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Original Article

Evaluation of Gram-Positive Growths in Blood Culture in the Pediatric Intensive Care Unit: Infection or Contamination?

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ABSTRACT

Objective: Gram-positive organisms are commonly identified in cultures, either as a result of true infection or contamination. This research focused on examining the correlation between commonly used laboratory indicators and clinical results.This study aimed to evaluate the relationship between clinical outcomes and routine laboratory markers, along with antibiotic choices, in pediatric patients with gram-positive culture results in the pediatric intensive care unit (PICU).

Methods: A total of 179 PICU patients with gram-positive culture findings were retrospectively analyzed using hospital records from 2016 to 2019. Data collected included demographic information (age, sex), fever status, microbiological results, antibiotic therapy administered, laboratory values, and survival outcomes.

Results: The patients had a median age of 33.00 months (IQR: 8.00–66.00). Of the cohort, 109 (60.89%) were male and 70 (39.11%) were female. Positive culture findings were documented in 90 patients (50.3%). Vancomycin was prescribed to 59 patients (33%), while 31 patients (17.3%) received teicoplanin. A total of 34 patients (18.9%) died during hospitalization. The identified microorganisms included *Staphylococcus species* (n=56, 31.3%), *methicillin-resistant Staphylococcus epidermidis (MRSE)* (n=81, 45.3%), *Staphylococcus aureus (S.aureus)* (n=22, 12.3%), *Staphylococcus epidermidis (S.epidermidis)* (n=15, 8.4%), and methicillin-resistant *Staphylococcus aureus (MRSA)* (n=5, 2.8%). White blood cell (WBC) and platelet (PLT) counts were significantly higher among survivors compared to non-survivors (p=0.001 and p<0.001, respectively). No statistically significant associations were found between mortality and categorical variables assessed (p>0.05).

Conclusion: Gram-positive culture results are frequently encountered in pediatric intensive care units. By evaluating the clinical and laboratory parameters of the patient, it should be evaluated whether there is an infection or contamination, and infections should be treated.

INTRODUCTION

Background/rationale

Gram-positive culture results are frequently encountered in pediatric patients hospitalized in the pediatric intensive care unit (PICU), due to infection or contamination. Some laboratory parameters can guide us in the evaluation of infection. White blood cell (WBC), platelet (PLT) and C-Reactive Protein (CRP) are the most frequently evaluated and uncluded in many scoring systems for the diagnosis of sepsis in the PICU.[1-4]

S. aureus is a prominent pathogen known for causing severe infections, especially among critically ill individuals in intensive care settings. In the pediatric intensive care setting, infections caused by *S. aureus* are often associated with serious complications such as sepsis, ventilator-associated pneumonia, and infections at surgical sites or around indwelling medical devices.

Vancomycin and teicoplanin are glycopeptide antibiotics commonly employed in the treatment of gram-positive bacterial infections. They are especially valuable in managing infections caused by MRSA. Among their comparative advantages, teicoplanin has been reported to be less nephrotoxic than vancomycin.[5,6] By evaluating the clinical and laboratory parameters of the patient, it should be

evaluated whether there is an infection or contamination, and infections should be treated.

Objectives

This study aimed to examine changes in WBC, PLT and CRP levels in PICU patients, and to investigate the association of these parameters with clinical outcomes and mortality.

MATERIALS AND METHODS

Study design and setting

This study was carried out in the Department of Pediatrics, Pediatric Critical Care Division, using patient records collected between January 1, 2016, and January 1, 2019, from the hospital database. Ethical approval was secured from the institutional review board, and all methods adhered to the principles of the Declaration of Helsinki. (Approval Date: 12.06.2020, Decision No: 647).

Participants

Pediatric patients hospitalized in the PICU were enrolled in this study. Over the study period, 915 patients were hospitalized in the PICU, of whom 180 presented with positive culture results. One patient was excluded due to incomplete laboratory data, resulting in a final sample of 179 participants (Fig. 1).

Variables

The hospital's digital patient database was used to retrieve the relevant data.The primary outcome was in-hospital mortality (survival vs. death). Additional recorded variables included WBC (per microliter), PLT (per microliter), CRP (mg/L), presence of fever, source of the culture (blood or catheter), isolated microorganism, and the administered antibiotic.

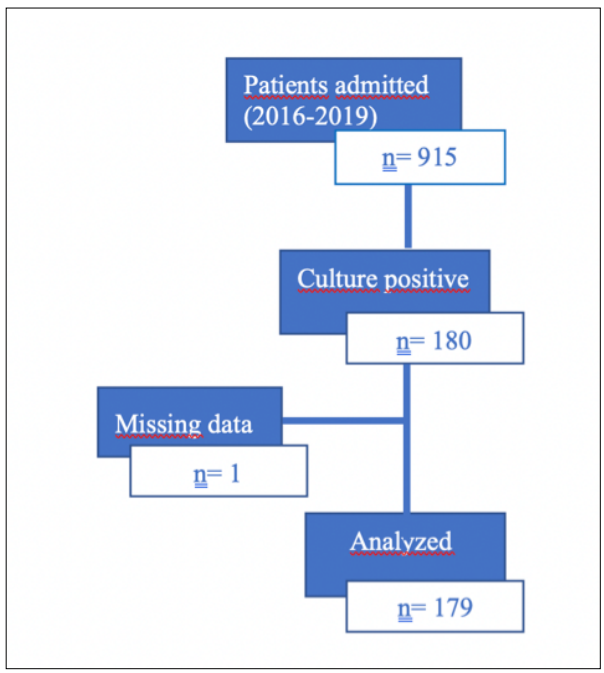

Figure 1. Participants of the study.

As per institutional protocol, patients with gram-positive culture results underwent a comprehensive evaluation that included clinical assessment (e.g., fever, perfusion, capillary refill time) and laboratory trends (WBC, CRP) to determine the need for antibiotic therapy.

Venous blood samples were collected at admission into anticoagulant tubes and analyzed via volume-conductivity-light scatter methodology. CRP levels were determined through immunoturbidimetric assay using the Beckman Coulter AU5800 system. All procedures followed the manufacturer's guidelines.

Catheter culture processing followed the Cleri et al.[7] method. Catheter tips were rolled onto blood agar, flushed with tryptic soy broth (TSB), and incubated to assess bacterial growth. Coagulase-negative staphylococci were identified per Kloos and Smith.[8]

Sample Size

The estimation of sample size was performed beforehand, considering mortality outcomes among three antibiotic regimens: None, vancomycin, and teicoplanin. Assuming a medium effect size (0.3), α=0.05, and 95% power, a minimum of 172 subjects was required.[9]

Statistical Methods

Data were analyzed using Jamovi. A threshold of $p<0.05$ was used to determine statistical significance.

RESULTS

Participants and Descriptive Data

A total of 179 children were evaluated, and the median age was 33 months (IQR: 8.00–66.00). The cohort included 109 males (60.89%) and 70 females (39.11%). There was no significant age difference by sex (p=0.415). Positive cultures were identified in 90 cases (50.3%). Antibiotics administered included vancomycin (n=59, 33%) and teicoplanin (n=31, 17.3%). Mortality occurred in 34 patients (18.9%). Predominant organisms included *Staph. spp.* (31.3%), methicillin-resistant *S. epidermidis* (45.3%), *S. aureus* (12.3%), *S. epidermidis* (8.4%), and MRSA (2.8%).

Outcome Data

No significant differences in WBC, PLT, or CRP were found based on gender or fever status. However, CRP levels were elevated in patients with confirmed infections. Survivors had significantly higher WBC and PLT counts than non-survivors. CRP levels varied significantly by antibiotic used, being highest in those receiving teicoplanin. Additionally, CRP levels were elevated in patients whose blood cultures yielded *S. aureus* or MRSA.

DISCUSSION

Key results

CRP was notably elevated in infections involving *S. aureus*, and both WBC and PLT were higher among survivors. Teicoplanin-treated patients and those with *S. aureus*-positive cultures had higher CRP levels.

Limitations

This retrospective study relied on protocol-based decisions by attending physicians, introducing potential variability. Inclusion of additional platelet indices (e.g., MPV, PDW) could have enhanced outcome prediction.

Interpretation

The nonspecific clinical presentation of febrile infants poses a significant challenge in distinguishing serious bacterial infections from benign viral illnesses.[10] Numerous investigations have sought to identify reliable screening biomarkers to aid clinicians in assessing the risk of bacterial infections among febrile children. One example is CRP, which is an acute-phase reactant that elevates swiftly during infectious or inflammatory processes.[11] Findings from the current study support the continued relevance of CRP as a diagnostic indicator for bacterial infections in critically ill children. This aligns with recent literature highlighting CRP's predictive value in identifying severe bacterial infections in febrile infants.[10]

Although prior research has demonstrated elevated white blood cell (WBC) counts in neonates with early-onset sepsis compared to their non-septic counterparts—persisting up to 24 hours post-admission[12] —our analysis did not find a significant association between WBC levels and variables such as sex, fever, infection status, antibiotic choice, culture results, or mortality. These findings are consistent with previous studies concluding that WBC alone lacks sufficient reliability to serve as a sole predictor of serious bacterial infections in febrile pediatric patients.[10,13]

The role of PLTs in sepsis has gained attention in recent literatüre.[14] During sepsis, PLTs contribute to hyperinflammation, intravascular coagulation, and thrombosis, potentially culminating in multi-organ dysfunction. In our study, survivors exhibited significantly higher WBC and PLT counts compared to non-survivors. The observed thrombocytopenia in deceased patients may reflect excessive platelet activation, resulting in increased consumption, immune-mediated destruction, and sequestration.[15,16] Appropriate antibiotic therapy remains fundamental to achieving favorable outcomes in critically ill patients. Inappropriate or delayed antimicrobial administration can contribute to treatment failure, prolonged hospitalization, and increased mortality.[17] Infections in the PICU setting require empiric antibiotic initiation based on local resistance patterns, followed by continuous clinical reassessment and de-escalation strategies as indicated.

MRSA is a frequent cause of severe infections, including bloodstream infections.[18] Vancomycin has traditionally been the first-line agent against MRSA, but concerns regarding nephrotoxicity have prompted consideration of alternatives.[19] Teicoplanin, a glycopeptide with similar antimicrobial efficacy, offers several advantages, including once-daily dosing, intramuscular administration, no requirement for drug-level monitoring, and a lower risk of renal impairment.[20] However, its higher cost remains a limitation. Patients treated with teicoplanin showed elevated CRP levels, which may indicate greater infection severity; however, mortality rates did not differ significantly among the antibiotic groups. These findings are supported by meta-analyses reporting comparable clinical and microbiological outcomes for vancomycin and teicoplanin.[21]

Conclusion

CRP remains a valuable biomarker for identifying bacterial infections and predicting clinical outcomes in pediatric intensive care settings. Platelet count may also serve as a useful prognostic indicator, with thrombocytopenia potentially reflecting underlying hyperinflammation, excessive consumption, or destruction. Finally, There was no meaningful difference detected in patient outcomes between vancomycin and teicoplanin, suggesting that both antibiotics are equally effective in managing severe gram-positive infections in the PICU.

Ethics Committee Approval

The study was approved by the Marmara University Clinical Research Hospital Ethics Committee (Date: 12.06.2020, Decision No: 647).

Informed Consent

Retrospective study.

Peer-review

Externally peer-reviewed.

Authorship Contributions

Concept: F.I.G., N.Y.Ö.; Design: F.I.G., N.Y.Ö.; Supervision: F.I.G., A.S., N.Y.Ö.; Materials: F.I.G.; Data collection &/or processing: F.I.G., A.S.; Analysis and/or interpretation: F.I.G., A.S.; Literature search: F.I.G., A.S., N.Y.Ö.; Writing: F.I.G., A.S.; Critical review: F.I.G., A.S., N.Y.Ö.

Conflict of Interest

None declared.

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Çocuk Yoğun Bakım Ünitesinde Kan Kültüründe Gram-pozitif Bakteri Üremesinin Değerlendirilmesi: Enfeksiyon mu, Kontaminasyon mu?

Amaç: Gram-pozitif mikroorganizmalar kan kültürlerinde sıklıkla saptanmakta olup, bu durum gerçek bir enfeksiyon ya da kontaminasyonu gösterebilir. Bu çalışma, çocuk yoğun bakım ünitesinde (ÇYBÜ) gram-pozitif kültür sonucu olan hastalarda rutin laboratuvar belirteçleri, klinik sonuçlar ve antibiyotik tedavisi arasındaki ilişkiyi incelemeyi amaçladı.

Gereç ve Yöntem: 2016-2019 yılları arasında gram-pozitif kültür sonucu saptanan 179 ÇYBÜ hastasının retrospektif olarak kayıtları analiz edildi. Demografik bilgiler, ateş durumu, mikrobiyolojik sonuçlar, uygulanan antibiyotik tedavileri, laboratuvar değerleri ve sağkalım sonuçları toplandı.

Bulgular: Hastaların medyan yaşı 33.00 ay (IQR: 8.00–66.00) olup, 109 (%60.9) erkek ve 70 (%39.1) kız hastaydı. Olumlu kan kültürü sonucu 90 hastada (%50.3) saptandı. Vancomycin 59 hastaya (%33), teikoplanin ise 31 hastaya (%17.3) verildi. Hastanede 34 hasta (%18.9) yaşamını yitirdi. İzole edilen mikroorganizmalar *Staphylococcus* türleri (%31.3), metisilin dirençli *Staphylococcus epidermidis (MRSE)* (%45.3), *Staphylococcus aureus* (%12.3), *Staphylococcus epidermidis* (%8.4) ve metisilin dirençli *Staphylococcus aureus (MRSA)* (%2.8) olarak tespit edildi. Beyaz kan hücresi (BKH) ve trombosit (PLT) sayıları, sağ kalanlarda kaybedenlere göre anlamlı olarak yüksekti (sırasıyla, p=0.001 ve p<0.001). Diğer kategorik değişkenler ile mortalite arasında anlamlı ilişki bulunmadı (p>0.05).

Sonuç: Gram-pozitif kültür sonuçları pediatrik yoğun bakım ünitelerinde sıkça karşılaşılmaktadır. Enfeksiyon ve kontaminasyonun ayrımını yapmak için klinik ve laboratuvar parametrelerinin dikkatle değerlendirilmesi ve enfeksiyon varlığında uygun tedavinin başlanması gerekmektedir.

Anahtar Sözcükler: Antibiyotik tedavisi; çocuk yoğun bakım ünitesi; gram-pozitif kültür sonucu.