SEPTIC SHOCK IN POLYTRAUMATIZED PATIENT: A CASE STUDY AND MANAGEMENT CHALLENGES

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Abstract

Septic shock is a life-threatening condition that represents the final stage of sepsis, where infection leads to widespread systemic inflammation, tissue hypoperfusion and multi-organ dysfunction. The management of septic shock becomes even more complicated in polytraumatized patients, where multiple severe injuries often contribute to both the patient's clinical deterioration and the risk of infection. We present the case of a 55-years-old male with multiple traumatic injuries including thoracic contusion, fractures of the cervical and rib bones and bilateral extremity fractures, who developed severe septic shock during his hospitalization. His medical history included type II diabetes mellitus and chronic gastritis.

Upon admission, the patient was intubated and mechanically ventilated, started on broad-spectrum antibiotics, anticoagulants and fluid resuscitation. Initial microbiological tests revealed no pathogens, but by day 10, Methicillin-resistant Staphylococcus aureus (MRSA), Pseudomonas aeruginosa and Acinetobacter species were identified. Despite aggressive antibiotic therapy, the patient developed worsening sepsis marked by hyperthermia, elevated inflammatory markers and oliguria by day 12. As his condition deteriorated, Cytosorb therapy was initiated on day 13, followed by hemodialysis on day 15 for acute kidney injury. On day 20, blood cultures revealed Vancomycin-resistant Enterococcus (VRE). As the infection evolved, additional pathogens including Klebsiella pneumoniae, Pseudomonas aeruginosa and Candida glabrata, were identified. Antifungal therapy with caspofungin was introduced on day 33. Despite the complexity of multiple infections and resistance patterns, the patient responded to tailored therapy, with negative blood cultures achieved by day 42.

This case highlights the challenges in managing septic shock in polytraumatized patients, particularly with the emergence of multidrug-resistant organisms. A multidisciplinary approach, involving timely microbiological testing, antibiotic stewardship and supportive therapies such as Cytosorb and renal replacement was essential for improving patient's outcome. The case also underscores the importance of vigilant management of fungal infections such as Candida glabrata in critically ill, immunocompromised patients.

Keywords: *Cytosorb**;** polytraumatized patients; replacement therapy; septic shock.*

Introduction

Septic shock is characterized by persistent hypotension despite adequate fluid resuscitation and is associated with high mortality rates, particularly in polytraumatized critically ill patients (1). It is often complicated by the presence of multidrug-resistant pathogens which further complicate the treatment. The management of septic shock in polytraumatized patients requires a multidisciplinary approach to treat both the underlying trauma and the associated infection (2). This case shows the challenges and management strategies in treating septic shock in a polytraumatized patient with multiple comorbidities and evolving microbial resistance. Infections are a major cause of morbidity and mortality in critically ill patients, often associated with a complex multi-organ involvement and an impaired immune response. While bacterial pathogens have traditionally been the primary focus of infection control in intensive care units (ICUs), fungal infections particularly co-infections with fungal organisms are increasingly recognized as a significant clinical concern (3). Fungal co-infections complicate the management of critically ill patients, exacerbating the severity of the underlying condition, prolonging hospital stay and worsening patients' outcome (4). Intensive care units are a critical environment for the management of patients facing life-threatening conditions, including those with acute kidney injury (AKI), sepsis and other complex multisystem failures (5). Advance therapeutic interventions used in ICU have increased significance among patients with sepsis induced organ failure, severe inflammatory responses and kidney failure, using renal replacement therapy (RRT) and Cytosorb therapy. Renal replacement therapy, which includes hemodialysis, hemofiltration and hemodiafiltration, is an important part in the administration of critically ill patients with respect to fluid balance, electrolyte disturbance and toxin removal. Meanwhile, Cytosorb is an extracorporeal cytokine adsorption therapy that addresses the overwhelming systemic inflammation that often accompanies conditions like septic shock (6).

Case Presentation

A 55-years-old male was admitted to the Intensive Care Unit (ICU) after a high-energy trauma resulting in multiple fractures: thoracic contusion, fracture of the transverse process of the first thoracic vertebra (Th1), a left pertrochanteric femoral fracture, right humeral neck fracture, right clavicular fracture, and serial fractures of ribs I-X. The patient's past medical history included type II diabetes mellitus on insulin therapy and chronic gastritis. Upon admission, the patient was intubated, placed on mechanical ventilation, and received fluid resuscitation with both crystalloids and colloids. A central venous catheter (CVC) was placed for central venous pressure monitoring and for the administration of medications and fluids. Empiric antibiotic therapy (carbapenems and polymyxins) was started based on the suspicion of infection, given the severity of trauma and signs of systemic inflammation. Gastroprotective agents and anticoagulation therapy were also initiated as part of standard critical care management. Initial microbiological testing, including blood cultures and tracheal aspirates, revealed no significant growth. Over the following days, however, the patient developed increasing signs of infection.

On the 10^{th} day of hospitalization, microbiological testing revealed the presence of Methicillin-resistant Staphylococcus aureus (MRSA) and Pseudomonas aeruginosa from

tracheal aspirates, and Acinetobacter species from blood cultures. Based on these findings, the antibiotic regimen was adjusted to include MRSA-targeted therapy:

- Vancomycin (MRSA-targeted): 1g IV every 12 hours,
- Meropenem (for *Pseudomonas* and *Acinetobacter* species): 2g IV every 8 hours,
- Polymyxin B (for multidrug-resistant organisms): 2.5mg/kg IV every 12 hours.

On the 12th day, the patient developed an increase in inflammatory markers (CRP, IL-6, procalcitonin), oliguria and persistent hyperthermia. The clinical picture was suggestive of progression to septic shock. Despite adequate fluid resuscitation, the patient remained hypotensive, requiring escalating doses of vasopressors to maintain a mean arterial pressure (MAP) >65mmHg. The patient's fluid balance and renal function continued to deteriorate, prompting the initiation of Cytosorb therapy**.**

On day 13, after consulting with a nephrologist, Cytosorb (cytokine adsorption therapy), to address the patient's persistent inflammatory state, a blood purification therapy for the removal of inflammatory mediators was initiated for 24 hours.

On day 15, due to the patient's progressive renal failure, it was likely secondary to sepsis-related acute kidney injury (AKI) leading to the decision to start hemodialysis. Hemodialysis was administered for 4-hours sessions, 3 times per week. Antibiotic dosing was adjusted during dialysis to account for changes in drug clearance:

- Vancomycin: Reduced to 500mg IV every 12 hours,
- Meropenem: Administered after each dialysis session (2g IV after each session),
- Polymyxin B: Maintained at 2.5mg/kg IV every 12 hours, with careful monitoring of renal function.

On day 20, Enterococcus faecium resistant to vancomycin (VRE) was isolated from blood cultures. This led to the escalation of the antibiotic regimen, including the addition of linezolid (an oxazolidinone) for VRE coverage:

- Linezolid: 600mg IV every 12 hours.

Throughout the hospitalization, the patient's infection profile evolved.

On day 29, microbiological tests revealed Klebsiella pneumoniae and Pseudomonas aeruginosa in tracheal aspirates. Blood cultures grew Candida glabrata, a resistant fungal pathogen, on the same day.

Given the risk of fungal sepsis in an immunocompromised patient, echinocandin therapy (caspofungin) was initiated on day 33, according to the antifungal susceptibility profile:

- Caspofungin**:** 70mg IV on day 1, followed by 50mg IV once daily thereafter.

Despite the frequent emergence of new infections and resistant organisms, targeted antibiotic therapy was adjusted based on the evolving microbiological results and antibiograms. The patient received a broad-spectrum approach, initially with carbapenems, polymyxins, oxazolidines, and later including antifungal therapy, which was critical in controlling the infection.

By day 42, blood cultures were negative, signaling the resolution of the bacterial sepsis.

Discussion

Septic shock often occurs in patients with multiple traumatic injuries, where the initial trauma serves as a precipitating factor for both local and systemic infections (7). This case can show several important challenges in the management of septic shock in polytraumatized patients.

Challenges of Managing MDR Organisms

The emergence of multidrug-resistant (MDR) organisms, such as MRSA, VRE and Candida glabrata**,** posed significant therapeutic challenges. Resistance mechanisms in this case, including beta-lactamase production and altered penicillin-binding proteins, required careful selection of antibiotics and frequent adjustments. The patient's treatment regimen, which included vancomycin**,** meropenem**,** polymyxin B**,** linezolid and caspofungin, demonstrated the need for combination therapy to address diverse resistant pathogens. A key challenge was adjusting dosing due to the patient’s progressive renal failure and the impact of hemodialysis on drug clearance.

Role of Fungal Infections in Septic Shock

Fungal infections, especially Candida species, are increasingly recognized as a major concern in critically ill patients (8). The identification of Candida glabrata in this case highlights the risk of opportunistic fungal infections in patients with complex comorbidities and prolonged ICU stays. Candida glabrata is known for its resistance to commonly used antifungal agents, making early identification and targeted antifungal therapy essential. Early use of caspofungin, as demonstrated in this case, has been shown to improve survival rates in critically ill patients with suspected fungal co-infections.

Sepsis-Induced Acute Kidney Injury (AKI) Mechanisms

Sepsis-induced AKI is a multifactorial condition characterized by renal hypoperfusion, direct tubular injury, and inflammation. In this case, the patient’s septic shock led to reduced renal blood flow and ischemic injury, exacerbating AKI. Pro-inflammatory cytokines, such as TNF-alpha and IL-6, contribute to endothelial dysfunction and glomerular filtration impairment (9).

Efficacy of Innovative Therapies (Cytosorb and RRT)

Renal replacement therapy (RRT**)** was essential in managing fluid balance, electrolyte disturbances, and toxin removal (10). Antibiotic dosing was carefully adjusted during hemodialysis sessions to avoid underdosing and drug accumulation. The use of Cytosorb therapy and hemodialysis was critical in addressing the systemic inflammatory response and

managing acute kidney injury in this patient. While Cytosorb therapy remains a controversial and evolving area, it was considered in this case due to the patient's persistent inflammatory state and poor response to standard therapies.

Multidisciplinary Approach Management involved coordinated work between trauma surgeons, intensivists, infectious disease specialists, nephrologists and pharmacists. Early identification of septic shock coupled with aggressive resuscitation and targeted therapy was critical in preventing further deterioration. Recent studies showed an increase in fungal co-infections in critically ill patients, and indicated the need of improving the strategies of diagnosis as well as therapy. A study by Wang et al. (2020) in Clinical Infectious Diseases found that co-infection with Candida species and Pseudomonas aeruginosa in ICU patients with ventilator-associated pneumonia was associated with significantly higher mortality than bacterial infections alone (11). Furthermore, a study in The Lancet Infectious Diseases (2021) concluded that early use of echinocandins in septic patients with suspected fungal co-infections resulted in improved survival outcomes suggesting the need for early antifungal therapy in high-risk patients (12).

Conclusion

This case underscores the complexity of managing septic shock in polytraumatized patients, particularly in the presence of multidrug-resistant infections and evolving pathogens. Understanding the infection and physiological aspects at the patient level is vital to a multidisciplinary individualized approach to sepsis therapy. Timely microbiological testing and appropriate antibiotic treatment, renal support and innovative strategies such as Cytosorb were indispensable in improving prognosis and patient's recovery. The emergence of pathogens such as Candida glabrata and other resistant pathogens emphasizes the need for continuous monitoring and appropriate use of antifungal agents in critically ill patients. Renal replacement therapy together with Cytosorb represents two of the most crucial interventions in intensive care, particularly for patients suffering from severe sepsis, AKI and other complex critical illnesses. RRT plays a key part in controlling kidney dysfunction and fluid imbalance, while Cytosorb treatment offers an innovative method to mitigate the hyper-inflammatory response which causes organ failure. Therefore, when the two therapies are combined the benefits become relevant in the intensive care unit setting for critically ill patients. Future research is needed to define optimal indications for these therapies, evaluate their long-term effectiveness, and integrate them into clinical guidelines for managing sepsis in critically ill patients.

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