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## External ventricular drains: is there a time limit in children?

Received: 26 August 2004  
Published online: 10 February 2005  
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There were no investments or financial interests in this work

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**Abstract** *Background/purpose:* The time limit for the use of external ventricular drains (EVDs) has always been controversial. The purpose of this study is to find out if there is a time limit with regard to infection of EVDs and their duration of use in children.

*Methods:* The records of 28 patients who had a total of 46 EVDs over a 4-year period at the Regional Paediatric Neurosurgical Centre at the Royal Liverpool Children's Hospital, Alder Hey, Liverpool, UK, were retrieved. The cerebrospinal fluid (CSF) white cell counts, CSF Gram stains and the CSF culture results were analysed.

*Conclusion:* There is no time limit for EVDs in children. They can be left as

long as clinically indicated provided strict protocols are followed in the handling of the set.

**Keywords** External ventricular drain duration · CSF · Infection

### Introduction

The time limit for external ventricular drains (EVDs) has been a controversial subject. Many reports have shown that a particular time limit has no effect on the infection rate of EVDs [4, 5]. Also, regular changes of the ventricular catheter at 5-day intervals did not reduce the risk of cerebrospinal fluid (CSF) infection [5]. Several studies have been carried out to determine the risk factors and identify markers for infection [2]. Our study aims to find out if there is a time limit in the paediatric age group, the accuracy of white cell counts (WCCs) in the CSF and the pathogens involved in infection.

### Materials and methods

The microbiological reports of all children aged 1 day to 16 years who had EVDs in the 4-year period from 1999 to 2003

at the Royal Liverpool Children's Hospital, Alder Hey, Liverpool, UK, were retrieved and analysed using the WCC, Gram stain and CSF cultures. The duration of use of each EVD was also documented and the time of infection recorded. The outcome of infected EVDs was also recorded.

### Results

Forty-six EVDs were inserted in 28 patients over a 4-year period. Twenty-eight EVDs were inserted with no previous CSF infections as documented by CSF cultures and 18 were inserted because of infection with positive CSF cultures from the first day. Of the 28 non-infected cases, 24 EVDs (Table 1) were placed for periods ranging from 6 to 26 days (mean 12.25 days). Four EVDs were in place for less than 6 days. The WCC in CSF, the microscopy and the cultures were analysed. Twenty-two of the 24 EVDs developed no

positive cultures during their duration of use. Only 2 developed positive cultures—1 on day 14 and 1 on day 9. Both had their EVDs changed. Of the 22 that had no positive cultures, only 4 had WCCs greater than  $10 \times 10^6/l$ . In the 4 EVDs that had been in place for less than 6 days there were no positive cultures and the WCC remained below  $10 \times 10^6/l$ . All 26 had no positive microscopy for bacteria. The 2 that developed positive cultures had WCCs less than  $10 \times 10^6/l$ , but had positive microscopy for bacteria. Of the 2, 1 developed methicillin-resistant *Staphylococcus aureus* (MRSA)-positive cultures and the other had *Pseudomonas aeruginosa* and skin flora.

There were 18 EVDs inserted for infection with documented positive cultures from the first day (Table 2). The duration of use of these EVDs ranged from 5 to 14 days (mean 8.3 days). Of the 18 EVDs, 4 belonged to one patient who persistently grew MRSA. Of the remaining 14, 10 grew *Staphylococcus epidermidis* in conjunction with other skin flora. One of these had *Pseudomonas aeruginosa*. Three grew *Staphylococcus aureus*, 1 of which was in conjunction with *Staphylococcus epidermidis*, and 2 grew *Enterococcus durans*. The 2 that grew *Enterococcus durans* belonged to

**Table 1** Non-infected group in which external ventricular drains (EVDs) were in place for longer than 5 days. WCC white cell count

EVD	Duration (days)	WCC $>10 \times 10^6/l$	Gram stain	Cultures
1	7	No	—	—
2	11	No	—	—
3	17	No	—	—
4	9	No	—	—
5	7	No	—	—
6	8	No	—	—
7	7	No	—	—
8	14	No	—	—
9	14	No	—	—
10	19	No	—	—
11	7	No	—	—
12	13	No	—	—
13	16	No	—	—
14	7	No	—	—
15	18	No	—	—
16	6	No	—	—
17	6	No	—	—
18	7	No	—	—
19	12	Yes	—	—
20	21	Yes	—	—
21	26	Yes	—	—
22	7	Yes	—	—
23	24	No	+	+
24	11	No	+	+

Yes denotes WCC  $>10 \times 10^6/l$  in cerebrospinal fluid (CSF)

No denotes WCC  $<10 \times 10^6/l$  in CSF

— denotes negative cultures/bacterial stains (CSF)

+ denotes positive cultures/bacterial stains (CSF)

**Table 2** EVDs with positive CSF cultures from day 1 of insertion

EVD	Duration (days)	WCC $>10 \times 10^6/l$	Gram stain
1	12	Yes	+
2	6	Yes	+
3	5	Yes	+
4	7	Yes	+
5	9	Yes	+
6	6	Yes	+
7	10	Yes	+
8	12	Yes	+
9	6	Yes	+
10	9	Yes	+
11	6	Yes	+
12	7	No	+
13	7	Yes	—
14	9	No	+
15	11	Yes	—
16	6	Yes	—
17	14	Yes	—
18	7	No	—

Yes denotes WCC  $>10 \times 10^6/l$  in CSF on day 1

No denotes WCC  $<10 \times 10^6/l$  in CSF on day 1

+ denotes positive microscopy for bacteria (CSF) on day 1

— denotes negative microscopy for bacteria (CSF) on day 1

the same child whose first infection did not clear within 7 days of EVD and antibiotics.

Fifteen out of the 18 EVDs had initial WCCs of above  $10 \times 10^6/l$  in conjunction with positive cultures. Thirteen (72.2%) had organisms seen on Gram stain on the first day. Two of those who had *Staphylococcus aureus* had the organisms cultured on the first day only and the third had it on the first 2 days only. All EVD patients had antibiotic treatment during their stay, as determined by cultures and sensitivity.

## Discussion

Wong et al. [5] conducted a randomised clinical trial to determine if the regular changing of EVDs at 5 days reduced the infection rate of the catheters and improved outcome. They concluded that regular changes of ventricular catheter at 5-day intervals did not reduce the risk of CSF infection. A single external ventricular drain can be employed for as long as clinically indicated.

In another study, Pfisterer et al. [4] reported that no significant correlation was found between drainage time and positive CSF culture. The only parameter that significantly correlated with the occurrence of a positive CSF culture was the CSF cell count.

The use of prophylactic antibiotics has also been debated. Alleyne et al. [1] in their study reported that prophylactic antibiotics did not significantly reduce the rate of ventriculitis in patients with EVDs, and they may select for resistant organisms.

The parameters for identifying CSF infection in EVDs have also been controversial, especially with the use of daily

CSF cultures. Hader and Steinbok [2] reported that routine culture of CSF in children with EVDs is not necessary, and that if CSF cultures are performed for new fever ( $>38.5^{\circ}\text{C}$ ) or peripheral leukocytosis, neurological deterioration, or a change in CSF appearance, infections will be identified in a timely fashion.

Our study has confirmed that in the non-infected group, EVDs could remain for longer than the standard 5 days without being infected. Only 2 out of the 24 had positive cultures, and the possibility of specimen contamination remains. The results of the study also show that the results of CSF analysis should be further examined carefully in children as a raised WCC, whilst raising the suspicion of CSF infection, is not entirely absolute in confirming it, and there should be a correlation between clinical and laboratory data before subjecting the patient to further therapy. These would include fever, seizure, high blood C-reactive protein, leukocytosis and a high protein level in the ventricular fluid [3]. CSF culture in our study remained the only sure way of diagnosing CSF infection. The way the EVD is handled and the method by which CSF is collected are also important for avoiding contamination and false positive results, or even contaminating the set itself. This is probably important in the infected group where skin flora and *Staphylococcus*

*epidermidis* dominated, although these were probably introduced at the time of the initial shunt insertion. Thus, many of the cultures that grew skin flora from the CSF might have just been contaminants, especially if there are no clinical signs to suggest ventriculitis. The Gram stain did help in the initial identification of pathogens before the culture results were out and could be used as an initial guide to CSF infection until the culture results are available. We have instituted a protocol in our hospital for aseptic CSF sampling.

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## Conclusion

External ventricular drains in children can remain for as long as clinically necessary providing CSF cultures remain negative. The WCC whilst a good indicator of possible CSF infection, should be interpreted in correlation with other laboratory parameters and clinical signs. The Gram stain technique is helpful in the initial identification of pathogens, especially in infected shunts or catheters. The time limits for failure of antibiotic therapy and change of catheter still need to be studied, but they are clearly longer than has been suggested in the past.

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