Case Report

SAGE Open Medical Case Reports

SAGE Open Medical Case Reports
Volume 12: 1–4

DOI: 10.1177/2050313X241272670
journals.sagepub.com/home/sco
Sage

CVVHDF combined with cytokine adsorption column ameliorates severe catheter-related bloodstream infection in a hemodialysis patient

Yingjing Shen

Abstract

In extracorporeal circulation, inflammatory mediators are eliminated through inflammatory cytokine adsorption. By interacting with inflammatory cytokines and removing them from the bloodstream, the adsorber's adsorbent lowers levels of inflammatory mediators and the inflammatory response. We present the case of a 67-year-old Chinese man diagnosed with sepsis due to a bloodstream infection from a catheter. We promptly utilized a cytokine adsorption column in conjunction with continuous veno-venous hemodiafiltration (CVVHDF), resulting in a decrease in interleukin-6 levels and complete removal of bascteria from the bloodstream. A critical turning point in illness management is reached as the levels of inflammatory cytokines drop and the dosage of patients' vasoactive medications improves significantly. In hemodialysis patients with secondary septic shock in the context of catheter-associated bacteremia, the combination of CVVHDF with cytokine adsorption therapy in hemodialysis may be clinically useful and improve or accelerate the patient's improvement.

Keywords

Cytokine adsorption, CVVHDF, sepsis, catheter-related bloodstream infection

Date received: 2 January 2024; accepted: 15 July 2024

Introduction

For patients receiving hemodialysis, establishing a suitable vascular access is crucial. Tunnel-cuffed catheters (TCCs), non-TCC, autogenous arteriovenous fistulas (AVFs), and arteriovenous grafts (AVGs) are the four main types of vascular access. These numerous access options each have unique qualities and are appropriate for varied patient populations. The best option for long-term vascular access is thought to be AVF.[1] TCC should only be used as a last resort in cases where AVF and AVG cannot be established.[1] The problems of clinical treatment are further increased by the coexistence of catheter-related bloodstream infection (CRBSI) and catheter clotting.

Case presentation

In our study, we examined a 67-year-old Chinese man with diabetes and hypertension. The patient presented with frothy urine in 2011 without any apparent cause. In early March 2021, the patient began experiencing chest tightness and dyspnea following exercise, making it challenging for him to ascend three flights of stairs. He was unable to rest totally flat due to nocturnal paroxysmal breathing problems. For a poor peripheral vascular state, an AVG was established in the left forearm on March 3, 2021. When the patient's blood creatinine level increased to 800 umol/l in April, indicating hemodialysis, the patient once more complained of severe chest tightness.

Unfortunately, in July 2021, her body temperature rose to 38°C and she experienced chills during dialysis that worsened after the procedure. The artificial internal fistula puncture site appeared inflamed, swollen, warm, and tender. AVG was considered infected because of an increased neutrophil percentage. A temporary hemodialysis catheter was

Department of Nephrology, Shanghai Tianyou Hospital, Shanghai, China

Corresponding Author:
Yingjing Shen, Department of Nephrology, Shanghai Tianyou Hospital, No. 528 Zhennan Road, Putuo District, Shanghai 200331, China.
Email: feixiangba_2010@126.com

attempted to be placed using the left femoral vein, but the surgery failed due to bleeding at the insertion site. The patient chose not to be treated in our hospital. We only found out on the second day after the interventional operation that AVG was recanalized to continue hemodialysis. However, we were not informed about the specific treatment plan or whether an etiology examination was carried out.

Unfortunately, AVG tremor and noise in the left forearm stopped in January 2023. He was admitted to the hospital for treatment of a thrombus in the AVG, and a TCC was inserted into the internal jugular vein instead. From June 2023, the patient began experiencing poor appetite, fatigue, tachycardia, even hypotension during hemodialysis initiation, indicating the onset of hemodynamic instability. During dialysis, he experiences chills and shivering, followed by a high fever (reaching up to 41°C) after the dialysis session. Cefdinir, an oral antibiotic, was prescribed 100 mg twice a day for 3 days, but as soon as the drug was stopped, the post-dialysis fever returned. The white blood cell count rose to 11.22×10^9/l, with procalcitonin (PCT) levels exceeding 100 ng/ml and interleukin (IL)-6 levels surpassing 5000 pg/ml. Unfortunately, the outpatient doctor failed to adhere to guidelines by not promptly sending the catheter blood culture for testing during the outpatient treatment period. On the first day of admission, we promptly conducted the catheter blood culture test. Since blood culture testing takes time, the official report was not released until 5 days after admission. Based on experience, we considered Gram-positive cocci as common bacteria in hemodialysis catheter infections before the blood culture report was available. So we used vancomycin for catheter sealing treatment.

In situations of refractoriness to antibiotic treatment for CRBSI, removal/replacement should be the first recommendation according to guidelines. Clinical practice is not always as good as expected. This patient is overweight and has poor vascular conditions in both upper limbs. A temporary hemodialysis catheter was placed in the femoral vein during the initial dialysis due to the failure to establish an AVG. The patient has undergone several femoral vein catheterizations during dialysis treatment, with several attempts resulting in hematoma formation due to failed vein exploration. Removing the long-term catheter in the internal jugular vein would deprive the patient of an effective vascular access, thus affecting dialysis. Despite being fully informed that their vascular resources are limited, the patient and the patient's family refuse to remove or replace the long-term hemodialysis catheter, opting for conservative treatment.

Intravenously, vancomycin (1 g once daily) combined with meropenem (1 g once daily) was administered due to the presence of sepsis. To address catheter infection, vancomycin 1 g was added daily to seal the tube. The dialysis regimen is continuous veno-venous hemodiafiltration (CVVHDF) combined with CA330 (a cytokine adsorption column; Jafron Biomedical, Zhuhai, China), once every other day, for 4 h each time. The blood flow rate, dialysate flow rate, post-substitute flow rate, and pre-substitute flow rate are 200 ml/min, 2500 ml/h, 2000 ml/h, 0 ml/h, respectively. After undergoing four sessions of cytokine adsorption, the indicators significantly improved. White blood cells dropped to 4.2×10^9/l with thorough therapy, and PCT and IL-6 levels were nearly normal (2.27 ng/ml and 16.7 pg/ml, respectively). Finally, bacterial growth was not observed in the blood culture bottles. The patient's dosage of vasoactive medications was significantly decreased as the levels of inflammatory factors rose, indicating a crucial turning point in the treatment of the illness (Table 1 and Figure 1).

Table 1. Evolution of parameters before and after treatment.

Classification	WBC (×109/l)	PCT (ng/ml)	IL-6 (pg/ml)	Dose of norepinephrine
Before treatment	11.22	>100	>5000	200 μg/h
After treatment	4.2	2.27	16.7	No need

IL: interleukin; PCT: procalcitonin; WBC: white blood cell.

Up to now (April 26, 2024), the patient has been receiving dialysis treatment at our hemodialysis center and has not shown any signs of infection such as fever or hypotension during dialysis. This is a positive sign indicating that the patient's infection symptoms have been controlled and the treatment has been effective.

Discussion

CRBSI is often described as bacteremia or septicemia brought on by an infection that entered the bloodstream through the catheter lumen or intravascular space. The amount and virulence of the invading microorganisms affect the patients' clinical symptoms.[2] After the start of hemodialysis, patients with CRBSI often exhibit systemic symptoms such as chills, rigors, and fever within minutes to around 30 minu. Hyperthermia is defined as a body temperature above 38°C. If your clinical symptoms worsen or if you experience recurrent bacteremia, you could be at risk of septic shock, a potentially fatal condition involving organ dysfunction.

There are various reasons for CRBSI, primarily due to the increasing challenges faced in establishing AVF. First, AVFs require a relatively long "maturation" period before they can be used, and premature activation significantly shortens their lifespan. Second, in patients, diabetes, low hemoglobin level, advanced age, and obese make it increasingly difficult to find ideal veins for successful AVF creation and easier to be attacked by bacteria.[3,4] Third, some dialysis patients or chronic kidney disease (CKD) patients expected to need future dialysis access have not protected all their central and peripheral veins. More patients have faced repeated failures in forearm and high brachial AVF formation due to poor vascular conditions. Fourth, this complication is related to

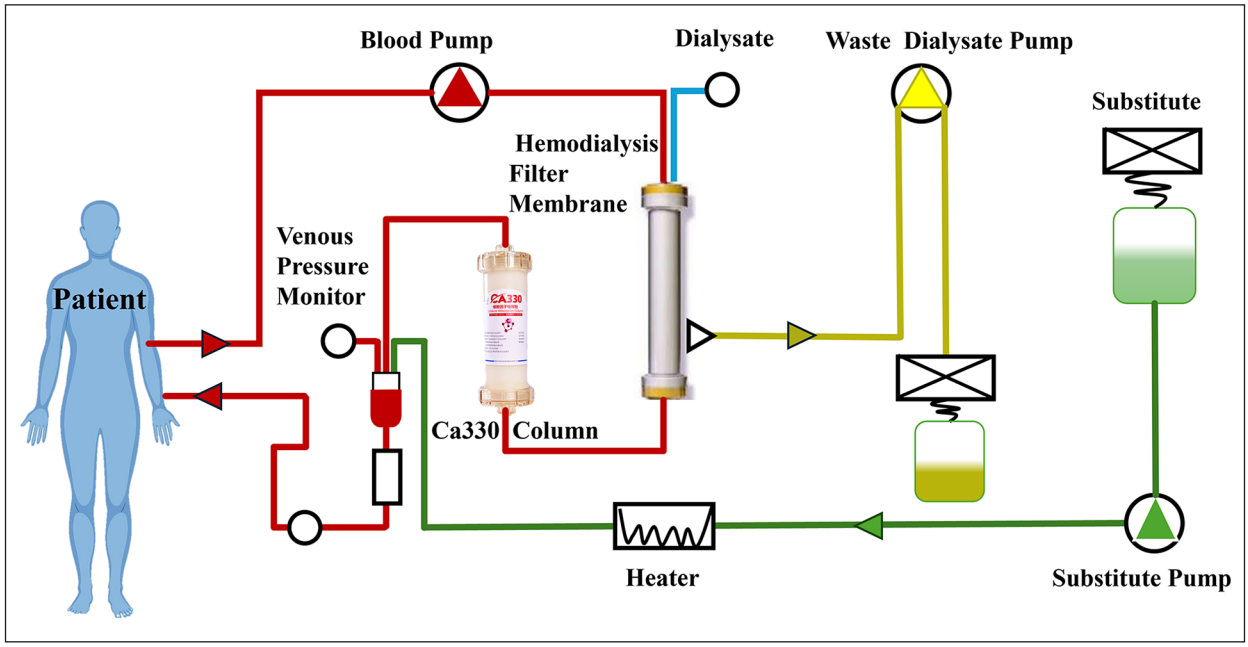

Figure 1. Extracorporeal circuit of CVVHDF with CA330.
CVVHDF: continuous veno-venous hemodiafiltration.

alterations in the immune system in CKD5, as uremia is linked with a state of immune dysfunction characterized by immunosuppression.[3] Patients are required to utilize hemodialysis catheters for maintenance hemodialysis treatment as a result of these numerous reasons. But merely changing the catheter in place or taking it out and putting it back in again does not completely get rid of the bacterial infection without systemic antibiotic therapy.[5] Therefore, the only option in such cases is to retain the catheter through systemic antibiotic therapy with an antibiotic lock.

In order to enhance patient prognosis, renal replacement treatment (RRT), such as plasma exchange, Oxiris®-AN69 membrane, and HA380 column, aims to decrease the amounts of circulating pro-inflammatory cytokines and endotoxins.[6] RRT may be necessary for patients in the intensive care unit because sepsis is the primary cause of Acute Kidney Injury (AKI).[7] In our case, the CA330 column is the first cytokine adsorption column authorized in China.

The pathophysiology of bloodstream infection is extremely complex, with immune dysregulation ranging from severe immune tolerance to deep hyperinflammation with excessive cytokine production, which prevents the host from eliminating the primary pathogens and leaves it vulnerable to secondary infections.[8] Pathogen molecules and cytokines interact with tubular cells and endothelial cells to produce a variety of physiologic changes.[9,10] Hemodynamic instability and lower susceptibility to vasoactive drug are two additional characteristics of severe systemic inflammation.[8] Cytokine adsorption is thought to be a desirable strategy to reestablish the inflammatory equilibrium and may be a viable option for treating septic shock.[11] Additionally, the use of vasopressors may be decreased as a result of CytoSorb therapy, and hemodynamic stabilization that occurs quickly.[8] On the other hand, this device has the ability to adsorb a variety of pharmaceuticals, including certain antibiotics.[12,13] A patient's prognosis may suffer as a result of some medications reaching subtherapeutic levels when improper monitoring is present.[12]

In light of immune cells playing a crucial role in the development of sepsis by releasing cytokines, an alternative strategy involves regulating the function of these cells or eliminating the activated leukocytes from the bloodstream. This approach aims to intervene in the dysregulated immune response seen in sepsis by either controlling the activity of immune cells or reducing their presence in circulation.[14] However, reports suggest that the use of cytokine adsorption did not result in decreased IL-6 levels or reduced need for vasopressors, and the available evidence for its positive effects on hemodynamic parameters and blood lactate levels is predominantly based on a specific set of cases.[11,15] There is no concrete evidence supporting a survival benefit from the CytoSorb® adsorber across a range of medical conditions, which questions the rationale for its extensive adoption in intensive care medicine.[16]

Conclusion

In summary, this case report discusses a patient undergoing hemodialysis who experienced a severe CRBSI. There is currently a debate surrounding the efficacy and safety of CVVHDF using a cytokine adsorption column in hemodialysis patients with inflammatory conditions. Further

investigation is needed through randomized controlled trials or high-quality prospective studies to definitely evaluate the efficacy of sorbent devices.

Acknowledgements

I would like to express my sincere gratitude to the following healthcare professionals, Ran Zhang, Xiaoxia Wang, and Huawen Dong, who involved in the care of the patient discussed in this case study. Their expertise, dedication, and teamwork were essential in providing the best possible treatment and achieving a positive outcome for the patient. I also want to thank the patient and their family for their cooperation, trust, and resilience throughout the treatment process. Their commitment to following medical advice and participating in the treatment plan played a crucial role in the patient's recovery. This study would not have been possible without the collective effort and collaboration of everyone involved, and we are truly grateful for their contributions.

Author contributions

Y.S. is in charge of writing and revising the entire article. I declare that Figure 1 was created by myself.

Data availability statement

The authors supplied the relevant data in response to reasonable requests.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethics approval

Ethical approval to report this case was obtained from "Ethics Committee of Shanghai Tianyou Hospital (APPROVAL NUMBER/2023_006)."

Informed consent

Written informed consent was obtained from the patient for their anonymized information to be published in this article.

ORCID iD

Yingjing Shen https://orcid.org/0000-0002-1755-2894

References

1. Chan CT, Blankestijn PJ, Dember LM, et al. Dialysis initiation, modality choice, access, and prescription: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference. *Kidney Int* 2019; 96: 37–47.
2. Almeida BM, Moreno DH, Vasconcelos V, et al. Interventions for treating catheter-related bloodstream infections in people receiving maintenance haemodialysis. *Cochrane Database Syst Rev* 2022; 4: CD013554.
3. Abbasi SH, Aftab RA and Chua SS. Risk factors associated with nosocomial infections among end stage renal disease patients undergoing hemodialysis: a systematic review. *PLoS One* 2020; 15: e0234376.
4. Weldetensae MK, Weledegebriel MG, Nigusse AT, et al. Catheter-related blood stream infections and associated factors among hemodialysis patients in a tertiary care hospital. *Infect Drug Resist* 2023; 16: 3145–3156.
5. Abdul SS, Masoud AT, Thongprayoon C, et al. Systematic review and meta-analysis of antibiotic and antimicrobial lock solutions for prevention of hemodialysis catheter-related infections. *Asaio J* 2021; 67: 1079–1086.
6. Hellman T, Uusalo P and Järvisalo MJ. Renal replacement techniques in septic shock. *Int J Mol Sci* 2021; 22: 10238.
7. Jarczak D, Kluge S and Nierhaus A. Sepsis-pathophysiology and therapeutic concepts. *Front Med (Lausanne)* 2021; 8: 628302.
8. Jansen A, Waalders N, van Lier D, et al. CytoSorb hemoperfusion markedly attenuates circulating cytokine concentrations during systemic inflammation in humans in vivo. *Crit Care* 2023; 27: 117.
9. Ankawi G, Xie Y, Yang B, et al. What have we learned about the use of cytosorb adsorption columns? *Blood Purificat* 2019; 48: 196–202.
10. Bottari G, Lorenzetti G, Severini F, et al. Role of hemoperfusion with CytoSorb associated with continuous kidney replacement therapy on renal outcome in critically ill children with septic shock. *Front Pediatr* 2021; 9: 718049.
11. Wendel GP, Hilty MP, Held U, et al. Cytokine adsorption in severe, refractory septic shock. *Intens Care Med* 2021; 47: 1334–1336.
12. Heymann M, Schorer R and Putzu A. Mortality and adverse events of hemoadsorption with CytoSorb® in critically ill patients: a systematic review and meta-analysis of randomized controlled trials. *Acta Anaesth Scand* 2022; 66: 1037–1050.
13. Schneider AG, André P, Scheier J, et al. Pharmacokinetics of anti-infective agents during CytoSorb hemoadsorption. *Sci Rep* 2021; 11: 10493.
14. Monard C, Abraham P, Schneider A, et al. New targets for extracorporeal blood purification therapies in sepsis. *Blood Purificat* 2023; 52: 1–7.
15. Moriyama K and Nishida O. Targeting cytokines, pathogen-associated molecular patterns, and damage-associated molecular patterns in sepsis via blood purification. *Int J Mol Sci* 2021; 22: 8882.
16. Becker S, Lang H, Vollmer BC, et al. Efficacy of CytoSorb®: a systematic review and meta-analysis. *Crit Care* 2023; 27: 215.