor practice of infection control measures. Sherah (2015) found only 3.4% of the participants had good level of practice regarding infection control measures. This is also evidenced by the continued need to apply appropriate infection control measures to reduce the high prevalence rate of NIs and to combat any subsequent emergence of antibiotic-resistant bacteria (Alshami, 2003). The need to enhance nurses' practice to avoid diverse current practices and improve their adherence to the recommended control measures for the prevention of intravascular catheter-related infection (Al-Sayaghi, 2011). Additionally, a recent study by Alwaber (2018) revealed that 14.7% of nurses working in Sana'a city hospitals in Yemen, had good practice in preventive measures regarding needlestick injury. All these indicates the need to enhance Yemeni nurses' practice regarding infection control measures.

Educational intervention play an important role in improving health care workers' knowledge and practices to implement appropriate infection control measures (Ribby, 2006; Suchitra & Lakshmi, 2007; Wu, 2007)**,** which subsequently assist in reducing infection and its related issues (Lam, Lee, & Lau, 2004; Salahuddin et al., 2004). Salahuddin et al. (2004) conducted a study to evaluate the effectiveness of an educational intervention in reducing the incidence of ventilator-associated pneumonia (VAP) rate. The authors concluded that implementing an educational intervention among ICU staff can improves their knowledge and reinforce preventive practices and reduce the VAP incidence rate significantly. The VAP incidence rate reduced by 51%, from 13.2±1.2 before the intervention to 6.5±1.5 post-intervention. Another study by Lam et al. (2004) assessed the HCWs' compliance with hand hygiene after receiving an educational intervention. The overall compliance of hand hygiene among nurses increased from 40% to 53% before patient contact and 39% to 59% after patient contact after the intervention. There is also an improvement in hand hygiene techniques after the intervention. Consequently, the nosocomial infections rate reduced from 11.3 to 6.2 per 1000 patient-days as well as decreasing the days of hospitalization stay.

As highlighted earlier in systematic review in this study, many studies evaluated the effectiveness of educational interventions in improving knowledge and practice of healthcare workers regarding infection control measures (Wu et al., 2010; Mockiene et al., 2011; Al-Hussami & Darawad, 2013; Ghezeljeh et al., 2015; Humphrey, 2015; Abd-Elhamid et al., 2016; Nour-Eldein & Mohamed, 2016; Aloush, 2017). However, it was found two studies (Wu et al., 2010; Al-Hussami & Darawad, 2013) out of these studies merged different teaching strategies with learning theories to deliver the intervention. Thus, were more effective in improving the healthcare workers' knowledge and practices, not only this, but also provided sustainable effect for at least six months after the intervention. Because the merge of teaching strategies and learning theories demonstrated an effectiveness in delivering the educational intervention in previous studies. The educational module in the current study was developed based on the Situated Learning Theory as well as incorporates with different teaching strategies to deliver the current educational module and ensure its effectiveness

Although written infection control policies are the starting point for developing infection control programs in hospitals, such programs and its related policies as well as the surveillance system regarding nosocomial infections have not yet been established or implemented in the Yemeni public hospitals (Ministry of Public Health and Population). Consequently, the lack of such policies as well as a lack of specific guideline to be followed by nurses result in poor infection control practices and increases the occurrence of NIs (Chipfuwa, Manwere, & Shayamano, 2014). Thus, a policy needs to be in place that works effectively in nurses' everyday practices in the Yemeni public hospitals to minimize the risk of nosocomial infections. Educating Yemen nurses would motivate them to participate actively in preparing written infection control policies and guideline.

1.3 Significance of the Study

The present study is significant in various ways. First, it would explore the level of knowledge and practices among Yemeni's nurses in selected hospitals. Therefore, its results are expected to help the authorities of the health institutes to identify the shortcomings in nursing education and in-service training courses about NIs control measures, and thus developing nursing curriculum based on the nurses' needs.

Secondly, this study would develop a theory based education module to improve nurses' knowledge and practices in effective nosocomial infection control and prevention measures. This can contribute to improving nurses' knowledge and skills in preventing transmission of NIs. Thirdly, the study will help nurses to grow professionally and hence further improve their practices of the nursing profession. Another significance of the study is that it can serve as a basis for hospital administrators to implement better infection control measures to protect their patients, HCWs and visitors as well. Further advocacy will be carried out to ensure the government, specifically the Ministry of Public Health and Population and High Institute for Health Sciences will improve the nursing curriculum with regards to NIs prevention and control.

Moreover, as a long-term impact, this study would assist in reducing the incidence of NIs, decreasing patients' complications and improving the occupational safety as well as the quality of health care especially at hospitals. This would be consistent with the trends of the Yemeni Ministry of Public Health and Population that aims to prepare public hospitals for accreditation programs, of which infection control program is considered an important part. Eventually, this will increase patient's confidence in the quality of medical services provided by Yemeni hospitals while at the same time reducing the costs involved in travelling abroad for treatment, therefore saving a lot of foreign exchange.

1.4 Research Questions

1. What are the current levels of knowledge and practices of NIs control measures among Yemeni nurses at baseline?
2. What are the factors associated with the Yemeni nurses' knowledge and practices in NIs control and prevention?
3. Is the theory-based educational module effective in improving the knowledge and practice scores of the Yemeni nurses regarding NIs control measures?
4. Is the intervention-1 (face-to-face intervention + module) more effective in improving the knowledge and practice scores of the Yemeni nurses regarding NIs control measures than intervention-2 (module only) and wait list group?
5. Is the intervention-2 (module only) more effective in improving the knowledge and practice scores of the Yemeni nurses regarding NIs control measures than waitlist group?

1.5 Research Objectives

1.5.1 General Objective

The general objective of this study was to develop, implement and evaluate the effectiveness of an educational module on nosocomial infection control measures on knowledge and practice among nurses in public hospitals in Azal Region in Yemen.

1.5.1.1 Specific Objectives

i. To describe socio-demographic characteristics, previous in-service training courses and working experience of respondents.
ii. To determine the current level of nurses' knowledge and practice related to NIs control measures at baseline.
iii. To determine the association between nurses' knowledge scores and previous in-service training courses and previous working experience at baseline.
iv. To determine the association between nurses' practice scores and previous in-service training courses and previous working experience at baseline.
v. To develop an education module on NIs control measures for nurses.
vi. To implement the educational module among in-ward-nurses in public hospitals.
vii. To evaluate the effectiveness of NIs control educational module in improving nurses' knowledge and practices at immediately after and three months post-intervention within and between intervention 1 and 2 and the waitlist group, after controlling for covariates.

1.6 Research hypothesis

H1: There is significant association between the nurses' knowledge in NIs control measures and previous in-service training and working experience at baseline.
H2: There is significant association between the nurses' practice in NIs control measures and previous in-service training and working experience at baseline.
H3: Intervention-1 (face-to-face intervention + module) will score significantly higher than the wait-list group on the immediate and three-month post-intervention evaluation of knowledge score of NIs control measures.
H4: Intervention-2 (module only) will score significantly higher than the wait-list group on the immediate and three-month post-intervention evaluation of knowledge score of NIs control measures.
H5: Intervention-1 (face-to-face intervention + module) will score significantly higher than the wait-list group on the immediate and three-month post-intervention evaluation of practice score of NIs control measures.
H6: Intervention-2 (module only) will score significantly higher than the wait-list group on the immediate and three-month post-intervention evaluation of practice score of NIs control measures.
H7: Intervention-1 (face-to-face intervention + module) will score significantly higher than intervention-2 (module only) on the immediate and three-month post-intervention evaluation of knowledge score of NIs control measures.
H8: Intervention-1 (face-to-face intervention + module) will score significantly higher than intervention-2 (module only) on the immediate and three-month post-intervention evaluation of practice score of NIs control measures.
H9: The knowledge score for intervention groups 1 and 2 at three-month post-intervention will be significantly lower than immediate post-intervention.
H10: The practice score for intervention groups 1 and 2 at three-month post-intervention will be significantly lower than immediate post-intervention.

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