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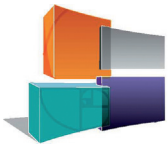

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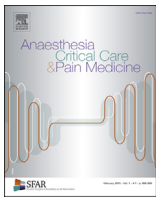

Original Article

# Fluid resuscitation in Ebola Virus Disease: A comparison of peripheral and central venous accesses

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ABSTRACT

*Introduction:* Ebola Virus Disease (EVD) causes severe diarrhoea and vomiting, leading to dehydration and electrolyte abnormalities. Treatment remains supportive and often requires intravenous (IV) access. IV catheters are difficult to insert and maintain in this context. Our primary objective was to compare peripheral venous catheters (PVCs) and central venous catheters (CVCs) for volume resuscitation in patients with EVD.
*Material and methods:* We performed a prospective observational study between January and March 2015 at the Conakry Healthcare Workers Ebola Treatment Unit (ETU). The primary judgement criterion was the ratio of the daily infused volume of fluids to the prescribed volume (DIV/PV).
*Results:* Fourteen patients were admitted. Twenty-eight PVCs and 8 CVCs were inserted. CVCs had a longer survival time ($96 \pm 34$ hours versus $33.5 \pm 21$ hours, $P < 0.001$). The mean DIV/PV was higher for the CVCs ($0.95 \pm 0.08$ versus $0.7 \pm 0.27$, $P < 0.001$), as well as the number of days with full administration of prescribed IV fluids (71.2% versus 34.1%, $P = 0.002$).
*Discussion:* Inserting CVCs is a safe and reliable way of obtaining IV access in ETUs, provided adequately trained personnel are available. CVCs optimize fluid infusion compared to PVCs. Further studies comparing fluid management strategies in EVD are necessary.


## 1. Introduction

The first large scale Ebola Virus Disease (EVD) epidemic ever recorded currently strikes West Africa. The main features of the disease are severe diarrhoea and vomiting [1–3]. This frequently leads to dehydration, which can further lead to organ failure. Treatment currently remains supportive and one of its major components is rehydration. Most patients require an intravenous (IV) access in order to provide volume resuscitation [1,2]. There is currently no evidence supporting the optimal technique for achieving IV access in EVD. Nevertheless, peripheral venous catheters (PVC) are recommended as the first line choice [4].

Case fatality rates remain high in Ebola Treatment Units (ETU) [1–3]. A significant proportion of patients die from complications related to sustained hypovolaemia, such as acute renal failure or hypovolaemic shock [1–3,5]. In contrast, lethality seems to be low in EVD patients hospitalized in developed countries [6–8]. Several factors might account for this difference, such as the availability of advanced organ support or a higher level of staffing. However, providing this level of care during epidemic conditions seems unrealistic. Fluid volumes infused in ETUs are much lower than

*Abbreviations:* CHWETU, Conakry Healthcare Workers ETU; CVC, Central Venous Catheters; DIV/PV, Daily Infused Volume/Prescribed Volume; ETU, Ebola Treatment Unit; EVD, Ebola Virus Disease; INR, International Normalized Ratio; IQR, Interquartile Range; IV, Intravenous; PPE, Personal Protection Equipment; PVC, Peripheral Venous Catheters; SD, Standard Deviation; WHO, World Health Organization.

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those reported in western countries [1,6–8]. Improving fluid delivery in ETUs might be a low cost and high potential benefit intervention [5].

Difficulty in obtaining and maintaining IV access may preclude adequate volume resuscitation. Healthcare workers must wear personal protective equipment (PPE) when caring for patients. PPE restricts the field of vision and impairs dexterity, potentially reducing the success rate of catheter insertion. Climatic conditions reduce the amount of time available for nursing patients [5]. Cultural and linguistic incomprehension, as well as delirium, lead to poor compliance and unintentional catheter removal.

It has recently been shown that inserting central venous catheters (CVC) is possible and safe in an ETU [9]. We hypothesized that volume resuscitation would be more reliably infused with CVCs than with PVCs. Our main criterion was the ratio of daily infused volume to prescribed volume (DIV/PV).

**Fig. 1.**

## 2. Patients and methods

This prospective study was conducted between January and March 2015 at the Conakry Healthcare Workers ETU (CHWETU) in Conakry, Guinea. All patients with proven EVD were included.

The CHWETU is a 10-bed unit staffed by French Army Medical Service personnel. Laboratory facilities support EVD diagnosis, routine haematology and biochemistry testing, but no microbiology. Point-of-care biology is also available.

Supportive care is provided according to World Health Organization (WHO) guidelines [10]. The latter includes oral and/or intravenous hydration, symptomatic relief of pain, vomiting and diarrhoea, as well as empiric antibiotics. Decisions concerning the route and volume of IV fluid administration are discussed daily by a multi-disciplinary staff of physicians, including infectious disease, internal medicine and anaesthesiology and critical care specialists. Fluid volume prescriptions are based on simple clinical data, such as the estimated quantity of stool, weight variations or daily urinary output. Laboratory data such as haematocrit, urea and serum creatinine are also used. Infusion fluids are mainly lactated Ringer's solution and, in a smaller proportion, 5% dextrose in water with adequate electrolytes.

All activities inside the "red zone" are performed in WHO-compliant PPE [11], which includes a fluid-proof suit, face mask, goggles and triple gloving. PVCs were inserted by nurses or physicians. Skin was prepared with 2% Chlorhexidine. 18G or 20G safety catheters were used (BD Insyte™ Autogard™ Winged, Becton Diffusion Infusion Therapy Systems Inc., USA). Peripheral catheters were secured using sterile dressings with adhesive strips (Tegaderm™ IV, 3M, Germany).

CVCs were inserted by anaesthesiology and critical care specialists. The choice of which insertion site to use was left to the attending physician. Heart rate and oxygen saturation were monitored during the procedure. Since no ultrasound device was available, external landmarks were used. Skin preparation was made with 2% Chlorhexidine. To lessen the climatic burden, a "semi-sterile" technique was used, with sterile gloving and strict attention not to touch the wire or catheter (image). Local anaesthesia with 1% lidocaine was used in all cases. Procedural sedation using ketamine and midazolam was administered if required. CVCs were inserted using a standard Seldinger over-the-wire method. We used 2 lumen, 20 cm, 7G catheters (Logicath™, Smiths Medical, Germany). They were secured with two non-resorbable 2-0 sutures and an occlusive dressing (Tegaderm™ Film, 3M, Germany).

Each needle puncture was considered as an attempt. Success was defined by the ability to flush a 10 ml 0.9% saline bolus through the catheter without signs of extravasation. The survival time of the catheter was also recorded, and whether its removal was deliberate or not. For CVCs, the insertion site and immediate or delayed complications were recorded. There was no systematic catheter replacement strategy. Catheters were removed if they were no longer necessary, non-functional or if there was a suspicion of local or systemic complications. Prescribed and infused volumes were recorded daily, as well as the DIV/PV ratio.

Statistical analysis was performed using Medcalc® 15.2.2 statistical software. Results are expressed as means ± standard deviations (SD) or medians (interquartile range [IQR]). Comparisons between groups were made with Fisher's tests for categorical data or Student *t*-tests for continuous data. Tests were considered statistically significant if $P < 0.05$ (Fig. 1).

Ethical approval was granted by the *Comité d'Éthique National pour la Recherche en Santé* (no. 29/CNERS/15).

## 3. Results

Fourteen patients with EVD were hospitalized during the study period. Five patients died (35.7%), all of whom were in the CVC group (Table 1). Thirteen patients required at least one IV access.

Thirty PVC insertions were attempted, with an overall success rate of 92.3%. The success rate at first attempt was 86.7%. The main indication was for rehydration (73.3%), followed by administration of IV-only treatments (26.7%). Fifty percent of all PVC removals were unintentional, whether due to accidental ablation or malfunction.

Eight CVCs were inserted in 7 different patients (Table 2). CVCs were inserted because of difficult peripheral IV access in 2 patients (25%) and for large volume infusion in 5 patients (75%). All attempts were successful, with 6 successes at the first attempt (range 1–3). Insertion took place a median of 5.5 (5–6) days from the onset of symptoms and the second (1.5–3) day of hospitalization.

There were 4 minor complications (50%) and no serious complications, defined by the necessity to take specific corrective measures. All patients with puncture site bleeding had a biological

**Table 1**
Patient characteristics.

| | All patients | No CVC | CVC | *P* |
|---|---|---|---|---|
| *n* | 14 | 7 | 7 | |
| Male sex, *n* | 13 | 7 | 6 | 1 |
| Age, median (IQR) | 31 (27–33) | 32 (29–33) | 28 (22–38) | 0.09 |
| Complications (any), *n* | 8 | 1 | 7 | 0.007 |
| Creatinine > 150μmol/l, *n* | 7 | 0 | 7 | 0.001 |
| Hypoxaemia, *n* | 5 | 0 | 5 | 0.02 |
| INR > 2, *n* | 6 | 1 | 5 | 0.1 |
| Haemorrhage, *n* | 3 | 0 | 3 | 0.2 |
| Death, *n* | 5 | 0 | 5 | 0.02 |