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Original Research

Microbiological Characteristics and Antimicrobial Resistance Patterns of Blood Culture Isolates in Pediatric Patients Suspected of Septicemia

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ABSTRACT:

Background:Bacterial infections continue to pose a significant threat to the health and well-being of children, leading to both mortality and morbidity. The potential exists to mitigate these impacts through timely detection and effective treatment. In response to infections, the immune system actively combats them. However, sepsis can arise when the immune response becomes excessive, inadvertently targeting the body's organs and tissues.**Methods**:The investigation involved the analysis of blood culture reports from 848 cases of suspected septicemias among pediatric patients at the department of pediatrics, employing the established Mackie and McCartney standard technique. Antibiotic sensitivity testing was conducted using Kirby-Bauer's disc diffusion method. Additionally, risk factors associated with sepsis were documented. All collected samples underwent processing at the Department of Microbiology.**Results**:Out of 848 samples, 25% exhibited positive culture results, while the remaining 75% were sterile. Gram-negative bacilli (GNB) constituted the majority of isolated bacteria at 71%, with Gram-positive cocci (GPC) comprising the remaining 29%. Escherichia coli (E. coli) was the predominant bacterial strain at 41.5%, followed by Staphylococcus aureus (Staph aureus) at 28.3%, and Klebsiella species at 13.2%. Other identified organisms included Pseudomonas species (7.5%), Enterobacter (4.7%), Coagulase-negative Staphylococcus (1.8%), Citrobacter (1.8%), and Acinetobacter (0.9%). Notably, E. coli emerged as the most frequently isolated bacterium across all age groups in the study.**Conclusion**:Detecting bloodstream infections poses a significant challenge and, at times, can be life-threatening. Hence, the prompt identification, detection, and antimicrobial susceptibility testing of pathogens present in the blood are crucial functions of a diagnostic microbiology laboratory.

Keywords:septicemias,bloodstream,detection,microbiology.

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INTRODUCTION

Bacteria, armed with a myriad of virulence factors, emerge as formidable adversaries in the realm of infectious diseases, capable of orchestrating life-threatening conditions. Their diverse arsenal enables them to navigate the intricate defenses of the human body, surmount immune responses, and embark on journeys to remote organs. In this intricate dance between pathogen and host, a dysregulated response is triggered, escalating the severity of the infection.Septicemia, a critical manifestation of bacteremia, unfolds as a symptomatic tableau of bacterial dissemination coursing through the body. Clinical presentations mirror not only the nature of the infective pathogen but also the specific organ system(s) under siege.[1] This complex interplay between the microbial invaders and the host's physiological landscape underscores the gravity of septicemia.In the diagnostic realm, the gold standard for confirming the presence of septicemia remains the cultivation of a positive blood culture. This meticulous process serves as a crucial gateway to unveiling the identity of the offending pathogen, guiding clinicians in tailoring targeted therapeutic interventions. The significance of timely detection, identification, and understanding the susceptibility of these blood-borne pathogens cannot be overstated, as it forms the cornerstone of effective management in the face of this life-threatening challenge.[2]

Sepsis, a formidable threat to the well-being of children, stands as a significant cause of both morbidity and mortality in the pediatric age group. In parallel to the dynamics observed in adults, the resilient immune systems of infants and children diligently combat infections, irrespective of whether the instigating agents are bacteria, viruses, or fungi. However, there exists a delicate balance, and in certain instances, the immune response can veer into a hyperactive state, precipitating a life-threatening condition known as septicemia.[3]What sets sepsis apart in the pediatric population is the subtlety and complexity of its symptoms, often making detection a challenging task. This condition can unfold from seemingly innocuous sources, such as an infected scratch on the arm, or escalate dramatically on the foundation of pre-existing critical ailments like acute appendicitis. The vulnerability of children, especially those with compromised immune systems due to factors like chemotherapy, magnifies the risk of sepsis development.Prevention takes precedence in the arsenal against sepsis in infants and children. Proactively averting infections becomes a pivotal strategy to mitigate the potential onset of this life-threatening condition. Recognizing that effective treatment hinges on a comprehensive understanding of prevalent microorganisms and their susceptibility to antimicrobial agents, the objective of this study is to illuminate the landscape of microbial agents prevalent in the region. Additionally, it aims to delineate the intricate patterns of antimicrobial sensitivity exhibited by these pathogens. By unraveling these insights, healthcare practitioners can significantly enhance their ability to tailor targeted and efficacious treatment strategies against bloodstream infections in the pediatric demographic, thereby advancing the quest for improved pediatric healthcare outcomes.[4]

The amplification of challenges associated with septicemia is markedly exacerbated by the evolving patterns and recurrent emergence of resistant bacteria. In the pediatric context, the clinical presentation of septicemia in affected children is characterized by a spectrum of symptoms, including fever, respiratory distress, tachycardia, malaise, feeding difficulties, and lethargy. Notably, asymptomatic bacteremia, where infected individuals exhibit no overt signs of illness, further complicates the diagnostic landscape. Recognizing the urgency of early detection, coupled with an in-depth understanding of antimicrobial susceptibility patterns, emerges as a crucial linchpin in mitigating the associated morbidity and mortality linked to bloodstream infections. Numerous studies affirm that timely identification significantly improves outcomes, emphasizing the pivotal role of proactive diagnostic measures.In the context of developing countries, the prevalence of sepsis among children and neonates unfolds as a complex interplay of various environmental and socio-economic factors. These include contaminated water sources, inadequate sanitation, indoor air pollution, overcrowded living conditions, instances of low birth weight, insufficient immunization and nutrition, and an increased reliance on invasive medical devices due to the prevalence of severe illnesses. This multifaceted backdrop creates an environment conducive to the invasion and unbridled multiplication of pathogens within the body.[5,6]Addressing the challenges posed by septicemia in these regions necessitates a comprehensive strategy that extends beyond medical interventions. Initiatives aimed at improving environmental conditions, bolstering public health infrastructure, and enhancing overall healthcare accessibility are crucial components of a holistic approach. By tackling the root causes and risk factors, such a comprehensive strategy seeks not only to treat but also to prevent the occurrence of septicemia, ultimately contributing to improved health outcomes for children in these vulnerable settings.

MATERIALS AND METHODS

This prospective study unfolded within the meticulous confines of the Department of Microbiology, where a dedicated focus was placed on patients belonging to the pediatrics age group (≤ 12 yrs). The investigative process was characterized by a thorough recording of essential details, including hospital identity, patient numbers, ages, genders, and specifics regarding the type and location of specimen collection. A structured proforma served as the instrument for systematically documenting these crucial data points. Subsequently, all collected samples underwent rigorous processing, executed with precision within the Department of Microbiology.

The study cohort comprised a substantial 848 clinically suspected septicemia patients, all of whom sought medical attention within the Pediatrics department. The inclusion criteria were defined by the manifestation of signs and symptoms commonly associated with sepsis, encompassing temperature instability, nausea, vomiting, slurred speech, altered sensorium, and inadequate urine production.Ethical considerations were paramount, and as such, written and informed consent was diligently obtained from all willing participants who met the specified criteria for inclusion in the study. The collection of blood, a pivotal aspect of this investigation, adhered to stringent aseptic precautions. Utilizing a sterile syringe, blood was drawn at the bedside of patients suspected of harboring bloodstream infections. The utmost hygiene was maintained, with immediate cleaning of the rubber caps of each culture bottle using 70% alcohol. Furthermore, a meticulous approach involved replacing the used needle with a new one before injecting venous blood into Brain Heart Infusion and sodium thioglycolate broths, maintaining a specific ratio of 1 part blood to 5 parts broth.To enhance the granularity of the analysis, the collected blood samples were systematically categorized into three distinct age groups: Group A (0-28 days, Neonates), Group B (>28 days to < 1 year),

and Group C (1 year to <12 years). This stratification aimed to discern potential age-related variations in the prevalence of septicemia. The post-collection phase involved the expeditious transport of the blood culture bottles to the laboratory, marking a critical juncture in the ongoing study, where the process of in-depth analysis and interpretation would unfold.

Following the meticulous collection of blood samples, a series of carefully orchestrated laboratory procedures unfolded. The collected blood samples, injected into Brain Heart Infusion and sodium thioglycolate broths at a specific ratio, were then incubated aerobically at 37°C for a duration of 7 days. To capture potential microbial growth, three subcultures were initiated at 24 hours, 72 hours, and the 7th day, employing MacConkey agar, blood agar, and Chocolate agar media. Each subculture was subject to incubation under the appropriate temperature and atmospheric conditions.For those samples that displayed no signs of microbial growth after the initial 7-day incubation period, a precautionary measure was taken. Another blind subculture was performed at the conclusion of the 7th day before officially categorizing them as negative. This additional step aimed to enhance the sensitivity of detection and ensure a thorough evaluation before ruling out any potential bloodstream infection.To further characterize the positive cultures, Gram staining was diligently conducted. Identification of microbial growths was pursued through a comprehensive analysis of colony characteristics and biochemical tests, thereby ensuring accurate categorization of the cultured organisms.A pivotal aspect of the investigation involved scrutinizing the antibiotic susceptibility of the isolated pathogens. This was achieved through Kirby-Bauer's disc diffusion methods, and the interpretation of results adhered to the Clinical and Laboratory Standards Institute (CLSI) guidelines. This systematic approach ensured a robust evaluation of the efficacy of various antibiotics against the identified microorganisms, paving the way for informed and targeted treatment strategies in the clinical setting. The integration of standardized methods and guidelines played a crucial role in upholding the reliability and reproducibility of the study's findings.

RESULTS

The comprehensive nature of this study involved the analysis of 848 non-repetitive blood samples collected from patients suspected of harboring bloodstream infections and attending or admitted to the Pediatrics Department. Within this cohort, the gender distribution revealed that 56.6% (480) were males, while 43.4% (268) were females. Vital patient details, including hospital identity, registration number, laboratory number, age, and sex, were meticulously recorded in a formatted proforma. Additionally, information regarding the type and place of specimen collection was systematically documented to ensure a comprehensive dataset for analysis.The results of the study highlighted that culture positivity was observed in 25% of the collected samples, indicating the presence of microbial growth, while a significant majority of 75% exhibited sterility. The breakdown of bacterial isolates revealed Gram-negative bacilli (GNB) as the predominant group, constituting 71% of the isolates. Gram-positive cocci (GPC) accounted for the remaining 29%. Escherichia coli (E. coli) emerged as the most frequently isolated bacterium, representing 41.5% of the positive cultures, followed by Staphylococcus aureus (Staph aureus) at 28.3%, and Klebsiella species at 13.2%. Other noteworthy organisms included Pseudomonas species (7.5%), Enterobacter (4.7%), Coagulase-negative Staphylococcus (1.8%), Citrobacter (1.8%), and Acinetobacter (0.9%).These findings provide valuable insights into the microbial landscape of bloodstream infections in the pediatric population. The prevalence and distribution of various bacterial species underscore the complexity of septicemia in this demographic, emphasizing the need for tailored diagnostic and therapeutic strategies. The study contributes significantly to the understanding of the microbial etiology of bloodstream infections in pediatric patients, laying a foundation for further research and informed clinical interventions.

Table 1: Antibiotic for GPC

Antibiotic	Potency(µg)	Symbol
Amikacin	60	AK
Cefoxitin	60	CX
Clindamycin	4	CD
Erythromycin	30	E
Linezolid	60	LZ
Penicillin	20	P
Vancomycin	60	VA

Figure1: Antibiotic for GPC

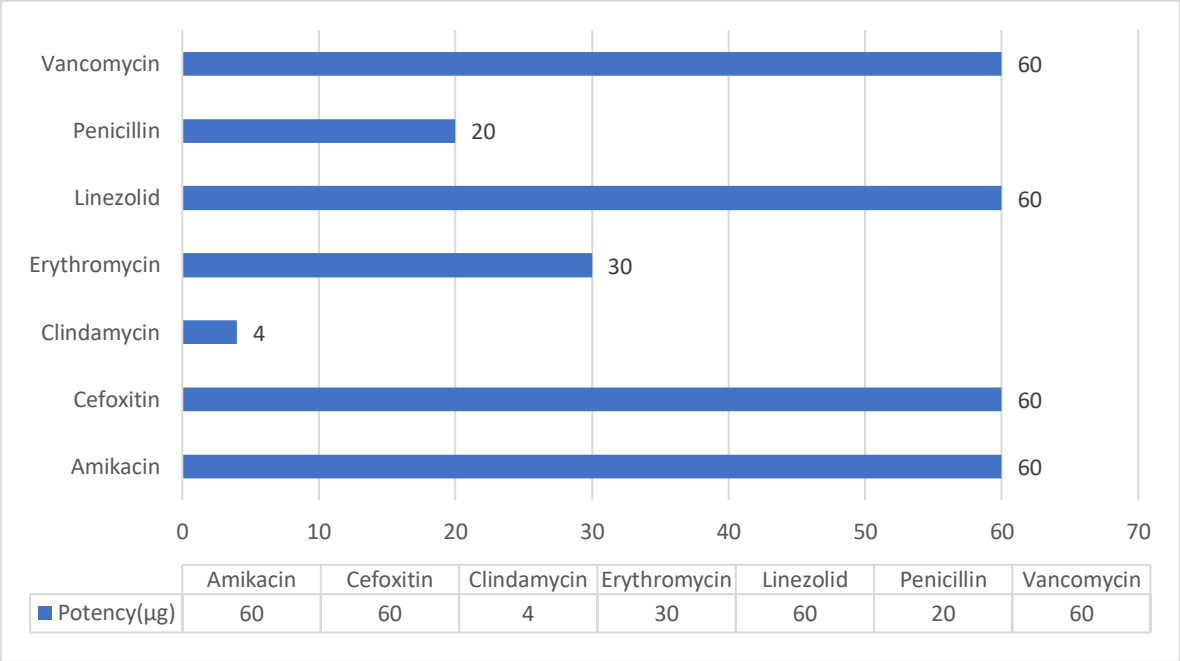
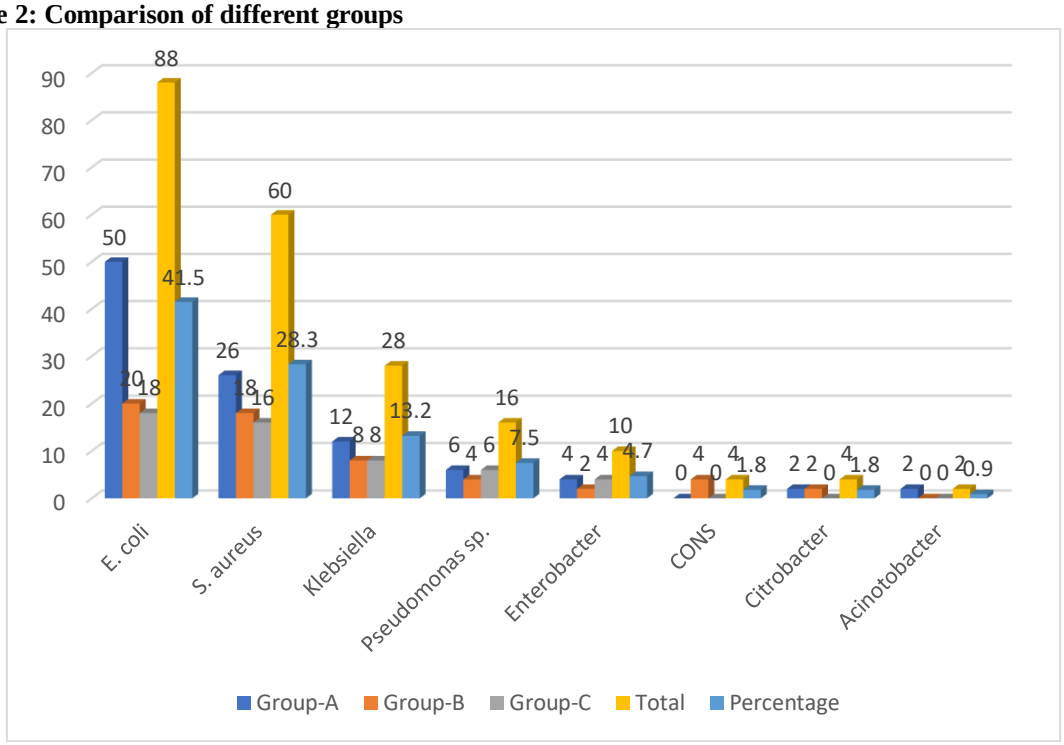


Table 2: Antibiotic for GNB

Antibiotic	Potency(µg)	Symbol
Ampicillin	20	AMP
Ceftriaxone	60	CRT
Piperacillin/tazobactam	200/20	PIT
Gentamycin	20	GEN
Cefoperazone/sulbactam	150/60	CFS
Chloramphenicol	60	C
Ofloxacin	10	OF
Cefepime	60	CPM
Amikacin	60	AK

Figure 2: Comparison of different groups



DISCUSSION

Bloodstream infections represent a multifaceted challenge with the potential for life-threatening consequences. Timely detection, accurate identification, and the meticulous assessment of antimicrobial susceptibility in blood-borne pathogens are paramount functions of a diagnostic microbiology laboratory.[7] The urgency of these tasks is underscored by the fact that any delay in initiating therapy is associated with an average decrease in survival of 8%, emphasizing the critical nature of swift and precise intervention.In the context of this study, the observed blood culture positivity rate of 25% aligns with the findings reported in various studies, where rates have been documented to range from 36% to 56%. Comparisons with studies conducted by Sharma et al. and Mondal et al. reveal a striking consistency, with reported culture positivity rates of 56% and 36%, respectively. This congruence across studies enhances the robustness of the current findings and reinforces their validity.

The breakdown of septicemia by bacterial type in this investigation is particularly noteworthy. Gram-negative septicemia, observed in 71% of cases, is consistent with findings from Mathur et al., further substantiating the prevalence of this microbial subtype in pediatricsepticemia. Concurrently, gram-positive septicemia accounted for 29% in this study, highlighting the diversity of microbial etiology and emphasizing the importance of tailoring treatment approaches based on bacterial characteristics.Amidst these findings, the study underscores the significance of infection prevention as the primary strategy in combatting sepsis in infants and children.[8] The adage that prevention is better than cure resonates strongly, emphasizing the crucial role of public health measures, vaccination, and other proactive interventions in mitigating the risk of septicemia in this vulnerable population.In conclusion, the collective insights derived from this study contribute significantly to our understanding of the microbial landscape in pediatricsepticemia. They not only inform clinical interventions but also serve as valuable benchmarks for ongoing efforts to refine diagnostic protocols and enhance preventive measures against the serious implications of bloodstream infections in pediatric patients.

In our study, the spectrum of gram-negative bacilli expanded to include Escherichia coli (E. coli) and other coliforms, each constituting 1.09% of the isolates. This proportionate representation is notably distinct from findings reported in studies conducted by Fox-Lewis et al., where E. coli accounted for a substantial 47.2% of positive isolates. Similarly, a study in Pakistan documented that both E. coli and other coliforms comprised 5% of the isolates each. These variations underscore the nuanced epidemiological landscape of bacterial pathogens in pediatricsepticemia, reflecting the influence of geographic and demographic factors.[9]Examining the antimicrobial susceptibility profiles, our study revealed that E. coli exhibited sensitivity to amikacin, whereas other coliforms demonstrated resistance to this antibiotic. Conversely, both these bacterial strains displayed robust sensitivity to ciprofloxacin (CIP), tigecycline (TGC), and cefoperazone/sulbactam, achieving a noteworthy 100% sensitivity rate. In contrast, a high level of resistance was observed against imipenem (IMI), clarithromycin, and the tested cephalosporins.These findings resonate with a study conducted by Madhu Sharma, wherein cephalosporins demonstrated varying degrees of resistivity. The parallel patterns in resistance underscore the persistent and evolving challenge of antimicrobial resistance, emphasizing the imperative for continuous surveillance and the development of targeted antibiotic stewardship strategies.In conclusion, the intricate interplay between microbial prevalence and antibiotic susceptibility patterns, as revealed in our study, provides critical insights into the dynamic nature of gram-negative bacilli in pediatricsepticemia. The observed variations underscore the need for region-specific treatment strategies and reinforce the call for a holistic approach to antimicrobial stewardship to effectively navigate the complexities of bacterial resistance in this vulnerable patient population.

Preventing sepsis in children necessitates a holistic and proactive approach, incorporating various key measures to mitigate the risk of life-threatening infections. One foundational strategy is the promotion of frequent handwashing.[10] Practicing proper hand hygiene is a fundamental and effective means of preventing the introduction of harmful germs into the body. Encouraging children and caregivers to consistently wash their hands, especially before meals, after using the restroom, and upon returning home, creates a crucial barrier against the transmission of infectious agents.Vaccination emerges as a pivotal cornerstone in the comprehensive prevention of sepsis. Ensuring that every child receives timely and complete vaccinations is imperative. Vaccines targeting preventable diseases such as Diphtheria, Tetanus, Pertussis, Measles, Polio, and others play a crucial role in bolstering the immune system and providing specific protection against pathogens that can potentially lead to sepsis. Routine vaccination not only shields individual children but also contributes to community-wide immunity, creating a collective defense against the spread of infectious diseases.Equally essential is the emphasis on timely medical treatment. Seeking prompt medical attention when a child exhibits signs of infection or illness increases the chances of early diagnosis and intervention. Quick access to healthcare allows professionals to initiate appropriate treatments, such as administering antibiotics or other therapeutic measures, thereby reducing the risk of the infection progressing to sepsis.[11] Caregivers and parents play a pivotal role in recognizing symptoms and promptly

seeking medical care.In summary, a comprehensive strategy for preventing sepsis in children encompasses the promotion of good hand hygiene practices, ensuring complete and timely vaccination, and advocating for prompt medical attention when necessary. By integrating these preventive measures into daily routines and healthcare practices, caregivers, parents, and healthcare providers collectively contribute to safeguarding the health and well-being of children and mitigating the risk of sepsis-related complications.

CONCLUSION

Bloodstream infection poses a formidable challenge, with the potential to escalate into a life-threatening condition. Recognizing the severity of this issue, timely detection, precise identification, and thorough antimicrobial susceptibility testing of blood-borne pathogens emerge as critical functions within a diagnostic microbiology laboratory. The significance of these processes lies in their pivotal role in informing appropriate and targeted therapeutic interventions.Timely detection is imperative to initiate prompt medical intervention, as the delay in identifying bloodstream infections can significantly impact patient outcomes. Identification of the specific pathogens causing the infection is crucial for tailoring treatment strategies, considering the diverse nature of microorganisms and their varying susceptibilities to antimicrobial agents.Antimicrobial susceptibility testing plays a central role in determining the most effective treatment options. This involves evaluating the response of isolated pathogens to different antibiotics, enabling healthcare providers to make informed decisions about the selection of antimicrobial agents. The accuracy of these tests is vital to ensure the efficacy of treatment and to prevent the development of antimicrobial resistance.In essence, the diagnostic microbiology laboratory serves as a critical component in the early and accurate diagnosis of bloodstream infections. The seamless coordination of detection, identification, and antimicrobial susceptibility testing not only facilitates timely and targeted therapeutic interventions but also plays a crucial role in the broader efforts to manage and combat infectious diseases, contributing to improved patient outcomes and overall public health.

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