Original Article :

Knowledge and Attitudes of Healthcare Professionals in The Central Region of Saudi Arabia Concerning Hand Cleanliness and The Identification of Multidrug-Resistant Bacteria

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Received on 16-11-2022 , accepted for publication on 01-01-2023, dx.doi.org/10.5455/mjhs.2023.02.013

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Abstract

Background and Aims:

The hand, an ideal habitat for microbes, can be easily contaminated with pathogenic bacteria, especially among health workers who are in frequent contact with patients. Owing to the increasing prevalence of multidrug-resistant nosocomial microbes, investigating their modes of transmission is required to establish efficient preventive measures. In this study, we aimed to investigate the levels of bacterial contamination on healthcare workers' hands in three Saudi Arabian hospitals and determine the frequency and nature of antibiotic resistance in the isolated bacteria.

Methods:

We administered a questionnaire among 216 healthcare professionals in three hospitals in the central region of Riyadh, Saudi Arabia and collected data on their knowledge about hand hygiene at the workplace, commitment to wearing gloves while performing tasks, and awareness on hands as a source of infection. Bacterial isolates were collected and screened using the Vitek 2 Compact system.

Results:

Out of the 64 hand swabs obtained from the three hospitals, 42 were positive for culture. The frequencies of positive cultures varied among the three hospitals, with hospitals A, B, and C showing contamination rates of 87.5% (21/24), 59% (13/22) and, 44.44% (8/18), respectively. The identified bacteria included Staphylococcus aureus, Staphylococcus hominis, Kocuria kristinae, Pseudomonas oryzihabitans, Pantoea agglomerans, and others. Antimicrobial susceptibility testing showed that majority of the coagulase-negative and coagulase-positive staphylococci were resistant to clindamycin, benzylpenicillin, and fosfomycin.

Conclusions:

The present study may help public health experts raise issues concerning infection control and increase the awareness among healthcare personnel on the importance of hand hygiene.

Keywords:

Healthcare workers, nosocomial infection, antimicrobial susceptibility, Saudi Arabia.

Introduction

Hand hygiene is a practical and cost-effective way to prevent nosocomial infections and the emergence of antibiotic resistance in all clinical settings, from primary to advanced healthcare facilities[1-3]. The World Health Organization (WHO) reported that 1,400,000 patients are affected by nosocomial infections, either directly or indirectly[4]. The increase in nosocomial infections is, therefore, one of the most significant issues being faced by the medical community[4]. Nosocomial infections are responsible for the increase in the duration of hospitalization, disability, and death of patients, placing a significant financial burden on them as well as the national healthcare system[5]. Studies were done to find out how poor hand hygiene with healthcare professionals wash their hands. The best way to stop the spread of illnesses linked to health care is to practice good hand hygiene, which may be accomplished by washing your hands or using a hand alcohol gel, but healthcare professionals rarely do either. Nosocomial infections are those that are contracted while receiving medical care but weren't present at the time of admission[4-5]. Moreover, nosocomial infections are the most frequent negative outcome of a hospital stay, with an estimated incidence rate between 5–10% in industrialized countries and approximately 40% in underdeveloped countries[5].

Hospital laboratories are one of the primary locations where harmful microorganisms can spread. During routine laboratory procedures, droplets containing microbes are created and contaminate the work surfaces, hands, fingers, and wrists of employees[6-7]. A serious problem is that employees with contaminated hands can transmit infections from hospital laboratories to other places. Additionally, they could unintentionally infect their eyes, lips, or noses. Although several safety guidelines for laboratory practices have been recommended to prevent infections, effective control measures to stop hand contamination have not yet been fully implemented. Gloves could help reduce the infection that might occur during the handling and testing of samples. However, the hands can get contaminated if the gloves are damaged or when the workers take them off [8-9]. Antimicrobial resistance (AMR) in bacteria is an emerging phenomenon that is rapidly attracting attention. The increase in antimicrobial drug resistance rates is currently thought to pose a serious threat to public health and has a considerable influence on morbidity and death[10-12]. The pathogens involved include Methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant Enterococcus (VRE), My-

cobacterium tuberculosis, Streptococcus pneumoniae, Klebsiella pneumoniae, Micrococcus, Acinetobacter baumannii, and Pseudomonas aeruginosa[13]. According to the Centers for Disease Control and Prevention (CDC), approximately 1.7 million infections related to medical treatments occur each year in US hospitals[14]. Hospital-acquired infections are among the top 10 causes of mortality and the main cause of infectious deaths, accounting for approximately 99,000 fatalities annually. Overall, approximately 350,000 of these infections are caused by MRSA, VRE, and Clostridium difficile, each causing approximately 12,000 fatalities[12-15].

Research is required to identify the potential modes of transmission of nosocomial pathogens to ensure efficient prevention owing to the growing prevalence of multidrug-resistant strains. Furthermore, studies on the frequency of antibiotic resistance in the Saudi Arabian medical community are limited. Our study investigated the level of bacterial contamination on healthcare workers' hands in selected Saudi Arabian hospitals and identified the susceptibility of isolated bacteria to various antimicrobial drugs.

Materials and methods

Study setting

The current study was conducted in three different hospitals in the Riyadh province of Saudi Arabia. The purpose was to assess the knowledge of 216 healthcare professionals, mostly working in laboratories, in the three selected hospitals about the correct way to maintain the cleanliness of their hands at the workplace during and after handling patients' samples. Furthermore, the participants were asked if they always cleaned their hands with antiseptics and were aware of the potential sources of infection. The hands of volunteers who provided their consent had sixty-four swab samples. We used culture swab (BD BBLTM culture swab TM. USA) collection and transport devices, as well as swab samples obtained from the top of hands. Aseptic procedures were performed during the sampling process. Of the 64 samples collected, 24 were from hospital A, 22 were from hospital B, and 18 were from hospital C. All healthcare professionals also gave their written informed consent before sample collection. Ethical clearance for this study was obtained from the Deanship of Scientific Research at Majmaah University (MUREC-Jan.6/COM-2022/18-6).

Isolation and identification of organisms

Swab samples were collected and incubated for 48 h at 37 °C on 5% sheep blood agar and MacConkey agar (Oxoid, UK) plates. Pure colonies were isolated on nutrient agar and 5% sheep blood agar. The

isolated colonies were purified and subcultured after incubation. The culture age was between 18–24 hours for gram-negative bacteria and 12–48 hours for Gram-positive bacteria. All isolates were first identified using Gram staining and several biochemical assays.

Bacterial identification

Using the VITEK DensiCHEKTM colorimeter (bioMérieux Inc., USA), 0.5–0.63 McFarland suspensions were prepared by mixing blood agar-grown bacterial colonies from each isolate in 0.45% sodium chloride solution, pH 4.5–7. The GP ID REF21342 and GN ID REF21341 cards were used to identify Gram-positive and Gram-negative bacteria, respectively, with the Vitek 2 Compact system (bioMérieux Inc., USA). All bacterial isolates were identified at the species level, and the manufacturer's instructions were followed for each test.

Antimicrobial susceptibility testing

The bacterial cell densities were adjusted by adding 145 ŮL of Gram-negative or 280 UL of Gram-positive bacterial suspension to 3 mL of 0.45% saline solution. For each isolate, a Vitek card was placed into the Vitek 2 automated reader-incubator using a suspension vial as the inoculum. Antimicrobial susceptibility testing was performed using AST-P580 (Staphylococcus spp., Enterococcus spp., and S. agalactiae) and AST-N291 (Gram-negative bacilli) cards. The Vitek 2 Compact version 07.01 was used to interpret the results[16].

Results

Questionnaires and level of contamination

From the three hospitals, 64 hand-swab samples were obtained, 42 of which were positive (Fig. 1 and Table 1). In general, the three hospitals had different number of contaminated hands; hospital A had the highest contamination rate of 43% and 57% of Gram negative and Gram positive , respectively (Fig.1), whereas the rates were 33% and 24% of Gram negative and Gram positive , respectively, in hospital B (Fig.1) . Finally, hospitals C have 24% of Gram negative and 19% of Gram positive (Fig. 1).

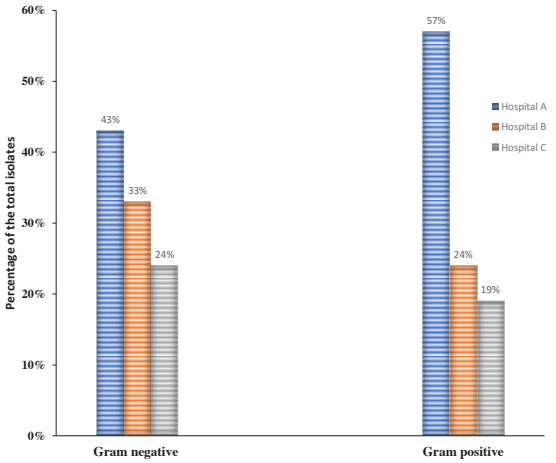


Figure 1: Frequencies of the bacteria isolated from hand-swab samples in selected hospitals. Blue bars represent percentage of the total isolates from hospital A. Orange bars represent percentage of the total isolates from hospital B. Gray bars represent percentage of the total isolates from hospital C.

Based on the surveys, 184 (86%) participants were working in hospitals, whereas 32 (14%) were not (Fig. 2). Out of the total, 187 (86.5%) participants know the right way to clean the hands before and after the work, and 29 (13.5%) never know the right way to clean their hands before and after the work. In addition, 84.7% of the participants working in laboratories always made sure to clean their hands after they had finished their duties, and 15.3% of the participants reported otherwise. When the participants from the selected hospitals were asked whether they cleaned their hands after taking patient, 181 (83.8%) responded in affirmation, while 35 (16.2%) responded in negation (Fig. 2). Interestingly, we discovered that 169 (78.2%) of the total participants never used gloves while taking patient samples and only 47 (21.8%) participants stated that they did. (Fig. 2). We discovered that approximately 65% of the participants used alcohol to sanitize their hands with antiseptic gels, while approximately 35% never applied antiseptics on their hands after using hospital facilities, such as elevators (Fig. 2). Moreover, approximately half of the participants (50.2%) used antiseptic gels after shaking hands (Fig. 2). Participants who were employed as medical professionals at the chosen institutions provided their comments; almost 69% used more than one pair of gloves during the day and approximately 31% stated they used only one pair of gloves throughout the workday (Fig. 2). The results from the survey showed that 136 (63.4%) of the participants wore gloves while using common lab computers and 79 (approximately 37%) used naked hands (Fig. 2). Majority of the participants (71%) did not wear gloves when they opened the lab doors and the remaining 29% wore them (Fig. 2).

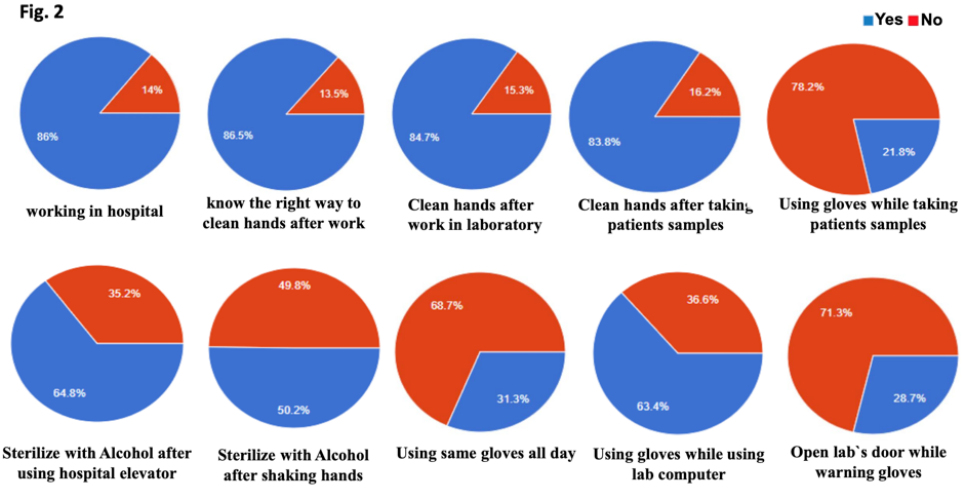


Figure 2: Survey results regarding hand hygiene among healthcare workers (n = 216) at the selected hospitals

Bacterial identification

The bacterial isolates and their frequencies are shown in Table 1. We obtained 42 bacterial isolates from 64 hand swab samples, of which 50% were Gram-positive bacteria from nine species, and 50% were Gram-negative bacteria from 13 species. We determined that coagulase-negative and coagulase-positive staphylococci were present in 28.57% of the hand swab samples. Hospital A had seven isolates from five different species, Hospital B had three isolates from three different species, and Hospital C had only one isolate. Compared to the samples from hospitals B and C, the samples from hospital A exhibited a higher contamination rate. In hospital A, 88.9% (8/9) were Gram-positive bacteria consisting of Staphylococcus aureus (1)*, S. hominis subsp. hominis* (1)*, S. haemolyticus* (1)*, S. warneri* (2)*, S. pseudiintermedius* (1)*, Micrococcus luteus/lylae* (1)*, kocuria Rhizophil* (1)*, K. kristinae* (3) were identified (Table 1). and 53.8 % (7/13) were Gram-negative bacteria. In hospital B, 55.6% (5/9) of the isolates were Gram-positive and 53.8% (7/13) were Gram-negative bacteria bacteria, specifically *Pseudomonas luteola* (1)*, Pseudomonas stutzeri* (1)*, Sphingomonas paucimobilis* (2)*, Escherichia vulneris* (1)*, Enterobacter cloacae complex* (1)*, and Citrobacter amalonaticus* (1),

Table 1: Frequency of bacteria isolated from hands of healthcare workers in selected hospitals

Name of the bacterial isolates	Hospital A	Hospital B	Hospital C	Total
Gram-positive Bacteria:				
Staphylococcus aureus	2	1	1	4
Staphylococcus hominis spp.	1	1	–	2
Staphylococcus haemolyticus	1	–	–	1
Staphylococcus warneri	2	1	–	3
Staphylococcus pseudintermedius	1	–	–	1
Micrococcus luteus/lylae	1	–	1	2
Kocuria rosea	–	–	1	1
Kocuria rhizophila	1	1	–	2
Kocuria kristinae	3	1	1	5
Gram-negative Bacteria:				
Pseudomonas oryzihabitans	2	–	1	3
Pseudomonas luteola	1	1	–	2
Pseudomonas stutzeri	–	1	–	1
Pseudomonas putida	–	–	1	1
Acinetobacter baumannii complex	–	–	1	1
Sphingomonas paucimobilis	1	2	1	4
Escherichia vulneris	–	1	–	1

Name of the bacterial isolates	Hospital A	Hospital B	Hospital C	Total
Enterobacter cloacae complex	–	1	1	2
Pantoea agglomerans	1	–	–	1
Citrobacter amalonaticus	–	1	–	1
Vibrio fluvialis	1	–	–	1
Serratia fonticola	2	–	–	2
Sphmon paucimobilis	1	–	–	1
Total	21 (50%)	13 (31%)	8 (19%)	42 (100%)

were identified (Table 2). In hospital C, 44.4% (4/9) of the isolates were Gram-positive and 38.5% (5/13) were Gram-negative bacteria. bacteria, specifically *Pseudomonas oryzihabitans* (1), *Pseudomonas putida* (1), *Acinetobacter baumannii complex* (1), *Sphingomonas paucimobilis* (1), *Enterobacter cloacae complex* (1), were identified (Table 2).

Antimicrobial susceptibility

A total of 21 Gram-positive bacteria, including 12 isolates from hospital A, were selected for antibiotic susceptibility testing (Table 2). Majority of the coagulase-negative and coagulase-positive isolates from the three hospitals were resistant to benzylpenicillin (MIC≥0.5), oxacillin (MIC≥4), clindamycin (MIC≥8), tetracycline (MIC≥16), Fosfomycin (MIC≥32), nitrogenfurantoin (MIC≥128), and trimethoprim/sulfamethoxazole (MIC≥320), with

intermediate resistance to erythromycin

Table 2. Antibiotic susceptibility of Gram-positive bacteria

Antibiotic	Staphylococcus aureus (4)[a]			Staphylococcus hominis (2)			Staphylococcus haemolyticus (1)			Staphylococcus warneri (3)			Staphylococcus pseudintermedius (1)			Micrococcus luteus/lylae (2)			Kocuria rosea (1)			Kocuria rhizophila 2))			Kocuria kristinae (5)		
	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R
Benzylpenicillin	0	0	4[b]	1	0	0	1	0	0	2	0	1	1	0	0	2	0	0	1	0	0	2	0	0	0	0	5
Oxacillin	3	0	1	1	0	1	1	0	0	3	0	0	0	0	1	0	0	2	1	0	0	2	0	0	0	0	5
Gentamicin	4	0	0	1	0	0	1	0	0	3	0	0	1	0	0	2	0	0	1	0	0	0	0	0	5	0	0
Tobramycin	4	0	0	1	0	0	1	0	0	3	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	0	5
Levofloxacin	4	0	0	1	0	0	1	0	0	3	0	0	1	0	0	2	0	0	1	0	0	2	0	0	5	0	0
Moxifloxacin	4	0	0	1	0	0	1	0	0	3	0	0	1	0	0	2	0	0	1	0	0	2	0	0	5	0	0
Erythromycin	4	0	0	1	0	0	1	0	0	3	1	0	1	0	0	1	1	0	1	0	0	2	0	0	5	0	0
Clindamycin	3	0	1	1	0	0	1	0	0	2	0	1	1	0	0	2	0	0	1	0	0	2	0	0	0	0	5
Linezolid	4	0	0	1	0	0	1	0	0	3	0	0	1	0	0	2	0	0	1	0	0	2	0	0	5	0	0
Teicoplanin	4	0	0	1	0	0	1	0	0	3	0	0	1	0	0	2	0	0	1	0	0	2	0	0	5	0	0
Vancomycin	4	1	0	1	0	0	1	0	0	3	0	0	1	0	0	2	0	0	1	0	0	2	0	0	5	1	0
Tetracycline	4	0	0	0	0	1	1	0	0	3	0	0	1	0	0	2	0	0	0	0	1	2	0	0	0	0	5
Tigecycline	4	0	0	2	0	0	1	0	0	3	0	0	1	0	0	2	0	0	1	0	0	2	0	0	5	0	0
Fosfomycin	4	0	0	0	0	1	0	0	1	0	0	3	0	0	1	0	0	2	0	0	1	0	0	2	0	0	5
Nitrofurantoin	4	0	0	1	0	0	1	0	0	3	0	0	0	0	1	2	0	0	1	0	0	0	0	2	0	0	5
Fusidic acid	3	1	0	0	1	0	0	1	0	0	1	0	1	0	0	1	1	0	1	0	0	2	0	0	0	5	0
Mupirocin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Antibiotic	Staphylococcus aureus (4)[a]			Staphylococcus hominis (2)			Staphylococcus haemolyticus (1)			Staphylococcus warneri (3)			Staphylococcus pseudintermedius (1)			Micrococcus luteus/lylae (2)			Kocuria rosea (1)			Kocuria rhizophila 2))			Kocuria kristinae (5)		
	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R
Rifampicin	0	3	0	0	1	0	0	1	0	0	1	0	1	0	0	2	0	0	0	1	0	0	0	0	0	0	5
Trimethoprim/ Sulfamethoazole	3	0	1	1	0	0	1	0	0	1	0	0	1	0	0	1	0	1	1	0	0	2	0	0	5	0	0

Note. I, intermediate; NA, not applicable; R, resistant; S, susceptible

aValues in brackets indicate number of isolates.

bNumber of resistant isolates indicated in bold.

(MIC≥8), vancomycin (MIC≥32), fusidic acid (MIC≥32), and rifampicin(MIC≥32). Micrococcus luteus/lylae isolates were resistant to oxacillin, fosfomycin, and trimethoprim/sulfamethoxazole. Kocuria rosea isolate was resistant to tobramycin, tetracycline, and fosfomycin. Kocuria rhizophila isolates were resistant to fosfomycin and nitrofurantoin (Table 3). Interestingly, all five Kocuria kristinae isolates were resistant to benzylpenicillin, oxacillin, clindamycin, tetracycline, fosfomycin, nitrofurantoin, and rifampicin. One isolate showed intermediate resistance to vancomycin.

Twenty-one Gram-negative bacteria were selected for antimicrobial susceptibility testing, including nine isolates from hospital A, seven from hospital B, and five from hospital C, the results of which are shown in Table 3. The results showed that Pseudomonas oryzihabitans was resistant to ampicillin (MIC≥32), cefaxitin (MIC=16), ceftriaxone (MIC≥64), and nitrofurantoin (MIC≥16). Pseudomonas luteola was resistant to cefaxitin and nitrofurantoin. Acinetobacter baumannii complex showed resistance to many drugs such as ampicillin, amoxicillin/clavulanic acid (MIC≥16), cefaxitin, ceftriaxone, and nitrofurantoin. Enterobacter cloacae complex also showed resistance to various drugs, such as ampicillin, amoxicillin/clavulanic acid, piperacillin/tazobactam (MIC≥128), cefalotin (MIC≥64), and cefaxitin. Pseudomonas putida strain was resistant to ampicillin, cefaxitin, nitrofurantoin, and trimethoprim/sulfamethoxazole. Serratia fonticola was resistant to piperacillin/tazobactam, cefotin, and nitrofurantoin. Pseudomonas stutzeri, Sphingomonas paucimobilis, Pantoea agglomerans Citrobacter amalonaticus, and Sphmon paucimobilis only showed resistance to nitrofurantoin, ceftazidime, cefalotin, and ceftazidime (MIC≥64), respectively.

Table 3. Antibiotic susceptibility of selected Gram-negative bacteria

Antibiotic	Pseudomonas oryzihabitans (3)[a]			Pseudomonas luteola (2)			Pseudomonas stutzeri (1)			Acinetobacter baumannii complex (1)			Escherichia vulneris (1)			Enterobacter cloacae complex (2)		
	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R
Ampicillin	0	2	1[b]	0	2	0	1	0	0	0	0	1	1	0	0	0	0	1
Amoxicillin/clavulanic acid	3	0	0	2	0	0	1	0	0	0	0	1	1	0	0	1	0	1
Piperacillin/tazobactam	3	0	0	2	0	0	1	0	0	1	0	0	1	0	0	1	0	1
Cefalotin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Cefaxitin	0	0	3	1	0	1	1	0	0	0	0	1	1	0	0	1	0	1
Ceftazidime	3	0	0	2	0	0	1	0	0	1	0	0	1	0	0	2	0	0
Ceftriaxone	2	0	1	2	0	0	1	0	0	0	0	1	1	0	0	2	0	0
Cefepime	2	1	0	2	0	0	1	0	0	1	0	0	1	0	0	2	0	0
Imipenem	3	0	0	2	0	0	1	0	0	1	0	0	1	0	0	2	0	0
Meropenem	3	0	0	1	1	0	1	0	0	1	0	0	1	0	0	2	0	0
Amikacin	3	1	0	2	0	0	1	0	0	1	0	0	1	0	0	2	0	0
Gentamicin	3	0	0	2	0	0	1	0	0	1	0	0	1	0	0	2	0	0
Ciprofloxacin	3	0	0	2	0	0	1	0	0	1	0	0	1	0	0	2	0	0
Tigecycline	3	0	0	2	0	0	1	0	0	1	0	0	1	0	0	1	1	0
Nitrofurantoin	0	0	3	1	0	1	0	0	1	0	0	1	1	0	0	1	1	0
Trimethoprim/ sulfamethoxazole	3	0	0	2	0	0	1	0	0	1	0	0	1	0	0	1	0	0

Note I, intermediate; NA, not applicable; R, resistant; S, susceptible

aValues in brackets indicate number of isolates

bNumber of resistant isolates indicated in bold

Table 3 contd.

	Antibiotic	Pseudomonas putida (1)			Sphingomonas paucimobilis (4)			Pantoea agglomerans (1)			Citrobacter amalonaticus (1)			Vibrio fluvialis (1)			Serratia fonticola (2)			Sphmon paucimobilis (1)		
	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R
Ampicillin	0	0	1	0	4	0	0	0	0	0	0	0	1	0	0	2	0	0	0	1	0
Amoxicillin/ clavulanic acid	0	1	0	4	0	0	1	0	0	1	0	0	1	0	0	2	0	0	1	0	0
Piperacillin/ tazobactam	1	0	0	4	0	0	1	0	0	1	0	0	1	0	0	0	0	2	1	0	0
Cefalotin	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2	0	0	0
Cefaxitin	0	0	1	4	0	0	1	0	0	1	0	0	0	1	0	2	0	0	1	0	0
Ceftazidime	1	0	0	0	1	3	1	0	0	1	0	0	0	1	0	2	0	0	0	0	1
Ceftriaxone	0	1	0	0	4	0	1	0	0	1	0	0	1	0	0	2	0	0	0	1	0
Cefepime	1	0	0	4	0	0	1	0	0	1	0	0	1	0	0	2	0	0	1	0	0
Imipenem	1	0	0	4	0	0	1	0	0	1	0	0	1	0	0	2	0	0	1	0	0
Meropenem	1	0	0	4	0	0	1	0	0	1	0	0	1	0	0	2	0	0	1	0	0
Amikacin	1	0	0	4	0	0	1	0	0	1	0	0	1	0	0	2	0	0	1	0	0
Gentamicin	1	0	0	4	0	0	1	0	0	1	0	0	1	0	0	2	0	0	1	0	0
Ciprofloxacin	1	0	0	4	0	0	1	0	0	1	0	0	1	0	0	2	0	0	1	0	0
Tigecycline	1	0	0	3	1	0	1	0	0	1	0	0	1	0	0	2	0	0	0	1	0
Nitrofurantoin	0	0	1	4	0	0	1	0	0	0	0	1	0	0	1	0	0	2	1	0	0
Trimethoprim/ sulfamethoxazole	0	0	1	4	0	0	1	0	0	1	0	0	1	0	0	2	0	0	0	0	0

Discussion

In the current study, the knowledge of health workers about hand hygiene was evaluated. The results showed that the majority of the participants knew how to clean their hands during and after finishing work, especially during COVID-19. This response was in line with a study conducted in Riyadh, which also showed that most of the health workers were aware of the importance of cleaning their hands before and after their shifts[17]. A similar study reported that approximately 90% of health workers frequently practiced hand washing before and after work[18-19]. Further, a study on healthcare workers in Pakistan revealed that practice was associated with knowledge and positive attitude; however, some discrepancies were found between knowledge and practice[20-21]. Another study conducted in Uganda revealed the adequate training and experience of health workers, however, it revealed a bad attitude toward washing hands during the COVID-19 pandemic[22]. According to a previous survey, more than 60% of participants concur that good hand cleanliness is crucial for reducing healthcare-associated diseases[2]. Majority of the participants in our study frequently applied antiseptic gel to their hands, in line with a previous study that discovered that approximately 89% of the subjects used hand sanitizers[21]. This study also evaluated the use of gloves while obtaining or handling samples from patients and observed that the majority did not use gloves while obtaining patient samples. In contrast, a study from Palestine accounted that approximately 68% of the healthcare workers reported that they wore gloves while handling patients[23].

Our results showed that the largest group (27%) of Gram-positive bacteria isolated from healthcare workers were the coagulase-negative and -positive staphylococci including S. aureus, S. warneri, and S. hominis. Our findings are similar to those from a study by Gabriel et al. who reported that the hands of approximately 49% of healthcare professionals were contaminated with germs, mostly comprising coagulase-negative staphylococci and S. aureus[24]. Another study by Tselebonis et al. isolated Staphylococcus spp. from 60% of the hands of health workers in hospitals[25]. Although these microbes are part of the skin microbiome, 71% of neonatal bloodstream infections are caused by coagulase-negative staphylococci, as reported by Sanderson et al., demonstrating that they cause opportunistic infections in newborns[26].

In the present study, the frequencies of Gram-positive cocci and Gram-negative isolated from the hands of healthcare workers were similar, both of which cause

infections among health workers in hospitals. Pseudomonas spp. was the most common Gram-negative bacteria (33%), followed by Sphingomonas paucimobilis (19%).

Resistance to fosfomycin, benzylpenicillin, oxacillin, and erythromycin has been reported in S. aureus, S. epidermidis, S. hominis, S. warneri, and S. pseudintermedius. Similar findings were reported by Asaad et al., who found that nosocomial bloodstream infections in Najran, Kingdom of Saudi Arabia, were caused by coagulase-negative staphylococci isolates that were highly resistant to penicillin, oxacillin, and erythromycin but sensitive to vancomycin and teicoplanin[27]. All five Kocuria kristinae isolates were sensitive to benzyl penicillin, oxacillin, clindamycin, tetracycline, fosfomycin, nitrofurantoin, and rifampicin, and vancomycin resistance was found in one isolate. K. kristinae is a member of the normal flora on human skin that can opportunistically infect humans. The first case of K. kristinae infection occurred in a patient with ovarian cancer who had bacteremia caused by a catheter[28]. Previous studies have found that it caused acute cholecystitis, brain abscesses, infective endocarditis, central venous catheter-related bacteremia in immunocompromised hosts receiving total parenteral nutrition, and dialysis-related peritonitis[29-33].

Conclusion

Our study demonstrates how a variety of pathogenic bacteria, including virulent strains, can infect the hands of healthcare personnel. When handling patient samples, bacteria can easily stick to the skin surface of health workers and can be easily transmitted to the general population and other patients. We observed a lack of knowledge and poor hygiene practices among healthcare professionals, which may increase the risk of spreading multidrug-resistant bacteria through a lack of hand hygiene. The development of active preventive strategies and training is required to reduce the risk of cross-infection.

Declaration of conflict of interest

There are none to declare.

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