ISSN: 1343-4292
Volume 140, Issue 05, August, 2022

EVALUATION OF RISK FACTORS FOR INFECTION WITH *S.AUREUS* AND MRSA AMONG PATIENTS ADMITTED TO AL-BATOOL TEACHING HOSPITAL FOR MATERNITY AND CHILDREN IN DIYALA, IRAQ

Mohamed Mahjoob Aljboori[1], Rideh A.Abdul-Jabbar[1], Ali Ibrahim Ali Al-Ezzy[2]

University of Tikrit, college of Science, Department of Biology[1]
University of Diyala, College of Veterinary medicine, Department of Pathology[2]

ABSTRACT— The study aims to evaluate the Risk Factors For Infection With S.aureus And MRSA Among Patients Admitted To Al-Batool Teaching Hospital For Maternity And Children In Diyala, Iraq. A total of 57 children admitted to Al-Batool Teaching Hospital For Maternity And Children In Diyala, Iraq were included. Standard microbiological procedures were used for diagnosis of S.aureus and Methicillin resistant S.aureus. No significant correlation of age group and S.aureus infection. Significant correlation was reported between the age group (5-7) years and MRSA infection. No significant correlation was reported between sex of children and MRSA infections. Significant correlation was reported between education level and infection with S.aureus. Invers significant correlation was reported between using of hand disinfectant and infection with S.aureus and MRSA among children No significant correlation was reported between previous hospitalization in last two months and infection with S.aureus and MRSA among patients. Significant correlation was reported between central venous catheterization and infection with S.aureus. No significant correlation was reported between number of family members and infection with S.aureus and MRSA among patients. The main risk factors for infection with S.aureus and /or MRSA were education level, using of hand disinfectant, central venous catheterization. Age and sex, Previous hospitalization in last two months, number of family members have no role as a risk factors.

KEYWORDS: S.AUREUS AND MRSA

1. INTRODUCTION

Staphylococcus aureus is a main pathogen of human infection that causes several diseases ranging from skin infections to necrotizing pneumonia, bacteremia, and life-threatening sepsis, and thus is a great threat to human health [46]. Nasal carriage of S. aureus is a main risk factor for staphylococcal infection for patients, and they represents as S. aureus carriers are more prone to staphylococcal infection and experience recurrence of disease, if they are colonized was for long time [30]. There is many studies about risk factors of S. aureus carriage have been studied extensively in the adult population, the adults have been to carry minimal S. aureus as there age, while, in the children have been to have a high carriage rate at birth, and then quickly decrease in the initial months and then rising again by the second to third year of age [35]. Methicillin-resistant Staphylococcus aureus (MRSA) infection formed a serious source of healthcare-associated infection in many countries. MRSA is readily spread by multiple routes and can remain in the environment for long periods [14]. In health and care regulation, transmission via staff hands remains the

most serious route for patient MRSA acquisition. Infection prevention and control (IPC) measures taken and control of the utilize, of antimicrobials are effective in decreasing the prevalence of MRSA [11].

Hospital-acquired methicillin-resistant S.aureus (HA-MRSA) strains are hugely disseminated in clinical environments and infect immunosuppressed hosts, whilst community-associated (CA-MRSA) strains have the ability to cause infections in healthy children, (babies) and adult [41].

The study aims to evaluate the Risk Factors For Infection With S.aureus And MRSA Among Patients Admitted To Al-Batool Teaching Hospital For Maternity And Children In Diyala, Iraq.

2. METHODS

The study was conducted at Al-Batool teaching Hospital for Maternity and Children. Diyala. Iraq. The study was performed according to Helsinki declaration. Informed consent with the was obtained from the family or guardians of children before their inclusion and take samples from them. The Clinical Research Ethics Committee at Al-Batool teaching Hospital for Maternity and Children. Diyala. Iraq, approved the study.

2.1 Study Participants

The current study was conducted between March and November 2020, the study included 57 children admitted to Al-Batool teaching hospital for maternity and children in Diyala. A survey was performed for children to collect clinical and epidemiological data including age, sex of children, using of hand disinfectant, previous hospitalization in last two months, central venous catheterization, number of family members.

2.2 Study Samples

Nasal, mouth, and skin swabs from patient children, were collected following a standardized protocol, inserting the swab tip of the places to be sampled and rotating and moving it for (five seconds) in each place. Transport swabs (AFCO, Origen Jordan) were used. The samples were submitted from hospital to its microbiology laboratory of reference belonging to Al-Batool teaching hospital for maternity and children. Diyala. Iraq. Isolation and diagnosis of S. aureus were based on standard microbiological procedures. Interpretations were in accordance with the EUCAST guidelines [30].

2.3 Isolation of S.aureus

Swabs were streaked on mannitol salt agar for 18-24 h and golden yellow colonies were selected for further investigation, Gram staining, catalase test, coagulase test, DNase.

Molecular diagnosis for S.aureus :
Conventional PCR was applied for detection of S.aureus using the specific primer

Staur 4	5’-ACGGAGTTACAAAGGACGAC-3’
Staur 6	5’-AGCTCAGCCTTAACGAGTAC-3’

The PCR condition according to [40]

Detection of Methicillin Resistant S.aureus:
MecA A gene was used as a marker for Methicillin resistant S.aureus (MRSA) and detected according to [40].

ISSN: 1343-4292
Volume 140, Issue 05, August, 2022

Methicillin Resistant Gene	mecA	mecA-F	162bp	5-TCCAGATTACAACTTCACCAGG-3
		mecA-R		3-CCACTTCATATCTTGTAACG-5

2.4 Statistical Analysis

Health care workers demography and cross tabulation were calculated by the Statistical Package for0the Social0Sciences for windows0version 17 (SPSS, Armonk, NY: IBM Corp). Pearson's0chi-square and Pearson's correlation coefficient0was utilized for the correlation between the changeable of 2 test. P value of ≤ 0.05 and ≤ 0.01(2-tailed) were set0to0be0statistically important".

3. RESULTS

As shown in table (1), *S.aureus* was isolated primarily from 6/57, (10.52%), at the age group (≤1-1)year and (5-7)year, followed by3/57,(5.26%) at the age group (11-13)year. Minority of patient with positive results at the age group (2-4) year and (8-10) year,2/57, (3.50%). Neither significant difference nor correlation with of age group and *S.aureus* infection. The risk of infection with *S.aureus* was (1.333) time among age group(11-13) year followed by(1.250)time for age group (8-10)year. other age groups have low risk for infection with *S.aureus*.

MRSA was isolated primarily from 6/57, (10.52%), at the age group (5-7) year, followed by2/57, (3.50%) at the age group (≤1-1)year and (11-13) year. Minority of patient with positive results at the age group (2-4)year and (8-10)year,1/57,(1.75%). Significant difference (value= 0.007) and correlation (p value= 0.002) were reported among the age group (5-7) and MRSA infection. The risk of infection with MRSA was (2.933) time among age group (2-4)year followed by(1.733)time for age group (≤1-1) year and (1.600) time among the age group(8-10) year.

Table (1): Age as a risk factor for infection with S.aureus and MRSA in Al-Batool teaching hospital for maternity and children

Age group	Type of isolates from patients admitted to Al-Batool teaching hospital for maternity and children		χ2	P value	R	P value	Risk estimate	C I 95%
	S.aureus							
	Negative	Positive						
≤1-1	9(15.78%)	6(10.52%)	0.407	0.523	0.085	0.532	0.750	0.313- 1.797
2-4	10(17.54%)	2(3.50%)	1.900	0.150	-.183	0.174	2.500	.607- 10.289
5-7	5(8.77%)	6(10.52%)	2.760	.098	.220	0.100	0.417	.146- 1.192
8-10	5(8.77%)	2(3.50%)	0.081	0.571	-.038	0.780	1.250	.267- 5.858
11-13	8(14.03%)	3(5.26%)	.225	0.463	-.063	0.642	1.333	0.399- 4.459
14-16	1(1.75%)	0(0%)	0.509	0.667	-0.094	0.484	ND	ND
Total	38(66.67%)	19(33.33%)	57(100%)					

Age group	Type of isolates from patients admitted to Al-Batool teaching hospital for maternity and children		$\chi 2$	P value	R	P value	Risk estimate	C I 95%
	S.aureus							
	Negative	Positive						
Age group	Type of isolates from patients admitted to Al-Batool teaching hospital for maternity and children		$\chi 2$	P value	R	P value	Risk estimate	C I 95%
	MRSA							
	Negative	Positive						
≤1-1	13(22.80%)	2(3.50%)	.730	0.393	-0.113	0.402	1.733	.451- 6.657
2-4	11(19.29%)	1(1.75%)	1.480	0.213	-.161	0.231	2.933	.419- 20.526
5-7	5(8.77%)	6(10.52%)	9.200	.007	0.402	0.002	0.222	0.082- 0.605
8-10	6(10.52%)	1(1.75%)	0.220	0.639	-0.062	0.646	1.600	0.212- 12.049
11-13	9(15.78%)	2(3.50%)	.068	0.579	-0.034	0.799	1.200	0.298- 4.835
14-16	1(1.75%)	0(0%)	0.271	0.789	-.069	0.610	ND	ND
Total	45(78.94%)	12(21.05%)	57(100%)					

As shown in table (2), S. aureus was recorded mainly among males 10/57, (19.29%). only 8/57, (14.03%) of females were infected with S.aureus. neither significant difference (p value= 0.535) nor correlation (p value= 0.852) were reported between sex of children and S.aureus infections. The risk for infection with S.aureus among males was(1.045) time versus (0.938) for females.

MRSA was recorded mainly among males 8/57, (14.03%). Only 4/57, (7.01%) of females were infected with MRSA. neither significant difference (p value= 0.577) nor correlation (p value= 0.585) were reported between sex of children and MRSA infections. Odd ratio for males was (0.462) time versus (0.684) for females. The risk for infection with MRSA among males was (1.267) time versus (0.867) for females.

Table (2): Sex as a risk factor for infection with S.aureus and MRSA in Al-Batool teaching hospital for maternity and children

Type of isolates from patients in Al-Batool teaching hospital for maternity and children					
Sex	S.aureus		MRSA		
	Negative	Positive	Negative	Positive	Total
Female	15(26.31%)	8(14.03%)	19(33.33%)	4(7.01%)	23(40.35%)
Male	23(40.35%)	11(19.29%)	26(45.61%)	8(14.03%)	34(59.64%)
Total	38(66.67%)	19(33.33%)	45(78.94%)	12(21.05%)	57(100%)
$\chi 2$	.036		0.311		

ISSN: 1343-4292
Volume 140, Issue 05, August, 2022

Type of isolates from patients in Al-Batool teaching hospital for maternity and children					
Sex	S.aureus		MRSA		
	Negative	Positive	Negative	Positive	Total
Female	15(26.31%)	8(14.03%)	19(33.33%)	4(7.01%)	23(40.35%)
Male	23(40.35%)	11(19.29%)	26(45.61%)	8(14.03%)	34(59.64%)
P value	0.535		0.577		
R	-0.025		0.074		
P value	0.852		0.585		
	Value	95% CI	Value	95% CI	
Risk estimate for Sex =male	1.045	0.659-1.659	0.867	0.541- 1.389	
Risk estimate for Sex =female	0.938	0.486- 1.810	1.267	0.531- 3.024	

As shown in table (3), S.aureus was recorded mainly among patients with Primary education level 10/57, (17.54%), followed by those with illiterate level ,9/57, (15.78%). Significant difference (p value =0.000) and correlation (p value = 0.000) were reported between education level and infection with S.aureus among patients admitted to Al-Batool teaching hospital for maternity and children. The risk of those with illiterates level to be infected with S.aureus was (1.308)time, which considered higher than those with primary education level(0.333). MRSA was recorded mainly among patients with Primary education level 8/57, (14.03%), followed by those with illiterate level ,4/57, (7.01%). Significant difference (p value =0.000) and correlation (p value = 0.000) were reported between education level and infection with MRSA among patients admitted to Al-Batool teaching hospital for maternity and children. The risk of those with primary level to be infected with MRSA was (1.067) time, which considered higher than those with illiterate education level(0.987).

Table (3): Education level as a risk factor for infection with S.aureus and MRSA in Al- Batool teaching hospital for maternity and children

Type of isolates from patients in Al-Batool teaching hospital for maternity and children					
Education level	S.aureus		MRSA		
	Negative	Positive	Negative	Positive	Total
Illiterate	38(66.67%)	9(15.78%)	43(75.43%)	4(7.01%)	47(82.45%)
Primary	0(0%)	10(17.54%)	2(3.50%)	8(14.03%)	10(17.54%)
Total	38(66.67%)	19(33.33%)	45(78.94%)	12(21.05)	57(100%)
$\chi 2$	24.255		25.355		
P value	0.000		0.000		
R	0.652		0.667		

Type of isolates from patients in Al-Batool teaching hospital for maternity and children					
Education level	S.aureus		MRSA		
	Negative	Positive	Negative	Positive	Total
Illiterate	38(66.67%)	9(15.78%)	43(75.43%)	4(7.01%)	47(82.45%)
Primary	0(0%)	10(17.54%)	2(3.50%)	8(14.03%)	10(17.54%)
Total	38(66.67%)	19(33.33%)	45(78.94%)	12(21.05)	57(100%)
P value	0.000		0.000		
	Value	95% CI	Value	95% CI	
Risk estimate Education level =illiterate	1.308	0.945- 1.809	0.987	0.740- 1.315	
Risk estimate for Education level=primary	0.333	0.107- 1.041	1.067	0.260- 4.380	

As shown in table (4), S.aureus was detected primarily from patients using hand disinfectant , 13/57, (22.80%) compared with those do not use hand disinfectant ,6/57, (10.52%).Significant difference was reported between using of hand disinfectant and infection with S.aureus among patients admitted to Al-Batool teaching hospital for maternity and children, (p value= 0.000).Invers significant correlation was reported between using of hand disinfectant and infection with S.aureus among patients admitted to Al-Batool teaching hospital for maternity and children (p value= 0.000). The risk of getting S.aureus infection was (1.667) time among patients admitted to Al-Batool teaching hospital for maternity and children which does not use hand disinfectant compared with (0.875)time ,for those using hand disinfectant.

MRSA was detected primarily from patients that use hand disinfectant, 11/57, (19.29%) compared with those do not use hand disinfectant ,1/57, (6.38%). significant difference (p value= 0.000), and inverse correlation (p value= 0.000) were reported between using of hand disinfectant and infection with MRSA among patients admitted to type of isolates from patients in Al-Batool teaching hospital for maternity and children. The risk of getting MRSA infection was (1.375) time among patients admitted to Al-Batool teaching hospital which does not use hand disinfectant compared with (0.711)time ,for those using hand disinfectant.

Table (4): Using of Hand disinfectant as a risk factor for infection with S.aureus and MRSA in Al- Batool teaching hospital for maternity and children

Type of isolates from patients in Al-Batool teaching hospital for maternity and children					
Using of Hand disinfectant	S.aureus		MRSA		
	Negative	Positive	Negative	Positive	Total
Yes	0(0%)	13(22.80%)	2(3.50%)	11(19.29%)	13(22.80%)
No	38(66.67%)	6(10.52%)	43(75.43%)	1(1.75%)	44(77.19%)
Total	38 (66.67%)	19(33.33%)	45(78.94%)	12(21.05%)	57(100%)
$\chi 2$	33.682		40.938		

ISSN: 1343-4292
Volume 140, Issue 05, August, 2022

Type of isolates from patients in Al-Batool teaching hospital for maternity and children					
Using of Hand disinfectant	S.aureus		MRSA		
	Negative	Positive	Negative	Positive	Total
Yes	0(0%)	13(22.80%)	2(3.50%)	11(19.29%)	13(22.80%)
No	38(66.67%)	6(10.52%)	43(75.43%)	1(1.75%)	44(77.19%)
Total	38 (66.67%)	19(33.33%)	45(78.94%)	12(21.05%)	57(100%)
P value	0.000		0.000		
R	-0.769		-0.847		
P value	0.000		0.000		
Risk estimate using of Hand disinfectant =yes	0.875	0.667- 1.149	0.711	0.590- 0.857	
Risk estimate for using of Hand disinfectant =No	1.667	0.519- 5.353	1.375	1.147- 1.648	

As shown in table (5), S.aureus was detected primarily from children that do not hospitalized in last two months, 16/57, (28.07%) compared with those who previously hospitalized in last two months ,3/57, (5.26%). Neither Significant difference (p value= 0.277) nor correlation (p value= 0.285). were reported between Previous hospitalization in last two months and infection with S.aureus among patients admitted to Al-Batool teaching hospital for maternity and children. The risk of getting S.aureus infection was (1.833) time among patients Previous hospitalization to Al-Batool teaching hospital for maternity and children compared with (0.844)time ,for those do not Previous hospitalization in last two months.

MRSA was detected primarily from children that do not hospitalized in last two months, 10/57, (17.54%) compared with those who previously hospitalized in last two months ,2/57, (3.50%). Neither Significant difference (p value= 0.475) nor correlation (p value= 0.483). were reported between Previous hospitalization in last two months and infection with MRSA among patients admitted to Al-Batool teaching hospital for maternity and children. The risk of getting MRSA infection was (1.600) time among patients Previous hospitalization to Al-Batool teaching hospital for maternity and children compared with (0.880)time ,for those do not Previous hospitalization in last two months

Table (5): Previous hospitalization in last two months as a risk factor for infection with S.aureus and MRSA in Al- Batool teaching hospital for maternity and children

Previous hospitalization in last two months	Type of isolates from patients in Al-Batool teaching hospital for maternity and children				
	S.aureus		MRSA		
	Negative	Positive	Negative	Positive	Total
No	27(47.36%)	16(28.07%)	33(57.89%)	10(17.54%)	43(75.43%)
Yes	11(19.29%)	3(5.26%)	12(21.05%)	2(3.50%)	14(24.56%)
Total	38 (66.67%)	19(33.33%)	45(78.94%)	12(21.05%)	57(100%)
$\chi 2$	1.184		0.511		

Previous hospitalization in last two months	Type of isolates from patients in Al-Batool teaching hospital for maternity and children				
	S.aureus		MRSA		
	Negative	Positive	Negative	Positive	Total
No	27(47.36%)	16(28.07%)	33(57.89%)	10(17.54%)	43(75.43%)
Yes	11(19.29%)	3(5.26%)	12(21.05%)	2(3.50%)	14(24.56%)
Total	38 (66.67%)	19(33.33%)	45(78.94%)	12(21.05%)	57(100%)
P value	0.277		0.475		
R	-0.144		-0.095		
P value	0.285		0.483		
	Value	95% CI	Value	95% CI	
Risk estimate for Previous hospitalization =yes	1.833	0.580- 5.800	1.600	0.413- 6.201	
Risk estimate for Previous hospitalization =No	0.844	0.637-1.118	0.880	0.647- 1.198	

As shown in table,(6),S.aureus was isolated primarily from 15/57, (26.31%) of patients who do not performed central venous catheterization compared with 4/47 , (7.01%) who performed central venous catheterization at Al-Batool teaching hospital for maternity and children. Significant difference (p value= 0.003), and correlation (p value= 0.003) were reported between catheterization and infection with S.aureus .The estimated risk for getting S.aureus infection among patients who do not performed central venous catheter was(1.267) time compared with those performed central venous catheterization.

MRSA was isolated primarily from 10/57, (17.54%) of patients who do not performed central venous catheter compared with 2/57, (3.50%) who performed central venous catheterization at Baqubah teaching hospital. Neither significant difference (p value= 0.141), nor correlation (p value= 0.146) were reported between catheterization and infection with MRSA.

Odds ratio for MRSA infection among patients who do not perform central venous catheterization versus those performed central venous catheterization was (4.300) times. The estimated risk for getting MRSA infection among patients who do not performed central venous catheter was(1.147) time compared with (0.267)time for those performed central venous catheterization.

Table (6): Central venous catheterization as a risk factor for infection with S.aureus and MRSA in Al-Batool teaching hospital for maternity and children

Central venous catheterization	Type of isolates from patients in Al-Batool teaching hospital for maternity and children				
	S.aureus		MRSA		
	Negative	Positive	Negative	Positive	Total

ISSN: 1343-4292
Volume 140, Issue 05, August, 2022

No	38(66.67%)	15(26.31%)	43(75.43%)	10(17.54%)	53(92.98%)
Yes	0(0%)	4(7.01%)	2(3.50%)	2(3.50%)	4(7.01%)
Total	38 (66.67%)	19(33.33%)	45(78.94%)	12(21.05%)	57(100%)
$\chi 2$	8.604		2.169		
P value	0.003		0.141		
R	0.389		0.195		
P value	0.003		0.146		
	Value	95% CI	Value	95% CI	
Risk estimate for Central venous catheter =yes	ND	ND	0.267	0.042- 1.702	
Risk estimate for Risk estimate for Central venous catheter =No	1.267	1.004- 1.598	1.147	0.883- 1.488	

As shown in table (7),S.aureus was detected primarily from patients lived with three family members , 9/57, (15.78%) ,followed by those lived with four family members , 7/57, (12.28%), those lived with five family members , 3/57, (5.26%). Neither significant difference nor correlation was reported between number of family members and infection with S.aureus among patients admitted to Al- Batool teaching hospital for maternity and children . The risk of getting S.aureus infection was (1.056) time among those lived with three members in a family which is higher than those lived with other number of family members .The second group of patient at risk for getting S.aureus infection among those lived in a family with four members , (1.000)time.

MRSA was detected primarily from patients lived with three family members, 6/57, (10.52%) followed equally by those lived with four family members, 5/57, (8.77%) and finally those lived with five family members 1/47,(1.75%).Neither significant difference nor correlation was reported between number of family members and infection with MRSA among patients admitted to Al- Batool teaching hospital for maternity and children. The risk of getting MRSA infection was (1.867) time among those lived with five members in a family which is higher than those lived with other number of family members.

Table (7): Number of family members as a risk factor for infection with S.aureus and MRSA in Al- Batool teaching hospital for maternity and children

Number of family members	Type of isolates from patients admitted to Al- Batool teaching hospital for maternity and children			$\chi 2$	P value	R	P value	Risk estimate	C I 95%
	S.aureus								
	Negative	Positive	Total						
Three	19(33.33%)	9(15.78%)	28(49.12%)	0.035	0.851	-0.025	0.855	1.056	.597- 1.868

Number of family members	Type of isolates from patients admitted to Al- Batool teaching hospital for maternity and children			χ2	P value	R	P value	Risk estimate	C I 95%
	S.aureus								
	Negative	Positive	Total						
Four	14(24.56%)	7(12.28%)	21(36.84%)	0.039	0.535	0.026	0.848	1.000	0.486-2.057
Five	5(8.77%)	3(5.26%)	8(14.03%)	0.073	0.540	0.036	0.792	0.833	0.222- 3.123
Total	38 (66.67%)	19(33.33%)	45(78.94%)						
Number of family members	Type of isolates from patients admitted to Al- Batool teaching hospital for maternity and children			χ2	P value	R	P value	Risk estimate	C I 95%
	MRSA								
	Negative	Positive	Total						
Three	22(38.59%)	6(10.52%)	28(49.12%)	0.005	0.600	0.009	0.947	0.978	0.516- 1.854
Four	16(28.07%)	5(8.77%)	20(35.08%)	0.289	0.415	0.071	0.599	0.853	0.393- 1.855
Five	7(12.28%)	1(1.75%)	8(14.03%)	0.410	0.460	-0.085	0.531	1.867	0.254- 13.740
Total	45	12	57						

4. DISCUSSION

Current results revealed, in Al-Batool teaching hospital for Maternity and Children, S. aureus isolated from (33.3%) of admitted children. MRSA was detected among (21.1%) of admitted children. The majority of patients were categorized at (≤1-1)years, (26.31%). S.aureus recorded dominantly in males, as they constituted (59.6%), versus (40.4%) for females. This result was lower than that reported in Iran, in which, (46.8%) of tested isolates were S. aureus based on results of PCR [22]. In USA, [3], reported that S. aureus was isolated from the abscesses of (24.5 %) of patients, while infection with MRSA was (33.3%).

In the USA, [42] reported that the prevalence of MRSA was 31.6%. But, was higher than that reported in the U SA in a previous study by [20], they stated that maternal (MRSA) colonization that occurred in (10%-17%) of mothers. The higher prevalence of MRSA, (20.9%) among children with two months. On the other hand, [20]. reported that infants born to the mothers with S. aureus vaginal colonization has five times more likely to be nasally colonized within two hours of birth [20]. One-fourth of infants (26.1%) born to infected mothers with vaginal S. aureus colonization had concurrent nasopharyngeal colonization by S. aureus. The fetus is sterile until pre-natal, and the child gets neonate and becomes colonized with bacteria after its birth [44].

In current study, significant correlations were reported between samples regarding the type of isolate S. aureus, also MRSA, and the significant likelihood ratio. A significant correlation between the positive S.

aureus, and positive samples to be MRSA.

Gradmann C. confirmed that the resistance to methicillin and different penicillin's-resistant is because of the existence of the mec operon, this mecA gene encodes a penicillin-binding protein is PBP2a, which has a lower affinity for beta-lactam antibiotics, PBP proteins take part in the construction of bacterial cell walls [16]. The results of the present study agree with [36], they stated that the mecA gene was identified by PCR as more sensitive and accurate than the oxacillin disk test and has unique genetic elements, according to the results, the presence of the mecA gene in 56 studied strains was 100% [36]. The current result was lower than that reported in Pakistan, [21] 35% were methicillin-sensitive S.aureus and 65% were MRSA. On the other hand, [21] stated that among MRSA isolates, mecA was present in 54% of isolates and 83% were multi-drug resistant, while only one MRSA isolate carried the mecA gene. In Taiwan. [43] reported that (46.4%) of children with atopic dermatitis were colonized with S. aureus, and (30.8%) were MRSA.

In the current study S. aureus was detected mainly among (10.52%), at the main age group (≤1-1) year and (5-7)years, while MRSA was detected mainly among (10.52%) in the main age group (5-7) years. No correlation was reported between the age of the patient and the isolation rate of S.aureus and MRSA in Al-Batool hospital for maternity and children.

In South Africa, [26], the greatest proportion of cases of S. aureus infections occurred in those aged <5 years MRSA (38%), and S. aureus (33%), with cases < 1-year-old accounting for MRSA (27%) and S. aureus (25%) cases. In Argentina, [37] MRSA colonization was 65% of S. aureus bacteremia in children. These results come in accordance with that reported, In the Saint Louis Children's Hospital U.S. [7], no correlation between MRSA and sex, age, race, Methicillin-sensitive S aureus (MSSA) was more spread (77.8%) than methicillin-resistant (MRSA) (22.2%). Unlike our study, S.aureus infection among early-onset infants was (41%) [39].

In the current study, S. aureus was detected mainly among males (19.29%). Only (14.03%) of females were infected with S.aureus, whilst, MRSA was detected mainly among males (14.03%), while (7.01%) of admitted females were infected with MRSA. nor correlation was reported between the sex of the admitted children and the isolation rate of S. aureus and MRSA in Al-Batool Hospital For Maternity And Children.

Unlike in current study, in Saudi Arabia, [2], among the nasal swabs of patients females and males, the MRSA colonization rate was (9.04%) for females was (5.85%) and for males (5.71%). In Nigeria, [31] the rate of (56.3%) of the children who were positive for S. aureus; were males (51.3) while (48.7) were females, also results saw that sex is not a significant risk factor in S. aureus carriage, while age was ($P< 0.05$). Clinical isolates of S. aureus were collected, for males was (31.25%, and for females as (37.5%), the most and the least positive cases in age groups (11-20) years was (50%) and age groups (51-60) years was 41.66% [1].

In the current study, S. aureus was recorded mainly among children with the main level in primary education level (17.54%), followed by illiterates, (15.78%), whilst MRSA infection was recorded mainly among children with the main level in primary education level (14.03%), followed by illiterates, (7.01%). Significant differences and correlations were reported between the education level of the children and the isolation rate of S.aureus and MRSA in Al-Batool Hospital For Maternity And Children.

The prevalence of S. aureus infection was 6.3% and (MRSA) was(16.3%), the factors associated with S. aureus infection in children were the attending preschool or school [32].

In current study, the majority of patients presented with Intraabdominal infections (85.96%), followed equally by respiratory tract infections, and wound and soft tissue infections (7.01%). S.aureus was recovered primarily from Intra-abdominal infections (19.29%), followed equally by respiratory tract infection, and wound and soft tissue infections (7.01%). MRSA was recovered primarily from intra-abdominal infections, (8.77%), followed by wound and soft tissue infections, (7.01%), and finally from Respiratory tract infections (5.26%). A significant difference (p-value =0.000) and correlation (p-value = 0.000) were reported between clinical presentation and isolation of S.aureus and MRSA from patients in Al-Batool hospital for Maternity and children. Unlike the present study, [18], in Sudan, recorded that respiratory tract infection shows the highest percentage of S. aureus (28.3%). In Taiwan, [9], reported that S. aureus isolates were identified in (36.0%) of patients, where a total of (71.8%) of isolates were community-associated and (45.8%) were inpatients associated and the common specimen of S. aureus was pus or wound (73.3%). In Taiwan, [47] reported that the Erysipelas/cellulitis (73.8%) was the most common pediatric, followed by acute lymphadenitis (13.6%) and furuncle/abscess/carbuncle (8.6%), were S. aureus(22.2%), and were MRSA(56.8%), the age group (0–1 month) was (P = 0.04).

In the current study, The majority of children presented with the following underlying diseases, Inflammatory disease (91.22%), followed by Chronic respiratory diseases(7.01%), S.aureus was recovered primarily from Inflammatory disease, (24.56%), followed by Chronic respiratory diseases (7.01%) and renal disease (1.75%). MRSA was recovered primarily from Inflammatory disease, (15.78%), followed by chronic respiratory diseases (5.26%) and renal disease (1.75%). A significant difference and correlation were reported between underlying diseases and isolation of S.aureus and MRSA from patients in Al-Batool hospital for Maternity and children.

In Iran, [17] Patients had positive S. aureus of the nose (15.9%), followed by patients in the throat (4.4%), followed by patients in the groin skin (3.1%), and urine (0.9%), positive of S.aureus was (20.8%) the patients had among whom, (1.8%) were MRSA infection. On the other hand, one of the studies showed which conducted in Al-Hilla teaching hospital and Al-Noor hospital for children in Iraq, the bacterial causes of tonsil infection include chronic and acute tonsillitis as a result of S. aureus rate (19.3%) for children [28]. In Greece, [6] reported that MRSA has been identified in 35% of children accepted in the hospital due to S.aureus osteoarticular infection, also, 75% of children with S. aureus pneumonia infection. In Italy, [23] S. aureus was isolated from upper respiratory tract infections with a rate of (19%), bloodstream infections (14%), osteoarticular infections (2%), acute conjunctivitis (2%), and infections in other sterile sites (2%), with a median age of 3.4 years.

In the current study, S. aureus was recovered primarily from skin swabs, (17.54%), followed by mouth swabs (40.35%). MRSA was recovered primarily from skin swabs, (12.28%), followed by mouth swabs (8.77%). No correlation was reported between the type of Specimen and isolation of S.aureus and MRSA from patients in Al-Batool Hospital For Maternity And Children.

In Scotland, UK, [25] the common sample type from S aureus was isolated as an oral, whereas for MRSA this was a tongue swab. The overall number of S. aureus recorded significantly decreased during 2020 [23]. The decrease in hospitalizations is due to the raised use of telehealth [12]. The a fundamental decrease in pediatric hospitalizations for several acute cases, such as asthma and bronchiolitis, during the wave of the COVID-19 pandemic in the world [45], [19].

In the current study, S.aureus was isolated primarily from (10.52%), in the age group (≤1-1)year and (5-7)year, followed by (5.26%) at the age group (11-13)year. No correlation between the age group and

S.aureus infection. MRSA was isolated primarily was (10.52%), in the age group (5-7) years, followed by(3.50%) in the age group (≤1-1) years and (11-13) years. A significant difference and correlation were reported among the age group (5-7) and S.aureus infection, the risk of infection with S.aureus was (2.933) times among the age group(2-4) years, in Al-Batool teaching hospital for maternity and children.

In China, [24] The average age of the registered f S. aureus bacteremia children was 56 months (4.6)years. In Aspen, The prevalence of nasal carriage of S.aureus was 30% among Spanish children, while MRSA prevalence was 1.4%, also, increased infections among children less than 4 years, which live in village areas, among the main risk factors for colonization were involved male gender, age above 5 years, atopic dermatitis, asthma or allergy, and residence in civilized areas [38]. [32] confirmed less prevalence was in the six months first of the life of preterm, and no find statistically significant differences or correlation in the prevalence of S. aureus with age group [32]. The demographic and clinical factors in this study such as age are not significantly correlated with having a bacterial infection [5].

In the current study, S.aureus was recorded mainly among males (19.29%), and only (14.03%) of females were infected with S.aureus. No correlation was reported between the sex of children and S.aureus and MRSA infections, MRSA was recorded mainly among males (14.03%), and only (7.01%) of females were infected with MRSA, the reported between the sex of children and MRSA infections, in Al-Batool teaching hospital for maternity and children.

In Germany, Age, and gender, [29] had a significant influence on S. aureus colonization. In Italy, [23], S. aureus was recorded in patients, male (53%), and female, (47%) with a median age of 3.4 years.

In the current study, S.aureus was recorded mainly among patients with a Primary education level (17.54%), followed by those with an illiterate level,(15.78%). Significant differences and correlations were reported between education level and infection with S.aureus among patients admitted to Al-Batool teaching hospital for maternity and children. The risk of those with an illiterates level being infected with S.aureus was (1.308) times, which is considered higher than those with a primary education level(0.333). MRSA was recorded mainly among patients with a Primary education level (14.03%), followed by those with an illiterate level,(7.01%). Significant differences and correlations were reported between education level and infection with S. aureus among patients admitted to Al-Batool teaching hospital for maternity and children.

Unlike in current study, The demographic and clinical factors in this study such as level of education, are not significantly correlated with having a bacterial infection [5]. In India, [33] a research study confirmed a prevalence of (16%) for S. aureus and MRSA which were (19%) among how school-going children.

In the current study, S. aureus was detected primarily in patients using hand disinfectant, (22.80%) compared with those who do not use hand disinfectant, (10.52%). An inverse significant correlation was reported between using of hand disinfectant and infection with S.aureus among patients admitted to Al-Batool teaching hospital for maternity and children. The risk of getting S.aureus infection was (1.667) times among patients admitted to Al-Batool teaching hospital for maternity and children who do not use hand disinfectant compared with (0.875) times, for those using hand disinfectant. MRSA was detected primarily in patients that use hand disinfectant, (19.29%) compared with those who do not use hand disinfectant, (6.38%). The risk of getting MRSA infection was (1.375) times among patients admitted to Al-Batool teaching hospital for maternity and children which does not use hand disinfectant compared with (0.711) times, for those using hand disinfectant.

Using zone of outgrowth inhibition with kill curve assays, they evaluated the performance of (46) commercially obtainable hand sanitizers that were obtained from pharmacies, market stores, and boutiques for antibacterial activity toward prototypical Staphylococcus aureus (Gram-positive) bacterial pathogens. The finding revealed significant variability in the effectiveness of several sanitizers evaluated, and also, revealed that E. coli was most susceptible to sanitizers in comparison to the S.aureus, there was significant from one strain to another variability in hand sanitizers and antimicrobial activity regardless of the organism [10].

Chlorhexidine gluconate (CHG) is most used as an antiseptic, preservative, and cosmetic product. Due to misuse of CHG concentrations and there have been studies on its inadequacy in infections control, and that exposure to an inhibitory concentration of Chlorhexidine gluconate (CHG) induced the evolution of S.aureus with the many common phenotypic and genotypic features of clinical S.aureus isolates, including rising biofilm formation [4]. In France, [27], There was a disincentive to hand hygiene with alcohol-based hand sanitizer, especially in contact with newborns, they mostly carriage S.aureus by touching their skin. [15] confirmed a reduced transmission of bacteria in a neonatal intensive care unit (NICU) after the application of a firm hand hygiene standards.

In the current study, S.aureus was detected primarily in children that do not been hospitalized in the last two months, (28.07%) compared with those who were previously hospitalized in the last two months, (5.26%). MRSA was detected primarily in children that do not been hospitalized in the last two months, (17.54%) compared with those who were previously hospitalized in the last two months, (3.50%). No correlation was reported between the Previous hospitalization in the last two months and infection with S.aureus and MRSA among patients admitted to Al-Batool teaching hospital for maternity and children. The risk of getting S.aureus infection was (1.833) times among patients with the Previous hospitalization to Al-Batool teaching hospital for maternity and children compared with (0.844) times, for those who do not have the Previous hospitalization in the last two months. The risk of getting MRSA infection was (1.600) times among children with the Previous hospitalization to Al-Batool teaching hospital for maternity and children compared with (0.880) times, for those who do not have a Previous hospitalization in the last two months.

Risk factors for MRSA infection include prolonged hospital stay, a stay in the intensive care unit, and procedures during hospitalization [8]. In Germany, an intermediate-prevalence country, the German Institute recommends eclectic MRSA testing of patients at risk of S.aureus [34].

In the current study, S. aureus was isolated primarily from (26.31%) of patients who do not perform central venous catheterization compared with (7.01%) who performed central venous catheterization at Al-Batool teaching hospital for maternity and children. Significant differences and correlations were reported between catheterization and infection with S.aureus. The estimated risk of getting S.aureus infection among patients who do not per-formed central venous catheter was(1.267) times compared with those who performed central venous catheterization. MRSA was isolated (17.54%) of patients who do not perform central venous catheters compared with (3.50%) of those who performed central venous catheterization at Al-Batool teaching hospital for maternity and children. No correlation was reported between catheterization and infection with MRSA.

In Germany, [13] Confirmed risk factors for (MRSA) colonization involved the presence of (76%) infection due to a central venous catheter. Risk factors for MRSA infection include procedures during hospitalization such as insertion of central venous catheters [8].

In the current study, S.aureus was detected primarily in children who lived with three family members (15.78%), followed by those who lived with four family members, (12.28%), and those who lived with five family members, (5.26%). MRSA was detected primarily in patients who lived with three family members, (10.52%) followed equally by those living with four family members, (8.77%) and finally, those who lived with five family members (1.75%). No correlation was reported between a number of family members and infection with S.aureus and MRSA among patients admitted to Al- Batool teaching hospital for maternity and children.

In Germany, [13], three more parents were positive for MRSA previous to the admission of their children to the transplant ward, on by another hand, in four of the patients, at minimum one parent (five in total), was parents tested and found to be colonized by (MRSA).

5. Conclusion

The main risk factors for infection with S.aureus and /or MRSA were education level , using of hand disinfectant, central venous catheterization. Age and sex, Previous hospitalization in last two months, number of family members have no role as a risk factors.

6. REFERENCES

[1] Afrasyabi, R., L. Modiri, K. Issazadeh, R. K. Darsanaki and A. Masiha (2013). "Prevalence and Antibiotic Susceptibility Pattern of Staphylococcus aureus Isolated from Personnel and Patients in Roudbar Hospitals (Northern Iran)." JOURNAL OF PURE AND APPLIED MICROBIOLOGY 7(2): 1379-1382.

[2] Albarrag, A., A. Shami, A. Almutairi, S. Alsudairi, S. Aldakeel and A. Al-Amodi (2020). "Prevalence and molecular genetics of methicillin-resistant Staphylococcus aureus colonization in nursing homes in Saudi Arabia." Canadian Journal of Infectious Diseases and Medical Microbiology 2020.

[3] Albrecht, V. S., B. M. Limbago, G. J. Moran, A. Krishnadasan, R. J. Gorwitz, L. K. McDougal and D. A. Talan (2015). "Staphylococcus aureus colonization and strain type at various body sites among patients with a closed abscess and uninfected controls at US emergency departments." Journal of clinical microbiology 53(11): 3478-3484.

[4] Baseri, N., S. Najar-Peerayeh, B. Bakhshi and F. Campanile (2022). "Phenotypic and genotypic changes of Staphylococcus aureus in the presence of the inappropriate concentration of chlorhexidine gluconate." BMC microbiology 22(1): 1-9.

[5] Bitew, A. M., B. M. Tegene, B. M. Yeshitila, R. Howe and M. Dagnew (2019). "BACTERIAL PROFILE, ANTIBACTERIAL SUSCEPTIBILITY PATTERN AND AS-SOCIATED FACTORS AMONG WOMEN ATTENDING ANTENATAL AND POST-NATAL HEALTH SERVICES AT THE UNIVERSITY OF GONDAR TEACHING HOSPITAL, NORTHWEST ETHIOPIA."

[6] Bouras, D., A. Doudoulakakis, M. Tsolia, I. Vaki, N. Giormezis, N. Petropoulou, E. Lebessi, V. Gennimata, A. Tsakris and I. Spiliopoulou (2018). "Staphylococcus aureus osteoarticular infections in children: an 8-year review of molecular microbiology, antibiotic resistance and clinical characteristics." Journal of Medical Microbiology 67(12): 1753-1760.

[7] Briscoe, C. C., P. Reich, S. Fritz and C. C. Coughlin (2019). "Staphylococcus aureus antibiotic susceptibility patterns in pediatric atopic dermatitis." Pediatric Dermatology 36(4): 482-485.

[8] Calfee, D. P., C. D. Salgado, A. M. Milstone, A. D. Harris, D. T. Kuhar, J. Moody, K. Aureden, S. S. Huang, L. L. Maragakis and D. S. Yokoe (2014). "Strategies to prevent methicillin-resistant Staphylococcus aureus transmission and infection in acute care hospitals: 2014 update." Infection Control & Hospital Epidemiology 35(7): 772-796.

[9] Chen, Y.-J., P.-A. Chen, C.-J. Chen and Y.-C. Huang (2019). "Molecular characteristics and clinical features of pediatric methicillin-susceptible Staphylococcus aureus infection in a medical center in northern Taiwan." BMC Infectious Diseases 19(1): 1-9.

[10] Chojnacki, M., C. Dobrotka, R. Osborn, W. Johnson, M. Young, B. Meyer, E. Laskey, R. Wozniak, S. Dewhurst and P. Dunman (2021). "Evaluating the Antimicrobial Properties of Commercial Hand Sanitizers." MSphere 6(2): e00062-00021.

[11] Coia et al . , J., J. Wilson, A. Bak, G. Marsden, M. Shimonovich, H. Loveday, H. Humphreys, N. Wigglesworth, A. Demirjian and J. Brooks (2021). "Joint Healthcare Infection Society (HIS) and Infection Prevention Society (IPS) guidelines for the prevention and control of meticillin-resistant Staphylococcus aureus (MRSA) in healthcare facilities." Journal of Hospital Infection 118: S1-S39.

[12] Curfman, A., S. D. McSwain, J. Chuo, B. Yeager-McSwain, D. A. Schinasi, J. Marcin, N. Herendeen, S. L. Chung, K. Rheuban and C. A. Olson (2021). "Pediatric telehealth in the COVID-19 pandemic era and beyond." Pediatrics 148(3).

[13] Füller, M. A., S. Kampmeier, A. M. Wübbolding, J. Grönefeld, A. Kremer and A. H. Groll (2022). "Prospective surveillance of colonization and disease by methicillin-resistant Staphylococcus aureus (MRSA) at a European pediatric cancer center." Supportive Care in Cancer: 1-9.

[14] Gibbs, K. A., R. E. Rohde, B. Sanders, M. Acosta and D. L. Wild (2018). "Staphylococcus and MRSA Prevalence in Physical Therapist Education Programs: Are Students at Risk?" Journal of Physical Therapy Education 32(1): 65-69.

[15] Giuffrè, M., E. Amodio, C. Bonura, D. M. Geraci, L. Saporito, R. Ortolano, G. Corsello and C. Mammina (2015). "Methicillin-resistant Staphylococcus aureus nasal colonization in a level III neonatal intensive care unit: Incidence and risk factors." American journal of infection control 43(5): 476-481.

[16] Gradmann, C. (2017). "From lighthouse to hothouse."

[17] Hadi, H., M. Jabalameli, A. Bagherifard, E. Ghaznavi-Rad, A. Behrouzi, A. Joorabchi and A. Azimi (2018). "Staphylococcus aureus colonization in patients undergoing total hip or knee arthroplasty and cost-effectiveness of decolonization programme." Archives of Bone and Joint Surgery 6(6): 554.

[18] Hamdan, E. M., A. A. Hassan, S. A. Amin, H. A. Ahmed, A. E. Ataelmanan and M. M. Elhassan (2022). "High Prevalence of Staphylococcal Enterotoxins (SEs) Virulence Genes Among Methicillin-Resistant Staphylococcus aureus Isolated from Patients with Different Clinical Manifestations in Khartoum State, Sudan." Egyptian Academic Journal of Biological Sciences, G. Microbiology 14(1): 77-83.

[19] Ippolito, G., A. La Vecchia, G. Umbrello, G. Di Pietro, P. Bono, S. Scalia, R. Pinzani, C. Tagliabue, S. Bosis and C. Agostoni (2021). "Disappearance of Seasonal Respiratory Viruses in Children

Under Two Years Old During COVID-19 Pandemic: A Monocentric Retrospective Study in Milan, Italy." Frontiers in pediatrics: 810.

[20] Jimenez-Truque, N., S. Tedeschi, E. J. Saye, B. D. McKenna, W. Langdon, J. P. Wright, A. Alsentzer, S. Arnold, B. R. Saville and W. Wang (2012). "Relationship between maternal and neonatal Staphylococcus aureus colonization." Pediatrics 129(5): e1252-e1259.

[21] Khan, A. A., A. Ali, N. Tharmalingam, E. Mylonakis and R. Zahra (2020). "First report of mecC gene in clinical methicillin resistant S. aureus (MRSA) from tertiary care hospital Islamabad, Pakistan." Journal of Infection and Public Health 13(10): 1501-1507.

[22] Khosravi, A. D., H. Hoveizavi and Z. Farshadzadeh (2012). "The prevalence of genes encoding leukocidins in Staphylococcus aureus strains resistant and sensitive to methicillin isolated from burn patients in Taleghani Hospital, Ahvaz, Iran." Burns 38(2): 247-251.

[23] La Vecchia, A., G. Ippolito, V. Taccani, E. Gatti, P. Bono, S. Bettocchi, R. Pinzani, C. Tagliabue, S. Bosis and P. Marchisio (2022). "Epidemiology and antimicrobial susceptibility of Staphylococcus aureus in children in a tertiary care pediatric hospital in Milan, Italy, 2017—2021." Italian Journal of Pediatrics 48(1): 1-8.

[24] Li, Y., Q. Li, G. Zhang, H. Ma, Y. Wu, Q. Yi, L. Jiang, J. Wan, F. Suo and Z. Luo (2019). "Time to positivity of blood culture is a risk factor for clinical outcomes in Staphylococcus aureus bacteremia children: a retrospective study." BMC infectious diseases 19(1): 1-9.

[25] McCormack, M., A. Smith, A. Akram, M. Jackson, D. Robertson and G. Edwards (2015). "Staphylococcus aureus and the oral cavity: an overlooked source of carriage and infection?" American journal of infection control 43(1): 35-37.

[26] Melony, C., S. Fortuin-de and A. Singh-Moodley (2015). "Staphylococcus aureus bacteraemia in Gauteng Academic Hospitals, South Africa." Int. J. Infect. Dis 30: 41-48.

[27] Menard, G., A. Morin-Le Bihan, H. Isly, G. Auger, K. Le Neindre, L. King, P. Martins-Simões, A. Tristan and P. Donnio (2021). "Clustered cases of infections due to an uncommon methicillin-resistant Staphylococcus aureus originating in a maternity ward." Infectious diseases now 51(6): 540-546.

[28] Nabat, Z. N., B. A. ALateef and I. M. Hussain (2019). "Bacteriological and Immunological Study of Patients with Tonsillitis in Hila City." Iraqi journal of biotechnology 18(2).

[29] Neidhart, S., S. Zaatreh, A. Klinder, S. Redanz, R. Spitzmüller, S. Holtfreter, P. Warnke, A. Alozie, V. Henck and A. Göhler (2018). "Predictors of colonization with Staphylococcus species among patients scheduled for cardiac and orthopedic interventions at tertiary care hospitals in north-eastern Germany—A prevalence screening study." European Journal of Clinical Microbiology & Infectious Diseases 37(4): 633-641.

[30] Novelli-Rousseau, A., I. Espagnon, D. Filiputti, O. Gal, A. Douet, F. Mallard and Q. Josso (2018). "Culture-free antibiotic-susceptibility determination from single-bacterium Raman spectra." Scientific reports 8(1): 1-12.

[31] Nsofor, C., V. Nwokenkwo and C. Nwaokpa (2015). "Nasal carriage of Staphylococcus aureus among apparently healthy school children in Owerri metropolis, Nigeria." FMOJ Cell Science and Report 2(5): 117-120.

[32] Pathak, A., Y. Marothi, R. V. Iyer, B. Singh, M. Sharma, B. Eriksson, R. Macaden and C. S. Lundborg (2010). "Nasal carriage and antimicrobial susceptibility of Staphylococcus aureus in healthy preschool children in Ujjain, India." BMC pediatrics 10(1): 1-8.

[33] Ramana, K., S. Mohanty and C. Wilson (2009). "Staphylococcus aureus colonization of anterior nares of school going children." The Indian Journal of Pediatrics 76(8): 813-816.

[34] Raschpichler, G., H. Raupach-Rosin, M. K. Akmatov, S. Castell, N. Rübsamen, B. Feier, S. Szkopek, W. Bautsch, R. Mikolajczyk and A. Karch (2020). "Development and external validation of a clinical prediction model for MRSA carriage at hospital admission in Southeast Lower Saxony, Germany." Scientific reports 10(1): 1-8.

[35] Reiss-Mandel, A., C. Rubin, A. Maayan-Mezger, I. Novikov, H. Jaber, M. Dolitzky, L. Freedman, G. Rahav and G. Regev-Yochay (2019). "Patterns and predictors of Staphylococcus aureus carriage during the first year of life: a longitudinal study." Journal of Clinical Microbiology 57(9): e00282-00219.

[36] Rezashateri, M., M. Ahrabi and M. Salehi (2021). "Molecular Analysis of the Presence of pvl, spa, and mecA Genes and Their Correlation with a Range of Antibiotics in Staphylococcus aureus Collected from Burn Patients." Iranian Journal of Medical Microbiology 15(6): 625-637.

[37] Romero, R., A. Mastroianni, L. Casimir and R. Bologna (2016). "Community-acquired Staphylococcus aureus bacteremia in children: a cohort study for 2010-2014." Arch Argent Pediatr 114(6): 508-513.

[38] Rosal, T., A. Méndez-Echevarría and C. Garcia-Vera (2020). "Staphylococcus aureus nasal colonization in Spanish children." The COSACO Nationwide Surveillance Study. IDR 13: 4643-4651.

[39] San Thi, K., Z. W. Moe and K. N. Thein (2019). GP242 Early onset sepsis in extramural hospital of myanmar (burma), BMJ Publishing Group Ltd.

[40] Sheela, G. M. (2017). "Study of pathogenic factors of Staphylococcus aureus from clinical cases of livestock and poultry."

[41] Shettigar, K. and T. S. Murali (2020). "Virulence factors and clonal diversity of Staphylococcus aureus in colonization and wound infection with emphasis on diabetic foot infection." European Journal of Clinical Microbiology & Infectious Diseases: 1-12.

[42] Sutter, D. E., E. Milburn, U. Chukwuma, N. Dzialowy, A. M. Maranich and D. R. Hospenthal (2016). "Changing susceptibility of Staphylococcus aureus in a US pediatric population." Pediatrics 137(4).

[43] Tang, C. S., C. C. Wang, C. F. Huang, S. J. Chen, M. H. Tseng and W. T. Lo (2011). "Antimicrobial susceptibility of Staphylococcus aureus in children with atopic dermatitis." Pediatrics International 53(3): 363-367.

[44] Tsai, M.-H., C.-Y. Chiu, K.-W. Su, S.-L. Liao, H.-J. Shih, M.-C. Hua, T.-C. Yao, S.-H. Lai, K.-W. Yeh and L.-C. Chen (2021). "Community-Associated Methicillin-Resistant Staphylococcus Aureus Colonization in a Birth Cohort of Early Childhood: The Role of Maternal Carriage." Frontiers in medicine: 1957.

[45] Wilder, J. L., C. R. Parsons, A. S. Growdon, S. L. Toomey and J. M. Mansbach (2020). "Pediatric hospitalizations during the COVID-19 pandemic." Pediatrics 146(6).

[46] Yasmin, M., H. El Hage, R. Obeid, H. El Haddad, M. Zaarour and A. Khalil (2016). "Epidemiology of bloodstream infections caused by methicillin-resistant Staphylococcus aureus at a tertiary care hospital in New York." American journal of infection control 44(1): 41-46.

[47] Yueh, C.-M., H. Chi, N.-C. Chiu, F.-Y. Huang, D. T.-N. Huang, L. Chang, Y.-H. Kung and C.-Y. Huang (2022). "Etiology, Clinical features, Management, and Outcomes of Skin and Soft Tissue Infections in Hospitalized Children: A 10-year Review." Journal of Microbiology, Immunology and Infection.