

Dialysis Toolkit for Ebola Virus Disease-Associated Acute Kidney Injury

Sourabh Sharma¹, Bianca Davidson², Rasha Darwish³, Mohamed Maalim⁴, Sanjay Kalra⁵

Abstract

Ebola virus disease (EVD), a high-fatality haemorrhagic fever endemic to Central and West Africa. EVD frequently presents with multiorgan dysfunction, including acute kidney injury (AKI). The management of AKI in EVD presents unique challenges owing to the infection's highly contagious nature, the need for critical care in low-resource environments, and the logistics of providing kidney replacement therapy (KRT) in high-biohazard settings. This manuscript outlines a "dialysis toolkit" to guide clinicians managing AKI in EVD. This toolkit covers infection control protocols, preferred KRT modalities, anticoagulation strategies, effluent disposal, and machine handling. Based on existing literature and biosafety guidance, this toolkit is intended for nephrologists, intensivists, intensive care unit nurses, dialysis nurses, infection-prevention teams, and biomedical staff. With this article, we aim to balance optimal nephrological care with maximal protection for healthcare workers across both resource-rich and austere outbreak settings.

Keywords: Acute kidney injury, Ebola virus disease, Dialysis, Hemodialysis, Kidney replacement therapy, Peritoneal dialysis.

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Introduction

EVD is a life-threatening disease caused by viruses of the genus *Ebolavirus*. The chief mode of transmission is direct contact with infected bodily fluids. EVD is complicated by systemic inflammation, endothelial dysfunction, and multiorgan failure.¹⁻³ AKI is a prominent contributor to EVD mortality, particularly in patients presenting with hypovolaemia, sepsis, or rhabdomyolysis. Aggressive supportive care, including KRT, has improved the outcomes, but delivering KRT in EVD poses various

biosafety challenges.^{4,5} Dialysis providers must operate under strict isolation protocols, manage biohazardous waste, and ensure the integrity of the dialysis circuit.⁶ The challenges to ensuring these practices are the availability of personal protective equipment (PPE), limited staff mobility, and infrastructural constraints.^{7,8} In this article, we propose a structured "dialysis toolkit" for the EVD setting to support clinicians in safely and effectively managing AKI while minimizing the risk of infection to healthcare personnel (Table).

Core Components and Clinical Considerations

The core concept of dialysis in EVD is the strict adherence to biosafety hazard protocols.⁶ Dialysis personnel should observe universal precautions and wear PPE, including impermeable gowns, double gloves, face shields, N95 or powered air-purifying respirators (PAPRs), and protective footwear. Isolated dialysis facilities or negative-pressure isolation tents are preferred to prevent aerosol spread and cross-contamination. Movement into isolation zones must be minimised and monitored by trained observers. Various KRT procedures must be designed to minimise circuit disconnections. There should be directions on how to utilise preassembled continuous kidney replacement therapy (CKRT) circuits and pre-primed lines to reduce the time spent in contact zones.^{6,7}

Establishing dialysis vascular access presents the highest risk for exposure to bodily fluids.⁹ The whole process, including insertion of the introduction needle, blood aspiration, and guidewire manipulation, carries a risk of blood splatter, necessitating careful technique and strict adherence to universal precautions. The procedure should be performed by an experienced dialysis healthcare provider, specifically trained in infection prevention and control procedures. Insertion should be done under real-time ultrasound guidance in an isolated room to avoid multiple cannulation attempts or arterial puncture. The right internal jugular vein or femoral vein is the preferred access site, depending on the patient's clinical condition and the clinician's preference. Attach closed, needle-free connector caps to catheter hubs to reduce the risk of blood exposure during connection or disconnection of dialysis tubing.^{7,10}

CKRT is the modality of choice for haemodynamically unstable patients.^{11,12} Compared to intermittent

¹Department of Nephrology, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, India; ²Division of Hypertension and Nephrology, Department of Medicine, Groote Schuur Hospital, University of Cape Town, Anzio Road, Observatory, Cape Town, South Africa; ³Kasr Alainy Faculty of Medicine, Cairo University, Egypt; ⁴Department of Medicine, Msambweni County Referral Hospital, Kwale County, Kenya; ⁵Department of Endocrinology, Bharti Hospital, Karnal, India.

Correspondence: Sanjay Kalra. e-mail: brideknl@gmail.com
ORCID ID: 0000-0003-1308-121X

haemodialysis (IHD), CKRT offers enclosed systems, reducing the risk of circuit breaches and facilitates the safe containment of dialysate and effluent. Closed-loop CKRT devices allow extended use without patient contact, a feature favourable to full PPE environments.^{6,7} CKRT should

Table: Dialysis Toolkit for Acute Kidney Injury in Ebola Virus Disease (EVD).

Component	Description and Rationale
Infection Control Measures	<ul style="list-style-type: none"> - Dedicated isolation unit with negative pressure or containment tents - Full PPE: N95/FFP3 masks, impermeable gowns, double gloves, face shields, boots - Strict donning/doffing protocols under observer supervision - Limit personnel exposure to essential staff only
KRT Modality of Choice	<ul style="list-style-type: none"> - Continuous Renal Replacement Therapy (CRRT) preferred - Minimizes haemodynamic instability - Closed circuit reduces exposure risk - Safer effluent containment and controlled ultrafiltration
Avoided Modalities	<ul style="list-style-type: none"> - Peritoneal Dialysis (PD): High risk of bowel perforation, poor solute clearance, challenging while in full PPE - Conventional IHD: Acceptable only if safe effluent disposal protocols and machine isolation are possible
Vascular Access	<ul style="list-style-type: none"> - Designate a highly competent individual to perform catheter insertion - Select the right internal jugular or femoral vein for catheter insertion based on patient factors and operator proficiency. - Avoid the subclavian site because bleeding at this site cannot be easily compressed. - Use temporary non-tunneled catheter dedicated to dialysis - Use real-time ultrasound guidance for all vascular access procedures - Maintain strict aseptic technique under full PPE
Effluent Management	<ul style="list-style-type: none"> - Treat all dialysis effluent as Category A infectious waste - Use sealed, puncture-resistant biohazard containers - Effluent bags should be solidified (e.g., with absorbent gels) and autoclaved or incinerated after use
Anticoagulation Strategy	<ul style="list-style-type: none"> - Regional Citrate Anticoagulation (RCA) preferred: maintains circuit patency without systemic bleeding risk - In centres lacking RCA, heparin-free protocols or heparin-bonded circuits may be used cautiously
Machine and Circuit Handling	<ul style="list-style-type: none"> - Dedicated CRRT/IHD machines for EVD patients - Disinfect post-use with EPA-approved virucidal agents (e.g., sodium hypochlorite, peracetic acid) - Circuits should be handled as biohazard waste and incinerated
Monitoring Parameters	<ul style="list-style-type: none"> - Strict input/output charting - Frequent monitoring of electrolytes, acid-base balance, urea, and creatinine - Watch for hyperkalaemia, acidosis, and volume overload—early signs to initiate RRT
Team Protocols and Safety	<ul style="list-style-type: none"> - Train dialysis personnel in PPE use, biosafety, and circuit disconnection emergencies - Establish clear code protocols for emergencies within containment area - Maintain redundant support staff trained in CRRT in PPE environment
Adjunct Measures	<ul style="list-style-type: none"> - Monitor for rhabdomyolysis (CK > 1000 U/L), especially in early phases - Volume replacement guided by CVP/ultrasound - Correct acidosis and electrolyte imbalances as per standard nephrology guidelines - Optimize nutritional support during CRRT per clinical guidelines. - Actively identify and treat sepsis due to co-infection or superinfection.
Monitoring, Audit, and Quality Improvement	<ul style="list-style-type: none"> - Track patient renal recovery and overall outcome - Monitor health care workers exposure - Audit and review IPC breaches and measures

be initiated early in oligo-anuric patients with volume overload, electrolyte abnormalities (notably hyperkalaemia and acidosis), or uraemic symptoms.¹³ and may also support cytokine clearance in severe inflammatory states.^{14,15} There are no specific CKRT dose adjustments in EVD. CKRT should be prescribed to achieve a delivered total effluent dose of 20–25 mL/kg/hour as per the Kidney Disease Improving Global Outcomes (KDIGO) recommendations.¹² Where CKRT is not available especially in resource-limited or constrained areas, prolonged intermittent kidney replacement therapy (PIKRT) can offer an alternative. Compared to conventional IHD, PIKRT provides improved haemodynamic tolerance and reduced circuit manipulation and can be safely implemented when strict infection-prevention and control measures are in place.¹⁶ PIKRT may also be used as a transition strategy, utilizing the same CKRT equipment to provide ongoing renal support until the patient achieves clinical and renal recovery and can safely exit the isolation setting.

Proper disposal of the dialysis effluent is another key infection control measure of EVD. All dialysis effluent must be treated as Category A infectious waste, necessitating containment in puncture-proof, sealed biowaste bags. Solidifying agents or sorbent materials may be added to these bags to facilitate autoclaving or incineration. Dialysis effluent must never be flushed into public drainage systems.⁶ Dialysis machines should be physically isolated and tagged for exclusive use in EVD units. Disinfection should be performed under PPE using agents effective against enveloped viruses, agents such as peracetic acid or high-concentration sodium hypochlorite. External surfaces should be wiped with a virucidal agent after each use, and internal circuits should undergo steam sterilization cycles or chemical disinfection as per manufacturer guidance. All extracorporeal components, like, circuits, bloodlines, and filters should be handled as biohazardous waste and incinerated in accordance with the local infection-prevention and environmental safety regulations.^{7,17,18} Anticoagulation during CKRT in EVD presents a paradox. EVD is classified as a viral haemorrhagic fever, but coagulopathy in these patients is often variable. There is early hypercoagulable state which progresses to disseminated intravascular coagulation in advanced phases.^{19,20} Regional citrate anticoagulation (RCA) should be preferred, as per local availability, for maintaining circuit patency without systemic bleeding risk.²¹ In resource-limited settings, anticoagulation-free protocols with or without heparin-coated membranes may be cautiously employed. Systemic anticoagulation should be avoided unless there is a compelling thrombotic indication and adequate platelet counts.²²

Team dynamics and workflow optimization are crucial in ensuring the safe delivery of dialysis without breaches in infection control.¹⁷ Roles and responsibilities must be pre-assigned, and protocols reinforced regularly. For better coordination, wireless communication and checklists should be implemented to enhance efficiency. All components involved in delivering a successful dialysis to EVD patients should be audited and monitored periodically for quality improvement. The indicators to be monitored can include patients' outcomes, healthcare workers' exposures, occupational health, and safety incidences, and near misses. This will improve patient outcomes, health care worker safety and protection, accountability, system learning, and preparedness. This toolkit is based on observational data, case series, expert consensus, and international guidance, as randomized trials in Ebola virus disease are lacking. Recommendations, therefore, prioritize biosafety, feasibility, and adaptation to local resources.

Conclusion

Dialysis for patients with EVD requires strict compliance with clinical protocols, logistical readiness, and infection prevention measures. This dialysis toolkit compiles current research to provide a standardized and flexible method for managing EVD-related AKI. By focusing on CKRT, implementing rigorous biosafety protocols, and employing safe anticoagulation and effluent management practices, we can enhance patient outcomes while safeguarding dialysis staff from occupational risks. As healthcare systems globally face regular outbreaks of high-threat pathogens, incorporating specialized toolkits into epidemic preparedness strategies will be crucial for developing strong and adaptable kidney care policies.

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