JIDC | THE JOURNAL OF INFECTION IN DEVELOPING COUNTRIES

Original Article

Incidence of septicemia. Etiology and antimicrobial susceptibility testing among patients admitted to tertiary care hospital

Furqan Mohammed Al-Asady[1], Dalia Abdulzahra Al-Saray[2], Ammar Wehaib Obed[3]

[1] *College of Pharmacy, University of Al-Ameed, Karbala, Iraq*
[2] *College of Dentistry, Department of Pharmacology, University of Babylon, Hilla City, Iraq*
[3] *Al-Hilla Hospital, Babylon Health Directorate, Iraq*

Abstract

Introduction: Septicemia is considered as an important cause of life-threating infections. The study was aimed at determining the incidence of septicemia considering different age groups and gender among suspected patients admitted to a tertiary care hospital in Iraq.
Methodology: A total of 168 blood samples were collected and cultured using BacT/Alert 3D automated system. The isolated pathogens were identified and subjected to antimicrobial susceptibility testing using automated Vitek 2 Compact system.
Results: Out of 168 blood samples, 53 (31.5%) gave positive microbial growth. Thirty-three samples (62.3%) came from male patients and 20 (37.7%) from female ones, both gender and microbial growth were significantly related ($P < 0.05$). Age group (21 year - 30 year) was found to have the highest percentage of positive growth (26.4%) while age group (51 year - 60 year) the lowest percentage (5.7%) of positive growth. Both microbial growth and age group were found to be associated to a significant level ($P < 0.05$). 36 isolates (67.9%) were Gram negative, 15 isolates (28.3%) were Gram-positive and 2 isolates (3.8%) were fungi. *Salmonella typhi* (41.7%) represented the most common pathogen isolated followed by *Acinetobacter baumannii* (22.2%). An isolate of *Pseudomonas aeruginosa* showed resistance to all antibiotics used.
Conclusion: Community-acquired septicemia occurred mainly in male than female. *Salmonella typhi* and *Acinetobacter baumannii* represented the most frequent causative agents of community-acquired septicemia. Antimicrobial susceptibility testing should be performed to detect the antibiotic of choice for each pathogen causing community-acquired septicemia.

Key words: Septicemia; age groups; gender; antimicrobial susceptibility; Iraq.

J Infect Dev Ctries 2020; 14(12):1387-1394. doi:10.3855/jidc.13089

(Received 20 May 2020 – Accepted 10 August 2020)

Introduction

Infection of blood is a systemic disease caused by microbes that invade the normally sterile blood [1]. Sepsis (or septicemia) might be the major consequence of bacteremia if patient not receive the targeted treatment at the appropriate time. Septicemia can originate from infections in different organ in the body including abdomen, lung and urinary tract [2].

People suffering from sepsis can present diverse sign and symptoms at different times including various grades of temperature, shivering, tachycardia, low urine output, difficulties in breathing (tachypnea), low blood pressure, decrease blood perfusion, cold extremities, altered mental status and even skin cyanosis [3].

Sepsis is regarded as a life-threatening dysfunction of organ related to dysregulation of host responses to an infection. Inability for earlier recognition and adequate management is associated with septic shock, multi-organ failure and even death. Any individual affected by an infection might potentially develop sepsis but some people are at higher risk than other including: elderly people, pregnant women, neonates, hospitalized patients, people with liver cirrhosis, kidney disease, autoimmune disease and cancer [4].

Resistance to antimicrobial agents is a major factor associated with bad outcome of sepsis, that is a crucial medical emergency [5]. One of the main concerns in blood infections is the development of multi-drug resistance (MDR) [6]. As a result, isolation of bacterial or fungal agents using blood culture is a gold standard for diagnosis of septicemia and antimicrobial susceptibility patterns for isolated agent represented an important step toward managing septicemia [7].

The use of newer blood culture media that impart high level of reliability, fastness in microbial detection, accuracy, simplicity, easier use and handling with improved continuous monitoring would have a tremendous impact in earlier microbial detection and hence, good controlling of septicemia. Using BacT/Alert three dimensional automated blood culture system is one of the way to achieve this [8]. Additionally, the use of new technology for microbial

identification and antimicrobial susceptibility testing (Vitek 2 Compact automated system) that offers rapid, precise, reliable and confirmed test report will provide relevant information for targeting antibiotic therapy [9].

In the present study, we focused on performing blood cultures for isolation of microbial agents causing bloodstream infection and subsequent antimicrobial susceptibility testing for the obtaining isolates (for detection of their level of antibiotics resistance) to determine the incidence of community-acquired septicemia regarding to different age groups and gender; among suspected patients admitted to a tertiary care hospital in Iraq.

Methodology

Collection of samples

Patients

The present study was conducted in a multi-specialty 400-bed tertiary care hospital, Babylon province, Iraq. The current study was conducted during the period from 1 / September / 2019 to 31 / January / 2020 including patients admitted to different clinical specialty departments in the hospital: pediatric, gynecology, surgery, Intensive Care Unit (ICU), Cardiac Care Unit (CCU), Respiratory Care Unit (RCU). This study was included 168 cases of clinically suspected septicemic patients (have signs and symptoms of septicemia mainly: fever, tachycardia, tachypnea, chill, general weakness, hypotension and others).

Seven age groups were involved in the study, each group included 24 patients (12 male and 12 female). In the present study, patients aged from 1 day to 60 years were included. All required information about the patients included in the study were taken properly, including patient history, gender, age, duration of hospitalization, concurrent diseases, previous use of antimicrobial agents.

Exclusion criteria

Any patient on antimicrobial therapy was excluded from the study. If blood sample not taken within 48 hours from patient admission to the hospital, this patient was excluded from the study.

Blood samples

Blood samples (venous blood) were collected aseptically from venous site (peripheral vein) after proper cleaning of area. The blood sample was taken once from each patient during the febrile period within 48 hours of admission to hospital. The standard volume of blood was 10 mL and 4 mL recovered from adult suspected patients and pediatric suspected patients, respectively. The obtained blood samples were sent directly for cultivation.

Blood culture and microbial isolation

Blood samples obtained from all patients were inoculated directly into blood culture bottles specific for BacT/Alert three dimensional (3D) automated blood culture system (microbial detection system using colorimetric sensor) of BioMerieux company (Marcy-l'Étoile, France). For pediatric patient with age ≤ 12 years (when only a small volume of blood available), the collecting blood sample for each pediatric was inoculated into BacT/Alert PF plus bottle. Concerning adults, the obtaining blood sample for each was divided equally into two pars each of 5 mL. The first 5 mL was added to BacT/Alert FN plus bottle (contains media and atmosphere useful for anaerobic pathogens) while the other 5 mL was added to BacT/Alert FA plus bottle (contains media and atmosphere useful for aerobic pathogens). In addition to the media found in these three bottles, they contain adsorbent polymeric beads (resins) which facilitate the early detection of pathogens in blood samples because these adsorbent beads act as antimicrobial neutralizing-inhibitor resins which reduce the chance of getting false-negative results in patients suffering from true septicemia although any patient on antimicrobial therapy was excluded from the study. This would impart a further confirmation that the antimicrobials were definitely absent in the blood sample. Moreover, these resins would not affect the interpretation of Gram-staining results.

All samples were processed depending on the standard guidelines recommended by the manufacturer. All bottles that gave positive signal (microbial growth) by BacT/Alert 3D automated system were subjected for routine Gram-staining technique. Gram-staining step was an important to determine the purity of sample (presence of single isolate or mixed isolates) and to detect whether the isolate is Gram-positive or Gram-negative.

After that, bottles with positive growth were sub-cultured on different sterile culture media (Nutrient agar plates, MacConkey agar plates, Blood agar plates, Chocolate agar plates, Sabouraud agar plates, Oxoid, Manchester, UK). The yielded plates were incubated regarding to standard incubation conditions.

Microbial identification and antibiogram

Following incubation, the obtained colonies for each sample were examined (concerning colony morphology, arrangement and purity). According to the

primary diagnosis of pathogen (following Gram-staining and colony behavior on different cultures media), the confirmation of pathogen identification with their antimicrobial susceptibility testing were occurred utilizing the more accurate, reliable automated Vitek 2 Compact System (BioMerieux Marcy-l'Étoile, France). In case of primary diagnosis of Gram-negative bacteria, both Vitek 2 GN ID Card (Gram-Negative Identity Card) with Vitek 2 AST Card (Antimicrobial Susceptibility Testing Card) specific for Gram-negative bacteria were used. When the primary diagnosis revealed Gram-positive bacteria, both Vitek 2 GP ID Card (Gram-Positive Identity Card) with Vitek 2 AST Card specific for Gram-positive bacteria were used. If the primary diagnosis denoted for yeast, both Vitek 2 YST ID Card (Yeast Identity Card) with Vitek 2 AST Card specific for yeast were used.

Statistical analysis

In this study, the data were entered and analyzed with SPSS version 25. Chi-square test was used as a statistical test to determine the association between variables. P values less than 0.05 were regarded as statistically significant.

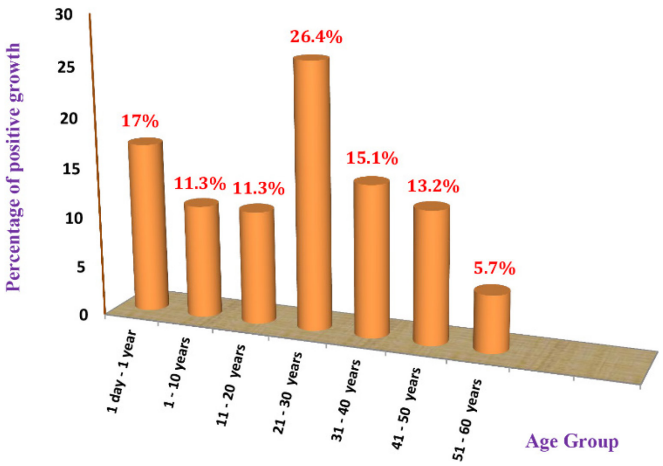
Ethics Declaration

In the study, consent was taken from each patient (or their parents in case of children) regarding all aspects of the study as a standard care for patients in the hospital. The study protocol was approved by ethics committee in Iraq which is the Institutional Review Board (IRB) (No. 26 IRB). The present study started after the permission declaration of the ethics committee in Iraq.

Results

The present study included seven diverse age groups. The number of patients, as well as number of male and female, that obtained in each group was equal as shown in Table 1

Figure 1. Positive blood culture percentages among different age group.



Both microbial growth positivity and age group were significantly dependent ($P < 0.05$) with age group 21 year - 30 year that showed the higher percentage of positive microbial growth while the lowest percentage recorded with age group 51 year - 60 year.

Out of 168 blood samples cultured for microbial growth determination, 53 (31.5 %) blood samples gave positive microbial growth. Age group 21 year - 30 year was found to have the highest number of positive cultures while the age group (51 year - 60 year) was involved the lowest number of positive cases among the other groups as summarized in Table 1.

Regarding concomitant diseases of patients and according to the patient's history, it was found that some pediatric patients in age of 1 day - 1 year suffered from low birth weight, premature labor, jaundice, congenital disorder (heart problem). Some children in age of 1 year - 10 years have juvenile diabetes mellitus, pneumonia, thalassemia, chronic tonsillitis. Concerning age from 11 - 20, some of them had psoriasis, chronic bronchitis, juvenile diabetes mellitus.

Some patients within age of 21 year - 30 year had autoimmune diseases (Crohn's disease, systemic lupus erythematosus, nephrotic syndrome), cancer (leukemia), hepatitis B infection, asthma, urinary tract

Table 1. The distribution of positive microbial growth among different age groups.

Age Group	Gender		No. of patients	No. of negative Growth	No. of positive Growth
	Male	Female			
1 day – 1 year	12	12	24	15	9
1 year – 10 year	12	12	24	18	6
11 year - 20 year	12	12	24	18	6
21 year – 30 year	12	12	24	10	14
31 year – 40 year	12	12	24	16	8
41 year – 50 year	12	12	24	17	7
51 year – 60 year	12	12	24	21	3
Total Number	84	84	168	115 (68 %)	53 (31.5 %)

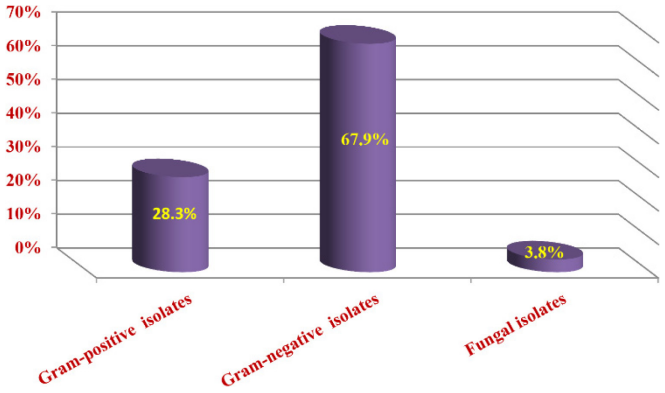
infection. About patients within age of 31 year - 40 year, some of them suffered from lymphoma, sever urinary tract infection, infectious mononucleosis. Many patients within age 41 year - 50 year suffered from type II diabetes mellitus, also renal impairment, chronic hypertension while some patients in age of 51 year - 60 year age group have congestive heart failure, end stage renal failure, mycobacterium tuberculosis.

The relationship between age group and occurrence of positive microbial growth was found to be significant (P value < 0.05) which means that both variables were related and dependent. The age group 21 year - 30 year included the highest percentage of positive growth (26.4%) while age group 51 year - 60 year included the lowest percentage (5.7%) among other age groups as best shown in Figure 1.

Of these 53 samples that gave positive microbial growth, 33 samples (62.3%) were male and 20 samples (37.7%) were female distributed among various age groups. According to these results, both gender and incidence of positive microbial growth were found to be significantly related (P value < 0.05).

The study involved mainly two types of microbial isolates; bacterial and fungal isolates. 51 isolates, of 53, were diagnosed as bacterial isolates and only 2 were found to be fungal isolates. The two fungal isolates obtained were both *Candida albicans* whereas the bacterial isolates (51 isolates) involved various kinds of both Gram-positive and Gram-negative bacteria. The types of bacterial and fungal isolates obtained (53 isolates) and their allocation regarding to the age groups and gender are best shown in Table 2.

Figure 2. Percentage of Gram-positive, Gram-negative and fungal isolates recorded in the study.



Gram-negative bacteria were the predominant septicemia-causing pathogen which constituted the higher percentage followed by Gram-positive and then fungi. Gram-negative anatomical structure may be associated with their higher level of virulence and persistence.

It was noticed that 36 isolates were diagnosed as Gram-negative bacteria, which constitute the highest number of isolates (meaning that it is the predominant causative agent of septicemia). Furthermore, 15 isolates were diagnosed as Gram-positive bacteria and 2 isolates were found to be fungal isolates. The percentage of Gram positive, Gram-negative and fungal isolates were best summarized in Figure 2.

Among the isolates of Gram-negative bacteria (36), 15 isolates (41.7%) were diagnosed to be *Salmonella typhi* and represented the most predominant bacteria causing blood stream infection among other Gram-negative bacteria and the most causative agent among all microbial isolates obtained in the study. Then,

Table 2. Allocation of bacterial and fungal isolate types according to different age group and gender.

Types of isolates	Age group							Total isolates No.
	1 day – 1 year	1 year – 10 year	11 year - 20 year	21 year – 30 year	31 year – 40 year	41 year – 50 year	51 year – 60 year	
Staphylococcus aureus	M,M			M	M			4
Staphylococcus hominis	F,M	F,M		F,F	F			7
Staphylococcus hemolyticus					F			1
Staphylococcus pseudintermedius			M,					1
Streptococcus pyogens				F		F		2
Salmonella typhi		M	F,F	M,M,M,F	M,M,M	F,F,M,M	F	15
Salmonella gallinarum	F							1
Shigella boydii				M				1
Klebsiella pneumoniae	M							1
Pseudomonas auruginosa				M,F	F	M		4
Escherichia coli			M,M	M,M	M			5
Acinetobacter baumannii	F,M	M	M	M		M	F,F	8
Burkholderia cepacia	M							1
Candida albicans		M,M						2
Total Number	9	6	6	14	8	7	3	53

* M: Male; F: Female.

followed by 8 isolates (22.2%) of *Acinetobacter baumannii* which regarded as the second most causative agent. On the other hand, among 15 isolates of Gram-positive bacteria, 7 isolates (46.7%) were diagnosed as *Staphylococcus hominis* which recorded as the most common Gram-positive bacteria causing septicemia followed by 4 isolates (26.7%) of *Staphylococcus aureus*. The two fungal isolates were diagnosed as *Candida albicans.*

Antimicrobial susceptibility testing was performed (using Vitek 2 system) for all Gram-positive, Gram-negative and fungal isolates as clearly illustrated in Table 3, 4 and 5, respectively. Different classes of antibiotics were used including penicillin, cephalosporin, carbapenem, fluoroquinolone, macrolide, aminoglycoside, tetracycline, sulfonamide and others. The bacterial and fungal isolates showed various degrees of resistance to antibiotics used in the present study. It was found that one fungal isolate is completely sensitive to all antifungal used while the other showed 33% resistance.

Regarding Gram-positive bacteria, it was reported that isolate No.6 (*Staphylococcus hominis*) and isolate No.12 (*Staphylococcus hemolyticus*) exhibited the lowest degree of antibiotic resistance (15.4%) (showed resistance to only 3 antibiotics, of 13, used in the study) while isolate No.7 (*Staphylococcus hominis*) and isolate No.14 (*Streptococcus pyogens*) revealed the highest degree of antibiotic resistance (84.6%) (showed resistance to 11 antibiotics, of 13, used in the study).

On the other hand, related to Gram-negative bacteria, it was demonstrated that isolate No.37 (*Pseudomonas aeruginosa*) showed the lowest degree of resistance (15.4%) (showed resistance to only 3 antibiotics, of 13, used in the study) while isolate No.34 (*Pseudomonas aeruginosa*) exhibited the highest degree of resistance (100%) among not only Gram-negative bacteria, but even among all microbial isolates recovered in the study (showed resistance to all 13 antibiotics used in the study).

In the present study, bacterial isolates exhibited various percentage of antibiotic resistance to antibiotics, some isolates showed low percentage of resistance (15.4%) but other may be associated with higher percentages of resistance reaching to 100% resist. Consequently, some isolates can be categorized as multidrug resistant or even extensively drug resistant including isolate No.7, No.14, No.22, No.30, No.32, No.34, No.35 and No.36.

Discussion

Blood culture remains the critical tool for diagnosis of septicemia [10]. Identification of pathogens and their antimicrobial susceptibility testing are important in initiation of adequate therapy and controlling of ongoing complications [11]. Risk for septicemia in different age groups vary widely depending on many factors like geographical location, immunological status, concurrent diseases, nutritional factors, patients with liver diseases, kidney diseases, autoimmune diseases and cancer [12].

Table 3. Antibiotic susceptibility pattern of Gram-positive bacterial isolates.

Types of bacterial isolates	Isolate no.	Antibiotic susceptibility pattern													% of bacterial resistance
		OX	TO	LE	MOX	ERY	CLI	LZ	TP	VA	TGC	F	RI	SXT	
Staphylococcus aureus	1	R	S	S	S	R	R	S	S	S	S	S	S	S	23.1%
Staphylococcus aureus	2	R	S	R	S	R	S	R	R	S	S	R	S	R	53.8%
Staphylococcus aureus	3	R	R	S	S	S	R	S	R	R	R	S	S	R	53.8%
Staphylococcus aureus	4	S	S	S	S	R	R	S	S	S	S	R	S	S	23.1%
Staphylococcus hominis	5	R	S	S	S	R	R	S	R	S	S	S	S	S	30.8%
Staphylococcus hominis	6	R	S	S	S	R	S	S	S	S	S	S	S	S	15.4%
Staphylococcus hominis	7	R	R	R	R	R	R	R	R	S	R	R	S	R	84.6%
Staphylococcus hominis	8	S	S	S	S	R	R	R	R	S	R	R	S	R	53.8%
Staphylococcus hominis	9	S	R	R	S	R	R	R	S	R	R	R	S	R	69.2%
Staphylococcus hominis	10	R	R	R	S	R	R	S	S	S	R	R	R	R	69.2%
Staphylococcus hominis	11	S	S	S	S	S	R	R	S	S	R	R	S	R	38.5%
Staphylococcus hemolyticus	12	R	S	S	S	R	S	S	S	S	S	S	S	S	15.4%
Staphylococcus pseudintermedius	13	R	R	S	S	R	R	R	R	S	R	R	S	S	61.5%
Streptococcus pyogens	14	R	R	R	R	R	R	S	R	R	R	R	S	R	84.6%
Streptococcus pyogens	15	S	R	R	S	R	R	R	R	S	S	R	S	R	61.5%

* R: Resistant to antibiotic; S: Sensitive to antibiotic. OX: Oxacillin; TO: Tobramycin; LE: Levofloxacin; MOX: Moxifloxacin; ERY: Erythromycin; CLI: Clindamycin; LZ: Linezolid; TP: Teicoplanin; VA: Vancomycin; TGC: Tigecyclin; F: Nitrofurantoin; RI: Rifampicin; SXT: Trimethoprim-sulfamethoxazole.

Table 4. Antibiotic susceptibility pattern of Gram-negative bacterial isolates**.**

Types of bacterial isolates	Isolate no.	Antibiotic susceptibility pattern													% of antibiotics resistance
		T/C	P/T	CAZ	FEP	AZM	IMP	MP	AK	GM	CP	LE	MN	CL	
Salmonella typhi	16	S	S	S	S	S	S	S	R	R	S	S	S	R	23.1%
Salmonella typhi	17	S	S	R	S	R	S	S	R	R	S	S	R	S	38.5%
Salmonella typhi	18	R	S	S	S	S	S	S	R	R	S	R	S	R	38.5%
Salmonella typhi	19	R	R	R	R	R	S	S	R	R	S	S	R	S	61.5%
Salmonella typhi	20	R	S	S	S	S	S	S	R	R	S	S	S	S	23.1%
Salmonella typhi	21	S	R	R	S	R	S	S	R	R	S	R	R	R	61.5%
Salmonella typhi	22	R	R	R	R	R	R	S	R	R	S	R	S	R	77%
Salmonella typhi	23	S	S	R	S	R	S	S	R	R	S	S	S	S	30.8%
Salmonella typhi	24	S	S	S	S	S	S	S	R	R	R	S	R	S	30.8%
Salmonella typhi	25	R	R	R	S	R	R	S	R	R	R	S	R	S	69.2%
Salmonella typhi	26	S	S	R	R	R	S	S	R	R	S	S	S	S	38.5%
Salmonella typhi	27	S	S	R	R	R	S	S	R	R	S	S	S	S	38.5%
Salmonella typhi	28	R	S	R	R	R	S	S	R	R	R	R	S	R	69.2%
Salmonella typhi	29	S	R	S	R	R	S	S	R	R	S	S	S	R	46.2%
Salmonella typhi	30	R	R	R	S	R	R	R	R	R	R	S	S	R	77%
Salmonella gallinarum	31	S	S	R	S	R	S	S	R	S	S	S	S	S	23.1%
Shigella boydii	32	R	R	R	R	R	S	S	R	R	R	R	S	R	77%
Klebsiella pneumoniae	33	S	S	R	R	S	S	S	S	R	R	R	S	R	46.2%
Pseudomonas auruginosa	34	R	R	R	R	R	R	R	R	R	R	R	R	R	100%
Pseudomonas auruginosa	35	R	R	R	R	R	R	R	R	R	R	R	R	S	92.3%
Pseudomonas auruginosa	36	R	R	R	R	R	R	R	R	R	R	S	S	S	77%
Pseudomonas auruginosa	**37**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**R**	**R**	**15.4%**
Escherichia coli	**38**	**S**	**S**	**R**	**R**	**R**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**23.1%**
Escherichia coli	**39**	**R**	**S**	**R**	**R**	**S**	**S**	**S**	**R**	**R**	**S**	**R**	**R**	**R**	**61.5%**
Escherichia coli	**40**	**S**	**S**	**R**	**R**	**R**	**S**	**S**	**S**	**R**	**S**	**R**	**S**	**S**	**38.5%**
Escherichia coli	**41**	**S**	**S**	**R**	**R**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**R**	**23.1%**
Escherichia coli	**42**	**S**	**S**	**R**	**R**	**R**	**S**	**S**	**S**	**R**	**R**	**R**	**R**	**S**	**53.8%**
Acinetobacter baumannii	**43**	**R**	**R**	**R**	**S**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**S**	**S**	**77%**
Acinetobacter baumannii	**44**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**S**	**92.3%**
Acinetobacter baumannii	**45**	**S**	**R**	**R**	**R**	**R**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**R**	**38.5%**
Acinetobacter baumannii	**46**	**R**	**R**	**R**	**S**	**R**	**R**	**R**	**S**	**R**	**R**	**R**	**S**	**S**	**69.2%**
Acinetobacter baumannii	**47**	**R**	**R**	**R**	**S**	**S**	**R**	**R**	**S**	**S**	**R**	**S**	**S**	**R**	**53.8%**
Acinetobacter baumannii	**48**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**S**	**R**	**S**	**R**	**84.6%**
Acinetobacter baumannii	**49**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**S**	**S**	**84.6%**
Acinetobacter baumannii	**50**	**R**	**R**	**R**	**S**	**S**	**R**	**S**	**R**	**S**	**R**	**S**	**S**	**R**	**53.8%**
Burkholderia cepacia	**51**	**R**	**R**	**S**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**S**	**S**	**S**	**69.2%**

R: Resistant to antibiotic; S: Sensitive to antibiotic. T/C: Ticarcillin-clavulanic acid; P/T: Piperacillin-Taozbactam; CAZ: Ceftazidime; FEP: Cefepime; AZM: Aztreonam; IMP: Imipenem; MP: Meropenem; AK: Amikacin; GM: Gentamicin; CP: Ciprofloxacin; LE: Levofloxacin; MN: Minocycline; CL: Colistin.

Table 5. Antibiotic susceptibility pattern of fungal isolates.

Types of fungal isolates	Isolate no.	Antibiotic susceptibility pattern						% of antifungal resistance
		FZ	VZ	CG	MG	APB	FC	
Candida albicans	52	S	S	S	S	S	S	0%
Candida albicans	53	R	S	S	S	R	S	33%

* R: Resistant to antibiotic; S: Sensitive to antibiotic. FZ: Fluconazole; VZ: Voriconazole; CG: Caspofungin; MG: Micafungin; APB: Amphotericin B; FC: Flucytocine.

In the current study, the majority of cases admitted to the hospital during the study period were aged from 1 day to 60 years. This may be attributed to the fact that the average lifespan of individuals in Iraq is around 60 years which may be related to the difficulties of life beside the inconvenient environmental conditions that render the individuals to be under continuous stressed conditions

In the study, incidence of septicemia and gender were significantly dependent and related. This is highly obvious from our finding that reported the lower incidence of septicemia in female than that of male. The finding of our study is in accordance with other previous study which recorded that prevalence of sepsis was lower in female (6%) than male (8.9%) [13]. Additionally, a study in the United States was performed for 22 years on sepsis patients and revealed that, in every year, men were more likely to have sepsis than women (mean annual relative risk, 1.28 (95% confidence interval, 1.24 to 1.32)) [14]. It has been reported that an elevation in estradiol level may stimulate immunity in female against the development of septicemia [15].

In the present study, Gram-negative bacteria especially *Salmonella typhi* represented the most common pathogen involved in causation of septicemia as compared with other types of bacteria. It was recorded that many areas in Babylon province suffered from poor personal hygiene (poor sanitation) in addition to the inappropriate drainage of sewage materials and found to be mixed with water source. As a result, many people lack access to safe water and food (they can acquire *salmonella* through contaminated water, food or even from infected animals). Depending on many factors, *salmonella* may reach blood circulation leading to septicemia. Furthermore, physiological structures (of Gram-negative bacteria like lipopolysaccharide) would entail additional resistance, and hence increase the tendency for septicemia.

In the study, Gram-negative bacteria (67.9%) were found to be the most relevant bacterial isolates over Gram-positive bacteria (28.3%). These findings were consistent with those of a previous study from Spain, which reported that Gram-negative bacteria were the most frequently involved in causing of sepsis (21.4% of cases) and there was a significant increase in the number of sepsis cases caused by them from 1999 onward [16].

In Pakistan Gram-negative bacteria were the most common strains: 60% of total isolates obtained from blood culture and 40% for Gram-positive bacteria [17]. Tamboli and his colleague, India, revealed that (67.4%) of total isolates recovered from blood culture were Gram-negative bacilli and the remaining isolates (32.6%) were Gram-positive bacteria [18]. While other study in Ethiopia reported the contrary, where the majority of isolates (69%) were Gram-positive bacteria (with coagulase negative staphylococci the mostly predominant isolates) followed by 31% Gram-negative bacteria [19]. This variation may be related to epidemiological differences of the causative agents included.

Antimicrobial susceptibility pattern is a very useful and important test for determination of the most suitable antibiotic for each isolate because it gives a clear picture about the susceptibility of each isolate toward various classes of antibiotics [20]. In the current study, many bacterial isolates exhibited a high level of antibiotic resistance and may be categorized as multidrug resistant or even extensively drug resistant including isolate No.7, No.14, No.22, No.30, No.32, No.34, No.35 and No.36. This finding was in accordance with that of Negussie and colleague, who stated that most isolates obtained from septicemic suspected patients were reported to be multidrug resistant (isolates showed different degrees of resistance to many antibiotics used [21]. Colistin resistance is mainly mediated by alteration the outer membrane (lipopolysaccharide) by mutations in genes coded for lipid A of an outer membrane. In addition to that, *mcr*-1 gene (plasmid-mediated colostin resistance gene) coded for transferase which identified in many Gram-negative bacilli especially *Salmonella spp., Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumoniae* [22]. As a result, proper microbial identification and adequate antimicrobial susceptibility reporting are crucial points affecting clinician's decision in selection of antimicrobial therapy and hence outcomes of septicemia [23].

Conclusions

Incidence of septicemia was higher in male than female. *Salmonella typhi* represented the most frequent causative agent of community-acquired septicemia followed by *Acinetobacter baumannii*. Antimicrobial susceptibility testing should be performed to detect precisely the antibiotic of choice for each pathogen causing community-acquired septicemia.

Acknowledgements

We would like to express my extreme thank to the medical staff in the tertiary care Hospital for their valuable assistance during the period of the study. It is pleasure to express my

deep appreciation to University of Al-Ameed for their continuous support. This work was conducted in the tertiary care Hospital and Babylon Research Center.

References

1. Archibald LK, McDonald LC, Nwanyanwu O, Kazembe P, Dobbie H, Tokars J (2000) A hospital-based prevalence survey of bloodstream infections in febrile patients in Malawi: Implications for diagnosis and therapy. J Infect Dis 181: 1414-1420.
2. Ogunleye VO, Ogunleye AO, Ajuwape ATP, Olawole OM, Adetosoye AI (2005) Childhood septicaemia due to Salmonella species in Ibadan, Nigeria. Afr J Biomed Res 8: 131-134.
3. Fleischmann C, Scherag A, Adhikari NK (2016) Assessment of global incidence and mortality of hospital-treated sepsis current estimates and limitations. Am J Respir Crit Care Med 193: 259-272.
4. Fleischmann-Struzek C, Goldfarb DM, Schlattmann P, Schlapbach LJ, Reinhart K, Kissoon N (2018) The global burden of paediatric and neonatal sepsis: a systematic review. Lanc Resp Med 6: 223-230.
5. Prabhu K, Sevitha B, Sunil R (2010) Bacteriologic profile and antibiogram of blood culture isolates in a pediatric care unit. J Lab Phy 2: 85-88.
6. Patel D, Archana N, Ankur S, Amit K, Somashekhar N (2014) Blood culture isolates in neonatal sepsis and their sensitivity in Anand district of India. Ind J Ped 81:785-790.
7. Nwokedi SI, Nwadioha EO, Kashibu E, Odimayo MS, Okwori EE (2010) A review of bacterial isolates in blood cultures of children with suspected septicaemia in a Nigerian tertiary hospital. Afr J Microbiol Res 4: 222-225.
8. Kirn TJ, Mirrett S, Reller LB, Weinstein MP (2014) Controlled clinical comparison of BacT/alert FA plus and FN plus blood culture media with BacT/alert FA and FN blood culture media. J Clin Microbiol 52: 839-843.
9. Simgamsetty S, Yarlagadda P, Yenigalla BM, Myneni RB (2016) Ease with VITEK 2 Systems, Biomerieux in identification of non-lactose fermenting bacteria including their antibiotic drug susceptibility: Our experience. Int J Res Med Sci 4: 813-817.
10. Gohel K, Amit J, Shailesh S, Sishir G, Ravindra S, Mahesh D (2014) Bacteriological profile and drug resistance patterns of blood culture isolates in a tertiary care nephrourology teaching institute. Bio Med Res Int 15: 1-5.
11. Philippe RS, Heather JA, James AK, Kimberly AN, Paulette FP, Jodi G (2012) Identification of blood culture isolates directly from positive blood cultures by use of matrix-assisted laser desorption ionization–time of flight mass spectrometry and a commercial extraction system: analysis of performance, cost, and turnaround time. J Clin Microbiol 50: 3324-3328.
12. Gotts JE, Matthay MA (2016) Sepsis: pathophysiology and clinical management. Brit Med J 353: 1585.
13. Adrie C, Azoulay E, Francais A, Clec'h C, Darques L, Schwebel C, Nakache D, Jamali S, Goldgran-Toledano D, Garrouste-Org M, Timsit JF (2007) Influence of gender on the outcome of severe sepsis: a reappraisal. Chest 132: 1786-1793.
14. Martine GS, Mannino DM, Eaton S, Moss M (2003) The epidemiology of sepsis in the Unites States from 1979 through 2000. N Engl J Med 348: 1546-1554.
15. Knoferl MW, Angele MK, Diodato MD, Schwacha MG, Ayala A, Cioffi WG, Bland KI, Chaudry IH (2002) Female sex hormones regulate macrophage function after trauma-hemorrhage andprevent increased death rate from subsequent sepsis. Ann Surg 235: 105-112.
16. Ballester JC, Ballester F, Sanchez AG, Quilis AA (2008) Epidemiology of sepsis in Valencian community (Spain), 1995-2004. Infect Control Hosp Epidemiol 29: 630-634.
17. Qureshi M, Aziz F (2011) Prevalence of microbial isolates in blood cultures and their antimicrobial susceptibility profiles. Biomed 27**:** 136-139.
18. Tamboli SS, Shrikhande S (2016) Puerperal sepsis: predominant organisms and their antibiotic sensitivity pattern. Int J Reprod Contracept Obstet Gynecol 5: 762.
19. Mulat D, Gizachew Y, Mucheye G, Alemayehu G (2013) Bacterial profile and antimicrobial susceptibility pattern in Septicemia suspected patients attending Gondar University Hospital, Northwest Ethiopia. BMC Res Notes 6: 283.
20. Raof M, Ghazai T, Kassem M, Agamya A, Amer A (2020). Surveillance of surgical-site infections and antimicrobial resistance patterns in a tertiary hospital in Alexandria, Egypt. J Infect Dev Ctries 14: 277-283. doi: 10.3855/jidc.12124.
21. Negussie A, Mulugeta G, Bedru A, Ali I, Shimeles D, Lema T, Aseffa A (2015) Bacteriological profile and antimicrobial susceptibility pattern of blood culture isolates among septicemia suspected children in selected hospitals Addis Ababa, Ethiopia. Int J Biol Med Res 6: 4709-4717.
22. Hu Y, Liu F, Lin IY, Gao GF, Zhu B (2016) Dissemination of the *mcr*-1 colistin resistance gene. Lancet Infect Dis 16: 146-147
23. Diekema DJ, Lee K, Raney P, Herwaldt LA, Doern GV, Tenover FC (2004) Accuracy and appropriateness of antimicrobial susceptibility test reporting for bacteria isolated from blood cultures. J Clin Microbiol 42: 2258-2260.

Corresponding author

Dr. Furqan Mohammed Al-Asady
College of Pharmacy, University of Al-Ameed,
Karbala Po Box 198, Iraq.
Phone: +9647801249841
E-mail: dr.furqan.alasady@gmail.com

Conflict of interests: No conflict of interests is declared.