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Assessing the Risk of Transmission of Various Organisms Like MRSA from Nurses in a Kidney Services Center

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: *Methicillin-resistant Staphylococcus aureus* is a leading cause of hospital-acquired infections and can be transmitted by colonized healthcare workers, posing a serious threat to immunocompromised patients.
Aim: to measure the *MRSA* nasal carriage rate of nurses in kidney center services.

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Methods: This study was a cross-sectional study, it was conducted in Al hawaria kidney services center, the samples collected by taking nasal swabs from 31 nurses, and the data were analyzed by SPSS to determine the frequencies and percentages of variables.
Results: According to this study, 16% of the samples were colonized by *Acinetobacter* and *Staphylococcus aureus*, separately, while 22% of the samples were carriers of *MRSA*. And the results of antibiotic profile showed that the isolated bacteria tested positive was 69 % resistant to amoxicillin and 47% to cefoxitin.
Conclusion: The presence of *MRSA* among nurses highlights the need for routine screening and stringent infection control measures to reduce the risk of transmission to vulnerable dialysis patients.

Keywords: Antibiotic; carrier; colonization; healthcare workers; infections; MRSA.

1. INTRODUCTION

MRSA has become a highly common infection in health care settings across the world; it is a gram-positive bacterium and it has acquired genes that perform them resistant to approximately all beta-lactam antibiotics (Baba et al., 2002). It stands to "*Methicillin-Resistant Staphylococcus Aureus*" (Warren et al., 2004). In the late 1960s, it was recognized in the United States (Boucher, 2007). It is a subclass within a strain of *staph* that has a resistance mechanism to methicillin and other antibiotics (Herimat, n.d.). And healthy people can have this type of bacteria on their nose and skin. Also, it often causes contamination on the skin, such as lesions and blotch (CDC, 2013).

Penicillin and its derivatives, such as methicillin, are working by combining with one of the enzymes on the cell wall to make penicillin-binding proteins (PBPs). When they bind, the wall of the cell is blocked resulting in bacterial death. Therefore, *MRSA* makes a new gene known as PBP2a; it can make walls of the cell, it has low affinity to antibiotics, and it is found in all *S. aureus* that are resistant to methicillin. This protein's gene is present on the chromosome, which allows for its wide distribution (Heymann, 2005).

MRSA leads to an increase the rate of death in hospitals for MRSA, for which the death rate associated with *MRSA* was 4.7 percent compared to 2.1 percent for non-*MRSA* (Elixhauser & Steiner, 2007). In addition, it leads to increases in cost; the annual costs that is related to MRSA infection in hospitals were between $42 and $59 million in Canada. In addition, the costs of administration and isolation of colonized patients was approximately $1,363 per admission in Canadian hospitals (Kim et al., 2001).

Furthermore, *MRSA* leads to increasing the length of stay in the hospital, which is estimated at 8 days longer for *MRSA* patients than others (Andreassen et al., 2017). Besides, the length of stay due to *MRSA* was estimated in another scientific study; it found that MRSA leads to an increase the length of stay in the hospital from 6 to 9 days with a hospital charge of 6916 dollars (Cosgrove et al., 2005).

MRSA can be transmitted in health care settings by colonized or carrier people directly during contact with a person who has an infection or by touching infected skin or indirectly through touching materials or surfaces that had contact with an infection such as infected towels, clothing, doorknobs (CDC, 2013). and by sharing personal items with others, such as tooth brushes, sport gear, or combs (Boucher, 2007). Colonized patients are the main reservoir of *MRSA*. The major mechanism of patient- to-patient transmission of resistant microorganisms is on the equipment and hands healthcare workers (Dengler & Lodise, 2016).

MRSA screening includes taking a swab from sample sites such as any wound or skin lesion, the nose, the groin, sputum and medical devices in healthcare settings such as intravenous line sites, tracheotomy sites and catheters (National Health Service, 2019). Also, Patient were admitted to high-risk units such as ICU, renal, neonatal, and surgical units (National Health Service, 2019).

HSE (2011) recommended that effective control measures depend on surveillance and early detection of colonized and infected cases; screening includes swabs from the nose, the groin or skin, and it includes swabs from medical devices such as catheters. Screening health care workers should be routine, for example, before starting a new job and during regular intervals

(Health Service Executive, 2011). Besides, wernitz et al. (2005) reported that screening programs to detect *MRSA* carriers at hospital admission have an effective role in decreasing the frequency rate of *MRSA*, which is resulting in a reduction of the predicted number of *MRSA* cases acquired in hospitals by 48% (Wernitz et al., 2005). Furthermore, West et al. (2006) conducted a comparative study of the effect of *MRSA* screening in a community hospital center, they compared the cost and rate of MRSA infection before and after surveillance. They reported that the MRSA rate reduced, and this helped in saving about 1,545,762 US dollars as a result of preventing 13 *MRSA* bacteremia and 9 *MRSA* skin infections (West et al., 2006). Additionally, in 2007, Robotham et al. studied the association between MRSA surveillance and control measures of infection; the screening includes detection of colonized or infected people. They observed that random screening plays an important role in controlling infection in hospitals, while admission screening plays an essential role in estimating the prevalence of *MRSA* in the community rather than in the hospital (Robotham et al., 2007). Moreover, Guleri et al. (2011) conducted a study to determine the cost and benefits of screening *MSA* program at Blackpool Victoria Hospital; hospital-acquired MRSA bacteremia decreased from 28 to 5 and the estimated cost saving was £396,285 over one year (Guleri et al., 2011).

Aim: This study aims to measure the MRSA nasal carriage rate of nurses in kidney center services.

Objectives: to determine the types of bacteria isolated from nurses' nose and to assess its sensitivity and resistance to some antibiotics.

2. METHODS AND MATERIALS

This study was conducted in the Al-hwari Kidney Services Centre in Benghazi, Libya, it involves descriptive research that is based on a quantitative and cross-sectional approach. The data was collected by taking nasal swab specimens. The total number of the nurses who working in this center were 71nurses and only 31 of them agreed to participating in this study. The data was collected between March and June 2019 and all nurses were informed of the purpose of this study, and their consent was obtained before specimen collection. Nasal swabs were collected with sterile cotton swab pre-moistened with sterile 0.9% saline solution, and transferred them directly to the laboratory in less than half hour. This study uses statistical package for social sciences (SPSS) version 22 software to analyze the collected data and determine the frequencies and percentages of some variables. The frequency and percentage of some variables were determined.

2.1 Ethical Consideration

This study was performed after getting permission from the manager of the aAl-hwari kidney services center and getting agreement from each nurse.

3. RESULTS AND FINDINGS

Table 1 shows that more than half of the sample was female (N=45, 78%) and 22% (N=13) were males and shows the largest proportion of the sample (N=42, 72.4%) hold a diploma degree, 15.5% (N=9) have a high school degree, and (N=4, 6.9%) have a bachelor degree, and 5.2% (N=3) have preparatory degree. It reported that more than half of the sample (63.8%) do not work in other institutions, while 36.2% work in other institutions. Additionally, it represents the respondents experience, in terms of years, which ranged from 1 to 25 years; the largest proportion of the sample had 0-5 years of experience (N=24, 41%); next comes 11-15 years with 26% (N=15), 6-10 years (N=10, 17%), and 9% (N=5) were 16-20 years, and the smallest proportion was (N=4, 7%) for 21-25 years. Furthermore, it demonstrates that the largest number of nurses (N=16, 27%) had 31-35 years, and 20.7% (N=12) for both 21-25 years and 36-40 years separately; next comes 26-30 years at 17.2% (N=10), 41-45 years (N=5, 8.6%), and 5.2% for more than 45 years.

MRSA screening: This study reports that 20% of the sample carry MRSA in their nose, while 23% were colonized by other bacteria and 7% were carriers to MRS (see Fig. 1).

Furthermore, Table 2 shows different pathogens types that were found in the nurses' noses, the grams positive were *Staphylococcus aureus*, *S epidermidis,* and *Streptococcus.* While gram negative isolated bacteria were *Acinetobacter*, *Klebsiella*, *Pseudomonas Aeruginosa*, *Proteus mirabilis* and *E. coli*.

Table 1. Demographic information of the nurse working in the Al-hwari Kidney Services Centre

Characteristics	Options	N (%)
Gender	Male	13 (22)
	Female	45 (78%)
Qualification	Preparatory level	3 (25%)
	High school	9 (15.5%)
	diploma	42 (72.4%)
	Bachelors	4 (6.9%)
	21-25 years	12 (20.7%)
	26-30 years	10 (17.2%)
	31-35 years	16 (27.6%)
	36-40 years	12 (20.7%)
	41-45 years	5 (8.6%)
	More than 45 years	3 (5.2%)
Year of expérience	0-5 years	24 (41%)
	6-10 years	10 (17%)
	11-15 years	15 (26%)
	16-20 years	5 (9%)
	21-25 years	4 (7%)
working in other institution	Yes	37 (64 %)
	No	21 (36 %)

Table 2. Types of isolated bacteria

Nasal carriage of MRSA bacteria among medical staff in Al-hwari Kidney Services Centre		
	Gram-positives	**Gram-negatives**
1	*S aureus*	*Klebsiella*
2	*S epidermidis*	*E-coli*
3	*Streptococcus*	*Acinetobacter*
4		*Pseudomonas aeruginosa*
5		*Proteus mirabilis*

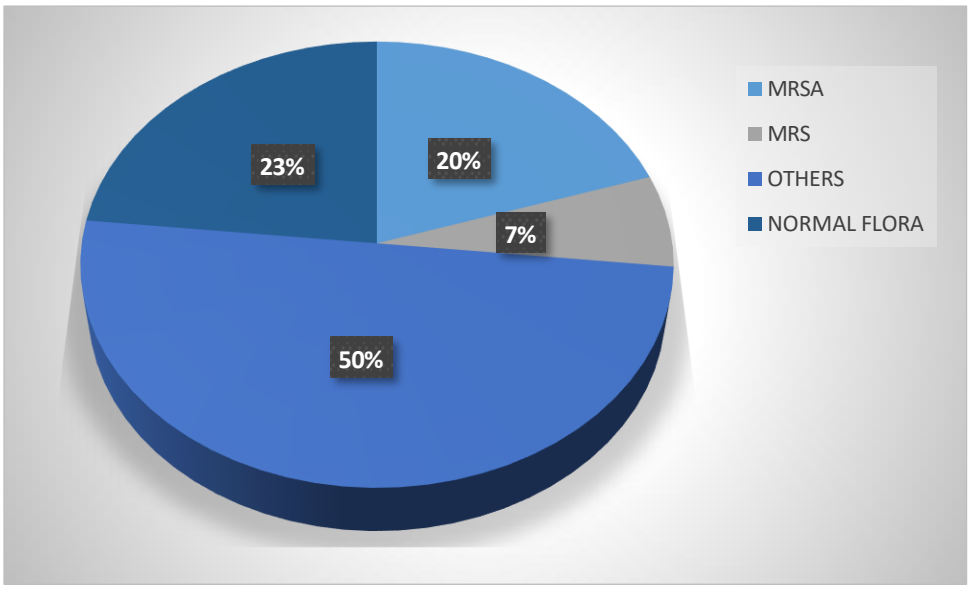

Fig. 1. MRSA screening of nasal carriage

Table 3. Antimicrobial susceptibility pattern of isolated bacteria

Isolated Bacterial species	GEN	CIP	AMO	LEV	AZT	CEF	IMI	RY	CLI
Acinetobacter	S	S	S	S	S	S	S	-	-
Acinetobacter	R	S	R	S	S	S	S	-	-
Acinetobacte	R	S	R	S	R	R	S	-	-
Acinetobacter	R	S	R	S	S	S	S	-	-
Acinetobacter	R	S	R	S	S	R	S	-	-
Klebsiella	S	S	S	R	S	S	S	-	-
Klebsiella	S	S	S	R	S	S	S	-	-
S. aureus	R	R	S	R	-	S	-	R	S
S. aureus	R	S	R	S	-	S	-	R	S
S. aureus	R	R	R	S	-	R	-	R	R
S. aureus	S	S	S	S	-	R	-	R	S
S. aureus	R	S	R	S	-	R	-	R	S
S. aureus	S	S	R	S	-	R	-	R	R
S. aureus	R	R	R	S	-	R	-	R	S
S. aureus	R	R	R	R	-	R	-	R	R
S. aureus	R	R	R	S	-	R	-	S	S
S. aureus	R	R	R	R	-	R	-	R	S
S. aureus	R	R	R	R	-	R	-	R	S
S. aureus	R	S	R	S	-	S	-	R	S
E. coli	R	S	R	S	S	S	S	-	-
E. coli	S	S	S	S	S	S	S	-	-
Pseudomonas aeruginosa	R	S	R	S	S	S	S	-	-
Proteus mirabilis	S	S	S	S	S	S	S	-	-

Amoxicillin (AMO), Azithromycin (AZT), Cefoxitine (CEF), Ciprofloxacine (CIP), Clindamycin (CLI) Erythromycin (RY), Gentamicine (GN), Imipeneme (IMI), Levofloxacin (LEV).

Table 3 represents the resistance profile of the isolated bacteria from nurses nose, which it reported that isolated bacteria were resistant 69% to gentamycin and amoxicillin separately, 47% to cefoxitin, and their resistance to ciprofloxacin was 30 %.

4. DISCUSSION

The results of the current study reported that 22% of the sample had MRSA; furthermore, this study reported another different pathogen in their nose, such as *MRS*, *Staphylococcus aureus*, *Klebsiella*, *Acinetobacter*, *Pseudomonas Aeruginosa* and *Lactobacillus*. Which *Acinetobacter* and *Staphylococcus* aureus found in 16% of the sample separately. This infection could be resulted from contamination in the hospital environment. And that could be the result of their low knowledge level regarding MRSA transmission and prevention (Mohamed et al., 2022).

Similarly, the prevalence of MRSA infection has been estimated among medical staff at Tripoli Centre Hospital in Libya; they reported that 15.7% of samples isolated *S. aureus* and 21.9% isolated *MRSA*. The highest rate of MRSA infection was isolated from nurses (7.8%). In addition, regarding the department, the highest rate was observed in the surgical department and operating room (Doro et al., 2016).

Furthermore, Belgasim et al. (2010) determined the prevalence of MRSA among medical staff who are working in intensive care units (ICUs) and operating theatres (OTs) at the African Oncology Institute in Sabrata, Libya. They observed that the rate of MRSA prevalence was (11.6%); in more detail, the prevalence rate among doctors was 20% and among nurses was 7.14%, which MRSA was reported in the nose and fingertips of physicians, while among nurses, it found only in the fingertips of nurses (Belgasim et al., 2010). Besides, Tejiram et al. 2017 screened MRSA from admitted burn patients in burn center, and they found that 4% of these patients were positive for MRSA and that was significantly correlated with increased length of stay in the hospital as well as increased the number of surgical procedures. Furthermore, these infected patients with MRSA had more wound infection (Tejiram et al., 2017).

Moreover, Rioux reported that 14 patients out of 273 admitted patients' had positive MRSA

culture, and this infection was determined from blood, wound, and bronchoalveolar lavage, which were 7, 6, and 1 patients, respectively. Furthermore, it indicated that 23 patients had positive MRSA nasal-swabs (Rioux et al., 2017).

Alongside this, Heckel et al. determined the prevalence of MRSA among patients of palliative care units at a German university hospital in 2017, they found that the prevalence rate of MRSA was 2.1%. Also, it found that all positive cases can be detected by a risk-factors-based screening approach, such a previous stay in an institution or places with high prevalence of MRSA, stay for more than 3 days in a hospital during the last year, direct contact with farm animals in the workplace, permanent need for nursing help, antibiotic therapy during the past 6 months, use of a urinary catheter or endoscopic tube, patients with kidney disease requiring dialysis, skin ulcers, and gangrene (Heckel et al., 2017).

Similarly, Moyo et al. (2017) assessed the rate of *MRSA* carriage among admitted patients and its association with some risk factors at attending regional hospitals. They reported that of 258 patients enrolled, 89 (34.5%) were colonized with *S. aureus,* and of them 22 (24.7%) were carriers of *MRSA*, giving an overall *MRSA* nasal carriage rate of 8.5% (22/258), and they did not find any significant association between risk factors and *MRSA* (Joachim et al., 2017).

Regarding resistance to antibiotics, the current study reported that isolated bacteria were resistance to several antibiotics; its resistance was 69 % for amoxicillin, 47 % for cefoxitin, 30% for ciprofloxacin. Furthermore, Doro et al. observed that isolated bacteria in their study were resistant to Oxacillin (100%). erythromycin (75%), ciprofloxacin (70%), clindamycin (30%), sulfamethoxazole (50%), quinupramine/dalfopristin (20%), vancomycin (15%), and mupirocin (4%) (Doro et al., 2016).

Moreover, Jochim et al. reported that most of the *S. aureus* isolates (95.5%) were resistant to penicillin; also, resistance to gentamycin, ciprofoxacin, kanamycin, linezolid and mupirocin were 14.6%, 11.2%, 11.2%, 3.4% and 1.1%, respectively (Joachim et al., 2017).

5. CONCLUSION

The results of the current study reported that nurses in this center pose a high risk for patients in the dialysis department, since *MRSA* was reported in 22% of the sample, while 16% were colonized with *Acinetobactera* and *Staphylococcus Aureus* separately. Almost *MRSA* cases were 69 % resistant to amoxicillin. Therefore, implementation of a screening policy (including staff at the start of employment) is an essential way to identify *MRSA* carriers among workers and patients, and decolonization of *MRSA* will help to reduce the spread of *MRSA* in the hospital.

6. LIMITATION

This study faced a number of difficulties; the majority of nurses refused to give nasal swab specimens during three times, as their reason was they were afraid of the results. So that this study just applies to taking swabs from only 31 out of 71 nurses.

CONSENT

As per international standards or university standards, Participants' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standards or university standards written ethical approval has been collected and preserved by the author(s).

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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