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ORIGINAL ARTICLE

Prevalence of methicillin resistant staphylococcus aureus in Rashid hospital, Dubai, United Arab Emirates

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ABSTRACT

OBJECTIVES: To evaluate the prevalence of Methicillin-resistant Staphylococcus aureus (MRSA) and its antibiotic susceptibility at Rashid hospital in Dubai, United Arab Emirates (U.A.E).

METHODS: This retrospective cohort study was conducted among patients at Rashid hospital in Dubai, U.A.E. from January-December 2021. Isolates were put in blood and McConckey agars and gram- positive cocci in clusters were identified then incubated in a highly automated system called VITEK®2 to identify Staphylococcus aureus and its antibiotic susceptibility.

RESULTS: Out of 665 samples of S. aureus isolates, MRSA were 236 (35.5%) while 429 (64.5%) were Methicillin Sensitive Staphylococcus Aureus (MSSA). Among male patients, the highest frequency MSSA & MRSA isolation was observed in the age bracket of 40-49 years (n=64/285; 22.4%) and 50-59 years (n=31/160; 19.4%) respectively. Smilarly, in females the highest frequency MSSA & MRSA isolation was observed in the age range of 20-29 years (n=24/144; 16.7%) and 60-69 years (n=13/76; 17.1%) respectively. MSSA was most commonly isolated from 269 (62.7%) wound sites. The MRSA demonstrated resistance to most of the antibiotics with highest resistance towards Ciprofloxacin 103 (44%) and Fusidic acid 100 (42%). Among different antibiotics, the isolates remained highly susceptible to linezolid, tigecycline, teicoplanin, rifampicin and vancomycin.

CONCLUSION: This retrospective study at Rashid Hospital in Dubai identified a notable prevalence of MRSA (35.5%) and MSSA (64.5%), predominant in male patients. Age-specific patterns revealed higher frequencies of MSSA and MRSA isolations in distinct age brackets. MRSA displayed resistance to several antibiotics, emphasizing the need for judicious antimicrobial management in this healthcare setting.

KEYWORDS: Staphylococcus aureus (MeSH); Methicillin-Resistant Staphylococcus aureus (MeSH); Methicillin Resistance (MeSH); Microbial Sensitivity Tests (MeSH); MRSA (Non-MeSH); MSSA, (Non-MeSH).

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INTRODUCTION

The staphylococcus aureus infection is associated with a wide range of infections" commonly involving the skin, soft tissue, bone, joints, and infections associated with indwelling catheters or prosthetic devices. In addition, S. aureus is a leading cause of bacteraemia in industrialized nations, due to frequent and/or unnecessary use of antibiotics, Methicillin-resistant Staphylococcus aureus (MRSA) is fast becoming a common health risk due to its association with an increased morbidity and mortality in multiple disease conditions.[1]

MRSA has become more widespread as a major contributor to hospital and community-acquired infections over the last two decades.[2] The prevalence of nosocomial MRSA varies greatly in different countries. For instance, the Europe, the Netherlands, and the entire Scandinavian region historically had relatively low MRSA prevalence rates, in comparison; other countries exhibit relatively moderate (such as in Spain, France, and Germany) or higher (such as in Italy, Greece, or Portugal) prevalence of MRSA.[3] The rise in the rates of MRSA infections most likely reflects the expanding influence of medical devices, therapies, aging, and patient comorbidities. Resistance most likely also develops due to misuse of traditional antibiotics.[4]

MRSA infections are difficult to treat because these organisms are resistant to currently available antibiotics. Due to a lack of novel drugs to overcome the rapidly mutating MRSA, precise identification of the organisms and use of available antibiotics based on antibiotic susceptibility tests has become mandatory in routine clinical practice.

The macrolide class of drugs is commonly used for oral treatment of MRSA and are also prescribed to patients allergic to penicillin. Clindamycin and other macrolides are effective against skin and soft tissue infections of MRSA.[5] Methicillin resistance is mediated by the MecA gene, this gene encodes the enzyme Penicillin-binding protein 2a (PBP2a), which crosslinks the peptidoglycans in the bacterial cell wall. PBP2a has a low affinity for β-lactams, resulting in

antibiotic resistance across the board, this gene encodes penicillin binding protein 2A (PBP2A), which has a low methicillin affinity.[6]

Many different studies conducted that have gone into the antibiotic sensitivity of MRSA to a spectrum of antibiotics have mainly been only in the USA and Europe. However similar findings from the United Arab Emirates (U.A.E) have remained exclusive. In addition, the retrospective clinical data is not thoroughly investigated to characterize the prevalence and driving factors of MRSA in Dubai hospital settings. As a result, there is an urgent need to thoroughly investigate the available clinical data with an aim to formulate future strategies.

This study aims to bridge this gap in literature by investigating MRSA antibiotic resistance in the middle east and especially here in U.A.E. In this research we are studying the most accurate representation of the different isolates of MRSA to the different commonly used antibiotics, this will provide a much clearer updated pharmacological view on the treatment of MRSA here in the U.A.E.

METHODS

We conducted a retrospective cohort study from January to December 2021 at Rashid Hospital, a general medical and surgical hospital with 786 beds located in Dubai, U.A.E.

Sample collection: We investigated various samples (blood, sputum, urine, pus, and body fluids) of hospital patients for culture and sensitivity analysis from different departments such as: Accident and Emergency, Surgical ICU, Neurosurgical ICU, Medical ICU, Cardiac ICU, Infectious ICU, Wards, and Outpatient Clinics. An aseptic technique was used to gather samples into sterile containers. All samples received were requested by the staff in charge of treating patients.

Culture and bacterial identification: Blood agar and McConkey's agar were utilized for sample inoculation; however, S. aureus-specific media were not used. Under an oil immersion lens, the gram-stained smear of the suspected colonies was examined. Gram positive cocci in clusters were incubated in a highly automated system called VITEK®2 to identify S. aureus. However, for gram positive cocci isolated from the blood, we additionally conducted polymerase chain reaction (PCR) to identify the S. aureus isolate and to check whether it is Methicillin Sensitive Staphylococcus Aureus (MSSA) or MRSA. The study comprised every S. aureus isolate obtained from various samples over the course of the investigation. However, if the same patient had further samples of blood, pus, body fluids or sputum that tested positive for S. aureus and had the same antibiogram, only the first isolate was included in the study. Following initial organism isolation, handling is kept at the SMART CARRIER STATION, where the VITEK® 2 Card and sample are virtually connected, then the inoculum is to be inserted into the VITEK®2 Cassette. Once the cassette is loaded, the system takes control of the incubation and reading of each card on its own.

Antibiotic Susceptibility: Antibiotic susceptibility tests of the S. aureus were performed by VITEK®2. The S. aureus isolate was subdivided into MSSA and MRSA according to its sensitivity to oxacillin based on the results from the VITEK®2 device and it was confirmed by applying it to a 30 μg Cefoxitin (FOX) disk.

Antibiotics used for susceptibility testing were Oxacillin, Gentamycin, Vancomycin, Teicoplanin, Clindamycin, Trimethoprim / Sulfamethoxazole, Tetracycline, Rifampicin, and Linezolid. Ceftaroline was the only antibiotic not used in the VITEK®2 system and rather used in a disc diffusion with 30μg and it was tested only on MRSA isolates in particular the ones that are isolated from lower respiratory, skin, and soft tissue.

Laboratory Protocol: The laboratory staff adhered to to laboratory protocol, led by particular internal Standard operating procedures, to improve the quality of specimen processing and storage in an effort to reduce pre-analytical, analytical, and post-analytical mistakes. When the specimens arrived in the lab, they underwent meticulous inspection, and those that were deemed unfit for processing, such as mislabeled or contaminated specimens, were subjected to rejection criteria. After sorting, it was important to guarantee proper incubation and storage of the specimens before processing, including, when necessary, the chilling of some specimens. The effectiveness of the culture media was evaluated using reference microbes from the American Type Culture Collection (ATCC). To guarantee that there was no contamination of cultures, sterility testing of the media was performed. The results of VITEK®2 were verified.

Data analysis: Chi-square test or Fisher's exact were used for the statistical analysis of the data and p values which were < 0.05 were considered statistically significant.

RESULTS

A total of 665 samples of S. aureus isolates (blood = 73, wound = 408, urine = 17, sputum = 130, body fluids = 6, biopsy = 16, and others = 15) were taken from patients attending the hospital. Out of 665 S. aureus isolates, 236 (35.5%) were MRSA and 429 (64.5%) were MSSA.

Out of 429 MSSA patients, 285 (66.4%) were male and 144 (33.6%) were female. On the other hand, out of the 236 MRSA patients, 160 (67.8%) were male, and 76 (32.2%) were female.

Among male patients with MSSA, the age bracket of 40-49 years exhibited the highest frequency (n=64/285; 22.4%) of MSSA isolations (Table I). In contrast, among male MRSA patients, the age range of 50-59 years showed the highest prevalence (n=31/160; 19.4%) of MRSA isolations (Table II).

In females, the age group of 20-29 years demonstrated the highest occurrence (n=24/144; 16.7%) of MSSA isolations, while the 60-69 age group showed the highest frequency (n=13/76; 17.1%) of MRSA isolations. Across all age groups, the incidence of MSSA was higher in males compared to females, except in the 0-9 age group where females outnumbered males (Table I).

As for MRSA patients the number of males who got MRSA outweighed the

Table I: Age-specific distribution of participants with Methicillin-Sensitive Staphylococcus Aureus infection: A gender-stratified analysis (n = 429)

Age groups In years	Males		Females		Total	
	Frequency (n=285)	Percentage	Frequency (n=144)	Percentage	Frequency (n=429)	Percentage
≥80	11	3.9	10	6.9	21	4.9
70-79	27	9.5	15	10.4	42	9.8
60-69	31	10.9	10	6.9	41	9.6
50-59	35	12.3	20	13.9	55	12.8
40-49	64	22.4	21	14.6	85	19.8
30-39	41	14.4	23	16	64	14.9
20-29	45	15.8	24	16.7	69	16.1
10-19	18	6.3	5	3.5	23	5.4
<10	13	4.5	16	11.1	29	6.7

Table II: Age-specific distribution of participants with Methicillin-resistant Staphylococcus aureus: A gender-stratified analysis (n = 236)

Age groups In years	Males		Females		Total	
	Frequency (n=160)	Percentage	Frequency (n=76)	Percentage	Frequency (n=236)	Percentage
≥80	4	2.5	7	9.2	11	4.7
70-79	8	5	5	6.6	13	5.5
60-69	20	12.5	13	17.1	33	14
50-59	31	19.4	12	15.8	43	18.2
40-49	29	18.1	10	13.2	39	16.5
30-39	33	20.6	10	13.2	43	18.2
20-29	20	12.5	8	10.4	28	11.9
10-19	11	6.9	5	6.6	16	6.8
<10	4	2.5	6	7.9	10	4.2

Table III: Prevalence of MSSA and MRSA in different departments of Rashid hospital collected between January 2021 and December 2021

Department	Methicillin-Sensitive Staphylococcus Aureus [Frequency (percentage)]	Methicillin-Resistant Staphylococcus Aureus [Frequency (percentage)]
Accident and Emergency	171 (39.9)	97 (41.1)
Surgical ICU	11 (2.6)	10 (4.2)
Neurosurgical ICU	14 (3.3)	8 (3.4)
Medical ICU	22 (5.1)	12 (5.1)
Cardiac ICU	9 (2)	3 (1.3)
Infectious ICU	12(2.8)	13 (5.5)
Wards	78(18.2)	44 (18.6)
Outpatient Clinics	112 (26.1)	49 (20.8)
Total	429 (100)	236 (100)

ICU=Intensive Care Unit; MSSA= Methicillin-Sensitive Staphylococcus Aureus; MRSA= Methicillin-Resistant Staphylococcus Aureus

number of females in all age groups except in the age groups of 0-9 and >80 where females outweighed the number of males (Table II).

Accident & Emergency department accounted for the highest number of MSSA and MRSA being isolated in relation to the other departments with a total of 171 (39.9%) and 97 (41.1%) respectively, on the other hand; Outpatient Clinics had 112 MSSA (26.1%) and 49 MRSA (20.8%), Wards had 78 MSSA (18.2%) and 44 MRSA (18.6%), Medical ICU had 22 MSSA (5.1%) and 12 MRSA (5.1%), Infectious ICU had 12 MSSA (2.8%) and 13 MRSA (5.5%), Neurosurgical ICU had 14 MSSA (3.3%) and 8 MRSA (3.4%), Surgical ICU had 11 MSSA (2.6%) and 10 MRSA (4.2%), and finally Cardiac ICU had 9 MSSA (2%) and 3 MRSA (1.3%) (Table III).

Among the MSSA isolates wound constituted the most famous site of isolation with a sum of 269 (62.7%) followed by sputum 76 (17.7%), blood 45 (10.5%), urine 13 (3%), others 12 (2.8%), biopsy 10 (2.3%), and fluid 4 (1%). For MRSA isolates wound also accounted for the highest number of isolates with a total of 139 (58.9%)

Table IV: Prevalence of MSSA and MRSA in different clinical samples of Rashid hospital collected between January 2021 and December 2021

Clinical Samples	MSSA n (%)	MRSA n (%)	Total Samples
Blood	45 (10.5)	28 (11.9)	73
Wound	269 (62.7)	139 (58.9)	408
Urine	13 (3)	4 (1.7)	17
Sputum	76 (17.7)	54 (22.9)	130
Fluid	4 (1)	2 (0.8)	6
Biopsy	10(2.3)	6 (2.5)	16
Others	12(2.8)	3 (1.3)	15
Total	429 (100)	236 (100)	665

MSSA= Methicillin-Sensitive Staphylococcus Aureus; MRSA= Methicillin-Resistant Staphylococcus Aureus

Table V:Antimicrobial susceptibility pattern according to methicillin resistance of different antibiotics Data are presented as numbers (percentages)

Drugs Tested	Methicillin Resistant Staphylococcus Aureus			Methicillin Sensitive Staphylococcus Aureus			P-Value
	Sensitive	Resistant	Not Tested	Sensitive	Resistant	Not Tested	
Clindamycin	182 (77)	54 (23)	0 (0)	377 (88)	52 (12)	0 (0)	0.0003
Ciprofloxacin	122 (51)	103 (44)	4 (2)	287 (67)	128 (29)	7 (2)	0.0005
Erythromycin	139 (59)	83 (35)	3 (1)	320 (75)	98 (23)	5 (1)	<0.0001
Fusidic Acid	132 (56)	100 (42)	4 (2)	325 (76)	5 (1)	99(23)	<0.0001
Gentamicin	183 (77)	31 (13)	4 (2)	410 (95)	5 (1)	11 (3)	<0.0001
Linezolid	236(100)	0 (0)	0 (0)	429(100)	0 (0)	0 (0)	1.0
Moxifloxacin	128 (54)	92 (39)	4 (2)	294 (68)	106 (25)	8 (2)	0.0005
Oxacillin	0 (0)	236(100)	0 (0)	429(100)	0 (0)	0 (0)	<0.0001
Penicillin	0 (0)	231 (98)	5 (2)	93 (22)	327 (76)	9 (2)	<0.0001
Rifampicin	235(100)	0 (0)	0 (0)	426(100)	1 (0)	2 (0)	1.0
Teicoplanin	233 (99)	0 (0)	3 (1)	429 (99)	0 (0)	4 (1)	1.0
Tetracycline	182 (77)	50 (21)	4 (2)	393 (92)	31 (7)	5 (1)	<0.0001
Tigecycline	232 (99)	0 (0)	4 (1)	429 (99)	0 (0)	5 (1)	1.0
Trimethoprim	160 (68)	76 (32)	0 (0)	347 (81)	82 (19)	0 (0)	0.0001
Vancomycin	236(100)	0 (0)	0 (0)	427(100)	1 (0)	1 (0)	1.0

followed by sputum 54 (22.9%), blood 28 (11.9%), biopsy 6 (2.5%), urine 4 (1.7%), others 3 (1.3%), and fluid 2 (0.8%) (Table IV).

The antibiotic susceptibility pattern of MSSA shows that 76% of MSSA isolates were resistant to Penicillin, furthermore 30% were resistant to Ciprofloxacin, 25% to Moxifloxacin, 23% to Erythromycin, 19% to Trimethoprim, 12% to Clindamycin, 7% to Tetracycline, 1% to both Fusidic acid and Gentamicin. For the rest of the (Linezolid, Rifampicin, Teicoplanin, Tigecycline and Vancomycin) the MSSA isolates showed no resistance to them (Table V).

Regarding the antibiotic susceptibility pattern of MRSA, 44% of MRSA isolates were resistant to Ciprofloxacin, while 42% were resistant to Fusidic acid, moreover; 39% were resistant to Moxifloxacin, 35% to Erythromycin, 32% to Trimethoprim, 22% to Clindamycin, 21% to Tetracycline, 13% to Gentamicin, on the contrary; Ceftaroline, Linezolid, Rifampicin, Teicoplanin, Tigecycline, and Vancomycin all had 0% resistance. The sensitivity, intermediate, and non-tested isolates are present in Tables III. Antimicrobial susceptibility pattern of MRSA to ceftaroline showed sensitive in 126 (53%) cases, Resistant in one (0.42%) case, intermediate in 6 (2%) cases. It was not tested in 103 (44%) cases.

DISCUSSION

MRSA represents a significant and ongoing challenge to healthcare facilities. In our study, the number of MSSA isolates in all departments were more than MRSA except in infectious ICU where the MRSA isolates were more than the MSSA, 13 and 12 respectively. The highest frequency of isolates for both MRSA and MSSA, based on the type of samples, was isolated from wound, 62.7% and 58.9% respectively, thus patients with wound injuries appear to be the most susceptible people to be infected with S.aureus.

The 665 S. aureus isolates had resistance rates of 35.5% to oxacillin. This may be partially related to the widespread usage of the safest antibiotics. Antibiotics like Vancomycin, Linezolid, Rifampicin, Tigecycline, and Teicoplanin should be judiciously used only in MRSA cases (Table III). Our study did not document any resistance to these antibiotics. These antibiotics should be preserved for future use which will be most important in treating the MRSA cases. Ceftaroline was tested in our MRSA samples that were isolated

from upper respiratory, skin and soft tissue, moreover the results showed that only one sample was resistant, and the rest were sensitive. Consequently, this shows the efficacy of this drug in treating MRSA strains.

There are variations in the prevalence data for MRSA where there was a study conducted in Jordan that concluded the prevalence of MRSA was 73.2%.[7] Another study conducted in Egypt revealed a high prevalence of MRSA which was 81.2%.[8] Moreover; in China it was 55%,[9] in India 29.1%.[10] On the other hand; a study conducted in Thailand illustrated a much lower prevalence of MRSA where 17% of isolates were MRSA.[11] The total number of isolates at Dubai, Rashid hospital were 665 where 236 of these isolates were MRSA (35%). Several factors, including study design, inclusion and exclusion criteria, specimen types, laboratory techniques, study duration, population, phenotype, and genotypic may account for the large difference in prevalence rate across regions.

An extended identification database, the most automated platform available, quick results, increased confidence, and little training time are all features of the ground-breaking VITEK®2 microbial identification system that was used in our research to identify S.aureus and check whether the isolate is MSSA or MRSA, finally to check the isolate's antibiotic susceptibility pattern. The next-generation VITEK®2 system platform offers more automation while boosting safety and removing monotonous manual tasks. Results can be delivered more quickly than with manual microbiological identification approaches thanks to the quick reaction time.

LIMITATIONS OF THE STUDY

Our study had some limitations that hindered our results. For instance: The results of our study would be more empowered if they were subdivided into hospital or community acquired. Furthermore, some antibiotics were not tested on all samples and the antibiotic ceftaroline was tested only on MRSA samples specifically the ones that are isolated from lower respiratory, skin, and soft tissue. The retrospective design of this study does not allow additional characterization of the factors associated with MRSA.

CONCLUSION

Our study provides valuable insights into the prevalence of MRSA and MSSA, demographic patterns of infection, gender-based variations, site-specific isolation, and the antibiotic susceptibility profile. The higher prevalence of MSSA in males across various age groups, except in the youngest age group, and the resistance patterns of MRSA highlight important aspects for consideration in the management of Staphylococcus aureus infections in the hospital setting. Additionally, the identified antibiotics to which isolates remain susceptible can guide appropriate treatment strategies.

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AUTHOR'S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under:

GA, FH, MH & AQ: Conception and study design, acquisition, analysis and interpretation of data, drafting the manuscript, approval of the final version to be published

YA: Analysis and interpretation of data, critical review, approval of the final version to be published

RQ: Conception and Study Design, critical review, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest

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DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request

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