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CytoSorb® in Combination with CRRT in A Patient Suffering from Septic Shock, Acute Respiratory Distress Syndrome (ARDS) and Acute Kidney Injury (AKI): A Case Report

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ABSTRACT

OBJECTIVE: We report a case of a patient suffering from septic shock with acute kidney injury (AKI) and acute respiratory distress syndrome (ARDS) treated with standard medical treatment and CRRT, as well as adjuvant extracorporeal hemoadsorption device called CytoSorb® to address the cytokine storm.
CASE PRESENTATION: This case outlines a 53-year-old female patient who was admitted to the hospital with fever and chills, loose stool, vomiting and severe weakness. On admission, she was feverish, hypotensive, with tachycardia, tachypnea, and hypoxic. Vasopressor were started to keep mean arterial pressure (MAP) stable. Chest scan revealed infiltrates, with pleural effusion. she was intubated and placed on mechanical ventilation due to work of breathing (WOB). Later, urine output dropped to anuric levels, followed by acidosis, necessitating the start of Continuous renal replacement therapy (CRRT). Adjuvant CytoSorb® was started due to the condition's deterioration and resistance to therapy.
RESULTS: Post two sessions of CytoSorb®, there was rapid improvement in hemodynamic stability, improvement in respiratory functions, reduction in vasopressors, and decrease in blood lactate.
CONCLUSION: Adjuvant CytoSorb® therapy in conjunction with standard treatment and CRRT was found to be a safe and effective therapeutic alternative in a patient suffering from septic shock, ARDS, and AKI.

Keywords: Acute kidney injury, Acute respiratory distress syndrome, CytoSorb, Cytokines, Hemoadsorption, Sepsis, Septic shock

INTRODUCTION

Sepsis has been defined as life-threatening organ dysfunction induced by a dysregulated immunological response to infection, and its most severe form, septic shock, reflects significant hemodynamic and metabolic deterioration with an increased risk of mortality.[1,2]

A "cytokine storm" is thought to be responsible for the progression of sepsis to septic shock.[3] A cytokine storm is a cascade of adverse immune dysregulation disorders involving both pro- and anti-inflammatory cytokines (including release of endogenous cytokines as well as exotoxin, such as pattern-associated molecular patterns (PAMPs) or damage-associated molecular patterns (DAMPs) molecules), which are linked to subsequent collateral organ damage and complications.[4,5]

Sepsis/septic shock is related with nearly 50% of acute kidney injury (AKI), with a fatality rate of up to 40 and 15-20% requiring renal replacement therapy.[6,7,8] Similarly, acute respiratory distress syndrome (ARDS), a devasting complication of severe sepsis, accounts for 10% and linked to poorer clinical outcomes.[9,10,11]

Although antibiotics, source control, hydration therapy, and targeted vasopressors are the standard treatments,[12] the complexity of septic shock with ARDS and AKI with rapidly deteriorating status makes treatment difficult in a few subgroups. To expect an improved outcome, it is critical to address severe cytokinemia in the deteriorating state.

One of the most contemporary adjuvant alternatives is the use of an extracorporeal hemoadsorption device called CytoSorb® for cytokine adsorption in severe cytokinemia. CytoSorb® is a biocompatible, porous polymer beads with pore size 8-50A that directly capture and decrease mid-molecular weight inflammatory mediators (up to 60 kDa).[13] Pro- and anti-inflammatory cytokines, chemokines, and bacterial toxins are predominantly adsorbed based on concentration gradient.[13]

We report a case of septic shock with ARDS and AKI treated with standard medical treatment and CRRT, as well as adjuvant CytoSorb® therapy, in this article.

CASE PRESENTATION

This case report outlines a 53-year-old female patient who was admitted to the hospital with a fever and chills for 8 days, loose stool, vomiting, severe weakness, and reduced oral intake for the preceding two days. Before her hospitalization, she was receiving outpatient empiric treatment (paracetamol, amoxicillin and clavulanate, and nimesulide). On admission, she was feverish (103 F), hypotensive (122/60 mm of Hg), with tachycardia (140/min), tachypnoea (40/min), and hypoxic (84%-88%) at room temperature. She was started on non-invasive ventilation (NIV) after initial resuscitation in the emergency room (ER), and all routine investigations were conducted. She received her first round of antibiotics (Ceftriaxone, Doxycycline and Oseltamivir). She was then transferred from the ER to the intensive care unit (ICU).

Laboratory results indicated substantially abnormal LFT, a low platelet count, and metabolic acidosis. Her initial bilirubin was 5.7 mg/dL, serum creatinine was 2.42 mg/dL, blood lactate was 5 mmol/L, and albumin was 1.8 g/dL. Her tropical disease work-up tests (malaria, dengue and typhoid) as well as hepatotropic viral tests were all negative. She tested positive for scrub typhus. Abdominal ultrasonography revealed hepatosplenomegaly. An echocardiogram indicated a 45% left ventricular ejection fraction. A high-resolution computed tomography (HRCT) of the chest revealed infiltrates consistent with viral or typical pneumonia, with little pleural effusion.

She required inotropes and a vasopressor to keep mean arterial pressure (MAP) stable. Norepinephrine 0.58 ug/kg/min, Epinephrine 0.08 ug/kg/min, and Vasopressin 0.03 unit/min were started. Following an initial trial of NIV, she was intubated and placed on mechanical ventilation due to work of breathing (WOB), with ventilator settings including a positive end expiratory pressure (PEEP) of 18 cmH2o, Fio2 of 90%, PaO2 of 95.2 mm Hg, and PaCo2 of 49.2 mm Hg. She had higher vasopressor requirement and the dose was escalated. Following a brief recovery in diuresis, urine output dropped to anuric levels, followed by acidosis, necessitating the start of Continuous renal replacement therapy (CRRT). The Sequential organ assessment (SOFA) and acute physiology and chronic health evaluation (APACHE II) score at that point were 16 and 15, respectively.

She became unresponsive to standard therapy due to the ongoing clinical deterioration; the decision was made to additionally integrate CytoSorb® hemoadsorber on the 5th day of ICU

admission in order to stabilize the hemodynamic condition. A total of two consecutive CytoSorb® therapy sessions were given for 48 hours (24 hours per treatment). CytoSorb was used in conjunction with CRRT in CVVHD/CVVHDF mode. Treatment with adjuvant CytoSorb® was associated with reduction in vasopressor requirements throughout the two treatment sessions (Norepinephrine decreased to 0.17 ug/kg/min and epinephrine to 0.025 ug/kg/min) with progressive decreasing doses requirement thereafter. Vasopressors could be stopped after 10 days.

With the second cycle of CytoSorb®, respiratory parameters improved (PaO2 of 95.2 mm Hg and PaCo2 of 37 mm Hg), accompanied by a reduction in ventilation setting (FiO2 40%). Renal function improved with combined CRRT and CytoSorb® therapy, with reduction in serum creatinine to 1.52 mg/dL and improved diuresis. Organ functions improved marginally, as evidenced by a decrease in SOFA score from 16 to 14. Also, serum lactate levels returned to normal (1.2 mmol/L) (**Table 1**). CRRT was continued for an additional eight days, along with mechanical ventilation, antibiotics, and supportive care. On day 9, she was successfully extubated. After 14 days in the ICU, she was transferred to ward. Finally, discharged in clinically stable condition, with a review plan.

Table 1. Parameters - Pre-Cytosorb® and post-Cytosorb®

Parameters	Pre -Cytosorb®	Post-Cytosorb® (after 2nd device)
Haemoglobin (g/dL)	10.6	10.2
Leukocytes (x 10^3/µl)	31.39	28.09
Platelets (x 10^3/µl)	70	80
Serum Creatinine (mg/dL)	2.42	1.52
Serum Lactate (mmol/L)	5	1.2
Bilirubin (mgl/dL)	5.69	4.9
Sodium (mEq/L)	138	138
Potassium (mEq/L)	4.15	4.13
Bicarbonates	27.1	25.8
Albumin (g/dL)	1.8	1.5
Pa02 (mm Hg)	80.9	95.2
PaCo2 (mm Hg)	49.2	37
FiO2 (mm Hg)	90	40
SOFA	16	14

FiO2, fraction of inspired oxygen; PaO2, partial pressure of oxygen: PaCo2, partial pressure of carbon dioxide: SOFA, Sequential Organ Failure Assessment

DISCUSSION

In this case report, we treated a critically worsening septic shock patient with ARDS and AKI with standard care along with CRRT and adjuvant CytoSorb® therapy. Adjuvant CytoSorb® therapy was associated with rapid hemodynamic stability, improvement in respiratory functions, reduction in vasopressor requirements, and decrease in blood lactate, all of which resulted in survival outcome.

The beneficial outcomes observed in our patient are consistent with clinical data, largely from case reports, case series, and retrospective studies, indicating that CytoSorb may be an effective rescue therapy in septic shock with accompanying complications (AKI /ARDS).[14,15,16,17,18]

In this patient, the decision was made to begin CytoSorb® therapy to counteract cytokine storm due to the rapid deterioration of the condition and deranged inflammatory state. CytoSorb® therapy helped to eliminate excess of cytokines as well as other metabolites, including endotoxins, thus achieving immunological homeostasis in severe cytokinemia.[13] It lowered the severity of the cytokine storm and its deleterious cascade, gaining precious treatment time for the standard treatment to take action. Despite the fact, Cytosorb was utilised in combination with CRRT rather than alone. The two techniques differ as

CytoSorb® therapy targets small tiny and medium-sized hydrophobic molecules, whereas renal replacement therapy targets hydrophilic compounds. In this case, no adverse events related to CytoSorb® device was encountered during or post therapy.

In this case, early use of CytoSorb® helped to stabilize the patients' rapidly deteriorating state, perhaps averting the onset of permanent organ failure. As a result, the authors suggest that Cytosorb can be used as a rescue therapy in such situations.

Further CytoSorb® clinical trials are needed to determine its clinical efficacy in similar circumstances.

CONCLUSION

In a patient suffering from Septic shock, ARDS, and AKI, adjuvant Cytosorb hemoadsorption therapy combined with conventional treatment and CRRT resulted in hemodynamic stability, improvement in renal and respiratory parameters, and resolution of hyperlactatemia. Thus, it can be a safe and effective adjuvant option.

Declaration by Authors

Ethical Approval: As this is a retrospective case report and all patient data were de-identified, the authors didn't require additional intervention or contact with the patients after their treatment. The intervention (CytoSorb) had already been screened and approved by the hospital authorities at the time of treating the patient.

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REFERENCES

1. Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, Bellomo R, Bernard GR, Chiche JD, Coopersmith CM, Hotchkiss RS, Levy MM, Marshall JC, Martin GS, Opal SM, Rubenfeld GD, van der Poll T, Vincent JL, Angus DC. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). JAMA 2016; 315: 801-810.
2. Rudd KE, Johnson SC, Agesa KM, Shackelford KA, Tsoi D, Kievlan DR, Colombara DV, Ikuta KS, Kissoon N, Finfer S, Fleischmann-Struzek C, Machado FR, Reinhart KK, Rowan K, Seymour CW, Watson RS, West TE, Marinho F, Hay SI, Lozano R, Lopez AD, Angus DC, Murray CJL, Naghavi M. Global, regional, and national sepsis incidence and mortality, 1990-2017: analysis for the Global Burden of Disease Study. Lancet 2020; 395: 200-211.
3. Weaver LK, Behrens EM. Weathering the storm: Improving therapeutic interventions for cytokine storm syndromes by targeting disease pathogenesis. Curr Treatm Opt Rheumatol 2017; 3: 33-48.
4. Rimmer E, Houston BL, Kumar A, Abou-Setta AM, Friesen C, Marshall JC, Rock G, Turgeon AF, Cook DJ, Houston DS, Zarychanski R. The efficacy and safety of plasma exchange in patients with sepsis and septic shock: a systematic review and meta-analysis. Crit Care 2014; 18: 699.
5. Fajgenbaum DC, June CH. Cytokine Storm. N Engl J Med 2020; 383: 2255-2273.
6. Ma S, Evans RG, Iguchi N, Tare M, Parkington HC, Bellomo R, May CN, Lankadeva YR. Sepsis-induced acute kidney injury: A disease of the microcirculation. Microcirculation 2019; 26: e12483.
7. Hoste EA, Bagshaw SM, Bellomo R, Cely CM, Colman R, Cruz DN, Edipidis K, Forni LG, Gomersall CD, Govil D, Honoré PM, Joannes-Boyau O, Joannidis M, Korhonen AM, Lavrentieva A, Mehta RL, Palevsky P, Roessler E, Ronco C, Uchino S, Vazquez JA, Vidal Andrade E, Webb S, Kellum JA. Epidemiology of acute kidney injury in critically ill patients: the multinational AKI-EPI study. Intensive Care Med 2015; 41: 1411-1423.
8. Uchino S, Kellum JA, Bellomo R, Doig GS, Morimatsu H, Morgera S, Schetz M, Tan I, Bouman C, Macedo E, Gibney N, Tolwani A, Ronco C; Beginning and Ending

Supportive Therapy for the Kidney (BEST Kidney) Investigators. Acute renal failure in critically ill patients: a multinational, multicenter study. JAMA 2005; 294: 813-818.
9. Hu Q, Hao C, Tang S. From sepsis to acute respiratory distress syndrome (ARDS): emerging preventive strategies based on molecular and genetic researches. Biosci Rep 2020; 40: BSR20200830.
10. Kim WY, Hong SB. Sepsis and Acute Respiratory Distress Syndrome: Recent Update. Tuberc Respir Dis (Seoul) 2016; 79: 53-57.
11. Mikkelsen ME, Shah CV, Meyer NJ, Gaieski DF, Lyon S, Miltiades AN, Goyal M, Fuchs BD, Bellamy SL, Christie JD. The epidemiology of acute respiratory distress syndrome in patients presenting to the emergency department with severe sepsis. Shock 2013; 40: 375-381.
12. Nandhabalan P, Ioannou N, Meadows C, Wyncoll D. Refractory septic shock: our pragmatic approach. Crit Care 2018; 22: 215.
13. Hawchar F, László I, Öveges N, Trásy D, Ondrik Z, Molnar Z. Extracorporeal cytokine adsorption in septic shock: A proof of concept randomized, controlled pilot study. J Crit Care 2019; 49: 172-178.
14. Basu R, Pathak S, Goyal J, Chaudhry R, Goel RB, Barwal A. Use of a novel hemoadsorption device for cytokine removal as adjuvant therapy in a patient with septic shock with multi-organ dysfunction: A case study. Indian J Crit Care Med 2014; 18: 822-824.
15. Mitzner SR, Gloger M, Henschel J, Koball S. Improvement of hemodynamic and inflammatory parameters by combined hemoadsorption and hemodiafiltration in septic shock: a case report. Blood Purif 2013; 35: 314-315.
16. Kogelmann K, Scheller M, Drüner M, Jarczak D. Use of hemoadsorption in sepsis-associated ECMO-dependent severe ARDS: A case series. J Intensive Care Soc 2020; 21: 183-190.
17. Kogelmann K, Jarczak D, Scheller M, Drüner M. Hemoadsorption by CytoSorb in septic patients: a case series. Crit Care 2017; 21: 74.
18. Boss K, Jahn M, Wendt D, Haidari Z, Demircioglu E, Thielmann M, Ruhparwar A, Kribben A, Tyczynski B. Extracorporeal cytokine adsorption: Significant reduction of catecholamine requirement in patients with AKI and septic shock after cardiac surgery. PLoS One 2021; 16: e0246299.

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