BACTERIAL ISOLATES FROM PEDIATRIC BLOOD CULTURE AND THEIR RESPONSE TO ANTIMICROBIAL AGENTS

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ABSTRACT

Background

The blood stream can be invaded by many bacteria in the course of many infections resulting in bacteremia or septicemia.

Objectives

The aim of this study was to identify the frequency and the types of bacteria isolated form pediatric blood cultures and identify their susceptibility to antimicrobial agents.

Pateints and methods

A retrospective study on the laboratory reports of blood cultures from pediatric patients attended Sulaimani Pediatric Teaching Hospital during 18 months period.

Results

From 6024 processed blood cultures, 512 cultures yielded positive for growth of bacteria (8.4%). *Staphylococcus aureus* was the commonest microorganism isolated from both Neonatal Intensive Care Unit (NICU) and other hospital units. This was followed by *Enterobacter* spp. and *Escherichia coli* in NICU, while in other hospital units *Staphylococcus aureus* was followed by *E. coli* and *Enterobacter* spp.. *Salmonella* Typhi was isolated from 5.8% of blood cultures. The isolates mostly were resistant to many antimicrobial drugs. Certain antimicrobial agents showed to be more effective such as vancomycin, amikacin and cefaclor while more than 80% of the isolates were resistant to other agents such as ampicillin, oxacillin, carbincillin and ceftriaxone.

Conclusion

Staphylococcus aureus was the commonest bacteria isolated from blood cultures followed by Gram negative Enterobacteriaceae. The isolated bacteria were resistant to many antimicrobial agents while vancomycin and amikacin were found to be more effective than other agents.

Keywords: *Pediatric blood culture, Bacteremia, Sulaimani, Antimicrobial susceptibility.*

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INTRODUCTION

Bloodstream infections are a major cause of morbidity and mortality. Clinical presentation of bloodstream infections range from benign transient bacteremia with little or no symptoms to fulminant septic shock with high mortality [1]. There are several methods to isolate or detect bacteria from blood. Blood culture processed either manually or automatically is a valuable tool, provided all technical factors were considered. Studies in unselected patient populations found that between 7.5 and 12% of all blood cultures are positive, and among these about 5% are considered contaminated [2-4]. In the neonatal intensive care units (NICU), infections represent a major cause of mortality and morbidity where reported incidences ranged from 6% to 33% [5] and up to 40% in neonates born before 28 weeks' gestational age or with birth weight of < 1000 g [6]. In neonates, septicemia accounts for 45–55% of all infections, followed by lower respiratory tract infections (16–30%) and urinary tract infections (UTIs, 8–18%) [5-7].

The causative agents of sepsis vary according to the involved ages. The National Institute of Child Health and Human Development Neonatal Research Network reported that 61% of sepsis of very low birth weight infants was caused by Gram-negative organisms (*Escherichia. coli* in 44% of cases) and 37% by Gram-positive organisms (*Streptococcus agalactiae* in 11% of cases), while 70% of late-onset infections were caused by Gram-positive bacteria, 18% by Gram-negative bacteria and 12% by fungal organisms [7, 8].

The incidence of bacteremia in children was studied in hospitals and ambulatory settings. In otherwise normal children, beyond the newborn age group, *Streptococcus pneumoniae*, *E. coli*, *Staphylococcus aureus*, group A streptococcus, *Salmonella* spp., and *Neisseria meningitidis* are the most common microorganisms causing bacteremia [9, 10]. Children with underlying illnesses that depress the host response to infection may develop bacteremia; however, in this population of children, especially when hospitalized, Enterobacteriaceae, *S. aureus*, coagulase-negative staphylococci, and fungi are the most important organisms commonly isolated from blood cultures [11, 12]. In hospitalized children, indwelling vascular lines, urinary catheters, endotracheal tubes, and other foreign materials further predispose already compromised children to nosocomial infections. The incidence of diagnosed septicemia has increased over the years, partly owing to improved medical technology and the greater numbers of individuals with immunocompromising conditions who previously would not have survived [13].

Blood cultures may be negative despite symptoms and signs of septicemia and even when disseminated bacterial or fungal infection is proven at autopsy. Sensitivity of blood culture in neonates ranges from 8 to 73% in different studies [14]. Negative blood cultures in infants with sepsis may be due to the administration of antibiotics to the neonate or to the mother during labor, insufficient blood sample volume, or to a systemic inflammatory response due to non-infectious causes [15].

There is no single optimal system for pediatric blood cultures; In suspected community-acquired bacteremia in otherwise normal children, a single aerobic blood culture of adequate volume is sufficient. Sick neonates, hospitalized children with indwelling intravascular devices, and immunocompromised children may need multiple blood cultures, paired cultures from an indwelling vascular catheter and a peripheral vein, or the use of special media [16]. Routine anaerobic blood culture is not recommended in children because obligate anaerobic bacteremia is rare in the pediatric population. However, a number of facultative anaerobic bacteria can cause community and hospital acquired infections in children and the utility of anaerobic blood culture for detection of these organisms is still unclear [17].

The aim of this study was to identify the isolated aerobic bacteria from pediatric blood cultures and to assess antimicrobial susceptibility of the bacterial isolates.

PATIENTS AND METHODS

This retrospective study was conducted on records of blood cultures of pediatric patients admitted to Sulaimani Pediatric Teaching Hospital, Sulaimani city, Iraq. Laboratory records of aerobic blood cultures and antibacterial susceptibility of isolated microorganisms from nonconsecutive 18 months period were included in the study.

Blood samples were collected under aseptic techniques; three milliliters of venous blood were collected either from femoral vein in neonates or from anticubital fossa veins [18] and inoculated into blood culture medium (Padtan Teb Co, Tehran, Iran). The inoculated broth media were incubated at 37°C and monitored daily for growth [18, 19]. Subcultures were performed on blood agar and MacConkey agar (HiMedia Laboratories) after 24, 48, and 72 hours and on the seventh day of incubation, subcultures were incubated at 37°C for 8-24 hours.

Identification of bacteria was done based on colonial morphology, Gram staining properties, biochemical tests [20, 21] and bacterial profile using Analytical Profile Index API 20 E system (biomeireux. France). Antimicrobial susceptibility performed according to Kerby Baur disk diffusion methods [22]. The microbiology laboratory of the hospital usually assesses the susceptibility of each isolate against 5-7 different antimicrobial agents. The following antimicrobial susceptibility discs, (Bioanalyse ® Turkey) were used: amikacin (AK 30 mcg/disc), ampicillin (AM 10 mcg/disc), amoxiclave (AMC 20/10 mcg/disc), carbincillin (ATM 100 mcg/disc), azithromycin (AZM 15 mcg/disc), chloramphenicol (C 30 mcg/disc), ceftazidine CAZ (30 mcg/disc), clindamycin (CD 2 mcg/disc), ceafclor (CEC 5 mcg/disc), cephalothin (CEP 30 mcg/disc), cefixime (CFM 5 mcg/disc), gentamicin (CN 10 mcg/disc), ceftriaxone (CRO, 30 mcg/disc), cefotaxime (CTX 30 mcg/disc), erythromycin (E 15 mcg/disc), lincomycin (L 2 mcg/disc), oxacillin (OX 1 mcg/disc), penicillin (P 10 U /disc), pipracillin (PiP 100 mcg/disc), tetracycline (TE 30 mcg/disc), ticarcillin (TIC 75 mcg/disc), trimethoprim /sulphamethoxazole or cotrimoxazole (TMP, 1.25/23.75 mcg/discs) and vancomycin (VA 30 mcg/disc). The results of antimicrobial susceptibility were recorded according to the standard values provided by Clinical and Laboratory Standards Institute [23].

Data were analyzed using Microsoft Excel 2010 while Chi-square test statistics was performed using "Biostatistics Student Edition" App for Ipad by Stephen S. Ashley.

RESULTS

This study included the results of pediatric blood culture performed in Sulaimani Teaching Padiatric Hospital during 18 nonconsecutive months period, from March 2012 to August 2013. During this period, 6024 blood cultures were received and processed, from these, 512 samples (8.4%) were positive for growth. Three blood cultures resulted in isolation of two different bacteria (mixed growth) so a total of 515 bacteria were isolated.

Different Gram-positive and Gram-negative bacteria were isolated from different hospital units. The main isolated bacteria were: *Staphylococcus aureus* (264 isolates, 51.3%) followed by *Escherichia coli* (53 isolates, 10.3%), *Enterobacter* spp. (52 isolates, 10.1%). *Salmonella* Typhi (30 isolates, 5.83%), viridans streptococci (27 isolates, 5.24%), *Pseudomonas aeuroginosa* (19 isolates, 3.59%), *Salmonella* Paratyphi A (18 isolates, 3.5%), *Streptococcus pneumoniae* (12 isolates, 2.3%), and others bacterial species, Table 1.

Comparing the bacterial isolates from Neonatal Intensive Care Unit (NICU) and other hospital units, it was observed that *Staphylococcus aureus* was predominant in both groups while Gram-negatives such as *Enterobacter* spp. and *E. coli* were more in NICU in comparison to *Salmonella* Typhi and viridans streptococci from other hospital units, Table 1. It was also observed that isolation of Gram- positives were more in both NICU and other units while the samples from NICU yielded more Gram-negatives in comparison to other units, Table 2. The type of isolated bacteria (according to Gram stain) were statistically different between the NICU and other units ($\chi 2$ =8.7, P=0.003). While more Gram-negative bacteria were isolated from NICU compared to other units (47% vs. 38%), more Gram-positives were found in other units compared to the NICU (62% vs. 53%).

Table 3 shows the antimicrobial susceptibility of the common isolates against the antimicrobial agents with the note that each bacterial isolate was tested for 5-7 antimicrobial agents. Concerning *S. aureus* isolates; the most effective agents were: vancomycin (86%), cephalothin (80%), amikacin (74.6 %) while these isolates were mostly resistant to cabincillin and pipracillin (100%), ceftriaxone (96%), cefixime (90%), and many other classes of antimicrobials agents. *Escherichia coli* isolates were mostly resistant to: amoxiclave and cephalothin (100%), ceftriaxone (95%), gentamicin (78.8%) and other agents while they were mostly susceptible cefclor (81.5%), ceftazidine (63%) and amikacin (59.5%). The other isolates were also exhibiting resistance activity against various antimicrobial agents, Table 3.

Regardless of the isolated organisms, the total response to each antimicrobial agent is illustrated in Figure 1. Up to 80% of the isoaltes and more were resistant against: ampicillin, carbincillin, cefixime, ceftriaxone, oxacillin, penicillin, pipracillin and ticarcillin, while few agents were more effective such as: amikacin, vancomycin, lincomycin and cephalothin but as seen from the chart the resistance response usually dominates the figure.

Figure 2 shows the numbers of antimicrobial agents each of the isolates was resistant for; while each isolate was tested for 5-7 antimicrobial agents, up to 22% of the isolates were resistant to three antimicrobial agents, 25% were resistant to four agents, 23% were resistant to five agents, 10% were resistant to six agents and 3% were resistant to seven antimicrobial agents, Figure 2.

Table 1. Bacteria isolated from blood culture from Neonatal intensive Care Unit (NICU) and other units of Sulaimani Pediatric Teaching Hospital.

Isolated bacteria	All Units No. (%)	NICU No. (%)	Other units No. (%)
Staphylococcus aureus	**264 (51.3)**	**83 (47.4)**	**181 (53.24)**
Escherichia coli	53 (10.3)	24 (13.7)	29 (8.52)
Enterobacter Spp.	52 (10.1)	32 (18.3)	20 (5.88)
Salmonella Typhi	30 (5.83)	3 (1.71)	27 (7.94)
Viridans Streptococci	**27 (5.24)**	**3 (1.71)**	**24 (7.05)**
Pseudomonas aeruginosa	19 (3.69)	9 (5.14)	10 (2.94)
Salmonella Paratyphi A	18 (3.5)	8 (4.57)	10 (2.94)
Streptococcus pneumoniae	**12 (2.33)**	**4 (2.29)**	**8 (2.35)**
Acinetobacter spp.	9 (1.75)	1 (0.57)	8 (2.35)
Streptococcus agalatiae	**8 (1.55)**	**2 (1.14)**	**6 (1.76)**
Salmonella Paratyphi B	5 (0.97)	2 (1.14)	3 (0.88)
Proteus spp.	4 (0.78)	1 (0.57)	3 (0.88)
Klebsiella pneumoniae	3 (0.58)	2 (1.14)	1 (0.29)
Micococci	**3 (0.58)**	**0 (0)**	**3 (0.88)**
Providencia spp.	2 (0.39)	0 (0)	2 (0.58)
***Bacillus* spp.**	**2 (0.39)**	**1 (0.57)**	**1 (0.29)**
Staphylococcus epidermidis	**2 (0.39)**	**0 (0)**	**2 (0.58)**
Neisseria spp.	1 (0.19)	0 (0)	1 (0.29)
Streptococcus faecalis	**1 (0.19)**	**0 (0)**	**1 (0.29)**
Total isolates	515 (100)	175 (100)	340 (100)

*** Bold typeface names and values are for Gram-positive bacterial isolates.**

Table 2. The number and percentage of Gram positive and Gram negative isolates from different hospital units.

	Gram-positive isolates No. (%)	Gram-negative isolates No. (%)	Total
NICU	93 (53.14)	82 (46.86)	175
Other units	226 (66.47)	114 (33.53)	340
All units	319 (61.94)	196 (38.06)	515

Table 3. Antimicrobial susceptibility*for five commonly isolated bacteria from pediatric blood culture. The parentage value also represented for simplicity as size of the colour band.

Antibiotic Name **		*S. aures* N=(268)			*E. coli* N=(57)			*Ebterobacter* N=(52)			*Sal. Typhi* N=(30)			*Virdanse Strep* N=(27)		
		S	R	I	S	R	I	S	R	I	S	R	I	S	R	I
AK	No	53	14	4	22	12	3	21	9	1	15	2	0	2	2	0
	%	74.6	19.7	5.6	59.5	32.4	8.1	67.7	29.0	3.2	88.2	11.8	0.0	50.0	50.0	0.0
AM	No	11	29	0	1	11	0	0	21	0	0	16	0	3	2	0
	%	27.5	72.5	0.0	8.3	91.7	0.0	0.0	100.0	0.0	0.0	100.0	0.0	60.0	40.0	0.0
AMC	No	19	73	1	0	13	0	0	8	0	1	2	0	7	5	1
	%	20.4	78.5	1.1	0.0	100.0	0.0	0.0	100.0	0.0	25.0	50.0	0.0	53.8	38.5	7.7
ATM	No	0	55	0	1	7	0	1	3	0	5	1	0	0	1	0
	%	0.0	100.0	0.0	12.5	87.5	0.0	25.0	75.0	0.0	83.3	16.7	0.0	0.0	100.0	0.0
AZM	No	12	47	1	8	3	1	3	4	0	0	2	0	1	2	0
	%	20.0	78.3	1.7	72.7	27.3	9.1	42.9	57.1	0.0	0.0	100.0	0.0	33.3	66.7	0.0
C	No	26	16	1	8	2	0	12	4	0	0	11	0	6	1	0
	%	60.5	37.2	2.3	80.0	20.0	0.0	75.0	25.0	0.0	0.0	100.0	0.0	85.7	14.3	0.0
CAZ	No	22	38	0	17	9	1	13	8	2	17	3	0	2	0	0
	%	36.7	63.3	0.0	63.0	33.3	3.7	56.5	34.8	8.7	85.0	15.0	0.0	100.0	0.0	0.0
CD	No	67	63	2	0	2	0	0	1	0	0	1	0	8	9	1
	%	50.8	47.7	1.5	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	44.4	50.0	5.6
CEC	No	29	46	2	22	4	1	18	5	0	9	0	0	6	3	0
	%	37.7	59.7	2.6	81.5	14.8	3.7	78.3	21.7	0.0	100.0	0.0	0.0	66.7	33.3	0.0
CEP	No	25	6	0	0	11	0	2	7	1	2	5	0	1	1	0
	%	80.6	19.4	0.0	0.0	100.0	0.0	20.0	70.0	10.0	28.6	71.4	0.0	50.0	50.0	0.0
CFM	No	0	18	2	2	7	0	2	11	0	2	3	0	0	2	0
	%	0.0	90.0	10.0	22.2	77.8	0.0	15.4	84.6	0.0	40.0	60.0	0.0	0.0	100.0	0.0
CN	No	31	37	0	10	26	1	12	19	2	12	4	1	4	5	0
	%	45.6	54.4	0.0	30.3	78.8	3.0	36.4	57.6	6.1	70.6	23.5	5.9	44.4	55.6	0.0
CRO	No	1	29	0	1	19	0	3	15	1	7	4	2	0	4	0
	%	3.3	96.7	0.0	5.0	95.0	0.0	15.8	78.9	5.3	53.8	30.8	15.4	0.0	100.0	0.0
CTX	No	9	56	2	7	23	0	7	22	0	7	9	3	3	0	0
	%	13.4	83.6	3.0	23.3	76.7	0.0	24.1	75.9	0.0	36.8	47.4	15.8	100.0	0.0	0.0
E	No	29	121	1	1	0	0	0	0	0	1	2	0	5	7	1
	%	19.2	80.1	0.7	100.0	0.0	0.0				33.3	66.7	0.0	38.5	53.8	7.7
L	No	45	35	0	1	0	0	0	0	0	0	0	0	3	20	1
	%	56.3	43.8	0.0	100.0	0.0	0.0							12.5	83.3	4.2
OX	No	24	109	4	0	1	0	0	0	0	0	0	0	1	11	0
	%	17.5	79.6	2.9	0.0	100.0	0.0							8.3	91.7	0.0
P	No	28	146	0	0	5	0	1	4	0	1	0	0	4	9	0
	%	16.1	83.9	0.0	0.0	100.0	0.0	20.0	80.0	0.0	100.0	0.0	0.0	30.8	69.2	0.0
PiP	No	0	7	0	1	12	0	2	11	0	0	3	0	0	0	0
	%	0.0	100.0	0.0	7.7	92.3	0.0	15.4	84.6	0.0	0.0	100.0	0.0			
TE	No	9	12	0	1	13	0	3	11	0	0	0	0	0	0	0
	%	42.9	57.1	0.0	7.1	92.9	0.0	21.4	78.6	0.0						
TIC	No	0	1	0	0	3	0	0	6	0	1	4	0	0	0	0
	%	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	20.0	80.0	0.0			
TMP	No	26	36	1	12	17	0	10	20	0	2	15	1	5	6	1
	%	41.3	57.1	1.6	41.4	58.6	0.0	33.3	66.7	0.0	11.1	83.3	5.6	41.7	50.0	8.3
VA	No	160	23	3	2	0	0	1	3	0	1	2	0	15	2	0

*** S: susceptible, R: Resistant and I: Intermediate response.**

**** AK: Amikacin, AM: Ampicillin, AMC: Amoxiclave, ATM: Carbincillin, AZM Azithromycin, C: Chloramphenicol, CAZ: Ceftazidine, CD: Clindamycin, CEC: Cefaclor, CEP: Cephalothin, CFM: Cefixime, CN: Gentamicin, CRO: Ceftriaxone, CTX: Cefotaxime, E: Erythromycin, L: Lincomycin, OX: Oxacillin, P: Penicillin, PiP: Pipracillin, TE: Tetracycline, TIC: Ticarcillin, TMP: Trimethoprim /Sulphamethoxazole or Cotrimoxazole and VA: Vancomycin.**

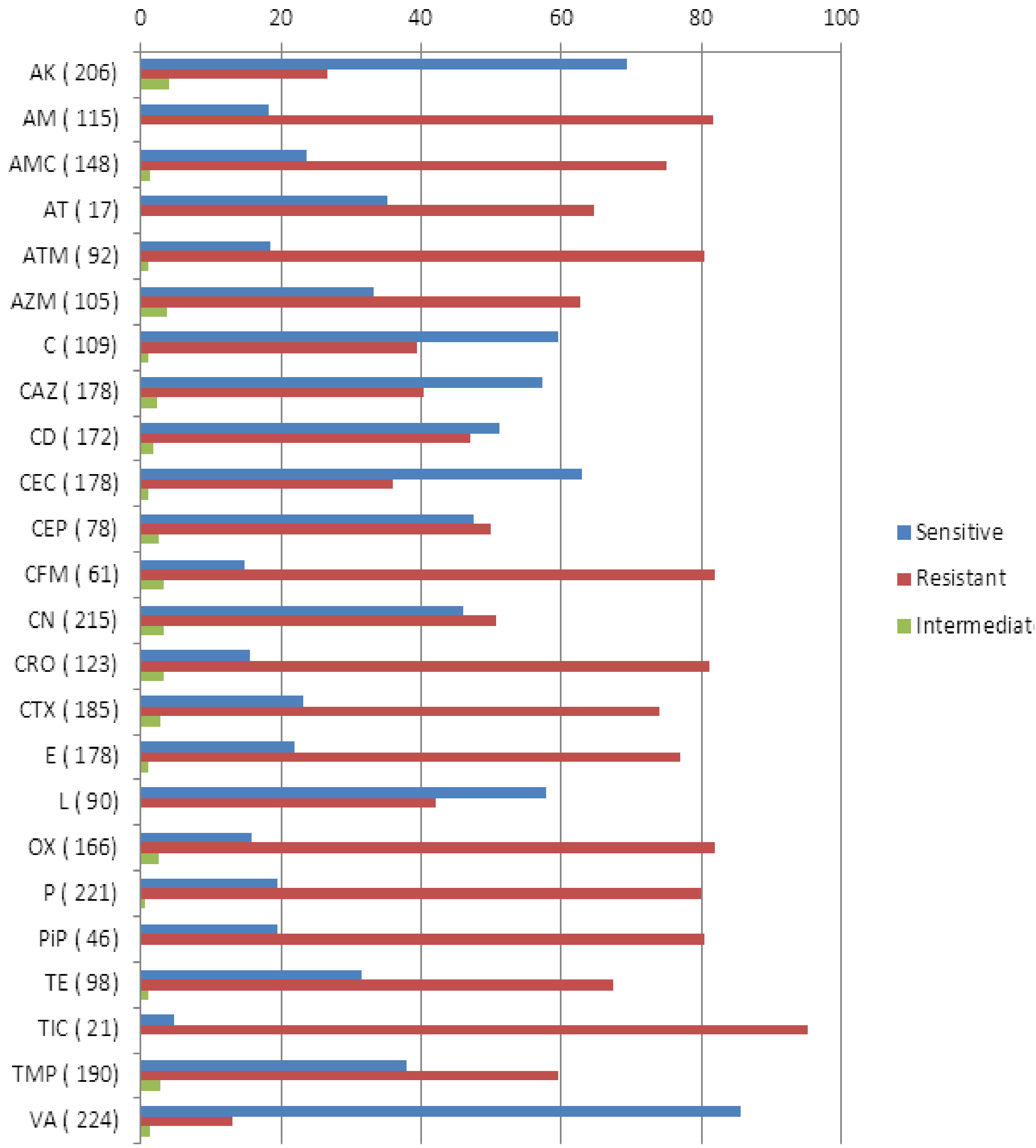

Figure 1. The overall response as percentage each antimicrobial agent reported in the study regardless to the isolated bacteria from the study.

AK: Amikacin, AM: Ampicillin, AMC: Amoxiclave, ATM: Carbincillin , AZM Azithromycin, C: Chloramphenicol, CAZ: Ceftazidine, CD: Clindamycin, CEC: Cefaclor, CEP: Cephalothin, CFM Cefixime, CN: Gentamicin, CRO: Ceftriaxone, CTX: Cefotaxime, E: Erythromycin, L: Lincomycin, OX: Oxacillin, P: Penicillin, PiP: Pipracillin, TE: Tetracycline, TIC: Ticarcillin, TMP: Trimethoprim /Sulphamethoxazole or Cotrimoxazole and VA: Vancomycin.

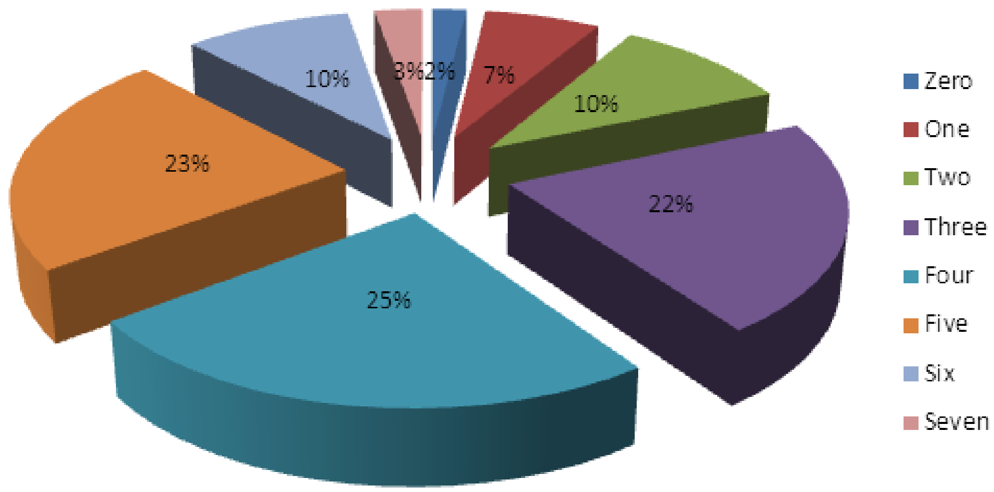

Figure 2. The percentage of bacteria resistant to zero or 1 to 7 different antimicrobial agents.

DISCUSSION

Blood culture represents a critical tool for the health care professional as a mean of detecting the dangerous presence of living organisms in the blood stream. A positive blood culture can suggest a definitive diagnosis, enable the targeting of therapy against the specific organism(s) in question, and provide prognostic value [(24)]. In the pediatric group blood culture is required in several conditions such as bacteremia, septic shock, fever without source and fever of unknown origin [(25)]. A variety of strategies have been investigated and employed to decrease contamination rates by: good skin preparation, culture bottle preparation, obtaining cultures percutaneously instead of via vascular catheters and using double needles [(26)].

In this study, there was no case selection and all blood cultures sent for the microbiology laboratory in the hospital were processed and included in analysis. The laboratory usually performs blood culture under aerobic conditions using one blood sample unless indicated individually. Perhaps processing more than one blood specimen patient will clear out doubtful results such as isolation of normal skin flora and may decrease the number of negative results [(18)].

In this study the percentage of positive cultures was 8.4% using manual method rather than automated BACTEC system, including within this rate is true bacteremia and contaminations and as a retrospective study on laboratory reports no confirmation for true bacteremia was possible [(27)]. Comparing our results to other studies, the rate of isolation from this hospital laboratory was within the values elsewhere such as that from the Stoesser *et al.* study in which the percentage of positive cultures was 7.9% [(28)] and as stated the rate of isolation is expected to be increased when a single culture is performed for a patient [(26)].

The types of isolated bacteria from blood culture varies according to the pediatric age, the community and vaccination programs implemented [(10, 29)]. The analyzed data from this study showed that 62% of the isolated bacteria were Gram positive and 38% were Gram negative. This was due to high isolation rate of *Staphylococcus aureus* (51.3%) which exceeded the sum of all other bacterial isolates and made Gram-positives bacteria more predominant than Gram-negative bacteria even in NICU. Not strangely *S. aureus* is considered as a nosocomial pathogen that causes many infections involving pediatric groups but less figures for Gram positives were reported from pediatric intensive care unit (30.4%) from the Lee *et al.* study [(30)] while in another study more Gram positives were reported (78.6%) [(31)]. *Staphylococcus aureus* was also the most common in Lee *et al.* study while in the Baby et al. study *S. aureus* was next to *Staphylococcus epidermidis* which raises the contamination problem as they also depended on the results form single culture [(30, 31)].

Next to *S. aureus* were enteric Gram negative (*Enterobacteriaceae*) such as *E. coli*, *Enterobacter* spp. and *Salmonella* with isolation rate of 10.3%, 10.1% and 5.83% respectively. These pathogens may reach blood in a variety of clinical conditions to cause bloodstream infection especially in neonatal groups. The reported enteric Gram-negative organisms are more common in neonatal bloodstream infections with various rates for each isolated organism [32-34].

In this region enteric fever is a common problem, all isolated salmonella species were near 10% of all bacterial blood isolates. In a previous study from the same hospital; it was found that out of 250 clinically suspected cases of enteric fever, only 95 (38%) were culture positive for salmonella indicating the extent of this infection in our community [35]. Even a higher incidence of salmonella was reported, *Salmonella* Typhi was found in 22.8% of isolates from pediatric bloodstream infections in Cambodia [28]. Furthermore, the incidence of salmonella bloodstream infections increased after the introduction of the heptavalent-conjugated pneumococcal vaccine in Northern California/USA [10].

Nosocomial pathogens such as *Pseudomonas aeruginosa*, *Acinetobacter* spp. were also isolated from blood which may indicate a true bacteremia and the possibility of immunosuppression [30, 31, 36]. The isolation of *Streptococcus pneumoniae* in this study (2.3%) was less than those reported elsewhere although vaccination against pneumococci is not included in the local vaccination programs. *Streptococcus pneumoniae* was reported from 4.5% of blood stream infection from Saudi Arabia [31] and up to 10.0% of blood cultures before the introduction of pneumococcal vaccine in Cambodia [28].

Other bacteria were isolated including normal skin flora such as viridans group streptococci, *Bacillus* spp., micrococci and *Staphylococcus epidermidis*. Due to the nature of these organisms and because a single culture was used in this hospital, the possibility of contamination with these organisms is there [26]. Comparing our results to local studies; *Staphylococcus aureus* and *E. coli* were found to be the commonest bacteria isolated from 80 pediatric patients with signs and symptoms of septicemia admitted to Central Teaching Hospital of Pediatric in Baghdad city where the rate of positive blood cultures was 25% [37]. While in another study it was found that among 120 neonates with sepsis admitted to neonatal care unit at Basrah Maternity and Children Hospital in Basrah, *Klebsiella* was the commonest bacteria isolated in (36.6%), followed by *E. coli* (27.5%), and *Enterobacter aerogenes* (22.5%) while *S. aureus* was found in 2.5% [38]. Compared with our findings, isolation of *S. aureus* was very low. This may be explained to be due to the small size study sample and selection of cases of Basrah study.

Before analyzing the results of antimicrobial susceptibility, few points must be clarified: 1.) The hospital laboratory lacks a fixed susceptibility protocol (i.e. the selected antimicrobial agents) for testing the isolates and it was not done according to a defined list but it was done according to the guess and availability of the antimicrobial disks; 2.) Due to small numbers of some bacterial isolates and many antimicrobial agents, the conclusion to the susceptibility may not be absolutely true for some isolates and for this purpose only the data for the main isolates such as *S. aureus* (264 isolates), *E. coli* (53 isolates), *Enterobacter* spp. (52 isolates), *Salmonella* Typhi (30 isolates) and to viridans group streptococci (27 isolates) were shown in the results; 3.) In many situations when bloodstream infection is suspected; an empirical antimicrobial therapy may be started after blood sampling for culture without waiting the antimicrobial susceptibility results, therefore the *in vitro* effectiveness of each antimicrobial agent was analyzed irrespective to the bacteria, Figure 1.

The data shows that in some bacteria, resistance to certain antimicrobial agent may reach 100% (*S. aureus* for carbincillin, *Enterobacter* spp. for ampicillin) but susceptibility will not reach such values even for drugs such as vancomycin and amikacin. The resistance response was also against many antimicrobial agents, (Figure 2) and up to 81% of the isolated was resistant to 3-7 antimicrobial agents, Figure 2.

The antimicrobial response by bacteria from this study is gloomy and worrying but it is expected to be due irrational use of antimicrobial drugs in this community. Antimicrobial susceptibility from previous studies in this community confirm our call [35, 39-41]. In all these studies, resistance against antimicrobials agents dominates susceptibility. In this study analyzed data also confirm the previous observations. Resistance against penicillins, third generation cephalosporin, macrolides were observed and these may be due to the common use of these agents.

In addition to the significant health and economic impact of true bloodstream infections, vast resources are also consumed by false-positive blood culture results. Overall, blood culture have a relatively low yield and the proportion of false-positive results is high [(42)]. For these reasons, it has become increasingly clear that to maximize the diagnostic utility of blood cultures, at least two sets of cultures should be performed [(26)].

Appropriate antimicrobial selection, surveillance systems, and effective infection-control procedures are key partners in limiting antimicrobial-resistant pathogen occurrence and spread [(43)]. Measures to decrease antimicrobial selective pressure on bacteria is needed to stop the phenomenon of resistance by restricting irrational antimicrobial drugs use and the availability of antimicrobial drugs to public without proper prescription.

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REFERENCES

1. Seifert H, Wisplinghoff H. Bloodstream infection and endocarditis. In: S. Peter Borriello, . PRM, Funke G, editors. Topley and Wilson's Microbiology and Microbial Infections. 1. 10 Edition ed. UK: Wiley; 2005. p. 1-46.

2. Darby JM, Linden P, Pasculle W, Saul M. Utilization and diagnostic yield of blood cultures in a surgical intensive care unit. Critical care medicine. 1997 Jun;25(6):989-94. PubMed PMID: 9201052.

3. Roberts FJ, Geere IW, Coldman A. A three-year study of positive blood cultures, with emphasis on prognosis. Reviews of infectious diseases. 1991 Jan-Feb;13(1):34-46. PubMed PMID: 2017629.

4. Weinstein MP, Murphy JR, Reller LB, Lichtenstein KA. The clinical significance of positive blood cultures: a comprehensive analysis of 500 episodes of bacteremia and fungemia in adults. II. Clinical observations, with special reference to factors influencing prognosis. Reviews of infectious diseases. 1983 Jan-Feb;5(1):54-70. PubMed PMID: 6828812.

5. Clark R, Powers R, White R, Bloom B, Sanchez P, Benjamin DK, Jr. Nosocomial infection in the NICU: a medical complication or unavoidable problem? Journal of perinatology : official journal of the California Perinatal Association. 2004 Jun;24(6):382-8. PubMed PMID: 15116140.

6. Brady MT. Health care-associated infections in the neonatal intensive care unit. American journal of infection control. 2005 Jun;33(5):268-75. PubMed PMID: 15947743.

7. Stolfi I MM, Lana S (1999) . 25:193–200. Frequenza e variabilità delle infezioni ospedaliere in Terapia Intensiva Neonatale (TIN). Riv Ital Pediatr. 1999;25:193-200.

8. Stoll BJ, Hansen N, Fanaroff AA, Wright LL, Carlo WA, Ehrenkranz RA, et al. Late-onset sepsis in very low birth weight neonates: the experience of the NICHD Neonatal Research Network. Pediatrics. 2002 Aug;110(2 Pt 1):285-91. PubMed PMID: 12165580.

9. Watson RS, Carcillo JA, Linde-Zwirble WT, Clermont G, Lidicker J, Angus DC. The epidemiology of severe sepsis in children in the United States. American journal of respiratory and critical care medicine. 2003 Mar 1;167(5):695-701. PubMed PMID: 12433670.

10. Herz AM, Greenhow TL, Alcantara J, Hansen J, Baxter RP, Black SB, et al. Changing epidemiology of outpatient bacteremia in 3- to 36-month-old children after the introduction of the heptavalent-conjugated pneumococcal vaccine. The Pediatric infectious disease journal. 2006 Apr;25(4):293-300. PubMed PMID: 16567979.

11. Patrick CC. Coagulase-negative staphylococci: pathogens with increasing clinical significance. The Journal of pediatrics. 1990 Apr;116(4):497-507. PubMed PMID: 2181097.

12. Albano EA, Pizzo PA. Infectious complications in childhood acute leukemias. Pediatric clinics of North America. 1988 Aug;35(4):873-901. PubMed PMID: 3047658.

13. Centers for Disease C. Increase in National Hospital Discharge Survey rates for septicemia--United States, 1979-1987. MMWR Morbidity and mortality weekly report. 1990 Jan 19;39(2):31-4. PubMed PMID: 2104656.

14. Mishra UK, Jacobs SE, Doyle LW, Garland SM. Newer approaches to the diagnosis of early onset neonatal sepsis. Archives of disease in childhood Fetal and neonatal edition. 2006 May;91(3):F208-12. PubMed PMID: 16632649. Pubmed Central PMCID: 2672708.

15. Stronati M, Borghesi A. Neonatal Bacterial and Fungal Infections. In: Buonocore G, Bracci R, Weindling M, editors. Neonatology A Practical Approach to Neonatal Diseases. Italy: Springer; 2012. p. 905-30.

16. Paisley JW, Lauer BA. Pediatric blood cultures. Clinics in laboratory medicine. 1994 Mar;14(1):17-30. PubMed PMID: 8181229. Epub 1994/03/01. eng.

17. Shoji K, Komuro H, Watanabe Y, Miyairi I. The utility of anaerobic blood culture in detecting facultative anaerobic bacteremia in children. Diagnostic microbiology and infectious disease. 2013 Aug;76(4):409-12. PubMed PMID: 23747032. Epub 2013/06/12. eng.

18. York MK. Blood Cultures- General Detction and Interpretation. In: Isenburg HD, editor. Clinical Microbiology Procedures Handbook. 1. 2 ed. Washington, D.C.: American Society for Microbiology; 2007. p. 3.4.1.-3.4.1.19.

19. Weinstein MP. Current blood culture methods and systems: clinical concepts, technology, and interpretation of results. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America. 1996 Jul;23(1):40-6. PubMed PMID: 8816127.

20. Colaninno PM. Identification of Gram-Positive Organisms. In: Goldman E, H. GL, editors. Practical Handbook of Microbiology. Second ed. Boca Raton CRC Press; 2009. p. 53-66.

21. Donna J. Kohlerschmidt, Kimberlee A. Musser, Dumas NB. Identification of Gram-Positive Organisms In: Goldman E, H. GL, editors. Practical Handbook of Microbiology. Boca Raton: CRC Press; 2009. p. 67-79.

22. Bauer AW, Kirby WM, Sherris JC, Turck M. Antibiotic susceptibility testing by a standardized single disk method. Am J Clin Pathol. 1966 Apr;45(4):493-6. PubMed PMID: 5325707.

23. CLSI. Performance Standards for Antimicrobial Disk Susceptibility Tests: Twenty-First Informational Supplement. Wayne, PA2011.

24. Bryan CS. Clinical implications of positive blood cultures. Clinical microbiology reviews. 1989 Oct;2(4):329-53. PubMed PMID: 2680055. Pubmed Central PMCID: 358128.

25. Kaplan SL, Vallejo JG. Bacteremia and Septic Shock. 2009. In: Feigin and Cherry's Textbook of Pediatric Infectious Diseases [Internet]. USA: ELSEVIER; [837-51].

26. Hall KK, Lyman JA. Updated review of blood culture contamination. Clinical microbiology reviews. 2006 Oct;19(4):788-802. PubMed PMID: 17041144. Pubmed Central PMCID: 1592696. Epub 2006/10/17. eng.

27. Stalnikowicz R, Block C. The yield of blood cultures in a department of emergency medicine. European journal of emergency medicine : official journal of the European Society for Emergency Medicine. 2001 Jun;8(2):93-7. PubMed PMID: 11436922.

28. Stoesser N, Moore CE, Pocock JM, An KP, Emary K, Carter M, et al. Pediatric bloodstream infections in Cambodia, 2007 to 2011. The Pediatric infectious disease journal. 2013 Jul;32(7):e272-6. PubMed PMID: 23838788. Epub 2013/07/11. eng.

29. Wisplinghoff H, Seifert H, Tallent SM, Bischoff T, Wenzel RP, Edmond MB. Nosocomial bloodstream infections in pediatric patients in United States hospitals: epidemiology, clinical features and susceptibilities. The Pediatric infectious disease journal. 2003 Aug;22(8):686-91. PubMed PMID: 12913767. Epub 2003/08/13. eng.

30. Lee CY, Chen PY, Huang FL, Lin CF. Microbiologic spectrum and susceptibility pattern of clinical isolates from the pediatric intensive care unit in a single medical center - 6 years' experience. Journal of microbiology, immunology, and infection = Wei mian yu gan ran za zhi. 2009 Apr;42(2):160-5. PubMed PMID: 19597649. Epub 2009/07/15. eng.

31. Babay HA, Twum-Danso K, Kambal AM, Al-Otaibi FE. Bloodstream infections in pediatric patients. Saudi medical journal. 2005 Oct;26(10):1555-61. PubMed PMID: 16228055.

32. Cordero L, Rau R, Taylor D, Ayers LW. Enteric gram-negative bacilli bloodstream infections: 17 years' experience in a neonatal intensive care unit. American journal of infection control. 2004 Jun;32(4):189-95. PubMed PMID: 15175611. Epub 2004/06/04. eng.

33. Blomberg B, Jureen R, Manji KP, Tamim BS, Mwakagile DS, Urassa WK, et al. High rate of fatal cases of pediatric septicemia caused by gram-negative bacteria with extended-spectrum beta-lactamases in Dar es Salaam, Tanzania. Journal of clinical microbiology. 2005 Feb;43(2):745-9. PubMed PMID: 15695674. Pubmed Central PMCID: 548071. Epub 2005/02/08. eng.

34. Kruse AY, Thieu Chuong DH, Phuong CN, Duc T, Graff Stensballe L, Prag J, et al. Neonatal bloodstream infections in a pediatric hospital in Vietnam: a cohort study. Journal of tropical pediatrics. 2013 Jul 18. PubMed PMID: 23868576. Epub 2013/07/23. Eng.

35. Mohammad MS, Omer SA, Radhid BR, Hamawandi AM. Enteric Fever in Sulaimani Pediatric Teaching Hospital: Risk factors, Presentation, and Drug Susceptibility. Journal of Sulaimani Medical College 2014;4(1):55-62.

36. Hsueh PR, Chen WH, Luh KT. Relationships between antimicrobial use and antimicrobial resistance in Gram-negative bacteria causing nosocomial infections from 1991-2003 at a university hospital in Taiwan. International journal of antimicrobial agents. 2005 Dec;26(6):463-72. PubMed PMID: 16280243. Epub 2005/11/11. eng.

37. Al-Rawazq HS, Mohammed AK, Al-Zubaidy RH. Bacterial Isolates in Blood Culture of Children with Septicemia. Fac Med Baghdad. 2012;54(1):96-9.

38. Jumah DS, Hassan MaK. Predictors of Mortality Outcome in Neonatal Sepsis. The Medical Journal Basrah University. 2007;25, No.1, 2007(1):11-8.

39. Abass VT, Omer SA. Oral Findings and Microflora in Type II Diabetes Mellitus in Sulaimani City. Journal of Sulaimani Medical College. 2011;1(1):13-28.

40. Fathi NN, Omer SA, Mohammed MO. Nasal Carriers of Methicillin-Resistant Staphylococcus aureus (MRSA), Infection Safety and Hand Hygiene Among Health Workers in Sulaimani City. Journal of Sulaimani Medical College. 2013;3(1):1-12.

41. Karwan Raoof Hassan IHAaZSR. Types of Organisms Causing Urinary Tract Infection and Their Antibiotic Sensitivity Pattern in Sulaimani Teaching Hospital. Journal of Sulaimani Medical College. 2014;4(2):11-7.

42. Shafazand S, Weinacker AB. Blood cultures in the critical care unit: improving utilization and yield. Chest. 2002 Nov;122(5):1727-36. PubMed PMID: 12426278.

43. Jones RN. Resistance patterns among nosocomial pathogens: trends over the past few years. Chest. 2001 Feb;119(2 Suppl):397S-404S. PubMed PMID: 11171776. Epub 2001/02/15. eng.