

Short Report

Blood tests are not always helpful in predicting bacterial meningitis in children

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ABSTRACT

Bacterial meningitis is characterized by inflammation of the meninges covering the brain. It is a life-threatening illness, if untreated. The aim of this study was to examine whether blood tests including C-reactive protein (CRP) and full blood count (FBC) predict bacterial meningitis in children. We also examined the relationship between cerebrospinal fluid (CSF) tests including gram stain, culture and polymerase chain reaction (PCR) and blood tests such as culture and PCR results. We studied 11 patients admitted with bacterial meningitis in the Paediatric wards, National Children's Hospital, Dublin, Northern Ireland (2012-2016). The mean age was 10.7 (SD, 14.7) months. In this group of patients, 5 (45.5%) had leucocytosis, 7 (63.6%) experienced

neutrophilia and 1 (9.1%) had both leukopenia and neutropenia. C-reactive protein (CRP) value of less than 1 mg/L was found in 2 patients (18.2%). No link was found between CSF gram stain and CSF culture (p value 0.66) or CSF PCR results (p value 0.75). Meningitis should be investigated and treated if clinically suspected, regardless of CRP values or peripheral blood results.

Keywords:

Bacterial meningitis; Child; Laboratory diagnosis

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INTRODUCTION

In a previous study, it has been shown that no single CSF value can reliably exclude the presence of meningitis in neonates [1]. Bacterial meningitis can occur in patients with CRP values less than 50 mg/l [2]. Serum CRP has a sensitivity of 76% and specificity of 68% in bacterial meningitis [3]. In those with meningitis, initial CSF white blood cell differential may be misleading [4]. Cerebrospinal fluid (CSF) culture is the gold standard test for determining the causative organism, with PCR being much faster and more sensitive in some circumstances [4]. Therefore, we set out to determine whether there is any relation between CRP, full blood count (FBC) and blood culture (or any combination of these) on one side and CSF tests such as gram stain, culture and PCR values on the other side.

METHODS

This study is a retrospective study in the Paediatric Department, National Children's Hospital, Dublin, Northern Ireland (2012-2016). Children with a diagnosis of bacterial meningitis over the previous 4 years were identified from the hospital database. Confirmed bacterial meningitis is defined as positive CSF culture and/or positive CSF PCR tests. SPSS version 22 was used to analyse the data.

RESULTS

We studied 11 children with confirmed bacterial meningitis. The mean age was 10.7 (SD, 14.7) months. All patients underwent blood tests including FBC and CRP; mean (SD) WCC 15.5 ($10.1 \times 10^9/L$), neutrophil 11.2 (9.1) and CRP 116.3 (95.4) mg/L. Of 11 patients, 5 (45.5%) children had leucocytosis, 7 (63.6%) experienced neutrophilia and 1 (9.1%) had both leukopenia and neutropenia. C-reactive protein (CRP) value of less than 1 mg/L was found in 2 patients (18.2%). Of 11 patients, 8 (72.7%) experienced CRP

values more than 50 mg/L of which 6 had high CRP of more than 100.

In this group of patients, CSF leucocytosis of more than 100 cells/cmm was found in 10 of 11 patients (90.9%) and greater than 1000 cells/cmm in 8 (72.7%). Differential CSF-WCC was performed in 9 patients and all had polymorphs count of above 60%. One patient had CSF-WCC of 5 cells/mm. Strikingly, this child had a positive *Streptococcus pneumoniae* detected by CSF-PCR assay; and this patient accordingly did not have differential CSF-WCC.

Gram staining was abnormal in 9 of 11 (81.8%) patients. Of 11 patients, 7 (63.6%) had positive CSF culture. CSF samples were examined for bacteria by PCR assay in 10 (91%) patients and bacteria were detected in 6 of them (60%). CSF-PCR tests were performed specifically for specific organisms, such as *Streptococcus pneumoniae* (4 patients), *Haemophilus influenzae* (1 patient), *Neisseria meningitidis* (1 patient).

Cerebrospinal fluid gram staining results were not significantly associated with CSF culture results (p value 0.66) or CSF PCR assay (p value 0.75). In this group of patients, 3 of 9 (33.3%) children with positive gram stain had negative CSF culture and 1 of 2 (50%) individuals with negative gram stain had positive CSF culture. Similarly, no significant association was noted between CSF PCR and CSF culture (p value 0.17). In this group of patients, 2 had a positive CSF-PCR for *Streptococcus pneumoniae* but negative CSF culture and gram stain. Cerebrospinal (CSF) culture failed to detect the causative bacteria in 4 of 5 patients (80%) with CSF specimens positive by PCR.

No bacteria have been identified by PCR assay or culture of peripheral blood in 6 (54.5%) and 5 (45.5%) patients, respectively. In 7 culture-positive CSF specimens, negative peripheral blood culture was documented in 3 (42.9%) children only. Two of 4 (50%) patients with culture-negative CSF specimens had positive blood culture samples. In this group of

patients, there was no significant association between CSF culture and blood culture (p value 0.23) or peripheral blood culture (p value 0.18).

In children with bacterial meningitis, approximately 1 in 5 had CRP values <1 mg/L and 1 in 2 had normal peripheral blood WCC. Normal peripheral blood neutrophil count was normal in approximately 1 in 4 patients. Notably 1 in 5 patients with CRP greater than 100 mg/dl had normal peripheral WCC and neutrophils. In this group of patients, no individual

had normal peripheral blood WCC, normal peripheral blood neutrophil and CRP values < 50 mg/L in combination. No link was found between CSF gram stain and CSF culture (p value 0.66) or CSF PCR results (p value 0.75).

CONCLUSION

Meningitis should be investigated and treated in children if clinically suspected, regardless of the CSF, CRP or peripheral blood results.

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