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Lujain Shah Date

Systematic Literature Review of Infection Control Practices that Prevent Transmission of Methicillin-resistant S*taphylococcus aureus,* Kingdom of Saudi Arabia, 2020

by

Lujain Shah
Master of Public Health
Hubert Department of Global Health

Scott JN McNabb, PhD, MS
Thesis Committee Chair

Systematic Literature Review of Infection Control Practices that Prevent Transmission of Methicillin-resistant S*taphylococcus aureus,* Kingdom of Saudi Arabia, 2020

by
Lujain Shah
B. Lab. Med., Umm Al-Qura University, 2014

Scott JN McNabb, PhD, MS
Thesis Committee Chair

An abstract submitted to the Faculty of the Rollins School of Public Health of Emory University in partial fulfillment of the requirements for the degree of Master of Public Health in Hubert Department of Global Health, 2020

Abstract

Systematic Literature Review of Infection Control Practices that Prevent Transmission of Methicillin-resistant S*taphylococcus aureus,* Kingdom of Saudi Arabia, 2020

by

Lujain Shah

Introduction: *Staphylococcus aureus* (SA) is a bacterium found on the skin. Generally harmless, it may, however, lead to sepsis or death. Methicillin-resistant *Staphylococcus aureus* (MRSA) is challenging to treat. Nasal carriage is linked to mild and life-threatening infections. The principle routes of MRSA transmission are skin-to-fomite, direct skin-to-skin, and direct contact with an infected individual. Poor hygiene standards and sweating can accelerate skin colonization during traveling and spread colonized reservoirs such as throat, axilla, and nares to a break in the skin barrier caused by insect bites, minor wounds, or scratching. Most are at risk of some infection. This systematic review aims to investigate infection control practices (ICP) of hospital-acquired MRSA (HA-MRSA) in Kingdom of Saudi Arabia (KSA) hospitals by summarizing existing data and measuring ICP compliance in reducing HA-MRSA.

Methods: Using PubMed, Web of Science, and ScienceDirect, a search was performed for MRSA studies. Articles reporting clinical outcomes of confirmed MRSA case-patients in KSA were included. Addressing the impact of ICP to prevent MRSA was the focus of this study.

Results: Among 11 eligible articles, most focused on awareness of ICP among healthcare workers (HCWs), when in direct contact with patients. Three reported 60%, 90%, and 5.1% of HCWs with good knowledge and adherence to hospital policy.

Conclusion: Our analysis found that most studies found adherence to ICP led to a reduction in healthcare-associated MRSA. Our results found a decrease in infection after hand hygiene compliance, antibiotic sensitivity, and awareness.

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Lujain Shah

Table of Contents

List of tables:

List of figures:

Introduction

Rationale

Staphylococcus aureus (S. aureus) is a bacterium found on the skin. Generally harmless, it may however, lead to sepsis or death. Methicillin-resistant *Staphylococcus aureus* (MRSA) is challenging to treat [1]. Infection with MRSA was first reported in 1961 [2]. Since then, incidence and prevalence have risen significantly in the United States [2]. Hospitalization rates of MRSA (in the United States) vary from 11.5% to 60% [2]. MRSA is the primary cause of hospital-acquired infection (HAIs) globally, with high morbidity and mortality [3].

Considered a human commensal and opportunistic pathogen, *S. aureus* is found in 30% of healthy individuals [4]. However, nasal carriage is linked to mild and life-threatening infection (e.g., osteomyelitis, septic arthritis, pneumonia, skin and soft tissue infection, and endocarditis) [4]. The principal routes of MRSA transmission are skin-to-fomite, direct skin-to-skin, and direct contact with an infected individual [4]. Poor hygiene standards and sweating can accelerate skin colonization during traveling and spread colonized reservoirs such as throat, axilla, and nares to a break in the skin barrier caused by insect bites, minor wounds, or scratching [4]. MRSA in many American and European hospitals is endemic (estimated 29% – 35% for all clinical isolates). In 1992, MRSA accounted for 57% of all acquired intensive care unit (ICU) *S. aureus* infections reported [5].

Mass gatherings are defined as a significant number of people attending one event and concentrated for a limited time at a specific location(s). One of the biggest annual mass religious gatherings is Hajj to the Islamic holy shrines in Makkah, Kingdom of Saudi Arabia (KSA). The annual number of pilgrims visiting Makkah for Hajj is approximately three million from over 184

countries. Most are at risk of some sort of infection. Hajj consists of six days spent in Jeddah or Al Taef, considered entry points to Makkah. Then pilgrims spend ten days in Madinah, followed by eight in Makkah.

There are increases in the risk of acquiring infectious diseases during mass gatherings; especially MRSA [6]. Since pilgrims come from > 184 countries – some of which sell antibiotics over the counter – accessibility of antibiotics is increased. Overuse of antibiotics is a risk factor for antibiotic resistance among pilgrims and MRSA is a common pathogen [7].

Objectives

This systematic review aims to investigate infection control practices (ICP) of hospital-acquired MRSA (HA-MRSA) in KSA hospitals by summarizing existing data and measuring the impact of compliance of ICP in reducing HA-MRSA. It measured hand hygiene compliance, awareness of healthcare workers (HCWs), and antibody sensitivity focused on confirmed cases with HA-MRSA and included prospective interventional studies, time series, cross sectional studies, retrospective studies, and public health surveillance (PHS).

Methods

This systematic review did not require Institutional Review Board approval because it consisted of summarizing existing published data.

Eligibility criteria

Inclusion: Articles were selected according to this outline.

Study Design

All articles that address the impact of ICP measures to prevent MRSA infections were included. Reports published as letters, reviews, and articles without abstracts were excluded.

Participants

MRSA cases of KSA nationals or residents ≥ 18 years of age were included.

Outcomes

Primary outcomes

- Hand hygiene compliance
- Antibiotic sensitivity
- Awareness of HCWs

Setting

Articles based in the KSA were included, and articles based outside of KSA were excluded.

Language

Articles published in English between 2011 and 2020 were included. Articles published in other languages were excluded.

Information sources

Published articles were retrieved from PubMed, Web of Science, and ScienceDirect.

Search Strategy

The systematic review related search was carried in the PubMed, Web of Science, and ScienceDirect for the period 2011 – 2020. The strategy and keywords used in the quest are "Methicillin-resistant *Staphylococcus aureus*"; "MRSA" OR "hospital acquired infections", incidence, significance, KSA, infection control and prevention practices. Titles and abstracts were reviewed for relevant data by using inclusion and exclusion criteria. Full text was obtained for all articles meeting inclusion criteria. Articles not meeting the inclusion criteria during full text review were excluded and duplicate studies were removed. There were no additional articles added to the systematic review after screening for inclusion/exclusion criteria.

Data Collection

Relevant information extracted from included articles were organized in a Summary of Findings table, including author's name, study design, population confirmed MRSA cases, hand hygiene compliance, antibody sensitivity, and awareness of HCWs.

Data synthesis and analysis

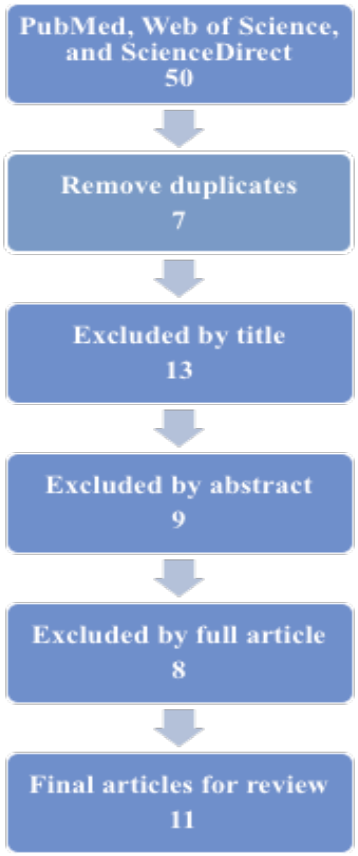
The main outcomes were extracted from eligible articles after screening for inclusion/exclusion criteria and summarized to describe the results of this systematic review like hand hygiene compliance, antibody sensitivity, and awareness of HCWs. Therefore, meta-analysis was not performed.

Results

Study selection

The MRSA-related literature search using PubMed, Web of Science, and Science Direct recognized 50 articles; all were imported into EndNote x9. Duplicates were removed, leaving 41 articles. Thirteen were excluded upon title review, and nine were excluded during abstract review. Eight articles were excluded at the full-text review. Eleven articles were included in this review. These eleven studies were conducted in KSA from 2011 – 2020 among populations in differing hospitals and regions. (Figure 1)

Figure 1. Included Studies of Infection Control Practices that Prevent Transmission of Methicillin-resistant *Staphylococcus aureus*, Kingdom of Saudi Arabia, 2020



Study characteristics

Hand hygiene

Al-Mendalawi, M., *et* al. reported in their observational, prospective, longitudinal study that a total of 163 healthcare professionals were surveyed for hand hygiene compliance with the composition as follows: physicians 57 (35%), nurses 92 (56.4%), and technicians 14 (8.6%). The overall hand hygiene compliance was 50.3%. However, hand hygiene compliance varied across positions: physicians 49.1%; nurses 52.2%; and technicians 42.8%. Physicians and nurses showed the highest compliance rate in surgical units. In contrast, the lowest compliance was observed in the Emergency Room and Outpatient Department, which are the high-intensity patient care areas. Technicians showed their compliance rate was 100% in medical units while 0% in various other clinical areas. The preferred hand hygiene option among healthcare professionals was alcohol-based hand sanitizer (74.5%); followed by water and soap (23.4%); and antimicrobial soap (2.1%). [8] (Table 1)

Table 1.Summary of Infection Control Practices that Prevent Transmission of Methicillin-resistant *Staphylococcus aureus* Among Studies Conducted in Kingdom of Saudi Arabia, 2011 - 2020

Author	Study Design	N (%)	Hand Hygiene Compliance (%)	Antibody Sensitivity (%)	Awareness of HCWs (%)
Al-Mendalawi, M., *et al.*	observational, prospective, longitudinal study	NA	50.3%	NA	NA
Ahmed Al Kuwaiti	prospective interventional study	The rate decreased from pre-intervention 3.37 to post-intervention 2.59	71.75%	NA	NA
Al-Tawfiq, *et al.*	descriptive time series study	The rate reduced from 0.42 in 2006 to 0.08 in 2011	85%	NA	NA
El Amin, N.M. and H.S. Faidah	retrospective study	40(52.6%)	NA	29.1%	NA
Al-Hamad, A. M., *et al.*	surveillance study	581 (64%)	NA	44% and 85% of HA-MRSA isolates were susceptible to gentamicin and rifampicin	NA
Iyer, A., *et al.*	study group	73 out of 100 cases	NA	73%	NA
Salem, O.A.	cross-sectional study	NA	NA	NA	60% of nurses had good knowledge of infection control measures
Ra'awji, B. A. A., *et al.*	cross-sectional study	NA	NA	NA	90% of HCWs adhered to hospital policy all time.
Cruz, J. P., *et al.*	cross-sectional study	NA	57.1%	NA	58.6% showed moderate knowledge and 5.1% demonstrated good knowledge of hand hygiene
Al-Humaidan, O. S., *et al.*	prospective study	36 (18%)	NA	Erythromycin (72.2%), Clindamycin (69.4%), and Tetracycline (11.1%).	NA
Khanfar, H., *et al.*	retrospective study	101 (11.5%)	NA	NA	NA

In another study conducted by Ahmed Al Kuwaiti in 2017, there was a significant rise in mean hand-hygiene compliance after a multicomponent intervention, which was based on the WHO hand hygiene recommendations [9] and included: 1) increase the accessibility of alcohol-based

hand rub and water supply; 2) Conduct an educational training on hand hygiene and infection control; 3) train and support monthly evaluation and feedback analysis; 4) perform visual presentations to improve hand hygiene practices; and 5) secure an institutional safety climate. The rates increased from 50.17% (95%CI: 44.84, 54.67) to 71.75% (95%CI: 70.59, 72.83) ($p < 0.05$) following the intervention.

Accordingly, HAIs rates decreased from pre-intervention 3.37 (95%CI: 3.05, 3.69) to post-intervention 2.59 (95%CI: 2.23, 2.90). These results demonstrate that HAIs were significantly reduced following the intervention ($p < 0.05$) [10]. In contrast, Al-Tawfiq, *et* al. in 2013 in a community hospital in KSA reported that the total hand-hygiene compliance rate rose from 38% in 2006 to 65% in 2010 and then in 2011 to 85% ($p < .001$). Compliance rates were 87% for doctors, 89% for nurses, and 93% for nutritionists. The rate of healthcare-acquired MRSA per 1,000 patient-days was significantly reduced from 0.42 in 2006 at the beginning of the intervention to 0.14 in 2009 and 0.08 in 2011, $p < .001$ [11].

Antibiotic sensitivity

El Amin, N. M. & Faidah, H. S. reported in 2012 in their retrospective study that there were 40 HA-MRSA (52.6%) infected cases. The overall MRSA isolates in their study were susceptible to vancomycin, linezolid, and teicoplanin. Other tested antibiotics among HA-MRSA were variable with significantly higher resistance to levofloxacin, erythromycin, and clindamycin. Resistance to four or more antibiotics was observed in 29.1% of the isolates and was considerably higher among HA-MRSA ($p=.03$). The most common documented co-morbidity was Diabetes mellitus (45.9% of MRSA, 50.0% of MRSA) [12].

A public health surveillance (PHS) study conducted by Al-Hamad, A.M., *et* al. in 2018 with a total of 581 (64%) HA-MRSA infections identified, compared with 322 (36%) CA-MRSA infections

over the study period. Until 2012, there was a decrease in HA-MRSA infections, followed by an increased rate (not statistically significant) for two years. The HA-MRSA infection rate declined in 2015. In contrast, MRSA isolation from outpatient settings increased in 2013 to 10.9 cases per 100,000 compared with 8.5 or less in the years prior to 2013. In the hospital setting, most of the infections due to MRSA were in surgical wards (24%), followed by the ICU (13%). The total number of cases from medical wards was 97 (11%), and the intermediate intensive care unit (IICU) was 45 (5%). The most-limited MRSA isolation was from the cardiac care unit (CCU) with an isolation of 10 (1%) and obstetrics ward (OBW) of 11 (1%). The majority of MRSA isolates were from skin/soft tissue infections, followed by comparable numbers of isolation from blood and lower respiratory tract. A total of 1972 *S. aureus* Skin/soft tissue infections were reported with 532 (27%) characterized as MRSA. Among these infections, 126 were MRSA in the bloodstream and 124 of the MRSA infections were in the lower respiratory tract. HA-MRSA isolates revealed a more complex resistance form against all antibiotics tested than the CA-MRSA isolates. Forty-four percent and 85% of HA-MRSA isolates were susceptible to gentamicin and rifampicin. While 62% and 92% for CA-MRSA. The overall *S. aureus* isolates, including MRSA, were completely susceptible to vancomycin and linezolid [13].

In 2014, a study conducted in a KSA hospital identified that 73 of 100 samples of HCWs were positive for MRSA based on antimicrobial susceptibility to oxacillin and culture results. Statistical analyses revealed that there was no significant relationship between MRSA carriage and sex and age of the study participants. A high number of MRSA positives among the HCWs was found in the burn unit with 47 of 58 samples positive (p-value = 0.04). Of the 24 samples in the ICU, 18 were positive (p-value < 0.05). In contrast, of the 18 samples from the Outpatient Department (OPD), only eight were positive (p-value = 0.09) [14].

Awareness of HCWs

A 2019 cross-sectional study was conducted in a tertiary-care hospital in KSA. Among the staff, 75% were nurses and 41.7% were between 20 and 25 years of age. In addition, the majority of the nurses had < five years of work experience (68.3%). When assessing their education level, the nurses who held a diploma degree in nursing were the highest percentage (60%); 50% of the nurses attended IPC training programs. When assessing nursing practice and knowledge associated with ICP, 78.3% had fair knowledge of these IPC measures. In contrast, all of the nurses demonstrated good knowledge of handwashing after completing the IPC training. However, all experienced poor hand washing practices before and after patient care. It was also found in this survey that nurses had good knowledge of gloving (71.7%), disinfecting (63.3%), and discarding procedures (93.3%). In general, 60% of the nurses had good knowledge of ICP measures, and 51.7% practiced poor ICP measures [15].

Ra'awji, B.A.A., *et* al. conducted a cross-sectional study in 2018 among a sample consisting primarily of 83% female and 80% nurses from different departments at three hospitals. The majority of the nurses were obtained from the King Fahad Specialized Hospital (60%), and their ages varied from 20 – 59 with a mean of 32 years. The nurses described using water and soap as the primary agent for hand hygiene. Alcohol-based hand sanitizer and other agents were used less than 25% of the time. However, regarding the knowledge assessment, the HCWs had low scores. The average score on a 100-point scale was 62.6 (standard deviation = 8.12). The scores ranged from 36% -- 88% with a normal distribution. As part of the knowledge assessment, the participants were not able to identify which actions prevent transmission to the patient versus to the HCWs.

Moreover, it was unclear in which scenarios they were required to practice hand hygiene, such as after emptying a bedpan, whether washing or rubbing. There were minor, non-significant

variations in hand hygiene knowledge between males and females or across professional levels (nurses vs. specialists vs. students). There were significant variations by the institution and by age. HCWs who had significantly higher knowledge scores were 30 years or older compared to those aged 20 – 29 ($p < 0.001$). HCWs at the King Fahad Specialized Hospital (KFSH) had significantly higher knowledge scores than HCWs at either the Buraidah Central or Al Rass General Hospitals (AGH) ($p = 0.001$). Generally, HCWs reported positive attitudes toward hand hygiene. More than 90% of HCWs reported that they adhered to the hospital policies at all times, and that it affects them positively. Moreover, almost all HCWs recommended that hand hygiene related guidelines, knowledge, and training is a requirement [16].

A cross-sectional study among HCWs in 2016 was conducted by Cruz, J.P., *et* al. with respondents of (60.6%) had attended a seminar or training on hand hygiene in the last six months. Moreover, more than half of the respondents (67.2%) were aware that they could cause cross-contamination in the hospital. Most of the respondents (57.1%) recognized that hand hygiene is effective in preventing HAIs. WHO Hand Hygiene Knowledge Questionnaires were used for HCWs. The nursing students were evaluated as moderate knowledge (mean 13.20 ± 2.80; range 6 – 23 of the total score of 25). The majority of the respondents (58.6%) showed moderate knowledge, and a few respondents (5.1%) demonstrated good knowledge of hand hygiene. Moreover, a moderate attitude (52.1%) was shown for more than half of the respondents, while a poor attitude (13.1%) toward hand hygiene was reported in a few of the respondents. The moderate practice of hand hygiene reported on 68.7% of the respondents, a good practice reported on 29.8%, and poor practice showed on only 1.5%. The practices of hand hygiene on KSA nursing students were primarily motivated by having a good attitude toward hand hygiene, being male, being knowledgeable and aware that hand hygiene is an effective intervention in preventing HAIs, and,

to a minor extent, attendance at hand-hygiene seminars and training. Having a positive attitude toward hand hygiene appeared in the largest beta weight ($\beta = 0.281$, $p < 0.001$), showing the largest participation in the regression equality while controlling for all other predictor variables. Gender held the second-largest participation ($\beta = -0.227$, $p < 0.001$), followed by knowledge and awareness of the effectiveness of hand hygiene in reducing HAIs ($\beta = 0.218$, $p < 0.001$) and attendance at hand-hygiene seminars and training ($\beta = 0.215$, $p < 0.05$). Academic level presented the lowest participation to the regression model ($\beta = -0.208$, $p < 0.05$) [17].

A prospective study in 2015 by Al-Humaidan, O.S., *et* al. was conducted on 200 isolates collected from HCWs. Of these, 80 (40%) were *S. aureus* carriers, and 36 (18%) were identified as MRSA carriers of all HCWs. There was a significant association of *S. aureus* according to the occupation, particularly among nurses (p=0.006), gender with male carriers (p=0.012), and term of hospital working years among 4 – 6 years group (p=0.002). Furthermore, risk factors evaluated were not significantly associated with the carriage rate of MRSA (p>0.05) [18].

A retrospective analysis of MRSA infection in 2012 among Saudi Aramco Dhahran Health Center, KSA, was conducted by Khanfar, H., *et* al. in which 878 cases of MRSA colonization/infection were identified during the study period. Of these, community-acquired MRSA (CA-MRSA) and HA-MRSA cases were 777 (88.4%) and 101 (11.5%), respectively. The number of HA-MRSA cases decreased, and the number of CA-MRSA cases increased during the study period. The rate of HA-MRSA was 1.17 in 2008 and 0.7 in 2009 per 1000 susceptible patient-days. The monthly colonization pressure varied from 0.1 to 1.62 during the two years. Throughout the study period, the nosocomial transmission was observed in 13 months of the 24-month. No association was observed between the colonization pressure of the previous month and the incidence of nosocomial transmission in the following month [19].

Discussion

Summary of Evidence

The purpose of this study was to evaluate the impact of ICP measures: hand hygiene compliance; antibiotic sensitivity; and healthcare worker awareness on HA-MRSA infections among HCWs in KSA. We systematically reviewed the published articles from KSA for these ICP measures and the outcome of interest, reductions in HA-MRSA among HCWs. The majority of studies focused on HCWs who carry out direct contact with patients.

Hand hygiene: Among 11 studies, three focused on hand-hygiene interventions. Two studies [8,11] reported that hand hygiene plays a role in inhibiting and reducing transfer of HAIs. The first study reported that HCWs should have 100% compliance with handwashing; however, the observed hand-hygiene compliance rate in this study was 50.3% [8]. Moreover, the increasing rate of compliance with hand hygiene means that there is an improvement in the commitment to ICP, leading to a decrease in the HA-MRSA. The second study showed a connection between adherence to hand-hygiene compliance and a significant reduction of HA-MRSA infection from 0.42 – 0.08 per 1,000 patient-days [11]. In contrast, a third study [10] reported that although the rates of HAI, including MRSA decreased from 3.37 to 2.55 after the multicomponent intervention with hand hygiene, hand-hygiene compliance alone was negatively correlated with HA-MRSA. Worth noting, this was a weak-negative association [10].

Antibiotic sensitivity: Of 11 studies, three were associated with antibiotic sensitivity. One [13] found that enhanced ICP reduced infectious outbreaks due to MRSA in healthcare settings. The study reported that although the antibiotic sensitivity of MRSA against ciprofloxacin, erythromycin, clindamycin, trimethoprim /sulfamethoxazole, and tetracycline were more resistant in healthcare settings compared to the community, the rate of MRSA isolation was relatively stable

for the past decade. This suggests the ICP worked to contain the spread of resistance [13]. A similar study [12] mentioned that approximately one-third of HA-MRSA were multidrug-resistant and were more resistant to erythromycin, levofloxacin, and clindamycin. This might result from excessive use and failure of dosage regulation of these antibiotics in hospitals [12]. It was not clear if there were interventions or adherence of ICP. One study [14] focused on colonization of HCWs and reported that 76% of the screened HCWs tested positive for asymptomatic nasal carriage of MRSA. This shows a very high incidence of MRSA. The nasal carriage percentage of the HCWs was related with the high-risk patient with whom they are in persistent contact. This study [14] supported that ICP that include the comply with dosage regulation of antibiotics, will play a role in reduction of HA-MRSA. While the non-rational use of antibiotics, and the failure to compliance to regulate the dose of antibiotics in the community, there is a great risk of transmission of hospital infections to the community, leading to the spread of community-acquired MRSA (CA-MRSA) [14]. Similar study [18] showed that the nurses were the potential colonizers of *S. aureus* and MRSA when compared to other HCWs. These carriers may serve as a disseminator and reservoir of MRSA and should be treated. Regular screening of carriers is required for the prevention of HAIs [18].

Knowledge: Among 11 studies, five were associated with awareness of HCWs. One study [15] supported that most of the nurses had good knowledge about ICP regarding hand washing before procedure, gloving, after procedure, discarding, and disinfection. Regarding the ICP, most of the nurses had a poor practice of hand washing before and after the procedure. The conclusions of the present study showed that there were insignificant differences between the nurse's knowledge and ICP. It is not clear in this study if the knowledge of nurses has an impact on reducing HA-MRSA infections. However, those nurses have proper awareness about hand hygiene, so that is good

enough to reduce the HA-MRSA [15]. A similar study [17] reported that most of the nursing students had a moderate attitude to hand hygiene, and about 34.8% had a good attitude. This result can be connected to the positive perception of respondents regarding hand hygiene, as explained by the positive responses of nurses about their awareness of the importance of hand hygiene in HAIs prevention [17]. In contrast to these studies, another study [16] reported that the knowledge rates of hand hygiene were low among HCWs. Also, many respondents thought handwashing was required when hand rubbing was sufficient, so they do both hand-hygiene techniques. By this error, they may be overreacting and that would not decrease the vulnerability of getting infected as they thought [16]. One study [19] supported that the adherence to ICP includes screening patients within 48 hours of admission, giving a single room to infected patients, rigorously implementing contact precautions for HCWs and visitors as well. Moreover, a policy of "once MRSA always MRSA" describes the decrease in the number of HA-MRSA cases during the study period [19].

Limitations

There were limitations to this study. One was a lack of studies regarding the importance of commitment to ICP in reducing the incidence of HA-MRSA. Moreover, it is possible that articles were missed, as this study did not include the grey literature (i.e., governmental agencies, websites) and other Arabic-language articles were excluded due to language barriers. There were inconsistencies in the included articles on measurement of the ICP as well as the primary outcome of interest, HA-MRSA infections. These inconsistencies made it additionally challenging to conclusively determine the impact of the IPC strategies.

Conclusion

Our analysis found most studies concluded that adherence to ICP led to a reduction in HA-MRSA. Our results showed a decrease in HA-MRSA after hand-hygiene compliance, antibiotic sensitivity, and awareness of HCWs. Moreover, patients who had just finished with critical procedures like open-heart surgery or immunocompromised patients should be placed in a single room with a signboard of protective precautions includes the ICP of putting on and taking off personal protective equipment and had a single use of physical signs equipment. Therefore, HCWs and visitors can apply hand hygiene and use and dispose of personal protective equipment correctly. Full compliance to the ICP is particularly imperative these patients who are the most vulnerable to infection.

Public health implications

The experience of MRSA in healthcare settings has significant implications for public health and the plan to case management of *S. aureus* infections. The appropriate use of PHS and reporting procedures is a crucial consideration to identify cases and new trends to manage the public health response. Although HA-MRSA has been mostly associated with soft-tissue and skin infections, severe invasive infections can occur also. *S. aureus* pathogen is common, and the appearance of strains that are resistant to antibiotics or more destructive may announce the start of more severe forms of common staphylococcal diseases (e.g., pneumonia, osteomyelitis, and skin infections). The plans for the management of these infections would require importance on early identification and the need to target antibiotic therapy accurately, with the use of culture results and susceptibility testing, as proper.

Therefore, MRSA forms a major public health concern in KSA, that requires the ICP team to apply guidelines strictly, and community-oriented campaigns and strategies to improve the public awareness of the risks of the uncontrolled use of antibiotics, nonadherence to hand hygiene.

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