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PREVALENCE OF METHICILLIN RESISTANCE STAPHYLOCOCCUS AUREUS AMONG ADULTS AND ADOLESCENTS WITH CHRONIC OSTEOMYELITIS IN MOSUL CITY CROSS SECTIONAL STUDY

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INTRODUCTION

Osteomyelitis is an infection that affects both the bone and the bone marrow. It usually begins in trabecular areas and can occur after surgery or an open fracture.[1] The most common bacteria excited with the foreign implants is Staphylococcus epidermidis, which is often non-pathogenic and often coagulase negative.[2] MRSA Methicillin-resistant Staphylococcus aureus (MRSA), is a particular group of gram-positive bacteria that differs genetically from other Staphylococcus aureus strains. MRSA causes human infections that are problematic to treat.[3] MRSA refers to any strain of Staphylococcus aureus that has developed resistance to multiple beta-lactam drugs by natural selection or horizontal gene transfer.[4] Diagnostic microbiology labs are essential for locating MRSA infections. Typically, a bacterium must be grown from samples of blood, urine, sputum, or other body fluids in sufficient quantities to allow for early confirmation tests.[5] Quantitative PCR methods are utilized in clinical laboratories to quickly detect and identify MRSA strains.[6] MRSA is a slow-growing bacterium that can thrive on a range of media, unlike methicillin-susceptible S. aureus (MSSA), which has been discovered to occur in mixed colonies with MSSA.[7]Treatment of an MRSA infection is critical, and postponement can be lethal. The location and history of the infection influence the course of treatment. An IV, oral, or combination of both forms of antibiotics effective against MRSA are available; the choice of which to use depends on the patient's characteristics and the specific circumstances.[8] Glycopeptide antibiotics such as vancomycin and teicoplanin are used to treat MRSA infections. Vancomycin's structural congener, tecoplanin, has a comparable spectrum of activities but a longer half-life.[9] Even toward vancomycin and teicoplanin, several recently identified MRSA strains exhibit antibiotic resistance. More serious infections that do not respond to glycopeptides like vancomycin can be treated with quinupristin/dalfopristin, daptomycin, ceftaroline, and tigecycline.[10]

EPIDEMIOLOGY

In 2023, MRSA kills around 11,285 persons in the United States.[3]

Hospitals, prisons, and nursing homes are popular places for MRSA infections to occur. These settings also put patients at higher risk of healthcare associated infections due to open wounds, invasive medical equipment like catheters, and compromised immune systems.[11] Since 2003, the middle East area has witnessed many conflicts, leaving thousands of innocents injured, particularly in Iraq. The majority of injuries involve extremities and are caused by bomb blasts and shell injuries which damage theconnective tissues and leave open fractures.[12]

Risk Factors of MRSA infection

- Hospitalized people.
- Prison inmates and military personnel.
- Animals.
- Athletes.
- Children.
- Intravenous drug users.

Prevention of MRSA

- Screening.
- Handwashing.
- Isolation.
- Restricting antibiotic use.
- Public health considerations.
- Decolonization.
- Agriculture.

AIM OF THE STUDY

The study aims to estimate the prevalence of MRSA

bacterial infection among adults &adolescents with chronic osteomyelitis in Mosul city.

Specific Objective

- To calculate the prevalence of (MRSA) among chronic osteomyelitis patients.
- To evaluate the possible contributing factors.
- To estimate other organisms in the cultures.
- To determine which antibiotics, use to treat it.

Patients and methods Study setting

The research was conducted at orthopedic consultation units and inpatients departments and outpatient departments of orthopedics; in (Al Jamhori Teaching hospital) which is located at the right side and the other (Al Salam Teaching Hospital) which was located on the left bank of Mosul.

Study design

A cross-sectional study, was selected in order to achieve the objectives of the present study. data was collected from the participants retrospectively by the non-randomized convenient technique.

Study Period

Data collection was done during six months' period from the 2nd of January 2024 to the 30th of June 2024.

Study sample

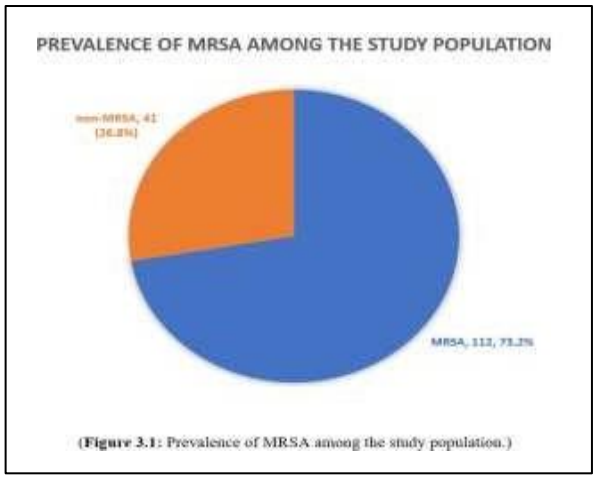
One hundred fifty-three participants.

Data collection tool

A questionnaire form was specially prepared in order to collect all the relevant information related to the study sample. the questionnaire contains detailed history of Age, gender, risk factors for MRSA infection, antibiotic used and its duration.

RESULTS

Study included 153 subjects, subjects with MRSA found in 112 (73.2%) and those without MRSA were 41 (26.8%). As shown in Figure 3.1.



(**Figure 3.1**: Prevalence of MRSA among the study population.)

Table 3.1 demonstrates the distribution of MRSA in the study population according to the age groups, among the age group of less than 20 years, MRSA was prevalent in 23 (63.9%) out of 36 subjects. Among the age group of (20 - less than 30), MRSA was prevalent in 30 (73.2%) out of 41 subjects. Among the age group of (30 - less than 40), MRSA was prevalent in 18 (81.8%) out of 22 subjects. Among the age group of (40 - less than 50) MRSA was prevalent in 17 (77.3%) out of 22 subjects. Among the age group of (50 - less than 60), MRSA was prevalent in 14 (63.6%) out of 8 subjects. Lastly, among the age group of 60 years and above, MRSA was prevalent in 10 out of 10 (100%) of subjects. As shown in table 3.1.

Table 3.1: Distribution of MRSA in subjects with osteomyelitis among different age groups (n=153).

Age group	MRSA		No MRSA		Total	
	No.	%	No.		No.	% of all participants
Less than 20 years	23	63.9%	13	36.1%	36	23.5%
20 - less than 30 years	30	73.2%	11	26.8%	41	26.8%
30 - less than 40 years	18	81.8%	4	18.2%	22	14.4%
40 - less than 50 years	17	77.3%	5	22.7%	22	14.4%
50 - less than 60 years	14	63.6%	8	36.4%	22	14.4%
60 years and above	10	100.0%	0	0.0%	10	6.5%

Table 3.2 shows the distribution of MRSA in study population according to their gender. Among the male gender, MRSA was prevalent in 98 (74.8%) out of 131 male subjects, while among the female gender, MRSA was prevalent in 14 (63.6%) out of 22 female subjects.

Table 3.2: Distribution of MRSA in subjects with osteomyelitis among different gender groups (n=153).

Gender	MRSA		No MRSA		Total	
	No.	%	No.	%	No.	% of all participants
Male	98	74.8%	33	25.2%	131	85.6%
Female	14	63.6%	8	36.4%	22	14.4%

Table 3.3 demonstrates distribution of MRSA in the study population according to history of smoking. Among those who have a history of smoking; MRSA was prevalent in 56 (74.7%) out of 75 subjects, while among those with no history of smoking, MRSA was prevalent in 56 (71.8%) out of 78 subjects.

Table 3.3: Distribution of MRSA in subjects with osteomyelitis according to smoking history (n=153).

Smoking history	MRSA		No MRSA		Total	
	No.	%	No.	%	No.	% of all participants
Smoking	56	74.7%	19	25.3%	75	49.0%
No smoking	56	71.8%	22	28.2%	78	51.0%

Table 3.4 shows the distribution of MRSA in the study population according to the history of diabetes. Among those who have history of diabetes; MRSA was prevalent in 9 (75%) out of 12 subjects, while among those with no history of diabetes, MRSA was prevalent in 103 (73%) out of 141 subjects.

Table 3.4: Distribution of MRSA in subjects with osteomyelitis according to history of diabetes (n=153).

Diabetes history	MRSA		No MRSA		Total	
	No.	%	No.	%	No.	% of all participants
Diabetes	9	75.0%	3	27.0%	12	7.8%
No diabetes	103	73.0%	38	27.0%	141	92.2%

Table 3.5 shows distribution of MRSA in study population according to the duration of osteomyelitis. Among subjects with a duration of osteomyelitis from 1 month to less than 6 months, MRSA was prevalent in 52 (78.8%) out of 66 subjects. Among subjects with a duration of osteomyelitis for 6 months to less than 1 year, MRSA was prevalent in 14 (73.7%) out of 19 subjects. Among subjects with a duration of osteomyelitis of 1 year to less than 2 years, MRSA was prevalent in 19 (73.1%) out of 26 subjects. Among subjects with duration of osteomyelitis of 2 years to less than 5 years, MRSA was prevalent in 19 (73.1%) out of 26 subjects. Lastly, among subjects with duration of osteomyelitis for 5 years and above, MRSA was prevalent in 8 (50%) out of 16 subjects. As shown in table 3.5.

Table 3.5: Distribution of MRSA in subjects with osteomyelitis according to duration of osteomyelitis (n=153).

Duration of osteomyelitis	MRSA		No MRSA		Total	
	No.	%	No.	%	No.	% of all participants
1 month - less than 6 months	52	78.8%	14	21.2%	66	43.1%
6 months - less than 1 year	14	73.7%	5	26.3%	19	12.4%
1 year - less than 2 years	19	73.1%	7	26.9%	26	17.0%
2 years - less than 5 years	19	73.1%	7	26.9%	26	17.0%
5 years and above	8	50.0%	8	50.0%	16	10.5%

Table 3.6 shows the distribution of MRSA in the study population according to the duration of the implant. Among subjects with no implant, MRSA was prevalent in 21 (70%) out of 30 subjects. Among subjects with a duration of implant for less than year, MRSA was prevalent in 41 (75.9%) out of 54 subjects. Among subjects with duration of implant for 1 year to less than 2 years, MRSA was prevalent in 21 (72.4%) out of 29 subjects. Among subjects with duration of implant for 2 years to less than 5 years, MRSA was prevalent in 17 (85%) out of 20 subjects. Among subjects with duration of implant for 5 years to less than 10 years, MRSA was prevalent in 4 (33.3%) out of 12 subjects. Lastly, among subjects with duration of implant for 10 years and above, MRSA was prevalent in 8 (100%) out of 8 subjects. As shown in table 3.6.

Table 3.6: Distribution of MRSA in subjects with osteomyelitis according to the duration of implant (n=153).

Duration of implant	MRSA		No MRSA		Total	
	No.	%	No.	%	No.	%
No implant	21	70.0%	9	30.0%	30	19.6%
Implant less than 1 year	41	75.9%	13	24.1%	54	35.3%
Implant 1 year – less than 2 years	21	72.4%	8	27.6%	29	19.0%
Implant 2 years – less than 5 years	17	85.0%	3	15.0%	20	13.1%
Implant 5 years – less than 10 years	4	33.3%	8	66.7%	12	7.8%
10 years and above	8	100.0%	0	0.0%	8	5.2%

Table 3.7 shows distribution of MRSA in study population according to the bone involved. Among subjects with ankle bone involved, MRSA was prevalent in 9 (90%) out of 10 subjects. Among subjects with

femur bone involved, MRSA was prevalent in 25 (59.5%) out of 42 subjects. Among subjects with foot bones involved, MRSA was prevalent in 6 (50%) out of 12 subjects. Among subjects with hand bones involved, MRSA was prevalent in 3 (75%) out of 4 subjects. Among subjects with humerus bone involved, MRSA was prevalent in 9 (75%) out of 12 subjects. Among subjects with tibia bone involved, MRSA was prevalent in 52 (80%) out of 65 subjects. Among subjects with other bones involved, MRSA was prevalent in 8 (100%) out of 8 subjects. As shown in table 3.7.

Table 3.7: Distribution of MRSA in subjects with osteomyelitis according to site of bone involved (n=153).

Bone involved	MRSA		No MRSA		Total	
	No.	%	No.	%	No.	%
Ankle	9	90.0%	1	10.0%	10	6.5%
Femur	25	59.5%	17	40.5%	42	27.5%
Foot	6	50.0%	6	50.0%	12	7.8%
Hand	3	75.0%	1	25.0%	4	2.6%
Humerus	9	75.0%	3	25.0%	12	7.8%
Tibia	52	80.0%	13	20.0%	65	42.5%
Other *	8	100.0%	0	0.0%	8	5.2%

*** Other bones included:** Radius in 2, radius & ulna in 2, epicondyle bone in 2, shoulder in 1, and clavicle in 1.

Table 3.8 illustrates the distribution of the study population according to different causes of osteomyelitis. Post-surgical causes were shown to be prevalent among 123 (80.4%) followed by trauma caused among 21 (13.7%) and idiopathic 9 (5.9%). As shown in Table 3.8

Table 3.8: Causes of osteomyelitis (n=153).

Cause of Osteomyelitis	Specific etiology	No.	%
Post-Surgical (123 cases)	Internal fixation	74	48.4
	External fixation	34	22.2
	Foreign body	6	4
	Internal and external fixation	2	1.3
	Bone cyst or benign tumor	2	1.3
	Infected open wound	2	1.3
	Below knee amputation stump infection	1	0.7
	Implant	1	0.7
	Abscess collection after fracture	1	0.7
Trauma (21 cases)	Open fracture/wound	8	5.2
	Infected wound	4	2.6
	RTA led to the fracture	5	3.3
	Crush injury or blast injury	3	2
	Fracture only	1	0.7
Idiopathic (9 cases)	unknown/sudden swelling	2	1.3
	Spontaneous boil	1	0.7
	Neuropathic ulcer	3	2
	Spontaneous infection after injury managed by bone cement	1	0.7
	Iliopsoas abscess due to septic arthritis with an infected wound	1	0.7
	Bony cyst	1	0.7

Table 3.9 shows different antibiotics used for the treatment of osteomyelitis, their numbers, percentages.

Table 3.9: Antibiotics used in treatment of osteomyelitis (n=153).

Antibiotic used	No.	%
Levofloxacin + Rifampicin	41	26.8
Vancomycin	38	24.9
Cotrimoxazole	18	11.8
Meropenem	15	9.8
Clindamycin	11	7.2
Imipenem	8	5.2
Ciprofloxacin + rifampicin	6	3.9
Ceftriaxone	4	2.6

Ciprofloxacin	3	2
Ceftazidime	3	2
Piperacillin tazobactam	2	1.3
Tigecycline	1	0.7
Levofloxacin alone	1	0.7
Ampicillin	1	0.7
Amoxiclav	1	0.7

Table 3.10 explains different bacterial profiles causing osteomyelitis among the study population. MRSA was found among 112 (73.20%) of the study population, followed by *Enterobacter cloaca* among 14 (9.15%). Moreover; *Pseudomonas aurignosa*, *Streptococcus species* and *Klebsiella pneumonia* were found among 7 (4.58%), 5 (3.27%) and 4 (2.61%) respectively. Furthermore; *Proteus mirabilis* and *Klebsiella oxytocin* were found among 3 (1.97%) for each one of them. Lastly; *Kocuria Kristina*, *Bacillus species*, *Citrobacter species*, *Corynebacterium* and Coagulase-negative *staphylococcus* were found among 1 (0.65%) of them. As shown in table 3.10. and figure 3.2.

Table 3.10: Types of bacteria causing osteomyelitis (n=153).

Bacteria	No.	%
MRSA	112	73.20
Enterobacter cloaca	14	9.15
Pseudomonas aurignosa	7	4.58
Streptococcus species	5	3.27
Klebsiella pneumonia	4	2.61
Proteus mirabilis	3	1.97
Klebsiella oxytocin	3	1.97
Kocuria Kristina	1	0.65
Bacillus species	1	0.65
Citrobacter species	1	0.65
Corynebacterium	1	0.65
Coagulase-negative staphylococcus	1	0.65

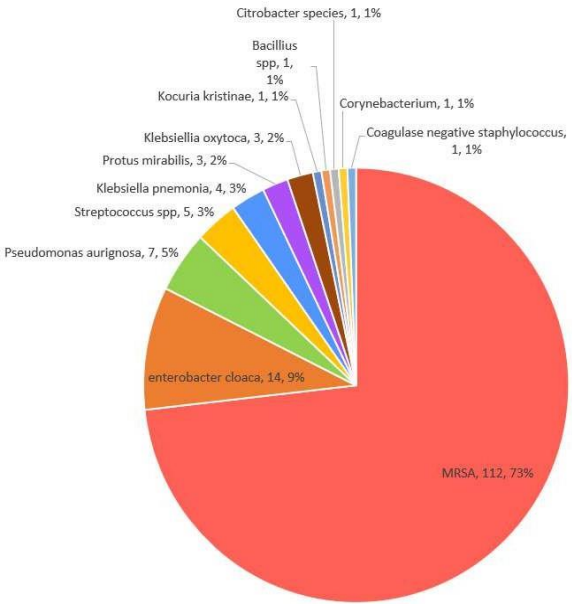


Figure 3.2: Types of bacteria causing osteomyelitis (n=153).

CONCLUSIONS

1. From this study, we conclude that:
2. Osteomyelitis patients were liable for MRSA infection.
3. MRSA can affect both sexes, but males are affected in more portion than females.
4. Lower extremity bones are affected by osteomyelitis more than upper extremity bones.
5. Tibial bone is the most common bone affected by MRSA infection.
6. Bone and soft tissue biopsy showed polymicrobial infection in non MRSA group more than MRSA group
7. Levofloxacin antibiotic was used more frequently to treat MRSA osteomyelitis.
8. Vancomycin antibiotic from the other hand was used more frequently to treat non MRSA osteomyelitis.
9. Empirical antibiotics almost given before biopsy was taken from the patient with and without MRSA.

Recommendations

1. Iraqi's Ministry of health promotion programs; should continuously aware the families about the risks of antibiotics resistances and how to take the infection prevention measures that decrease infection spread.
2. Following strict protocols should be followed by all medical staffs, regarding antibiotic use and hand hygiene, personal protective equipment etc.
3. Early treatment of osteomyelitis can improve the overall prognosis and prevent the future consequences.
4. Biopsy should be taken from the patients with osteomyelitis before starting empirical antibiotics.

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