

Prevalence of Staphylococcus aureus Infections among Individuals in Kirkuk City (Iraq)

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Abstract— The versatile pathogenic bacteria, *Staphylococcus aureus* can cause skin and soft tissue infections which are systemic life-threatening diseases and major community-acquired and hospital-acquired diseases. The aim of the present study was isolation, diagnosing and investigating *S. aureus* bacteria from skin and wound infections from patients. In the current cross-sectional study, total of (50) participants were enrolled. During the July–November 2025 period, they visited outpatient clinics in Kirkuk, Iraq. They were diagnosed with skin and wound infections resulting from surgeries, accidents, diabetic foot and others by specialized physicians. The swab samples were taken and cultured on blood and Mannitol Salt Agar, and then examined microscopically after staining with Gram stain. Biochemical and VITEK-2 system tests were also done to confirm the diagnosis. The results in this study showed that all samples showed positive growth for *Staphylococcus aureus* bacteria. The number and percentage of males was higher 30(60%) than that of females 20(40%). Urban regions accounted for 36 (72%) of the participants, while rural areas accounted for 14 (28%). The highest infection rate with *S. aureus* bacteria 14(28%) was in the age group (36–45) years, and the highest infection rate was obtained from diabetic foot lesions 14 (28%). Infection with *S. aureus* bacteria is wide spread in skin and wound infections of clinics out patients. The highest infection rate was observed in diabetic foot lesions. Consequently, it is essential to implement focused and effective preventive and therapeutic strategies to reduce the spread of these bacteria, especially in hospitals and health clinics.

Keywords— *Staphylococcus aureus*; infection; wound; blood.

I. INTRODUCTION

The versatile Gram +ve coccus, *Staphylococcus aureus* is the facultative aero-anaerobic bacteria, which lives as either opportunistic pathogens or commensal microorganisms and has the ability to cause many diseases to humans [1,2]. These pathogens are the most clinically-important bacteria that are responsible for causing infections which range from superficial skin infections and surgical site infections (SSIs) to systemic fatal diseases like endocarditis, pneumonia, osteomyelitis, septic arthritis as well as bacteremia [3,4].

Although *S. aureus* colonizes skin, anterior nares, and mucosal surface in about 1/3 of healthy people, they can breach the host's barrier or immune defense to start invasive infection to underscore their resilience and adaptability [5].

The pathogenicity success of *S. aureus* is mainly due to the widespread virulence factor of this pathogen, allowing its adherence to the tissues of hosts, evasion from immune system as well as host cell damage [6,7].

Their adhesion to the host tissues and cells and is facilitated by the Clumping factor and fibronectin binding protein are examples of surface proteins. Simultaneously, tissue damage and systemic toxicity is achieved by secreted toxin such as α -haemolysin, Panton Valentine leucocidin as well as toxic shock syndromes toxin-1 [8]. Also, the capability of this bacterium for robust biofilm formation on prosthetic implant and medical instruments boosts its persistence though protecting it from host defense and antimicrobials, driving recurrent and chronic infection [9].

The extraordinary ability of this pathogen further complicates its clinical management for acquiring and developing antimicrobial resistance [10]. The appearance of

methicillin resistant *S. aureus* (MRSA) in both community and healthcare facilities rendered several first line antimicrobials ineffective, resulting in higher global morbidities and mortalities [11].

In general, *Staphylococcus aureus* is a very opportunistic and adaptable pathogenic agent that is able to colonize different body sites, evading host immune system, and cause a broad spectrum of infections [12,13]. It is worth noting that infectious diseases arising from bacterial pathogens [14,15] are not less crisis and disruptive to global health than viral ones [16,17], and the primary concern remains controlling the emergence of new strains and preventing antibiotic resistance [18].

Therefore, there is an ongoing need to study the most common bacterial species locally, and the purpose of this research was to determine the prevalence of *S. aureus* infections in Kirkuk, Iraq.

II. PATIENTS AND METHODS

In this cross-sectional study, total of (50) individuals attended to Kirkuk Teaching Hospital and outpatient clinics in Kirkuk city (Iraq) were participated. They were diagnosed with skin and wound infections resulting from surgeries, accidents, diabetic foot and others by specialized physicians. The investigation was carried out between July and November of 2025. They were of both genders, aged 15years old and above, and had given informed consent to participate in the study. The (50) samples were collected using sterile cotton swabs. Swab samples were taken from infected skins, surgical sites, wounds and diabetic foot infections of the patients. After that, the swabs were cultured on MacConkey agar, Blood agar, Mannitol salt agar, and examined microscopically after staining with Gram stain. The biochemical tests involved

citrate test, methyl red (MR), catalase enzyme, coagulase and oxidase tests. The VITEK-2 system tests were also done to confirm the diagnosis.

Statistical Analysis

The data was statistically analyzed using the SPSS program, and tabulated in the form of frequencies and percentages (%). Also, excel figures were also used to illustrate some of the results.

III. RESULTS

The frequency and rate of males was higher 30(60%) than that of females 20(40%) as demonstrated in table & figure (1).

TABLE I. Proportion of studied participants according to gender.

Participants	Frequency	Percentage (%)
Males	30	60%
Females	20	40%
Total	50	100%

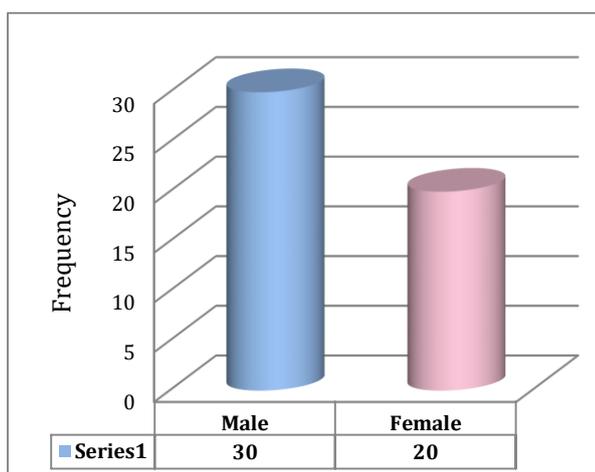


Fig. 1. Distribution of studied participants according to gender.

As shown in table (2), distribution of samples according to residence demonstrated that the number and percentage of residents of urban areas was 36 (72%) compared to the residents of rural 14 (28%) areas (Figure 2).

TABLE II. Proportion of studied participants according to residence

Participants	Frequency	Percentage (%)
Urban area residents	36	72%
Rural area residents	14	28%
Total	50	100%

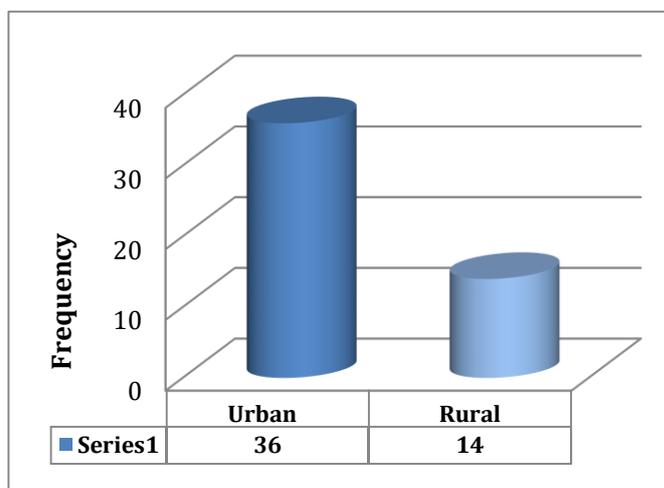


Fig. 2. Distribution of studied participants according to residence

TABLE III. Proportion of studied participants according to age groups.

Age group (years)	Frequency	Percentage (%)
15-25	5	10%
26-35	6	12%
36-45	14	28%
46-55	10	20%
56-65	8	16%
>66	7	14%
Total	50	100%

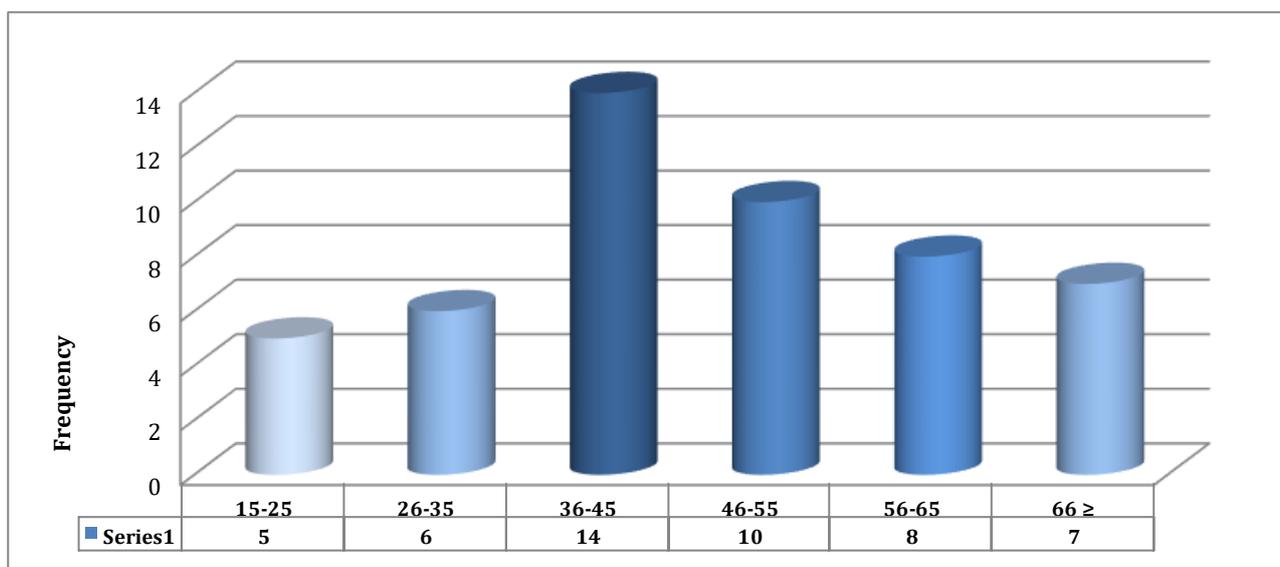


Fig. 3. Distribution of studied participants according to age groups

TABLE IV. Microscopic and culture characteristics of *S. aureus* bacteria.

Phenotypic characteristics	Agricultural characteristics				Bacteria
	IMP	Mannitol	Blood	MacConkey	
Single or double colonies or clustered, cluster-like	No growth	Golden or yellow colonies	White colonies with hemolysis type β	No growth	<i>S. aureus</i>

TABLE V. Biochemical tests of *S. aureus* bacteria.

Citrate	MR	Indole	Urease	TSI	Coagulase	Catalase	Oxidase	Test Type
P ⁺	P ⁺	N ⁻	P ⁺	N ⁻	P ⁺	P ⁺	N ⁻	Type of bacteria
N ⁻	N ⁻	N ⁻	P ⁺	N ⁻	N ⁻	N ⁻	N ⁻	<i>S. aureus</i>
								Coagulase negative Staph spp

The results in table (3) revealed that the highest number and percentage 14(28%) of patients infected with *S. aureus* bacteria was in the age group (36-45) years, while the lowest number and percentage 5 (10%) of patients was in the age group (15-25) years (Figure 3).

Table (4) showed microscopic and culture diagnosis of *S. aureus* bacteria. Microscopic examination showed the bacteria as Gram +ve and aggregated as clusters. On Mannitol agar, the colonies appeared golden or yellow, and on Blood agar they appeared as white colonies with β hemolysis, while on MacConkey agar, there was no growth.

The biochemical results revealed that coagulase positive.

S. aureus bacteria showed positive results for citrate utilization, Methyl red (MR) test, urease test, coagulase test and catalase test, while it showed negative results for indole test, Triple sugar iron agar (TSI) test and oxidase test. Other coagulase negative *Staphylococcus* spp. showed negative results for these biochemical tests except the urease test which showed positive result, as illustrated in table (5).

The results in our study showed that the distribution of positive swab sites of *S. aureus* isolates was as follows: the highest number and percentages of swabs 14(28%) were taken from diabetic foot lesions, followed by bowel and colon surgeries and hand wounds 10(20%), then appendix surgeries 8(16%), then foot and leg wounds 5(10%), then cholecystectomy surgeries 2(4%) and finally plastic surgery 1(2%), as shown in table (6).

TABLE VI. Distribution of positive bacterial growth swabs according to sites.

Swab site	Frequency	Percentage (%)
Diabetic foot	14	28%
Bowel and colon surgeries	10	20%
Hand wounds	10	20%
Appendix surgeries	8	16%
Foot and leg wounds	5	10%
cholecystectomy surgeries	2	4%
Plastic surgery	1	2%
Total	50	100%

IV. DISCUSSION

The results in the present study showed that there was a predominance of males over females among infected individuals. This finding agreed with many studies who found the same result such as [19] and also [20] who found (71% male, 29% female) in ICU units and (64% male; 36% female) in non-ICU wards. Many reports found that men are more likely to have staphylococcus infections, which is attributed to factors like greater colonization and different hygiene practices [21, 22]. However, no significant differences were found in gender ($P > 0.05$) in the study of Cui et al., 2025. On

the contrary, the study conducted by Cui et al., 2025 indicated that women were more likely to carry this pathogen [23]. Also, it was found by Ahmed, 2024 that females were highly significantly infected with *S. aureus* than males [24].

The highest incidence rate of infection with *S. aureus* in our study was observed in the age group (36-45) years, which is almost similar to the finding of another study which detected the infection in patients more than 36 years. One study found that older adult patients, especially adults >60 years, are more vulnerable to be infected with *S. aureus* because of certain factors such as weak immune systems and more chronic disease [25].

In previous study, less infection rate was recorded in persons with <20 years age, who attributed it to low exposures to health care facilities, less common antibiotic use, and a commonly stronger immune responses. Also, young people usually have less comorbidity that can reduce their risks to acquire infection with *S. aureus* [26].

Many studies agreed with us that the urban area residents were more affected by *S. aureus* infection than rural residents such as [26,27]. The variable carriage prevalence of *S. aureus* seen between rural and urban residents could be associated with specific socioeconomic variations between these two populations. For instance, urban area inhabitants often live in overcrowded places in comparison with rural area inhabitants [28].

Basic biochemical investigations have been applied on samples that showed positive reactions for coagulase and catalase, but showed negative reaction for oxidase.

They were prone to reactions of coagulase which showed the capability of bacteria to produce the enzyme coagulase which distinguishes between the species of *S. aureus* (coagulase +ve) and otherspecies of *Staphylococcus* species (coagulase -ve) because of the coagulase enzyme reaction of *S. aureus* with human blood's prothrombin to form staphylo-thrombin (clot) which converts fibrinogens into fibrins. *S. aureus* revealed negative oxidase result, which distinguishes it from other species in the genus *Micrococcus* [29].

These bacteria can ferment mannitol, and this can be identified after culturing *Staphylococcus aureus* on Mannitol agar, when the color is changed from red to yellow [30]. For *Staphylococcus aureus*, the results of gram staining showed that they appeared as Gram+ve bacteria having purple colour with round shapes (Cocci) which is arranged in irregular grape-like groups [31].

The current study showed that the highest prevalence rate of infection with *S. aureus* was in patients with diabetic foot ulcers, followed by bowel and colon surgeries and hand

infection, followed by appendix surgeries, followed by foot and leg wounds, followed by cholecystectomy surgeries. This is consistent with it being the main clinical feature of skin infections and associated with several toxins resulting from them, inducing a diverse and intense clinical spectrum [32].

The skins moist areas rich in sebaceous glands are preferentially colonized by *S. aureus*, these areas include the groin, axilla as well as perineum. The ability of *S. aureus* to adhere to corneocytes, the outermost cells of skin, facilitates colonization via specific surface proteins such as surface protein-G (Sas-G) and clumping factor-B (Clf-B). Binding to host protein e.g. involucrin, loricrin and is facilitated by cytokeratin, which are plentiful in cornified layer of the skin [33].

Staphylococcus aureus causes a significant proportion of postoperative infections. Recently, postoperative *S. aureus* infection management was complicated by the distribution and increased antibiotic-resistant *Staphylococcus aureus*. Since postoperatively infections with *S. aureus* can lead to serious outcomes to the patients, there is an increased needs to efficient intervention that aim to manage and prevent such infections [34].

Many previous studies indicated that *Staphylococcus aureus* had the highest percentage among all bacterial isolates that were collected from different wound areas that were contaminated with these bacteria or the source of contamination was external, represented by various germs, or the source of contamination was in the environment of operating rooms and people working in operations or surgical tools and materials in the operating room [35].

Staphylococcus aureus is the most predominant pathogenic bacteria isolated from diabetic foot infection (DFIs). The majority of isolates of *S. aureus* develop methicillin resistance, thus, treatment is suggested with antibiotics active against methicillin-resistant *S. aureus* (MRSA) in individuals with risk factors related to infections with MRSA [36].

The most common microorganism in appendix was *E. coli* which accounted for 29(58%) isolates, followed by *Klebsiella pneumoniae* isolates 8 (16 %), 5(10%) isolates of *Pseudomonas aeruginosa*, 2(4%) isolates of *Enterococcus faecalis*, 1(2%) isolates of *Enterobacter aerogenes*, 1(2%) isolates of *Salmonella typhi* and 1(2%) of *Proteus mirabilis*. *Staphylococcus aureus* is the major frequent microorganism in Gram+ve bacteria in appendix which accounted as 2(4%). While *Staphylococcus epidermidis* was accounted as 1 (2%). Our results being found were in agreement with other results recorded by [37].

Despite its rarity, uremia due to *Staphylococcus aureus* and *Klebsiella pneumoniae* infections can be caused by appendicitis, with extensive implication for examinations and antibiotic managements [38].

Another research found that, apart from *E. coli*, *Staphylococcus* was the second most prevalent bacteria seen after cholecystectomy. According to several studies, between 50% and 75% of bile is infected. For this reason, it's critical to identify the microbial mass and then treat the illness with antibiotics. Positive cultures were found in 14 instances,

including 13cases of *E. coli* and one infection of *Staphylococcus* [39].

In hand infections, the thumb and web spaces are the most frequent location zones of the abscesses. The most frequent identified microorganism was *Staphylococcus aureus* followed by *Streptococcus*β-hemolytic group A then coagulase-ve *Staphylococcus*. *Klebsiella oxytoca* was the least frequent microorganism. The most frequent hand abscess cause was *Staphylococcus aureus* and puncture wounds led to hand abscesses. Thus, we can conclude that in puncture wound cases, the patients must be timely assessed by physician for the bacterial cause and treated accordingly for avoiding the worst prognosis [40].

V. CONCLUSION

It can be concluded from this study that infection with *S. aureus* bacteria is wide spread in skin and wound infections of both hospitalized and out patients. The study results showed the prevalence of *Staphylococcus aureus* bacteria, with elevated concentrations observed in patients with diabetic foot lesions, bowel and colon surgeries, and hand wounds, indicating a significant health threat in the local medical setting. This necessitates the adoption of targeted and effective preventive and therapeutic strategies to reduce the spread of this bacterium, particularly in hospitals and healthcare facilities.

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