



Trends in Blood Stream Infections of Adolescents the Forthcoming Challenges in a North Indian Tertiary Care Hospital IGMC Shimla, India

Pankaj Katoch^{1*} and Sanjay Chandel²

¹Senior Resident, Department of Microbiology, IGMC Shimla, India

²Assistant Professor, Department of Forensic Medicine, DR. RKGMC Hamirpur, Himachal Pradesh, India

*Corresponding Author: Pankaj Katoch, Senior Resident, Department of Microbiology, IGMC Shimla, India.

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Abstract

Background: Septicaemia and bacteremia are among the major challenges faced by health care professionals worldwide, these days leading to increased chances of morbidity and mortality for patients of all age groups.

The incidence among newborns can be low, but the chances of adverse consequences are increased. Blood culture forms a critical part of the evaluation of patients with suspected sepsis [1]. However, very little is known about the trends of bacterial bloodstream infections and antimicrobial susceptibilities among the adolescent population, as the literature is less. Hence, the present study is designed to evaluate the current trends in incidences and the etiological profile of BSI among adolescents using automated Bactec systems

Objective: To formulate guidelines for the care of adolescents from birth to 18 years of age.

Materials and Methods: All blood culture samples received in the Department of Microbiology for culture by Bactec Bd fx from July 2015 to June 2016 were included in the study. The blood culture was observed in the Bactec Bd fx system for at least 5 days before reporting as sterile.

Results: A total of 563 samples in the adolescent age group and suspected of BSI's received in the Department of Microbiology, IGMC, Shimla. All indoor and outdoor patients with temperatures ≥ 38 degrees C. Among them, 324(57.5%) were of males while 239(42.5%) were females. Among the total of 563 samples, 124(22%) were found to be positive in culture, 426(75.7%) were negative, while 13(2.3%) had contaminants defined by the growth of three different types of colonies in the medium. Among the 124 positive cases, 67(54%) were men while 57(46%) were women.

Conclusion: Bloodstream infection is an important cause of morbidity and mortality in patients of the adolescent age group. All febrile patients in the study group diagnosed with bacterial infections were included in this study. There was relatively high positivity in blood culture among the age group. Positivity was high in males compared to females.

Keywords: Infections; Culture; Bactec; Group of Adolescents

Introduction

Data especially from developed countries indicates that nearly 52 million incidents of sepsis occur throughout the world each year, with estimates of about six million deaths. The characteristic features of endothelial dysfunction by sepsis include an increase in the level of oxidative stress, systemic involvement, leading to

inflammation, the glycocalyx degrades, leading to shedding, endothelial damage or death, the blood-tissue barrier is disrupted, more leukocyte adhesion occurs, consequently leading to the cascade of a procoagulant antifibrinolytic state [2].

Low- income and developing countries face a huge burden of bloodstream infections which in turn contribute to morbidity, mor-

tality, and increased financial burden on patients or their families, as per Okeke, *et al.* [3] Reynolds R., *et al.* [4]. Diekema DJ., *et al.* [5]. Adolescent age group patients with BSI can present a dilemma in diagnosis and therapeutic difficulty because they can present with a normal or low body temperature as per Parajuli NP, *et al.* [6]. Bloodstream infections (BSIs) are among the main factors causing mortality and morbidity all over the world but are given less recognition. The terms bloodstream infection and bacteremia are concurrently in practice and point to the fact about the replication and growth of a microorganism in a culture from a patient with signs of infection. In practice, bacteremia can manifest from limiting infections to life-dangering septicemia which requires prompt antimicrobial treatment [7,8]. *Staphylococcus aureus* and Coagulase-negative staphylococci (CoNS) are some of the common Gram-positive isolates. The virulence of CONS organisms is relatively lower, but they can cause significant infections in the bloodstream and other sites. Risk factors for these infections include the presence of invasive devices (such as catheters, central venous lines, intravascular catheters) and immunosuppressed states. It is very difficult to distinguish true infection from contamination. The true bacteremia of *Staphylococcus aureus* is relatively severe and has significant complications even with appropriate therapy. *Streptococcus pyogenes* is a common cause of pharyngitis and other associated invasive complications. When we consider Gram-negative bacteria, they are generally associated with hospital-acquired infections and catheter-related invasive devices. *Pseudomonas aeruginosa* is one of the most commonly implicated gram-negative aerobic bacteria in the differential diagnosis of hospital-acquired infections. *Pseudomonas aeruginosa* is one of the most commonly considered gram-negative aerobic bacilli in the differential diagnosis of several probable gram-negative infections, especially in the immunosuppressed hosts, is antibiotic-resistant, complicating therapy selection, and has a significant mortality rate. *E.coli* meningitis early can present without signs of nervous system involvement. Some other Gram-negative bacilli, such as *Citrobacter koseri*, *Salmonella* species, can cause brain abscesses in infants with meningitis. Salmonellae are motile Gram-negative bacilli that can infect a wide range of mammalian hosts. They cause several infections in humans including gastroenteritis, enteric fever, endovascular infection, focal or localized infections such as osteomyelitis or abscess.

Bloodstream infections leading to septicemia, are a big challenge in therapeutic medicine. This life-threatening infection gets worsened quickly due to the circulation of infecting pathogens or their toxic metabolites in the blood. Neonates and young children

are among the most susceptible groups to catching diseases due to their weak immune status. The problem is more serious particularly in infants and young children with high-grade fever and undetected focus of infection [9]. Changing patterns of isolates, increasing rates of antimicrobial resistance, and the wide application of new medical technologies as the rampant use of dwelling devices can change the epidemiology and outcome of BSIs [10].

Therefore, it is necessary to continually review and update the epidemiology of BSIs mainly due to the antibiotic susceptibility pattern of circulating common pathogens, so that prompt and necessary empirical treatment of patients can be initiated [11].

Bloodstream infections (BSIs) are significant causes of morbidity and mortality worldwide but are poorly documented and do not receive the proper attention. Illness associated with bacteremia ranges from self-limiting infection to life-threatening sepsis, that is, mortality ranging from 20% to 50% [12].

BSIs are associated with an increased duration of hospitalization and are a huge financial burden on patients or their families. Improvement in clinical microbiology infrastructure and services for the empirical treatment guidelines could contribute to a better outcome [13].

Most studies related to the laboratory diagnosis of BSI focus either on infants or the adult population. This study in IGMC Shimla INDIA was conducted on the adolescent age group using an automated Bactec BD FX machine for culture. Therefore, the present study is being done to evaluate the incidence of BSIs among the adolescent age group.

Objectives

Determine the epidemiological BSIs among the adolescent age group using automated Bactec systems.

Material and Methods

- **Study Design:** Prospective observational study
- **Study Setting:** Department of Microbiology, Indira Gandhi Medical College And Hospital, Shimla, India
- **Study Period:** One year from July 2015 to June 2016.

Inclusion criteria

- All blood culture samples received in the Department of Microbiology for blood culture that falls within the age range of the study group.

- Patient attendants were present with informed consent and were willing to study.
- Blood cultures from age groups.

Exclusion criteria

- Patient or their attendants not willing to study.
- Blood cultures showing mixed microbial growth.

Methodology

All blood culture samples of the age groups in the Department of Microbiology for culture were included in the study. The culture was observed in the Bactec bd fx system for at least 5 days before being reported as sterile.

The sample to be tested is inoculated into the vial for children, which is then inserted into the Bd Bactec fluorescent series instrument for incubation. Each bottle has a sensor that detects the increase in CO₂ produced by the growth of microorganisms. The sensor monitors every 10 minutes for an increase in fluorescence, which is proportional to the amount of CO₂ present. A positive reading indicates the tentative presence of viable pathogens in the bottle. The positive bottle will be sub-cultured on blood agar and McConkey agar plates. Following the subculture in solid media from each positive bottle, a smear will be prepared for gram staining from that blood culture vial. The smear will be analyzed for the presence of pathogens and the presumptive report will be transmitted to the respective departments. *Escherichia coli* ATCC 25922, *Staphylococcus aureus* ATCC25923, *Staphylococcus epidermidis* ATCC 12228, *Streptococcus pneumonia* ATCC 49619, and *Pseudomonas aeruginosa* ATCC 27853 were inoculated along with the test organisms. All positive isolates were stocked.

Antibiotic susceptibility test

The antibiotic sensitivity test was performed by diffusion of discs as per the CLSI guidelines. The antimicrobial susceptibility pattern was analyzed by the Kirby-Bauer disk diffusion method. The susceptibility of isolated organisms to agents was tested using Mueller-Hinton agar. Drug-resistant strains were evaluated to determine methicillin resistance in *Staphylococcus aureus* (MRSA) strains and extended-spectrum beta-lactamases (ESBLs) in gram-negative bacterial isolates.

Statistical analysis

Data were analyzed by statistical analysis-epi info7. The data was collected and analyzed in a spreadsheet. Analysis in terms of demography, positivity in samples, type of species, was done using statistical software epi-info version (7.1.1.0).

Results

A total of 563 samples from the adolescent group suspected of BSIs were received in the Department of Microbiology, IGMC, Shimla. Among them, 324(57.5%) were male while 239(42.5%) were of females (Figure 1).

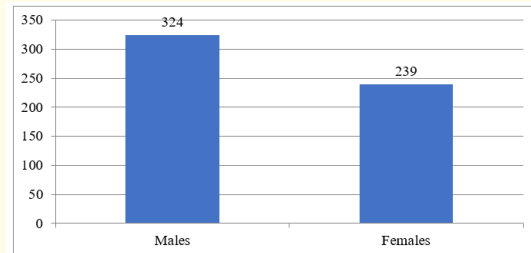


Figure 1: Distribution age group cases.

Among the total of 563 samples, 124(22%) were positive in culture, 426(75.7%) were negative, while 13(2.3%) had contaminants (Figure 2).

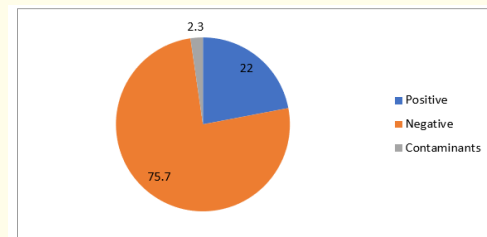


Figure 2: Culture results from the Adolescent age group.

Among the 124 positive cases, 67 (54%) were men while 57(46%) were women (Table 1).

Positive Negative		Culture Results			Total	
		Contaminants				
Gender	Male	Count	67	249	8	324
		%	54.0%	58.5%	61.5%	57.5%
	Female	Count	57	177	5	239
		%	46.0%	41.5%	38.5%	42.5%
Total		Count	124	426	13	563
%			100.0%	100.0%	100.0%	100.0%

Table 1: Gender distribution of culture-positive and negative cases.

<i>S. aureus</i>	18(14.5%)
Group B <i>Streptococcus</i>	14(11.29%)
Coagulase-negative <i>Staphylococcus</i> species	8(6.45%)

Table 2: Gram-Positive isolates.

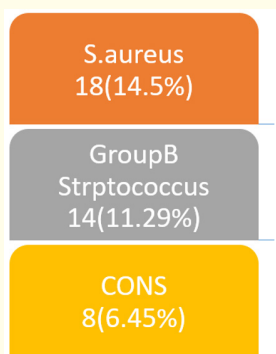
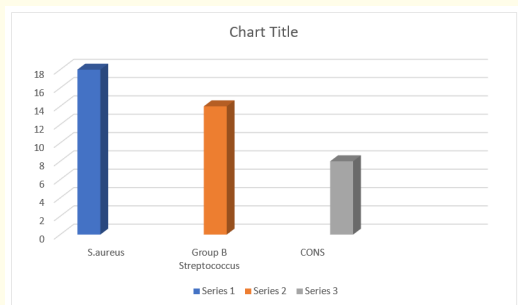


Figure a

<i>E. coli</i>	24 (19.35%)
<i>K. pneumoniae</i>	20 (16.13%)
<i>P. aeruginosa</i>	18 (14.52%)
<i>Salmonella Typhi</i>	12 (9.68%)
<i>Citrobacter koseri</i>	5 (4.03%)
<i>Acinetobacter baumannii</i>	5 (4.03%)

Table 3: Gram-negative Isolates.

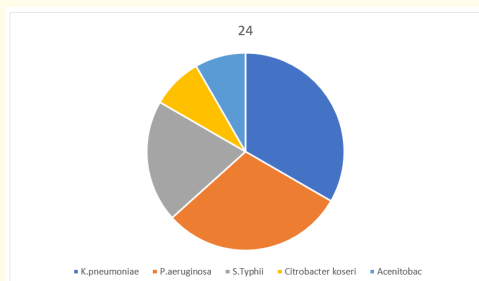


Figure b: Gram-Negative Isolates.

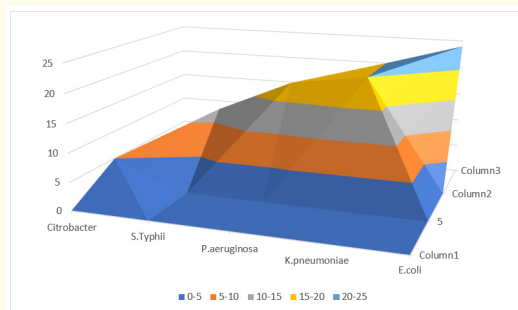


Figure c: Gram-Negative isolates in ascending order.

Of the 40 Gram-positive isolates, *S. aureus* was isolated in 18 cases (14.5%), Group B *Streptococcus* 14(11.29%), Coagulase-negative *Staphylococcus* species in 8 (6.45%) cases. Regarding gram-negative isolates, *E. coli* was found in 24(19.35%) cases of *K. pneumoniae* 20(16.13%) cases, *P. aeruginosa* 18 (14.52%), *Salmonella Typhi* 12(9.68%) *Citrobacter koseri* 5(4.03%) and *Acinetobacter baumannii* 5(4.03%) cases. Extended beta spectrum isolates were reported to be 20 of 84 (23%) and methicillin-resistant *Staphylococcus aureus* cases 5 of 40 bacteria that is 12.5 (%).

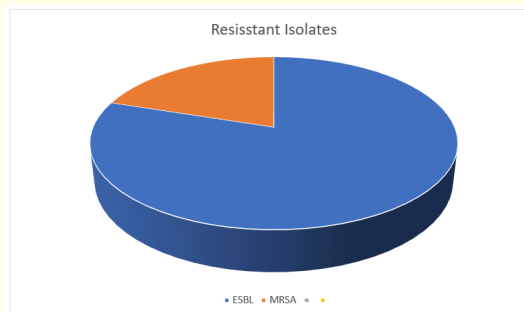


Figure d

Discussion

Based on the present study, we attempted to determine epidemiologic BSIs among the adolescent age groups. Detecting bacteria in the blood has an important role in the diagnosis of a febrile patient; to establish the cause of infection, to assure the treating physician about the therapy chosen, and to provide up-to-date information on the local etiologic patterns and antibiotic sensitivities, as this will guide the clinician in the management of the patient.

The characteristic features of endothelial dysfunction by sepsis are an increase in the level of oxidative stress, systemic involvement, and subsequent inflammation, the glycocalyx degrades, leading to shedding, endothelial damage, or death, the blood-tissue

barrier is disrupted, more leukocyte adhesion occurs, consequently resulting in a cascade of procoagulant and anti-fibrinolytic state [2].

Rapid detection and isolation of clinically important microorganisms in blood cultures are essential to determine antimicrobial susceptibility patterns for prompt administration of antimicrobial therapy has been demonstrated to reduce effectively the morbidity and mortality with bloodstream infections. Therefore, blood culture remains the mainstay of the investigation of definitive diagnosis and management of bloodstream infection in the adolescent age group, despite recent advances in the molecular diagnosis of bacterial sepsis [14]. Blood cultures are usually obtained along with clinical investigations to search for a focus of infection and therefore provide specific antimicrobial therapy.

In the present study, a total of 563 samples in the adolescent age group suspected of BSI's were received at the Department of Microbiology, IGMC, Shimla. Among them, 324(57.5%) were men while 239(42.5%) were women. Among the total of 563 samples, 124(22%) were found positive in culture, 426(75.7%) negative while 13(2.3%) were having contaminants that grow more than three types of colonies in the medium. Among the 124 positive cases, 67(54%) were men while 57(46%) were women.

The culture Positivity rates documented in other studies conducted similarly to our study settings reported the following results 48.9% Meremikwu MM., *et al.* [13], 20.2% Arora U and Devi P [14], 18.7% Murthy DS and Gyaneshwari M [15] and 16.6% Qureshi and Aziz F [16] and our results are in agreement with other studies conducted before.

This variation might be because patients admitted to the tertiary care hospital received antibiotics before they came to the tertiary care hospital and another factor contributing in our country India is that in most cases self-medication is very common as the medicines are available at the counter. It is implied in a tertiary level institution that patients have received prior antibiotics and not responding they present themselves in a tertiary care institution. Thus variations in culture positively rate are most probably due to prior treatment with antibiotics [17,18].

Bloodstream infections continue to be a challenge for infectious disease physicians due to the ever-changing bacterial etiology and the emergence of antimicrobial resistance. Early detection of causative pathogens and determination of their susceptibility profile is

necessary to help clinicians decide on rational empirical therapy, which decreases the emergence of resistance. Despite advances in diagnosis and treatment, bacterial sepsis continues to be a major cause of adolescent morbidity and mortality, particularly in developing countries. The causative agents of sepsis and their antibiotic susceptibility patterns also become varied from time to time and from place to place. The findings of a study conducted also emphasize that the duration of hospital stay and mechanical ventilation of children (neonates, infants, and children 1 to 18 yrs of age) admitted to NICUs and PICUs have a significant association with ventilator-associated pneumonia which in turn, leads to an increase in the mortality rate [19]. Detection of bacteria in the blood has a very important role in the diagnosis of a patient with BSI especially in Pyrexia of Unknown origin infection, assuring the clinician about the therapy chosen, and provides valuable insight on local etiologic patterns and sensitivities as this will help the clinician in the treatment of the patient.

Conclusion

This study provides some insight into local trends and bacterial etiology of bloodstream infections among patients in the adolescent age group. There was relatively high positivity in blood culture among the adolescent group. Positivity was high in males compared to females. The exact contributing factors for bloodstream infections (BSI) within these groups need to be further elucidated. Rational use of antibiotics, formulation of antibiotic policy, and prompt therapy of bloodstream infections for the effective management and prevention of drug resistance are urgently needed in setting, as noted by the prevalence of extended-spectrum beta-lactamases and Methicillin-resistant Isolates increasing prevalence.

Consent for Publication

Not applicable.

Availability of Data and Materials

Not applicable

Competing Interests

Nil.

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Nil.

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