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Spread of Nosocomial Infections: A Systematized Review on Nurses' Perceptions, Attitudes and Practices

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Abstract

Background: Nosocomial infections are a significant problem in global healthcare setting. Nurses have an important role in transmitting and preventing nosocomial infections.

Objective: This review investigated nurses' knowledge, practices attitudes about nosocomial infections. It aimed to unfold differences between nurses in terms of working in general settings and intensive care unit (ICU), working as a beginner and as experienced, and the extent of impact of the organizational support offered to nurses on their knowledge, attitudes, and practices.

Methods: To achieve the objective of the study, a review of the published literature was undertaken, utilizing four electronic databases. Nine studies out of eighteen were included based on the author's criteria of selection, which were published 2012-2017

Findings: Variability was found in nurses' knowledge, attitudes, and practices in relation to nosocomial infections. This variability persists in nurses working in different settings. The findings revealed a positive significant correlation between nurses' practice experience, and their knowledge, attitudes, and practices and between nurses' knowledge, attitudes and practices and organizational support.

Conclusion: The review has contributed to identifying how nurses' knowledge, attitudes and practice can be improved to enable them to contribute more effectively to nosocomial infection prevention.

Keywords: Nurses; Perceptions; Attitudes; Practices; Nosocomial infections

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Background

Nosocomial infections refer to iatrogenic, 'hospital-acquired', or 'healthcare-associated' infections. They occur in a previously uninfected patient within the first 48 hours of hospitalization, within the first three days of discharge, or within 30 days of a surgical procedure [1]. They can be acquired in any healthcare setting, as most healthcare settings harbor a large number of a wide variety of virulent, pathogenic microorganisms [2]. They are most common in settings admitting critically ill, immunocompromised patients, such as intensive care units (ICUs) [3]. A nosocomial infection may involve any localized or systemic infection in a patient; however, the most common nosocomial infections reported in the United Kingdom (UK) were lower respiratory tract infections (22.8%), urinary tract infections (17.2%) and surgical site infections (15.7%) [4], and this prevalence is roughly the same in Saudi Arabia [5].

Nosocomial infections are a significant problem for global healthcare systems. National Audit Office [4] reported that 6.4% of all patients, admitted to a hospital in the UK each year acquire some type of nosocomial infection. In Saudi Arabia, the author's context of practice, the rates of nosocomial infection were even higher than in the UK, at around 8.0% [5]. Furthermore, Saudi Arabian healthcare settings are at significant risk of pandemic nosocomial infections, such as the outbreaks of Middle East Respiratory Syndrome coronavirus (MERS-CoV) which have been recorded in the country since 2012, and which have a mortality rate of >35% [1].

Most nosocomial infections are caused by ubiquitous – and often endogenous – microorganisms, including *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas* species [4,6]. There is evidence to suggest that nurses often act as unwitting agents in the transmission of these microorganisms to and between patients,

to cause nosocomial infections. White, Duncan and Baumle [7] suggest that “most [nosocomial] infections are transmitted by health care personnel who fail to practice proper ... hygiene [practices]”. In both the UK and Saudi Arabian healthcare contexts, nurses have a greater degree of contact with patients than any other type of healthcare professional. Therefore, it is not unreasonable to assume that they have the most significant role in nosocomial infection transmission.

There are a variety of evidence-based, clinical practice guidelines which aim to support nurses and other healthcare professionals to reduce and prevent nosocomial infection transmission in their practice. Most of these guidelines focus on five key interventions: hospital environmental hygiene, hand hygiene, use of personal protective equipment, safe use, and disposal of sharps, and use of the principles of asepsis, where appropriate [8]. However, evidence suggests that nurses’ compliance with these guidelines is poor. A recent systematic review and meta-analysis of international studies concluded that nurses’ compliance with hand hygiene averaged only 38.7% [9].

Nurses have an important role in the spread or prevention of nosocomial infections. Under the Code of Professional Standards of Practice and Behavior, nurses practicing in the UK have the legal, ethical and professional responsibility to act to preserve the safety of the patients they care for [9], and healthcare practitioners in Saudi Arabia have similar responsibilities (Saudi Commission for Health Specialties). Benson suggests that the nosocomial infection control practices should be recognized as, and become, an integral part of standard nursing practice. In improving the understanding of nurses’ knowledge, attitudes and practices in relation to nosocomial infection, this review is expected to contribute to identifying how these can be improved to enable nurses to contribute more effectively to infection prevention and, subsequently, to understanding how rates of nosocomial infections may be decreased in the nursing context.

The author works as a registered nurse in an ICU at a tertiary hospital in Saudi Arabia. The author identified the prevalence of nosocomial infections in this setting to be a major problem. Around 46.7% of all nosocomial infections reported in Saudi Arabia occurred in ICUs [5]. The author also agrees with the research that implicates nurses in the transmission of nosocomial infections and recognizes nurses as fundamentally important in preventing the spread of nosocomial infections. The author considers it important to develop a greater understanding of nurses’ knowledge, attitudes, and practices regarding nosocomial infections (particularly considering the paucity of existing reviews on this topic to better appreciate the impact this may have on the spread of – and, therefore, to generate ideas about strategies to prevent – nosocomial infections.

Several systematic have been conducted to examine nurses’ knowledge, attitudes and practices regarding specific topics such as the care of patients with specific complex illnesses (i.e. Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS)) [10], borderline personality disorder [11], the use of evidence-based practice [11], patient safety [13], Pharmacovigilance [14], and influenza vaccination [15], etc. Although a number of these existing reviews touch on topics

of infection [15], none consider nurses’ knowledge, attitudes and practices regarding nosocomial infections specifically. This systematized review, which considers nurses’ knowledge, attitudes and practices in relation to nosocomial infections, therefore fills an important gap in the existing literature.

Research Objectives and Questions

The objective of this study was to conduct a systematized review on nurses’ knowledge, attitudes and practices in relation to nosocomial infections, and the subsequent impact on the spread of nosocomial infections. The review considered healthcare settings in the UK and Saudi Arabia specifically, and to a lesser extent, comparable international settings. It aimed to determine registered nurses’ general knowledge, attitudes and practices in relation to nosocomial infection, differences between general settings and nurses working in ICU settings, differences between beginner and experienced nurses, and the impact of the organizational support offered to nurses on their knowledge, attitudes and practices. The main question that the study aims to answer:

- What are registered nurses’ general knowledge, attitudes, and practices in relation to nosocomial infection?

This question has six sub-questions:

- What are registered nurses’ general knowledge, attitudes, and practices in relation to nosocomial infection?
- Are there critical differences in knowledge, attitudes and practices between registered nurses working in general settings and nurses working in ICU settings in relation to nosocomial infections?
- Are there critical differences in knowledge between beginner and experienced registered nurses?
- Are there critical differences in attitudes between beginner and experienced registered nurses?
- Are there critical differences in practice between beginner and experienced registered nurses?
- How does organisational support impact on nurses’ knowledge, attitudes and practices in relation to nosocomial infection?

The main research questions were framed using the PICO (Population, Intervention, Comparison, and Outcome) framework [16]. This is a useful, widely utilized framework used to identify the research evidence necessary to answer a research question [17]. The use of the PICO framework in this article is illustrated in **Table 1**.

Methodology

This study took the form of a systematized review. Like a systematic review, a systematized review aims to systematically retrieve, evaluate, and collate a body of literature on a topic of interest [18]. However, systematized reviews – including this one – typically involve less comprehensive search strategies, and less rigorous quality appraisal processes, than systematic reviews. Furthermore, whereas systematic reviews include all

Table 1 PICO framework of the current study.

Population(p)	Intervention (i)	Comparison (c)	Outcome (O)
The studies selected for inclusion focused on registered nurses practising in the UK, Saudi Arabia or a comparable setting.	The studies selected for inclusion focused on registered nurses' knowledge, attitudes and practices in relation to nosocomial infection.	The studies selected for inclusion had various comparisons, including: Beginner vs experienced nurses and Nurses working in ICU versus general settings	The studies selected for inclusion focused on outcomes such as knowledge scores, attitude scores and practice scores

Table 2 Term search.

Nurse*	Knowledge	Attitude*	Practice*	Nosocomial	Other terms
	aware* comprehend* understand*	perception* view* opinion*	skill*	HAI "hospital acquired infection"	general ICU "intensive care" "critical care" beginner experience* "organisational support"

the high-quality literature on a topic [19], systematized reviews only consider a number of pieces of the best quality and/or most relevant literature. Like systematic reviews, though, systematized reviews involve summarizing the published knowledge on a topic, with the aim of informing evidence-based practice [20].

Selection of databases

Four electronic databases were used to retrieve literature in the searches conducted for this systematized review (Academic Search Elite, The Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycINFO, PubMed/Medical Literature Online (MEDLINE)). These databases were accessed through Ebsco HOST, which is a search platform, providing simultaneous access to a variety of full-text databases. It was used because it allows searches on different databases to be undertaken concurrently, thereby increasing the efficiency of the search process. These databases were selected because they each contain a large body of peer-reviewed, English-language, full-text nursing literature [21]. Furthermore, the databases of CINAHL and MEDLINE are indexed and filtered, enabling searches to be straightforward and highly accurate [22]. Occasionally, a piece of literature retrieved on the databases was not available in full text under the university's subscriptions or licenses; in this case, the literature was retrieved from the broad search engine database, namely Google Scholar.

Term search strategy

The terms used to retrieve literature were developed from the research questions and are set out in the **table 2** below.

Criteria for inclusion and exclusion

The inclusion and exclusion criteria were applied to the literature to identify those most appropriate to answering the research questions [23]. **Table 3** details such criteria.

Nine studies were selected for inclusion in this systematized review [24-32]. The original search strategy, using the search terms and limiters, returned a total of 655 results across all databases; after duplicates were removed, this was reduced to 630 results. Screening titles and abstracts resulted in the removal of 604 results. The remaining 26 results underwent full-text screening, and from these results the nine studies selected for inclusion were identified. The outcomes of the search process

are shown in a modified Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram: The nine pieces of literature selected for inclusion in this review focused on answering one or more of the review's research questions. Most of this literature was found on the databases accessed through the Ebsco HOST search platform. The literature was mostly published in journals focused on infection control – for example, the Journal of Infection Prevention [24], Antimicrobial Resistance and Infection Control [28], and the Journal of Infection Control and Public Health [31] but also in general hospital practice and nurse education journals. Literature was sourced specifically from the author's contexts of practice:

- Saudi Arabia [25,29,30,31,32] and comparable settings [27];
- The UK [24] and comparable settings [26,28]. The key features of the nine pieces of literature selected for inclusion, presented in order of discussion in this chapter, are outlined in **Table 5**.

Assessment of the quality of the studies for inclusion

The methodological quality of the studies selected for inclusion was assessed using the Critical Appraisal Skills Programme's (CASP, 2013). The CASP checklists are widely utilized frameworks which guide the critical appraisal of research papers across a number of key domains, in a systematic way [33]. Eight items on the Cohort Study Checklist [34] were considered particularly relevant to the studies included in the review; these items therefore formed the basis of the quality assessment. See the items from the CASP Cohort Study Checklist selected to guide the quality appraisal below.

- Did the study address a clearly-focused issue? (CASP Question 1)
- Was the cohort recruited in an acceptable way? (CASP Question 2)
- Was the outcome accurately measured to minimize bias? (CASP Question 4)
- Have the authors identified all the potential confounding factors, and taken these into account in the analysis? (CASP Questions 5a and 5b)

Table 3 inclusion and exclusion criteria.

Inclusion Criteria	Exclusion Criteria	Justification
Published July 2012 to July 2017 inclusive (5 years' currency)	Published prior to July 2012	The time period is narrow enough to ensure the currency and relevance of the literature retrieved, but broad enough to ensure a sufficient amount of literature was retrieved.
Published in/translated into English	Not published/ translated into English	This limiter was necessary considering the narrow scope of the review.
Academic paper, full-text and peer-reviewed	Not an academic paper, full text and/or not peer reviewed	Evidence required to answer the questions posed for this review needed to be derived from academic research, available in full-text and of high quality.
Qualitative or quantitative empirical research study	Not an empirical research study (e.g. a systematic review, report, audit, expert opinion piece, etc.)	Evidence required to answer the questions posed for this review needed to be derived from academic research and of high quality.
Directly relevant to answering one or more of the research questions	Not directly relevant to answering one or more of the research questions	This was necessary to ensure the relevance of the review and its findings to the questions posed for this review.
Studies were conducted in Saudi Arabia, the UK, or in a comparable international setting	Studies were not conducted in Saudi Arabia, the UK or in a comparable international setting	This was necessary to ensure the relevance of the review and its findings to the questions posed for this review.
Studies were evaluated using an appropriate critical appraisal tool (see Section 2.7) to be of acceptable quality	Studies were evaluated using an appropriate critical appraisal tool to be of poor quality	This was necessary to ensure the highest quality relevant evidence was retrieved to the questions posed for this review.

- Are the results precise? (CASP Question 8)
- Do you believe the results? (CASP Question 9)
- Can the results be applied to the local population? (CASP Question 10)
- Are the results consistent with other evidence? (CASP Question 11)

Data extraction

The process of data extraction involves returning to each of the studies selected for inclusion in a systematized review and searching them for information necessary to answer the research questions [35]. For this systematized review, this information was recorded on a data extraction tool developed by the author. This tool was designed to collect information relevant to each of the research questions and is presented in **Table 4**.

To ensure the utility and accuracy of this tool, it was piloted on a number of the studies excluded during the full-text screening prior to being used in the formal, final data extraction process.

Data analysis

Once the data were extracted from the studies included in this review, the data were analyzed using thematic analysis. This involves identifying dominant concepts or 'themes' in the literature [33], which are then used to answer each of the research questions. This is done by reading and re-reading each of the studies selected for inclusion to identify key ideas [36]. This process was undertaken deductively, with the explicit aim of addressing the research questions posed for the review.

Findings

The main findings that the study revealed were:

- There is a considerable degree of variability in nurses' knowledge, attitudes and

knowledge, attitudes and

- Practices in relation to nosocomial infection (Research Question 1).

This variability persists in nurses in Saudi Arabia, the UK, and comparable international settings, and in both general and ICU settings (Research Question 2).

- Despite this variability, there is a positive correlation between nurses' practice experience and their knowledge, attitudes and practices in relation to nosocomial infection – specifically, the more practice experiences a nurse has, the more positive or correct their knowledge, attitudes and practices in relation to nosocomial infection tend to be (Research Questions 3, 4 and 5).
- There is a positive relationship between nurses' knowledge, attitudes and practices in relation to nosocomial infection, and other factors such as perceived organizational support (Research Question 6).

To be specific, the findings are organized according to the six research questions:

As for the first questions, it asked about registered nurses' general knowledge, attitudes and practices in relation to nosocomial infection. Two studies were retrieved which evaluated nurses' knowledge, attitudes and practices in relation to nosocomial infections, in single cohorts of registered nurses, in the Saudi Arabian context [29,32]. Alsaifi and Cheng [29] found that the knowledge of the registered nurses participating in their study in relation to nosocomial infections was variable. For example, although 90% of nurses correctly identified the importance of isolating patients who tested positive for Middle East Respiratory Syndrome coronavirus, 42% believed incorrectly that the virus could be spread through mosquito bite [29]. These findings are supported by Al Qahtani and Almetrek [32]; for example, although 87% of the nurses in this study correctly identified the

Table 4 Data extraction tool in the systematised review.

No	Author	Method	sample	Findings	Country	QA Score
1.	Alsahafi & Cheng, 2016	Descriptive, cross sectional questionnaire study	n = 685 RNs in general settings (also included n = 267 medical practitioners, pharmacists, radiology techs, lab techs – not included in the analysis for this systematised review)	RNs' knowledge in relation to nosocomial infections is variable • RNs' attitudes in relation to nosocomial infection control are strongly positive (92%) • RNs' practices in relation to nosocomial infections are "suboptimal" (p. 1220)	KSA	7
2.	Al Qahtani & Almetrek, 2017	Descriptive, cross sectional questionnaire study	n = 109 RNs in general settings	RNs' knowledge in relation to nosocomial infections is variable • RNs' attitudes in relation to nosocomial infection control are strongly positive (86%) • RNs' practices in relation to nosocomial infections are "satisfactory" (p. 107)	KSA	6
3.	Alotaibi et al., 2016	Descriptive, cross sectional questionnaire study	n = 215 RNs in ICU settings	• RNs' knowledge in relation to nosocomial infections (specifically, prevention) is good • RNs' attitudes in relation to nosocomial infection control are strongly positive	KSA	7
4.	Ullman et al., 2014	Descriptive, cross sectional questionnaire study	n = 253 RNs in ICU settings	RNs' knowledge in relation to nosocomial infections is variable • RNs' practices in relation to nosocomial infections are variable	Australia/ New Zealand	7
5.	Slyne et al., 2012	Descriptive, cross sectional questionnaire study	n = 414 RNs in general settings	There is a positive correlation between nurses' practice experience and their knowledge about nosocomial infections • There is a positive correlation between nurses' practice experience and their practice in relation to nosocomial infections	UK	7
6.	Al Zahrani et al., 2014	Descriptive, cross sectional questionnaire study	n = 466 RNs in general settings	There is a positive correlation between nurses' practice experience and their knowledge about nosocomial infections	KSA	7
7.	Fashafsheh et al., 2015	Descriptive, cross sectional questionnaire study	n = 271 RNs in general settings	There is no correlation between nurses' practice experience and their knowledge about nosocomial infections • There is no correlation between nurses' practice experience and their practice in relation to nosocomial infections	Palestine	6
8.	Cruz & Bashtawi, 2016	Descriptive, cross sectional questionnaire study	n = 271 undergraduate nursing students in general settings	Undergraduate nursing students' attitudes in relation to nosocomial infection control are 'moderate'	KSA	6
9.	Kamunge et al., 2015	Descriptive, cross sectional questionnaire study	n = 352 RNs in general settings	There is a positive correlation between organisational support and nurses' knowledge • There is a weak but statistically significant correlation between organisational support and attitudes and practices	USA	7

Reference	Research Question(s) Addressed						Results: Knowledge	Results: Attitudes	Results: Practice	Results: Other Outcome(s)
	1	2	3	4	5	6				

importance of wearing gloves when handling medical equipment, only 17% knew the recommended frequency of microbiological testing for this equipment [32]. Overall, it can be concluded that there is a general “deficiency” in nurses’ knowledge in relation to nosocomial infections [32].

Alsahafi and Cheng [29] assessed the attitudes of the registered nurses participating in their study in relation to nosocomial infections by asking about their ‘eagerness’ to apply infection control measures. More than 92% of nurses reported ‘agreeing’ or ‘strongly agreeing’ that they were eager to apply infection control measures in their practice [29], indicating a strong positive attitude to nosocomial infection control in this group. Al Qahtani and Almetrek [32] measured nurses’ attitudes in relation to nosocomial infections slightly differently – across six domains, including about nurses’ practice intentions. Overall, 86% of the nurses participating in this study were considered to have a positive attitude in relation to nosocomial infection control [29]. It is important to note that it is unclear whether the concept of ‘eagerness’ in Alsahafi and Cheng’s [29] study corresponds with the concept of ‘practice intentions’ in Al Qahtani and Almetrek’s [32] study; given the latter concept is more clearly defined, it is this study which must be given the most weight in answering this aspect of first research question.

As for practices, Alsahafi and Cheng [29] found that only 65% of nurses reported washing their hands after every patient contact, and only 46% reported wearing a particulate filter mask during every patient contact, as per national infection control guidelines. Al Qahtani and Almetrek [32] disagree with this finding, concluding that the nurses participating in their study had “an overall satisfactory level of practice of infection control procedures”. This conclusion is reflected in an overall practice score of 92% among the nurses participating in Al Qahtani and Almetrek’s [32] study. The reasons for these differences between the studies are unclear; however, it may be due to the different data collection tools used in the studies (including the fact that one asked about Middle East Respiratory Syndrome coronavirus [29] and the other asked about nosocomial infection in renal dialysis, or it may be related to differences in the knowledge, attitudes and perceived organizational support, etc., of the nurses in the different cohorts.

The second question asked about critical differences in knowledge, attitudes, and practices in relation to nosocomial infections between registered nurses working in general settings and nurses working in ICU settings. This section builds on the findings of Alsahafi and Cheng [29] and Al Qahtani and Almetrek [32]. These studies considered the knowledge, attitudes and practices of nurses working in general settings specifically. To this discussion, two papers considering the knowledge, attitudes and practices of nurses working in ICUs have been added: that by Ullman et al [26], conducted in Australia and New Zealand, settings comparable to the UK; and that by Alotaibi et al [30], conducted in Saudi Arabia. It must be noted again that no relevant studies – that is, those which evaluated knowledge, attitudes, and practices in single cohorts of registered nurses – from the UK were retrieved in the literature search conducted for this review. One relevant study, by Alkubati, Ahmed, Mohamed,

Fayed and Asfour, was excluded from this section because it was conducted in Egypt; although this is a setting broadly comparable to Saudi Arabia, as noted above a more relevant study from Saudi Arabia was included.

Alsahafi and Cheng [29] and Al Qahtani and Almetrek [32] both found that the knowledge of the registered nurses working in general clinical settings was variable. This is a finding supported by Ullman, et al. [26]; for example, although 96% of the ICU nurses participating in this study identified the correct dressings for central venous catheter insertion sites to prevent infection, just 18% could list the five items required to create a sterile barrier during catheter insertion. Alotaibi, et al. [30] found that most of the ICU nurses in their study understood the mechanism of transmission of ventilator-associated pneumonia; however, this was the only outcome associated with knowledge measured in this study, and the term ‘most nurses’ is not explicitly quantified and therefore this study was given little weight in answering this research question. Based on Ullman, et al. [26], Alsahafi and Cheng’s [29], and Al Qahtani and Almetrek’s [32] studies, it can be concluded that nurses’ knowledge about nosocomial infections is variable regardless of the context in which they practice (i.e. it is not setting-dependent).

As for attitudes, Alsahafi and Cheng [29] and Al Qahtani and Almetrek [32] both found strong positive attitudes of the registered nurses, working in general clinical settings. These findings are supported by Alotaibi et al [30], who agreed that the ICU nurses in their study had positive attitudes about nosocomial infections. 99% of the nurses in their study either ‘strongly agreed’ or ‘somewhat agreed’ about the importance of the strategies to prevent the development of nosocomial infections [30]. It is important to highlight that Ullman et al [26] did not measure the attitudes of the ICU nurses participating in their study in relation to nosocomial infections; furthermore, no other studies from Saudi Arabia, the UK, or comparable settings were found which measured ICU nurses’ attitudes.

Alsahafi and Cheng [29] and Al Qahtani and Almetrek [32] reported disparate findings about the practices of the registered nurses working in general clinical settings. The former found nurses’ practice was sub-optimal, while the latter found nurses’ practice was satisfactory [29,32]. Ullman et al [26] support both findings by suggesting that ICU nurses’ practice in relation to nosocomial infection control is variable; indeed, the nurses in this study scored an average of 5.7 out of a possible 10 on nosocomial infection control practice scores. Ullman, et al. [26] also note that the practice scores differed significantly between nurses in the different ICUs involved in this study, but that “the reason for this variation remains unclear”. Overall, then, there is conflicting evidence about whether the effectiveness of nurses’ infection control practices is setting dependent.

As for the third question, three studies were retrieved which considered differences in the level of knowledge about nosocomial infections between beginner and experienced registered nurses: a UK-based study by Slyne et al [24] a Saudi Arabian study by Al Zahrani, et al. [25]; and a study by Fashafsheh, et al. [27] from Palestine, a setting broadly comparable to Saudi Arabia. Slyne, et al. [24] found a strong correlation between nurses’ practice

experience and their knowledge about nosocomial infections, with the most experienced group in their study (20+ years practicing) achieving significantly higher knowledge scores than the least experienced group (≤ 1 -year practicing). For example, 68% of the most experienced group demonstrated accurate knowledge about methicillin-resistant *Staphylococcus aureus* (MRSA), while this was seen in only 36% of the least-experienced group. In their Saudi Arabian cohort, Al Zahrani, et al. [25] found a similar correlation; however, the cohort in this study was divided into a 'most experienced' group of >5 years practicing and a 'least experienced' group of ≤ 5 years practicing. Differences in the definition of 'beginner' and 'experienced' between these two studies make direct comparisons difficult; however, overall, it can be said that there is a correlation between nurses' experience and their knowledge about nosocomial infections. Interestingly, the study by Fashafsheh, et al. [27] contradicts the findings of Slyne, et al. [24] and Al Zahrani, et al. [25], discussed above, suggesting that there is no statistically significant correlation between nurses' knowledge and their practice experience. Fashafsheh, et al. [27] explain this finding incompletely, simply suggesting that "years of experience does not [necessarily] contribute to acquisition of knowledge" without further explanation. It is also important to note that Fashafsheh, et al. [27] considered nurses' knowledge generally, whereas Slyne, et al. [24] considered MRSA specifically and Al Zahrani, et al. [25] considered blood-borne viruses specifically, making it difficult to directly compare the results of these studies. Furthermore, Fashafsheh, et al. [27] study was not undertaken in a setting directly relevant to this author's context of practice; therefore, it is this study which must be given the least weight in answering the third question.

The fourth question asked whether there are critical differences in attitudes in relation to nosocomial infections between beginner and experienced registered nurses. No single study in Saudi Arabia, the UK, or any other settings compared the attitudes of between beginner and experienced registered nurses about nosocomial infections. Therefore, to answer this question, the review will return to the findings of the studies by Alsahafi and Cheng [29] and Al Qahtani and Almetrek [32] who involved experienced nurses in Saudi Arabia. These findings will be supplemented by those of Cruz and Bashtawi [31], who considered the attitudes of nursing students in Saudi Arabia. Although not registered nurses, this cohort can be considered roughly equivalent to 'beginner' nurses, particularly in the absence of any other relevant literature.

Alsahafi and Cheng [29] and Al Qahtani and Almetrek [32] both found that the attitudes of the experienced registered nurses participating in their study in relation to nosocomial infections were strongly positive. In their cohort of beginner nurses, however, Cruz and Bashtawi [31] found different results; indeed, in this study, only 35% were considered to have a 'good' attitude, and the majority 52% was considered to have a 'moderate' attitude. It is interesting to note that each of these three studies compared nurses' attitude in relation to a different aspect of nosocomial infection prevention – Middle East Respiratory Syndrome coronavirus prevention [29], hepatitis prevention [32], and general prevention through hand hygiene which makes it difficult to draw direct comparisons between the findings.

The fifth question asked whether there are critical differences in practice in relation to nosocomial infections between beginner and experienced registered nurses. To answer this question, the review will return to the findings of the studies by Slyne, et al. [24] and Fashafsheh, et al. [27], introduced earlier. These studies directly compared differences in the level of knowledge about nosocomial infections between beginner and experienced registered nurses. Slyne, et al. [24] found a correlation between nurses' practice experience and their practice in relation to nosocomial infections; indeed, the most experienced group in this study (20+ years practicing) achieved significantly higher correct practice scores than the least experienced group (≤ 1 -year practicing), although the authors acknowledge that both groups scored "reasonable" practice scores [24]. For example, 77% of experienced nurses versus 69% of inexperienced nurses demonstrated correct hand hygiene practices, and 81% versus 76% demonstrated the correct use of personal protective equipment in practice. Extending on these findings, Slyne et al [24] also identified that the more practice experiences a nurse had, the more confident they reported themselves to be in their practice; for example, while 83% of the most experienced nurses reported themselves to be confident in caring for a patient with MRSA, only 36% of the least experienced nurses reported the same. Interestingly, as with the findings for nurses' knowledge, the study by Fashafsheh, et al. [27] contradicts the findings of Slyne, et al. [24], suggesting that there is no statistically significant correlation between nurses' nosocomial infection-related practice and their practice experience.

The sixth question asked about how does organizational support impact on nurses' knowledge, attitudes and practices in relation to nosocomial infection. In the literature search conducted for this systematized review, just one considered the relationship between organizational support and nurses' nosocomial infection-related knowledge, attitudes, and practices: that by Kamunge et al. [28]. This study was conducted in the United States, a comparable international setting to the UK. No relevant studies were found from Saudi Arabia or a comparable setting. Kamunge et al [28] found a significant positive correlation between nurses' experience of organizational support in relation to nosocomial infections, and their respective knowledge. This study also found a weak but statistically significant positive correlation between organizational support and nurses' attitudes and practice in relation to nosocomial infections [28]. However, Kamunge, et al. [28] study is significantly limited in that it fails to clearly define what constitutes 'organizational support'; therefore, it is also unclear about the nature of extent of the organizational support provided to the nurses it studied. The relationship between organizational support and nurses' nosocomial infection-related knowledge, attitudes and practices is therefore an important area for future research.

Discussion

The findings of this systematized review revealed a considerable degree of variability in nurses' knowledge, attitudes, and practices in relation to nosocomial infection. In this systematized review, this variability was found to persist in cohorts of nurses in Saudi Arabia, the UK, and comparable international settings. This

variability can also be seen more broadly in the Saudi Arabian healthcare context among doctors and healthcare workers [37] and, interestingly, also among patients attending healthcare centers [38]. It is not unreasonable to assume that similar variability in knowledge, attitudes and practices exists in the healthcare workforce in the UK.

The review's findings revealed existence of a complex, dynamic relationship exists between nurses' knowledge, attitudes, and practices in relation to nosocomial infection. To be specific, nurses' knowledge about nosocomial infections directly influences their practice; this can be seen in the studies outlined earlier, where educational interventions about nosocomial infection control generated significant improvements in nurses' practice. Although all the studies selected for inclusion in this systematized review were descriptive rather than correlational, a number agree that a correlation between nurses' knowledge, attitudes, and practices in relation to nosocomial infection is likely to exist [24,29,31]. A systematic review with meta-analysis to quantify the extent of this correlation may be useful.

The variability in nurses' knowledge, attitudes, and practices in relation to nosocomial infection persists in cohorts of nurses working in both general and ICU settings. Positive or correct knowledge, attitudes, and practices in relation to nosocomial infection may be particularly important in critical care settings such as ICUs, because of the acuity – and, subsequently, significant vulnerability of patients in this setting [39]. However, a particularly alarming finding of this systematic review, and one of relevance to the author's context of practice, is that ICU nurses' practice

in relation to nosocomial infection is sub-standard [26]. This is also reflected in the broader literature; for example, a recent observational study by Mahfouz et al [40] found that 59% nurses working in an ICU in Saudi Arabia were compliant with guideline-recommended hand hygiene practices. This is also seen in the UK; for example, Haac et al [41] found that 7% of nurses working in a critical care setting in the UK were compliant with guideline-recommended hand hygiene practices. This is particularly problematic considering that hand hygiene is one of the fundamental strategies to reducing nosocomial infection transmission [42]. The reason(s) for ICU nurses' sub-standard practice in relation to nosocomial infection is not clearly explained in the literature, which might be attributed to poor knowledge. However, this is an important topic for future research.

Despite the variability in nurses' knowledge, attitudes, and practices in relation to nosocomial infection – as per the findings of this systematized review – most of the literature revealed a positive correlation between nurses' practice experience and their knowledge, attitudes, and practices. Specifically, this review suggested that the more practice experience a nurse had, the more positive or correct their knowledge, attitudes, and practices in relation to nosocomial infection tended to be. This trend was seen more broadly in the healthcare setting in Saudi Arabia; for example, medical students [43] and dental students [44] also have comparatively poor knowledge about, and practice in relation to, nosocomial infections.

Beginner nurses' 'moderate' attitudes towards nosocomial infections [31] was a particularly surprising finding revealed by this literature review. It was one given its due attention in this paper. It was extrapolated in the broader literature. For example, there were multiple studies revealing that healthcare students in Saudi Arabia, the equivalent of 'beginner' healthcare practitioners, are often less willing to treat patients with infectious diseases [45], and less willing to comply with infection prevention activities, such as preventative vaccination and the use of personal protective equipment [46]. Underpinning these poor attitudes, in many cases, is a lack of knowledge about nosocomial infection [45]. Therefore, beginner nurses should therefore be the target of nosocomial infection education.

The studies included in this review recommended that education, both for beginner and experienced nurses, is as an important intervention in reducing the risks associated with nosocomial infections [24,26,27,31]. Education has significant positive impacts on nurses' knowledge, attitudes and/or practices in relation to nosocomial infections, both in Saudi Arabia [46-48] and the UK [49]. Mahfouz, et al. [40] found that an educational programme increased hand hygiene compliance. However, Khan, Shah, Amhad and Fatokun [50] found that the attitudes of nurses in Saudi Arabia towards participating in a nosocomial infection control programme offered by their organization was largely negative, perhaps due to the fact that these nurses did not perceive such a programme to be effective in reducing nosocomial infection rates. Exactly what constitutes 'effective' education to improve nurses' knowledge, attitudes and/or practices in relation to nosocomial infection, and what effectively engages nurses in this education, are interesting topics for a future systematized review?

All of the studies selected for inclusion in this systematized review are quantitative, descriptive cross-sectional questionnaire studies. Cross-sectional studies are particularly effective at measuring point prevalence (e.g. knowledge, attitudes or practice now) [51], providing a 'snapshot' in time about a particular cohort of people [52]. They do not consider the cohort longitudinally for example, measuring trends over time. Furthermore, they are not particularly effective at identifying correlations between variables (e.g. knowledge attitudes practice) [53-70]. Therefore, it is important to highlight that the evidence on which the findings of this systematized review are based are primarily descriptive that is [71-87], they measure nurses' knowledge, attitudes and practice at a point in time, without further explaining the reasons for these findings or the relationships between them [88-96].

Conclusion

This systematized review has made a significant contribution to the body of knowledge about nurses' knowledge, attitudes, and practice in relation to nosocomial infections. It has demonstrated that although nurses' knowledge, attitudes, and practices in relation to nosocomial infection are variable, generally the more practice experience a nurse has, the more positive or correct their knowledge, attitudes, and practices in relation to nosocomial infection tend to be. Furthermore, it has demonstrated that there is a positive relationship between nurses' knowledge,

attitudes, and practices in relation to nosocomial infection, and perceived organizational support. this review will contribute to identifying how nurses' knowledge, attitudes and practices can

be improved to enable them to contribute more effectively to infection prevention. Further, the review demonstrated research gaps, which should be bridged in the future studies.

References

- World Health Organization (2012) Healthcare-Associated Infections: Fact Sheet. Geneva, WHO.
- Funnell R, Koutoukidis G, Lawrence K (2008) Tabbner's Nursing Care: Theory and Practice (5th Edn). NSW: Churchill Livingstone/Elsevier, Sydney.
- Dasgupta S, Das S, Chawan NS, Hazra A (2015) Nosocomial infections in the intensive care unit: Incidence, risk factors, outcome and associated pathogens in a public tertiary teaching hospital in Eastern India. *Indian J Crit Care Med* 19: 14-20.
- National Audit Office (2009) Reducing Healthcare Associated Infections in Hospitals in England.
- Balkhy HH, Cunningham G, Chew FK, Francis C, Al Nakhil DJ, et al. (2006) Hospital- and community-acquired infections: A point prevalence and risk factors survey in a tertiary care centre in Saudi Arabia. *Int J Infect Dis* 10: 326-333.
- Iyer AP, Baghallab I, Albaik M, Kumosani T (2014) Nosocomial infections in Saudi Arabia caused by methicillin resistant *Staphylococcus aureus* (MRSA). *Clin Microbiol* 3.
- White L, Duncan G, Baumle W (2013) Medical Surgical Nursing: An Integrated Approach (2nd Edn). Clifton Park, NY: Delmar/Cengage Learning.
- Loveday HP, Wilson JA, Pratt RJ, Golsorkhi M, Tingle A, et al. (2014) Epic3: National evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect* 86: S1-S70.
- Nursing and Midwifery Council (2015) The Code: Professional Standards of Practice and Behaviour for Nurses and Midwives and nursing associates.
- Madeleine LR, Chan MF, Thayala NV (2011) A systematic review of the knowledge, attitudes and practices of trained nurses towards patients with HIV/AIDS. *JB Libr Syst Rev* 9: 2105-2165.
- Leung K, Trevena L, Waters D (2014) Systematic review of instruments for measuring nurses' knowledge, skills and attitudes for evidence-based practice. *J Adv Nurs* 70: 2181-2195.
- Dickens GL, Lamont E, Gray S (2016) Mental health nurses' attitudes, behaviour, experience and knowledge regarding adults with diagnosis of borderline personality disorder: Systematic, integrative literature review. *J Clin Nurs* 25: 1848-1875.
- Brasaita I, Kaunonen M, Suominen T (2015) Healthcare professionals' knowledge, attitudes and skills regarding patient safety: A systematic literature review. *Scand J Caring Sci* 29: 30-50.
- Bhagavathula AS, Elnour AA, Jamshed SQ, Shehab A (2016) Health professionals' knowledge, attitudes and practices about pharmacovigilance in India: A systematic review and meta-analysis. *PLoS One* 11: e0152221.
- Smith S, Sim J, Halcomb E (2016) Nurses' knowledge, attitudes and practices regarding influenza vaccination: An integrative review. *Journal of Clinical Nursing* 25: 2730-2744.
- Chiapelli F (2010) Evidence-Based Practice: Towards Optimising Clinical Outcomes. UK: Springer, London.
- Grove S, Gray G (2015) Understanding Nursing Research: Building an Evidence-Based Practice. St Louis: Elsevier Saunders.
- Clarke M (2007) Reviewing Research Evidence for Nursing Practice: Systematic Reviews. In: Webb C, Roe B (Eds). Blackwell Publishing, Oxford, UK.
- Houser J (2012) Nursing Research: Reading, Using and Creating Evidence. MA: Jones & Bartlett Learning, Sudbury.
- Bettany-Saltikov J (2012) How to do a Systematic Literature Review in Nursing: A Stepby- Step Guide. Open University Press, McGraw-Hill Education, New York.
- Polit DF, Beck CT (2010) Essentials of Nursing Research: Appraising Evidence for Nursing Practice (7th Edn). Philadelphia: Wolters Kluwer Health/Lippincott Williams and Wilkins.
- Boswell C, Cannon S (2014) Introduction to Nursing Research: Incorporating Evidence-Based Practice (2nd Edn). MA: Jones & Bartlett Publishers, Sudbury.
- Williamson G, Whittaker A (2011) Succeeding in Research Project Plans and Literature Reviews for Nursing Students. Learning Matters, Ltd, London, UK.
- Slyne H, Phillips C, Parkes J (2012) Infection prevention practice: How does experience affect knowledge and application? *J Infect Prev* 13: 92-96.
- Al-Zahrani AO, Farahat F, Zolaly EN (2014) Knowledge and practices of healthcare workers in relation to bloodborne pathogens in a tertiary care hospital, Western Saudi Arabia. *J Community Health* 39: 959-964.
- Ullman AJ, Long DA, Rickard CM (2014) Prevention of central venous catheter infections: A survey of paediatric ICU nurses' knowledge and practice. *Nurse Educ Today* 34: 202-207.
- Fashafsheh I, Ayed A, Eqtait F, Harazneh L (2015) Knowledge and practice of nursing staff towards infection control measures in Palestinian hospitals. *J Educ Pract* 6: 79-90.
- Kamunge E, Cahill T, Zipp G, Parasher R (2015) Knowledge, attitudes and practices of registered nurses regarding the spread of nosocomial infections and the impact of organisational support. *Antimicrob Resist Infect Control* 4.
- Alsahafi AJ, Cheng AC (2016) Knowledge, attitudes and behaviours of healthcare workers in the Kingdom of Saudi Arabia to MERS Coronavirus and other emerging infectious diseases. *Int J Environ Res Public Health* 12: 1214-1421.
- Alotaibi AK, Alotaibi SK, Alshiyqi M, Ramalingan S (2016) Knowledge and attitudes of Saudi intensive care unit nurses regarding oral care delivery to mechanically ventilated patients with the effect of healthcare quality accreditation. *Saudi J Anaesth* 10: 208-212.
- Cruz JP, Bashtawi MA (2016) Predictors of hand hygiene practice

- among Saudi nursing students: A cross-sectional self-reported study. *J Infect Public Health* 9: 485-493.
- 32 Al Qahtani AS, Almetrek MA (2017) Knowledge, attitudes and practice of nurses in renal dialysis units regarding infection control in Ahba City – Saudi Arabia, 2015. *Egypt J Hosp Med* 66: 103-114.
 - 33 Moule P, Aveyard H, Goodman M (2014) *Nursing Research: An Introduction*. Sage Publications, London.
 - 34 Critical Appraisal Skills Program (CASP) (2013) Cohort Study Checklist.
 - 35 Coughlan M, Cronin P (2017) *Doing a Literature Review in Nursing, Health and Social Care* (2nd Edn). Sage Publications, London, UK.
 - 36 Green J, Thorogood N (2014) *Qualitative Methods for Health Research*. Sage Publications, London.
 - 37 Ghabrah TM, Madani TA, Albarrak AM, Alhazmi MA, Alazraqi TA, et al. (2007) Assessment of infection control knowledge, attitude and practice among healthcare workers during the Hajj period of the Islamic year 1423 (2003). *Scand J Infect Dis* 39: 1018-1024.
 - 38 Ibrahim NK, Alwafi HA, Sangoof SO, Turkistani AK, Alattas BM (2017) Cross infection and infection control in dentistry: Knowledge, attitudes and practices of patients attending dental clinics in King Abdulaziz University Hospital, Jeddah, Saudi Arabia. *J Infect Public Health* 10: 438-445.
 - 39 Eggimann P, Pittet D (2002) Infection control in ICU. *Chest* 120: 2059-2093.
 - 40 Mahfouz AA, El Gamal MN, Al-Azraqi TA (2013) Hand hygiene non-compliance among intensive care unit health care workers in Aseer Central Hospital, south-western Saudi Arabia. *Int J Infect Dis* 17: 729-732.
 - 41 Haac B, Rock C, Harris AD, Pineles L, Stein D, et al. (2017) Hand hygiene compliance in the setting of trauma resuscitation. *Injury* 48: 165-170.
 - 42 World Health Organization (2017a) Middle East Respiratory Syndrome coronavirus (MERS-CoV). Saudi Arabia.
 - 43 Amin TT, Al Noaim KI, Bu Saad MA, Al Malhm TA, Al Mulhim AA, et al. (2013) Standard precautions and infection control, medical students' knowledge and behaviour at a Saudi university: The need for change. *Glob J Health Sci* 5: 114-125.
 - 44 Al-Essa NA, AlMutairi MA (2017) To what extent do dental students comply with infection control practices? *Saudi J Dent Res* 8: 67-72.
 - 45 Abolfotouh MA, Al Saleh SA, Mahfouz AA, Abolfotouh SM, Al Fozan HM (2013) Attitudes of Saudi nursing students on aids and predictors of willingness to provide care for patients in Central Saudi Arabia. *SAGE Open* 3: 1-11.
 - 46 El Beltagy K, El Saed A, Sallah M, Balkhy HH (2012) Impact of infection control educational activities on rates and frequencies of percutaneous injuries (PIs) at a tertiary care hospital in Saudi Arabia. *J Infect Public Health* 5: 297-303.
 - 47 Mahfouz AA, Al-Zaydani IA, Abdelaziz AO, El-Gamal MN, Assiri AM (2014) Changes in hand hygiene compliance after a multimodal intervention among healthcare workers from intensive care units in Southwestern Saudi Arabia *J Epidemiol Glob Health* 4: 315-321.
 - 48 Stirling BV, Harmston J, Alsobayel H (2015) An educational programme for nursing college staff and students during a MERS-coronavirus outbreak in Saudi Arabia. *BMC Nursing* 14.
 - 49 Ward DJ (2011) The role of education in the prevention and control of infection: A review of the literature. *Nurse Educ Today* 31: 9-17.
 - 50 Khan MU, Shah S, Ahmad A, Fatokun O (2014) Knowledge and attitude of healthcare workers about Middle East Respiratory Syndrome in multispecialty hospitals of Qassim, Saudi Arabia. *BMC Public Health* 14: 1281-1291.
 - 51 Ellis P (2016) *Evidence-Based Practice in Nursing* (3rd Edn). SAGE Publications, London, UK.
 - 52 Glasper A, Rees C (2017) *Nursing and Healthcare Research at a Glance*. Wiley Blackwell, Oxford, UK.
 - 53 Al Maweri SA, Tarakji B, Shugaa-Addin B, Al Shamiri HM, Alaizari NA, et al. (2015) *GMS Hygiene and Infection Control*. ePublication.
 - 54 Luangasanatip N, Limmathurotsakul D, Lubell Y, Lee AS, Harbarth S, et al. (2015) Comparative efficacy of interventions to promote hand hygiene in hospital: Systematic review and meta-analysis. *BMJ* 351.
 - 55 Al-Abdallat MM, Payne DC, Alqasrawi S, Rha B, Tohm R et al. (2014) Hospital-associated outbreak of Middle East Respiratory Syndrome Coronavirus: A serologic, epidemiologic and clinical description. *Clin Infect Dis* 59: 1225-1233.
 - 56 Al-Abdely HM, Alshehri AD, Rosenthal VD, Mohammed YK, Banjar W, et al. (2017) Prospective multicenter study in intensive care units in five cities from the Kingdom of Saudi Arabia: Impact of the International Nosocomial Infection Consortium (INICC) multidimensional approach on rates of central line-associated bloodstream infection. *J Infect Prev* 18: 25-34.
 - 57 Al-Tawfiz JA, Abed MS, Al-Yami N, Birrer RB (2013) Promoting and sustaining a hospital-wide, multifaceted hand hygiene program resulted in significant reduction in health care-associated infections. *Am J Infect Control* 41: 482-486.
 - 58 Askarian M, Mirzaei K, Mundy LM, McLaws ML (2005) Assessment of knowledge, attitudes and practices regarding isolation precautions among Iranian healthcare workers. *Infect Control Hosp Epidemiol* 26: 105-108.
 - 59 Assiri A, McGeer A, Perl TM, Price CS, Al Rabeeah AA, et al. (2013) Hospital outbreak of Middle East Respiratory Coronavirus. *N Engl J Med* 369: 407-416.
 - 60 Aveyard H (2014) *Doing a Literature Review in Health and Social Care: A Practical Guide* (3rd Edn). Berkshire: Open University Press, McGraw Hill Education.
 - 61 Benner P (1984) *From Novice to Expert: Excellence and Power in Clinical Nursing Practice*. CA: Addison-Wesley, Menlo Park.
 - 62 Sandra B, Jan P (2011) Your role in infection prevention. *Nursing Made Incredibly Easy* 9: 36-41.
 - 63 Butt TS, Koutlakis-Barron I, AlJumaah S, AlThawadi S, AlMofada S (2016) Infection control and prevention practices implemented to reduce transmission risk of Middle East Respiratory Syndrome coronavirus in a tertiary care institution in Saudi Arabia. *Am J Infect Control* 144: 605-611.
 - 64 Crisp J, Taylor C, Potter PA (2009) *Potter & Perry's Fundamentals of Nursing* (3rd edn). Mosby Elsevier, Chatswood.
 - 65 De Angelis G, Murthy A, Beyersmann J, Harbath S (2010) Estimating the impact of healthcare-associated infections on length of stay and costs. *Clin Microbiol Infect* 16: 1729-1735.
 - 66 DiCenso A, Guyatt G, Ciliska D (2005) *Evidence-Based Nursing: A Guide to Clinical Practice*. Lippincott Williams & Wilkins, Inc.
 - 67 Mateo MA, Foreman MD (2014) *Research for Advanced Practice Nurses: From Evidence to Practice*. Springer Publishing Company, New York.

- 68 Drosten C, Muth D, Corman VM, Hussain M, Al Masri M, et al. (2014) An observational, laboratory-based study of outbreaks of Middle East Respiratory Syndrome coronavirus in Jeddah and Riyadh, kingdom of Saudi Arabia. *Clin Infect Dis* 60: 369-377.
- 69 El Bushra HE, Al Arbash HA, Mohammed M, Abdalla O, Abdallah MN, et al. (2017) Outcome of strict implementation of infection prevention control measures during an outbreak of Middle East respiratory syndrome. *Am J Infect Control* 45: 502-507.
- 70 Erasmus V, Brouwer W, van Beeck EF, Onema A, Daha TJ, et al. (2019) A qualitative exploration of reasons for poor hand hygiene among hospital workers: Lack of positive role models and of convincing evidence that hand hygiene prevents cross-infection. *Infect Control Hosp Epidemiol* 30: 415-419.
- 71 Ghazal SS, Hakawi AM, Demeter CV, Joseph MV, Mukahal MA (2011) Intervention to reduce the incidence of healthcare-associated methicillin-resistant *Staphylococcus aureus* infection in a tertiary care hospital in Saudi Arabia. *Infect Control Hosp Epidemiol* 32: 411-413.
- 72 Gluyas H (2014) Understanding non-compliance with hand hygiene practices. *Nurs Stand* 29: 40-49.
- 73 Gonçalves ICM, Gonçalves MJF (2013) Knowledge, attitudes and practices of nurses and doctors about the vertical transmission of Hepatitis B. *Revista Latino-Americana Enfermagem* 21: 1030-1038.
- 74 Hardey M, Mulhall A (2013) *Nursing Research: Theory and Practice*. Chapman & Hall, London, UK.
- 75 Hastings DL, Tokars JI, Aziz IZ, Alkhalidi KZ, Bensadek AT, et al. (2016) Outbreak of Middle East Respiratory Syndrome at a tertiary care hospital, Jeddah, Saudi Arabia, 2014. *Emerg Infect Dis* 22: 794-801.
- 76 Health Protection Agency (2012) *Health Care Associated Infection Operational Guidance and Standards for Health Protection Units*. Public Health England.
- 77 Hill KS (2010) Improving quality and patient safety by retaining nursing expertise. *Online J Issues Nurs* 15.
- 78 Holland K, Rees C (2010) *Nursing: Evidence-Based Practice Skills*. Oxford University Press, New York.
- 79 Inweregbu K, Dave J, Pittard A (2005) Nosocomial infections. *Continuing Education in Anaesthesia Critical Care & Pain* 5: 14-17.
- 80 Jolley J (2013) *Introducing Research and Evidence-Based Practice for Nursing and Healthcare Professionals (2nd Edn)*. Routledge/Taylor and Francis Group, London, UK.
- 81 Keele R (2011) *Nursing Research and Evidence-Based Practice: Ten Steps to Success*. MA: Jones and Bartlett Learning, Sudbury.
- 82 Khalil H (2015) Willingness of Saudi dental professionals to treat Hepatitis B virus infected patients. *Niger J Clin Pract* 18: 247-250.
- 83 McCaffrey R (2012) *Doctor of Nursing Practice: Enhancing Professional Development*. PA: FA Davis Company, Philadelphia.
- 84 McHugh MD, Lake ET (2010) Understanding clinical expertise: Nurse education, experience and the hospital context. *Res Nurs Health* 33: 276-287.
- 85 Melnyk BM, Fineout-Overholt E (2014) *Evidence-Based Practice in Nursing Practice: A Guide to Best Practice*. Baltimore: Wolters Kluwer/Lippincott Williams & Wilkins.
- 86 Memish ZA (2002) Infection control in Saudi Arabia: Meeting the challenge. *Am J Infect Control* 30: 57-65.
- 87 Mohd HA, Memish ZA, Alfaraj SH, McClish D, Altuwaijri T, et al. (2016) Predictors of MERS-CoV infection: A large case control study of patients presenting with ILI at a MERS-CoV referral hospital in Saudi Arabia. *Travel Med Infect Dis* 14: 464-470.
- 88 National Institute for Health and Care Excellence (2014) *Infection Prevention and Control*.
- 89 Rabaan AA, Alhani HM, Bazzi AM, Al Ahmed SH (2017) Questionnaire-based analysis of infection prevention and control in healthcare facilities in Saudi Arabia in regards to Middle East Respiratory Syndrome. *J Infect Public Health* 10: 548-563.
- 90 Saimbert MH (2017) *Comprehensive Systematic Review for Advanced Practice Nursing*. In: Holly C, Salmond S, Saimbert M (Editors). NY: Springer Publishing Company, New York.
- 91 Sha A (2015) Knowledge, Attitude and practice towards infection control measures amongst healthcare workers in a medical teaching hospital of Calicut District, Kerala, India. *Antimicrob Resist Infect Control* 4: 270-279.
- 92 Sharif A, Arbabisarjou A, Balouchi A, Ahmadidarrehshima S, Kashani HH (2016) Knowledge, attitude and performance of nurses toward hand hygiene in hospitals. *Glob J Health Sci* 8: 57-65.
- 93 Sheng WH, Chie WC, Chen YC, Hung CC, Wang JT, et al. (2005) Impact of nosocomial infections on medical costs, hospital stay and outcome in hospitalised patients. *J Formos Med Assoc* 104: 318-326.
- 94 Sodhi K, Shrivastava A, Arya M, Kumar M (2013) Knowledge of infection control practices among intensive care nurses in a tertiary care hospital. *J Infect Public Health* 6: 269-275.
- 95 Whittemore R (2007) *Reviewing Research Evidence for Nursing Practice: Systematic Reviews*. In: Webb C, Roe B (Editors). Blackwell Publishing, Oxford, UK.
- 96 World Health Organization (2017b) *WHO guidelines on hand hygiene in health care*. Geneva, WHO.