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Detection of Bacteria Causing Burn Infection Isolated from Several Hospitals in Baghdad

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Abstract

The results of the present study showed that twenty-five samples were collected for the age group 35–40 years and four samples for the age group 65–70 years for both genders. The results showed that 48 (48%) of the samples were obtained from the hands, 16 (16%) from the legs, 12 (12%) from the abdominal area, and 10 (10%) from the chest area. The four (4%) samples were obtained from burns in the back and thighs area. The samples taken according to the cause of burns were 40 (40%) due to hot water, hot liquids, or hot steam, followed by 18 (18%) due to the use of hot tools, 15 (15%) due to fires, 12 (12%) due to electric currents, 10 (10%) due to chemicals such as strong acids, alkaline lye, paint thinner, or gasoline, and 5 (5%) due to sun ray burns. Sixty pathogenic bacteria were obtained from the burn samples. The number of bacteria isolated from burn wounds was 34 isolates from men and 26 isolates from women. The predominant were 15 (25%) *Staphylococcus aureus*, 12 (20%) *Acinetobacter baumannii*, 10 (16.7%) *Pseudomonas aeruginosa*, 8 (13.3%) *Klebsiella pneumoniae*, 7 (11.7%) *Escherichia coli*, 6 (10%) *Proteus mirabilis*, and 2 (3.3%) *Burkholderia cepacia*. The antibiotic sensitivity test using the Vitek2 Compact System showed that the resistance rate was recorded in *Staphylococcus aureus* against Amikacin by 13 isolates, with a rate of 86.6%, and in *Acinetobacter baumannii*, towards Ceftazidime and Piperacillin antibiotics by 12 isolates at a rate of 100%, and *Pseudomonas aeruginosa* towards Colistin and Tobramycin at a rate of 6 isolates at a rate of 60%, and *Klebsiella pneumoniae* towards Colistin and Tobramycin at a rate of 8 isolates at a rate of 100% and *Escherichia coli* against Amikacin, Colistin, and Imipenem with 7 isolates and 100%, and *Proteus mirabilis* against Colistin and Tobramycin with 6 isolates and 100%, and *Burkholderia cepacia* against 8 antibiotics with a rate of 100%. We conclude from the present study that the most susceptible age group to burns is the active age group and that the pathogenic bacteria from burn wounds are mostly resistant to antibiotics.

Keywords: Burn wounds, Pathogenic bacteria, Antibiotic resistance.

1. Introduction

Burns are one of the most destructive forms of injury. Patients with effective thermal injuries need immediate specialized care in order to reduce morbidity and mortality. Data from the National Center for Injury Prevention and Control in the United States indicate that roughly 2 million fires were investigated each year, resulting in 1.2 million individuals with burn wounds [1]. Invasive infections caused by burns are responsible for 51% of deaths [2]. Approximately 500,000 people in the United States need medical assistance for burns annually, with 40,000 patients needing hospitalizations to minimize bacterial infection [3].

The existence of microbes on the burn wound has a direct relationship with virulence factors. In theory, the high temperature disinfects the burn wound at first. Normal skin flora and existing infections, on the other hand, grow fast. Cultures confirm that 9–54% of patients in the pediatric burn unit are polluted with pathogenic bacteria at the time of admission [4]. Despite advances in topical and intravenous antimicrobial therapies, as well as the technique of immediate transverse eradication, bacteria remain a serious problem in the treatment of burn victims [5]. Moreover, due to overcrowding in burn hospitals, cross-infection occurs between different burn patients [6]. In fact, 75% of all deaths in individuals with accidental burns greater than 40% of the body surface area are due to septic shock and health difficulties caused by infection. Continuous stay in the aggravating care unit, preventive and surgical procedures, and the nature of burn injury all result in excess rates of hospital infections in burn patients [7], wound inoculation is a valuable tool in wound healing and wound colonization. Wound invasion occurs after 5-7 days for patients with significant burns. Since the majority of early disease in burn patients is caused by endogenous bacteria, performing a primary wound culture at entry is good clinical practice [4]. Despite advances in topical and intravenous antimicrobial therapies, as well as the technique of immediate transverse eradication, bacteria remain serious complications in the treatment of burn patients [8]. Moreover, due to overcrowding in burn hospitals, cross-infection occurs between different burn patients [7].

Several microbes can also be transferred to a patient's surroundings by contact with an infected person through the surfaces of different agents, such as water, steam, air, and the hard hands of caregivers [7]. Burn wound infection is still mostly caused by *S. aureus* [6]. MRSA has emerged as the primary bacteria in critical care units in recent years due to the extended use of antibiotics. In an infected person, colonization with any of these pathogens is usually asymptomatic, but they are also a source of infectious agents that can cause serious illness and death [8]. Antibiotic susceptibility patterns in burn infectious diseases constitute an important therapeutic problem for caretakers of burn patients [9, 10].

[11], collected 105 burn wound swabs from burn patients admitted to the burn unit of Al-Sadr Teaching Hospital in Misan City, Iraq. He isolated nine distinct bacterial species, of which, *Pseudomonas aeruginosa* was the most common pathogen, followed by *Staphylococcus aureus*, *Enterobacter spp.*, *Proteus vulgaris*, *Proteus mirabilis*, *Escherichia coli*, *Klebsiella pneumoniae*, and at last, *Staphylococcus lentus* and *Aeromonas sobria*. [12] took 70 burn wound swabs from patients admitted to the teaching medical Al-Kendi hospital in Baghdad, Iraq. *Pseudomonas aeruginosa* was found to be the most common isolate, followed by *Staphylococcus aureus*, *Citrobacter braakii*, *Enterobacter spp*., Coagulase-negative *Staphylococci*, *Proteus vulgaris*, *Corynebacterium spp*., *Micrococcus*, *Proteus mirabilis*, *Enterococcus faecalis*, *E. coli*, *Klebsiella spp*., *Bacillus spp*., *Serratia macerscens,* and *Serratia rubidia*.

[5] collected a total of 960 isolates from different sample kinds and cultured them for 615 burn patients who were hospitalized at the Amir-Al-Momenin Burn Center, Shiraz, Iran. They found *Pseudomonas aeruginosa* to be the most frequent pathogen, followed by *Klebsiella sp*., *Acinetobacter sp.,* and *Staphylococcus aureus*. [13] isolated *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Escherichia coli*, and *Staphylococcus aureus* from 151 burn patients admitted to the burn unit of Dicle University Hospital in Diyarbakır, Turkey.

[11] proved most isolates showed high resistance to Tobramycin, Trimethoprim, Cephalothin, and Imipenem, while isolates mostly had high susceptibility to Amikacin, Cefotaxime, and Ciprofloxacin. Wound burn infection still represents a serious problem for burn patients, with many bacteria developing different degrees of resistance to most known antibiotics. [12] conducted an antimicrobial susceptibility test on the bacterial isolates against 8 antibiotics, in which ciprofloxacin was found to be the most effective drug against most of the Gram-negative and Gram-positive isolates, followed by amikacin, while chloramphenicol and gentamicin were less sensitive to a few isolates, as well as doxycycline, as compared with the other two, mentioned previously. Oxacillin was the worst of them all. [5] confirmed that the trend of resistance to meropenem was declining in P. aeruginosa isolates. Klebsiella sp., the second most prevalent agent, showed a high level of resistance to the studied antibiotics. The antibiogram results for S. aureus isolates showed an increasing trend in MRSA isolates. [13] found that the most effective antibiotic against A. baumannii was colistin, followed by levofloxacin and trimethoprim-sulfamethoxazole. The most effective antibiotics against P. aeruginosa were amikacin, ciprofloxacin, and levofloxacin. The most effective antibiotics against E. coli were amikacin, meropenem, and imipenem.

The current study aimed to describe the epidemiological characteristics of patients with hospital-contaminated burns in the ward of the Burn Department, Burn Center, Yarmouk Teaching Hospital, and Burns Specialist Hospital in the Medical City, Baghdad, Iraq. We also identified common bacterial pathogens involved in burn wound infections and studied antibiotic resistance patterns in order to improve our therapeutic approach and prevent burn wound infections in Iraqi hospitals due to the paucity of studies on this topic.

2.Materials and Methods

2.1.Sample Collection

One hundred samples of burn wounds of different ages and genders were collected from the Burn Center, Yarmouk Teaching Hospital, and Burns Specialized Hospital in the Medical City for the period between October 17, 2021, and January 10, 2022. The samples of burn wounds were cultured on different media for the purpose of isolation and the initial diagnosis of pathogenic bacteria.

2.2.Isolation and identification of pathogens bacteria

Burn wound samples were inoculated on different media and incubated at 37 °C for 24 hours. For further phenotypic characteristics, isolates were subcultured on (Eosin methylene blue CHROMagar Orientation). Then, isolates were subjected to Gram stain and biochemical tests, including IMViC (indole, VP, MR, citrate), oxidase, catalase, urease, and Kligler iron agar tests. The identification of isolates was confirmed by the Vitek2 compact system according to the manufacturer's instructions [14].

2.3. VITEK-2 Compact system for detection of Antibiotic Sensitivity Test (AST)

This method was carried out according to [14]. One drop of the broth was routinely subcultured on 5% sheep blood agar and MacConkey agar. Both plates were incubated at 37°C for 18–20 hours to obtain isolated colonies. An isolated colony was picked and added to sterile saline solution provided by the manufacturer, BioMerieux, to make a suspension equivalent to a 0.5 McFarland standard, adjusted by using DensiCHEK Plus (BioMerieux), and further processed as per the manufacturer's instructions. The AST panel AST-P628 was used for gram-positive organisms and AST-N280 for gram-negative organisms. The results were given as Sensitive (S), Intermediate (I), and Resistant (R).

2.4. Statistical analysis

The data were entered into a database using the SPSS program. The independent sample t-test was used for categorical and continuous variables, respectively.

3. Results

3.1.Sample Collection

The results showed that 25 samples (25%) were collected for the age group 35–40 years and 4 samples (4%) for the age group 65–70 years. For both genders, **Table 1**.

Table 1. Number of samples according to age group and gender.

Age group /Years	Gender					
	Female		Male		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
5-10	8	16	6	12	14*	14
15-20	9	18	10	20	19	19
25-30	9*	18	10*	20	19*	19
35-40	10*	20	15*	30	25*	25
45-50	7	14	5	10	12*	12
55-60	4	8	3	6	7	7
65-70	3*	6	1*	2	4*	4
Total	50	100	50	100	100	100

*There are significant differences between the number of samples and the factors of age and sex (p≤5).

The results showed that 48 of the samples (48%) were obtained from the hands, legs, abdominal area, and chest area. The 4 samples that formed (4%) were obtained from burns in the back and thighs area (**Table 2**).

Table 2. Number and percentage of samples taken from the affected area.

The affected regions in burn patients	Number	Percentage%
Head and neck	6	6%
The hands	48*	48%
Chest area	10*	10%
Abdominal area	12*	12%
Back area	4	4%
Thighs area	4*	4%
Legs	16*	16%
Total	100	100%

*There are significant differences between the number of samples taken from affected area (p≤5).

The results showed that 40 of the samples that formed (40%) according to the cause of burns were due to hot water, hot liquids, or hot steam, followed by 18 samples that formed (18%) due to the use of hot tools. And the 5 samples that form (5%) due to Sun ray burns **Table 3**.

Table 3. The number and the percentage of injuries according to the cause of the burns.

The cause of the burn	Number	Percentage
Hot water, hot liquids or hot steam	40*	40%
Use hot tools	18*	18%
Electric currents	12*	12%
Chemicals such as strong acids, alkaline lye, paint thinner or gasoline	10*	10%
Fires	19*	19%
Sun rays	5*	5%
Total	100	100%

*There are significant differences between the number of injuries according to the cause of the burns (p≤5).

Sixty pathogenic bacteria were obtained from the burn samples. Which included *Staphylococcus aureus* 15 (25%), *Acinetobacter baumannii* 12 (20%), *Pseudomonas aeruginosa* 10 (16.6%), *Klebsiella pneumoniae* 8 (13.3%), *Proteus mirabilis* 6 (10%), *Escherichia coli* 7 (11.6%), *and Burkholderia cepacia* 2 (3.3%), **Figure 1**.

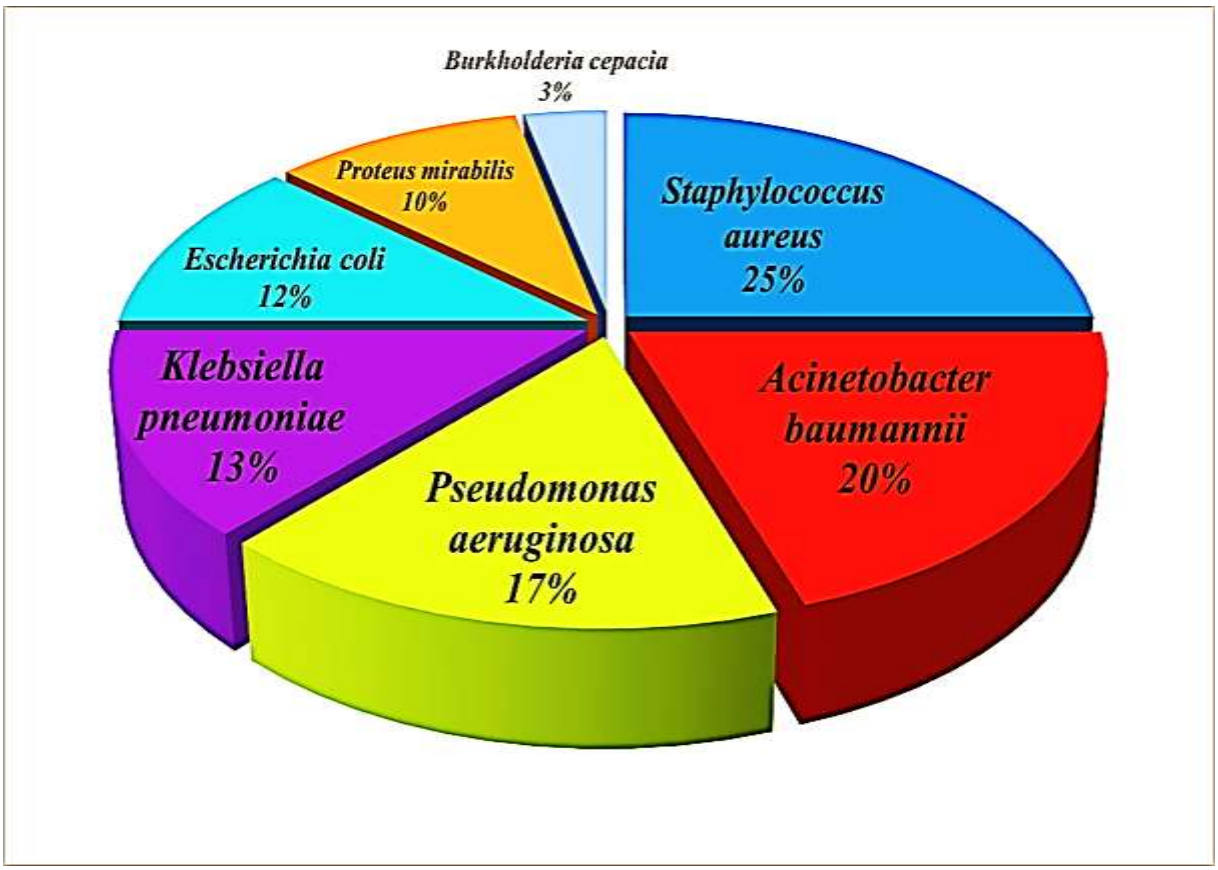

Figure1. The percentage of Bacteria isolated from burn samples**.**

The results showed that the number of bacteria isolates from burn wounds was 34 from males (56.70%), while the number was 26 from females which form (43.30%), (**Table 4**).

Table 4. Types, number and percentage of bacteria isolates according to gender.

Bacterial isolates	**Female**		**Male**	
	No.	**%**	**No.**	**%**
Staphylococcus aureus	5*	8.33%	10*	16.66%
Acinetobacter baumannii	4	6.66%	8	13.33%
Pseudomonas aeruginosa	3	5%	7*	11.66%
Klebsiella pneumoniae	5 *	8.33%	3	5%
Escherichia coli	6*	10%	1	1.66%
Proteus mirabilis	2	3.33%	4	6.66%
Burkholderia cepacia	1*	1.66%	1*	1.66%
Total	26	43.30%	34	56.70%

*There are significant differences between the number of samples and the sex ($p \leq 5$).

The antibiotic sensitivity test using the Vitek2 Compact System showed that the resistance rate was recorded in *Staphylococcus aureus* against Amikacin by 13 isolates, with a rate of 86.6%. In *Acinetobacter baumannii*, towards Ceftazidime and Piperacillin antibiotics by 12 isolates at a rate of 100%, *Pseudomonas aeruginosa* towards Colistin and Tobramycin at a rate of 6 isolates at a rate of 60%, and *Klebsiella pneumoniae* towards Colistin and Tobramycin at a rate of 8 isolates at a rate of 100%, *Escherichia coli* against Amikacin, Colistin, and Imipenem with 7 isolates and 100%, *Proteus mirabilis* against Colistin and Tobramycin with 6 isolates, and *Burkholderia* against 8 antibiotics with a rate of 100% (**Table 5**).

Table 5. Antibiotic susceptibility test using vitek2 compact system.

Antibiotics types	Resistance			Intermediate			Sensitive		
	No.	**%**	**MIC**	**No.**	**%**	**MIC**	**No.**	**%**	**MIC**
Amikacin	2	10	>=64	3	15	32	15	75	<=2
Cefepime	4	20	>=64	3	15	8	8	40	2
Ceftazidime	7	30	>=64	4	20	16	9	45	4
Ciprofloxacin	5	25	>=4	5	25	2	8	40	<=0.25
Colistin	7	35	>=16	10	50	/	3	15	<=0. 5
Gentamicin	4	20	>=16	6	30	8	10	50	<=1
Imipenem	7	35	>=16	/	/	/	11	55	<=0.25
Meropenem	15	75	>=16	/	/	/	5	25	<=0.25
Piperacillin	6	30	>=128	5	25	/	9	45	8
Piperacillin/Tazobactam	5	25	/	/	/	/	15	75	8
Ticarcillin	4	20	>=128	2	/	/	14	70	32
Ticarcillin/Clavulanic Acid	7	35	>=128	2	/	/	11	55	32
Tobramycin	8	40	>=16		/	/	12	60	<=1

4.Discussion

Burns are tissue damage caused by prolonged exposure to scorching heat, the sun, or any other radiation, chemical, or electric current. Burns can be minor or even life-threatening.

The results showed that 25 samples (25%) were collected for the age group 35–40 years and 4 samples (4%) for the age group 65–70 years, for both genders. These results are in agreement with many studies [15, 16], which found that almost all samples collected were from age groups 20 to 40 because these age groups are more active compared with other age groups.

The results showed that 48 of the samples (48%) were obtained from the hands, legs, abdominal area, and chest area. The four samples that form (4%) were obtained from burns in the back and thighs areas. These findings are in agreement with many studies [17]. In which the results were explained, the hands are the most used part of the body at work and are more prone to accidents, and the upper parts of the body are more susceptible to burns than the lower parts of the body.

The results showed that 40 of the samples that formed (40%) according to the cause of burns were due to hot water, hot liquids, or hot steam, followed by 18 samples that formed (18%) due to the use of hot tools. And the 5 samples that form (5%) due to sun ray burns These findings are in agreement with many studies [18], where they pointed out that the frequent use of hot liquids in several fields puts them at the forefront of the causes of burns.

In the present study, sixty pathogenic bacteria were obtained from the burn samples. The predominant bacteria isolated were *Staphylococcus aureus (*15%), followed by *Acinetobacter baumannii (*12%), *Pseudomonas aeruginosa (*10%), *Klebsiella pneumoniae* (8.3%), *Escherichia coli* (7.6%), *Proteus mirabilis (*6%), and *Burkholderia cepacia* (2.3%). These results are in agreement with several studies [19, 20] where the same species of bacteria were isolated from burn wounds in close proportions.

Previous studies [21] mentioned that *P. aeruginosa* represented the highest percentage of bacterial species that were isolated from burn wounds, while [22] reported that the highest percentage of bacterial species that were isolated from infected burn wounds was *P. aeruginosa* followed by *E. coli,* and the lowest percentage was found in the cases of *Acinetobacter spp.* and *Bacteroides spp.* A similar finding was reported by other investigators [23, 24].

The results showed that the number of bacteria isolated from burn wounds was 34 in male form (56.70%), while the number was 26 in female form (43.30%). These findings are in agreement with many studies [25, 26], in which the reason for the large number of burn injuries in men

compared to women is that men are more active and motivated in dealing with burn-causing materials.

The antibiotic sensitivity test using the Vitek2 Compact System showed that the resistance rate was recorded in *Staphylococcus aureus* against Amikacin by 13 isolates, with a rate of 86.6%, and in *Acinetobacter baumannii*, towards Ceftazidime and Piperacillin antibiotics by 12 isolates at a rate of 100%, and *Pseudomonas aeruginosa* towards Colistin and Tobramycin at a rate of 6 isolates at a rate of 60%, and *Klebsiella pneumoniae* towards Colistin and Tobramycin at a rate of 8 isolates at a rate of 100% and *Escherichia coli* against Amikacin, Colistin and Imipenem with 7 isolates and 100%, and *Proteus mirabilis* against Colistin and Tobramycin with 6 isolates and 100%, and *Burkholderia cepacia* against 8 antibiotics with a rate of 100%. These results are in agreement with many studies [27, 28]. Burn wound infection remains a serious problem for burn patients as many bacteria develop varying degrees of resistance to most known antibiotics. They demonstrated that most of the isolates showed high resistance to tobramycin, trimethoprim, cephalothin, and imipenem, while the isolates were mostly more sensitive to amikacin, cefotaxime, and ciprofloxacin.

5.Conclusion

We conclude from the current study that most types of bacteria causing burn wound contamination are Gram-negative bacteria, and most of them are multiresistant to commonly used antibiotics.

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