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Ventriculostomy related infection in intensive care unit: Diagnostic criteria and related conditions

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ABSTRACT

Objective: To evaluate the usefulness of clinical signs, blood tests, microbiological cultures and cerebrospinal fluid (CSF) analysis to detect ventriculostomy related infections (VRI), and to describe related conditions.

Methods: A retrospective study was carried out including all patients with external ventricular drain admitted to intensive care unit from January 2000 to December 2006. Diagnosis of VRI, mortality, demographic and clinical data, time and number of drains, microbiological and biochemical CSF results and blood test were recorded. Difference between infected and uninfected patients was statistically significant at $P < 0.05$.

Results: The results revealed 136 drainages in 120 patients with 22 (18.33%) infected (15.39 infections per 1 000 days of drainage). This group was on overage older, had more severe systemic response syndrome and a significantly higher number of drains and longer duration of drain insertion. We found statistical differences in proteinorrachia, glycorrhachia, and glycorrachia/glycemia ratio during 8.5-day drain insertion (interquartile range 7–10.25). A total of 31 cultures were positive in patients without VRI and 47 were negative in patients with VRI. Furthermore, 35 patients died (2 belonging to the infected group). Significantly higher risk of VRI in intraventricular fibrinolysis and subarachnoid haemorrhage was observed. We made a multivariate regression model resulting in a prediction rule with 55.7% area under curve (95% *CI* 0.43–0.70).

Conclusions: CSF routine cultures and biochemical studies are not recommended to diagnose VRI. Clinical signs, external ventricular drain manipulation and a drainage insertion over a week justify the routine measurement of proteinorraquia, glycorrhachia and the ratio of glycorrachia/glycemia.

1. Introduction

The external ventricular drain (EVD) constitutes a clinical standard for the continuous monitoring of intracranial pressure (ICP) and facilitates the drainage of cerebrospinal fluid (CSF). Indications for an EVD include primary hydrocephalus, obstructive hydrocephalus secondary to expansive processes or intracranial haemorrhage, ICP control in patients with cranioencephalic trauma and prevention of postoperative CSF fistulas[1,2]. It facilitates the treatment using intraventricular fibrinolysis (IVF) and the administration of local antibiotics [1,3]. Its indications are limited by the risk of bleeding during the insertion procedure and the risk of ventriculostomy-related infection (VRI)[1–6]. The published indication on the VRI seems to be conflicting since incidence rates vary between 0% and above 50% depending on the authors[1,2,4–10]. There are no universal criteria to establish its diagnosis; strategies focus on clinical monitoring and blood and CSF microbiological and citobiochemical results[1,2,4,6–14]. The clinical assessment of the patient and certain test results that suggest infection (leucocytosis, CSF pleocytosis, hypoglycorrhachia, *etc*.) lose their predictive value due to the particular characteristics of the neurocritical patient[15–17], and they can cause delay in its detection and early treatment; the lack of rentability of the cultures and the fact that waiting is needed for their results to be available are also obstacles to an early diagnosis[18,19].

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The need to establish uniform criteria which are both highly sensitive and specific for the diagnosis of VRI seems necessary, and, also, to determine CSF parameters to predict its development[12]. The etiological agent most commonly involved is the coagulase-negative staphylococci[1,2,11–13,18,20], however, the detected amount of Gram-negatives is increasing. Many factors that could contribute to the development of VRI have been identified (associated craniotomy, systemic infection, depressed cranial fracture, intraventricular haemorrhage, catheter manipulation, and instillation of local treatments)[1,2,4,11,13,14,21,22], whereas some others are subjects of continuous debate (use of prophylactic antibiotics, the number of devices, corticosteroids administration, lengthy stays in critical care units, placement site of the catheter, prophylactic replacement of the catheter, duration of the derivation, *etc*.)[1,4,14,20–28].

The main objective of this study is to evaluate the usefulness of CSF and blood clinical, cytobiochemical and microbiological parameters to detect VRI, and the secondary objective is to describe possible related conditions to such infection.

2. Materials and methods

2.1. Patients

The setting is a 13 bed intensive care unit (ICU) located in a tertiary referral hospital, which is reference for an area of 400 000 citizens. A retrospective review was conducted on the patient prospective database of our unit and their clinical history, and those patients who were admitted between 2000 and 2006 and carried one or more EVD were included. Two of the authors, working independently from one another, registered the following variables: demography, main diagnosis, score on severity scales 24 h after admission [Acute Physiology and Chronic Health Evaluation II (APACHE)[29], and Simplified Acute Physiology II Score (SAPS II)[30]], VRI diagnosis, EVD duration (number of days from insertion until removal), number of catheters per patient, intraventricular haemorrhage (IVH) stratified using the Graeb scale[31], treatment with IVF and administration of systemic antibiotherapy prior of after treatment. The presence of systemic inflammatory response syndrome (SIRS)[32], at the same time of VRI and mortality while in ICU were also registered.

2.2. Insertion technique and care of EVD

While this study was conducted, the clinical guidelines for the management of EVDs did not suffer any significant alterations.

For insertion, a Lundberg technique modified by the neurosurgery staff was used in theatre or in the ICU, under asepsis and sterile conditions. Always according to availability and the preferences of the neurosurgeon in charge of the procedure, either silicon tunnelled ventricular catheters (Becker® PS Medical® by Medtronic Neurosurgery; Minneapolis, MN, USA) or clindamycin or rifampicin covered catheters (Codman Bactiseal®; Raynham, USA) were used. Ventricular drainage systems (LCR EDS 3 external drainage system; Codman®, Switzerland) and transducers for the monitoring of intracranial pressure were also used (CAMINO® laboratories; NeuroCare San Diego, USA).

For IVF, those patients with a Graeb score above 5 for IVH were given 10 000 intraventricular units of urokinase, for a length of time determined by clinical and tomographic criteria (a decrease in the amount of intraventricular blood along with a Graeb score below 6)[31].

For nursing care, watertight drainage system was strictly preserved and only broken to drain and obtain samples of CSF or for the instillation of local treatments, and strict asepsis measures were kept at all times.

For catheter removal, the time of EVD treatment was determined by the clinical evolution of the patient and the need of CSF drainage or ICP monitoring. If malfunction or accident occurs when removing catheter, but the catheter was still needed, the insertion of a new EVD on an alternative location was carried out. VRI did not justify the removal of the EVD when there was no indication for such removal.

Those patients with mechanical ventilation for a period longer than 48 h were subjected to selective digestive decontamination with a pool of amphotericin B, polymyxin, gentamicin and excipients, and a 3-day course of 2 g of intravenous ceftriaxone every 24 h.

2.3. Microbiological tests and test results

All EVD patients were subjected to a cytobiochemical test and CSF culture every 24–72 h from the insertion of the catheter until its final removal, accompanied by a simultaneous blood test. The CSF samples were cultured in a specific 35 °C and 5% CO_2 environment; germs were identified and the corresponding antibiogram with standard microbiological tests was carried out.

For collection and statistical analysis purposes, the moment of catheter insertion was defined as Day 0. The microbiological and cytobiochemical results were registered (glycorrhachia, proteinorrhachia, leucocyte count in CSF, blood sugar levels, leucocytes in blood and erythrocyte in blood and CSF) noting the drainage day corresponding to each simple. Several patients needed EVD during many days, then led to collect many samples; for data analysis purposes, for each one, five samples were selected following uniformity criteria. Discrepant data were corrected using an overall review of the computerised clinical history.

2.4. VRI definition and exclusion criteria

The VRI diagnosis was documented in the medical history of the patient, and the criteria for its diagnosis was established as follows: a known pathogen on CSF cultures with the association of at least two SIRS criteria[32], or, cytobiochemical suspicion[1] (less than 45 mg/dL hypoglycorrhachia and neutrophilic pleocytosis higher than 100 per mL) and SIRS symptoms with a negative culture[32]. The specificity of the positive cultures and the SIRS symptoms were subjected to the judgement of the doctor in charge of the patient who could interpret the symptoms as EVD colonization or contamination of the culture (in absence of symptomatology) or as symptoms related to another condition (pneumonia, urinary tract infection, *etc*.).

2.5. Data analysis

SPSS 11.0 (SPSS Ic. Chicago, Illinois) was used. Qualitative variables were expressed as frequencies and continuous variables were expressed as mean ± SD and median and interquartile