Applicability, Safety, and Cost-Effectiveness of Improvised External Ventricular Drainage: An Observational Study of Tunisian Neurosurgery Inpatients

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OBJECTIVE: **External ventricular drainage (EVD) is an emergent neurosurgical procedure. Many commercial sets are available for EVD that are not always obtainable in all hospitals. The aim of our study was to describe new techniques to perform EVD using simple improvised materials to check the real-world applicability of the same device in the management of acute hydrocephalus and its effectiveness and safety.**

METHODS: **We illustrated 2 techniques for a "do it yourself" improvised EVD device using materials available even in non-neurosurgery-dedicated operating rooms. We performed an observational study in our institution (April 2015 to December 2016). We included all patients presenting with acute hydrocephalus and requiring EVD.**

RESULTS: **During a 20-month period, the new EVD device was used as a lifesaving solution for 33 patients. Good outcomes were noted in 11 of the 33 patients (33%). The EVD was complicated by fatal meningitis in 4 of the patients (12%). Malfunction occurred in 6 patients. The new EVD device costs less than US$20 for the first technique and less than US$10 for the second technique. In contrast, the cost of a standard EVD set ranges from US$170 to US$380 in Tunisia.**

CONCLUSIONS: **The new EVD device has the potential to improve the quality of efficiency of care in difficult economic times that have changed the medical landscape, because it is both easy to make and cost-effective. Because it is an inexpensive technique, it could also be suitable for low-income countries, where neurosurgery is not yet the first and foremost health priority.**

INTRODUCTION

The placement of an external ventricular drainage (EVD) device is one of the most elementary and most common neurosurgical procedures worldwide.[1-3] It is used as an emergency treatment for acute hydrocephalus, increased intracranial pressure (ICP), and temporary cerebrospinal fluid (CSF) diversion in patients with craniocerebral infection.[4-8]

EVD must be emergently performed when acute hydrocephalus or increased ICP has been diagnosed. EVD consists in placing an intraventricular catheter connected to an external drainage device. Many commercial sets are available to perform this procedure. However, these sets are not obtainable in all hospitals, especially those lacking neurosurgical departments. In addition, the clinical condition of patients waiting for transfer to a specialized center can deteriorate. As a rescue solution, we have described 2 techniques of a "do it yourself" improvised EVD device using materials available even in non-neurosurgery–dedicated operating rooms. The EVD device can also be used at the bedside in intensive care units.

This new EVD device is effective and less expensive than commercial sets. Therefore, it could be suitable for low-income countries, where cost pressures have necessitated such creative approaches and where neurosurgery is not yet a health priority.

Key words
- Acute hydrocephalus
- CSF drainage device
- External ventricular drainage
- Technique

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
EVD: External ventricular drainage
ICP: Intracranial pressure

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Supplementary digital content available online.

Citation: World Neurosurg. (2018) 119:428-436.
https://doi.org/10.1016/j.wneu.2018.07.261

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

METHODS

To demonstrate the effectiveness and safety of the new EVD device, we conducted a prospective observational study during a 20-month period (April 2015 to December 2016). During this period, we experienced a shortage of standard EVD commercial sets in our hospital. The patients who presented with acute hydrocephalus were included after obtaining the patients' or their relatives' informed consent. EVD was performed using the new device. A data form was completed for all the patients and included the underlying disease, complications (tearing, dysfunction, or infection), and outcomes. The ethics committee reviewed and approved the utility of the described EVD device as a life-saving solution in the case of lack of standard commercial sets (approval number, CCP Sud 00 47/2017).

Device Description

Here, we report the technique for 2 "homemade" EVD devices. The trademarked equipment shown in the photographs were only included for demonstration (similar products could also be used and we used other trademarked equipment in our series).

First Technique. For the new EVD device, we needed the following materials: a 14-gauge central venous catheterization set (Figure 1A and B); a urimeter (Figure 1C–E); a 3-way stopcock (Figure 1F); a connector tube (coiled or not; Figure 1G); and a Foley catheter. All the required materials are shown together in Figure 1H.

For the placement of the EVD using the 14-gauge central catheter (Figure 2A–K), the patient's position and the cranial approach used were the same as those for a standard EVD. The patient was placed supine on a standard table. The head rested on a horseshoe headrest, exposing the ventricular puncture area. We marked the midline, coronal suture, and midpupillary line, which was 2–3 cm from the midline. The entry point was located on the midpupillary line, 10 cm from the orbital rim. The frontal incision was 1 cm anterior of the coronal suture and 2–3 cm from the midline. Next, we drilled a right frontal burr hole and opened the dura mater. The ventricle puncture was performed the same as for the usual procedure using the same anatomical reference marks (i.e., the nasion and homolateral tragus) and the central venous catheter. The central venous catheter was assembled on a metal guide (Figure 3A) to act as a ventricular catheter. High-pressure CSF poured through the drainage device (Figure 2A). The catheter was tunneled under the scalp (Figure 2B–D) and fixed using the "wings" present in the proximal part of the catheter. The central catheter set included a suitable patch for fixing the catheter (Figure 2E–K).

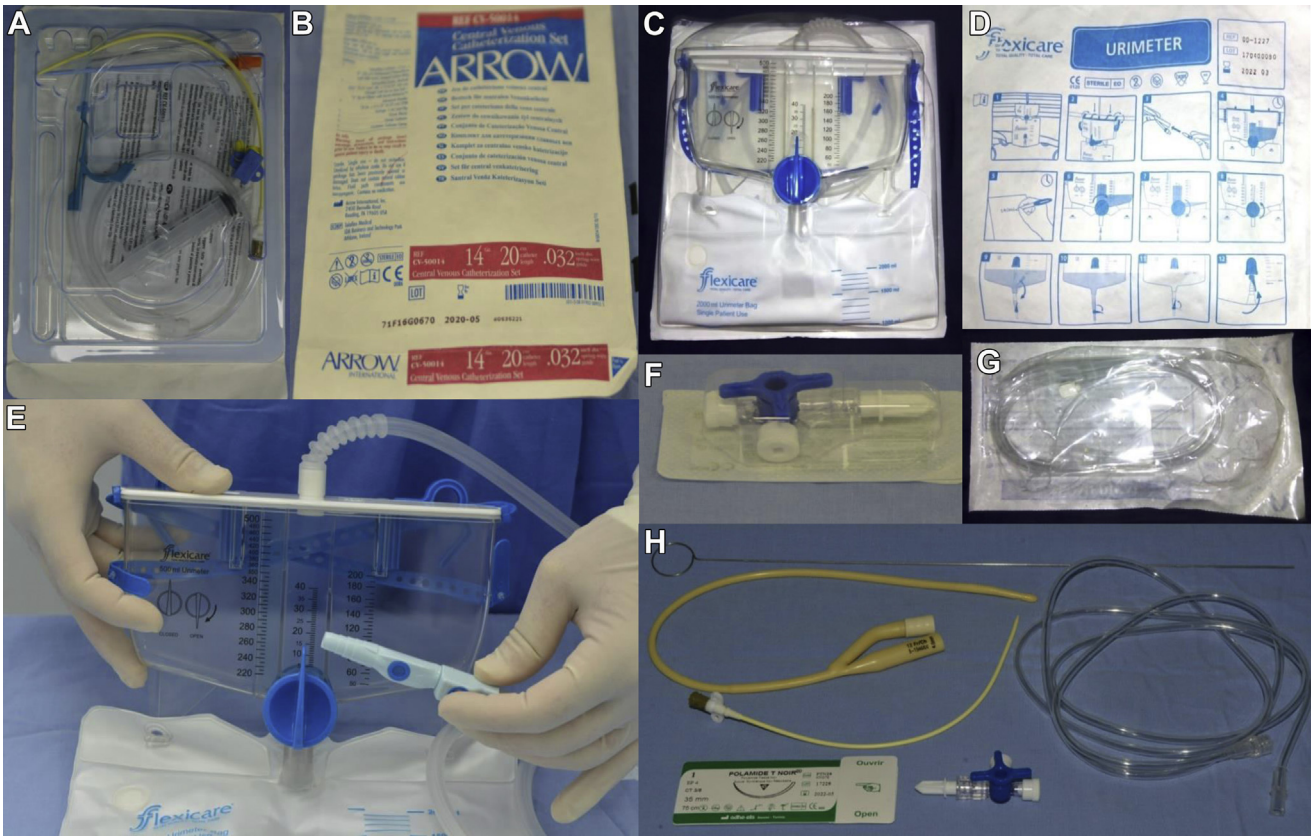

Figure 1. Material required for the drainage device using the first technique. (**A**, **B**) A 14-guage central venous catheterization set; (**C**–**E**) urimeter; (**F**) 3-way stopcock; (**G**) connector tube; and (**H**) all the needed materials (with the metal guide and nonabsorbable suture).