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Published in:
BMJ : British medical journal

DOI:
10.1136/bmj.323.7321.1111

Citation for published version (APA):
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BMJ 2001;323:1111-1114
doi:10.1136/bmj.323.7321.1111

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Evidence based paediatrics

Evidence based management of seizures associated with fever

Martin Offringa, Virginia A Moyer

**The case**
A previously healthy 19 month old boy was rushed to the emergency department after being found unconscious at home by his mother. As she went to wake him from his afternoon nap she heard a short cry. She found him lying on his back, rigid and unresponsive, with blue lips and apparently not breathing. His breathing and circulation were adequate on arrival in the emergency room. His pulse rate was 110 per minute, blood pressure 100/60 mm Hg, and temperature 39.9°C. The boy was lethargic and confused but seemed to recognise his mother. Apart from a slightly red pharynx there was no obvious focus of infection and no rash. Neck rigidity was difficult to evaluate because he actively resisted examination and refused to sit.

**Background**
A febrile seizure is defined as a seizure occurring in a neurologically healthy child aged 6 months to 5 years. Simple febrile seizures are brief (under 15 minutes duration), are generalised, and occur in association with fever and only once during any 24 hours. Seizures occurring with fever are the most common neurological disorder in paediatrics, affecting 2–4% of all children in Britain and the United States. Children whose seizures are attributable to a central nervous system infection and those who have had a previous febrile seizure or central nervous system abnormality are not considered to have simple febrile seizures.

**Finding the evidence**
A number of questions arise in this case. You wonder how likely it is that this boy has meningitis and whether lumbar puncture is necessary. If this is a simple febrile seizure, what is the likelihood of future febrile seizures, epilepsy, or brain damage? You also wonder whether you should begin treatment with anticonvulsants. You wish to use an evidence based approach, so you frame your questions to maximise the yield from searching.

**Questions and search strategies**

**Question 1:** In young children with a seizure associated with fever (patient/population, event) what is the probability of bacterial meningitis (outcome)? [baseline risk]


**Question 2:** In young children with a seizure associated with fever (patient/population, event) can a normal physical examination and history (intervention/test) reliably exclude bacterial meningitis (outcome)? [diagnosis]

Search: PubMed: Clinical queries → diagnosis → "fever and seizures and meningitis"

**Question 3:** In children with a first febrile seizure (patient/population, event), can prophylactic treatment with antiepileptic drugs (intervention) as compared to no therapy (comparison) decrease the likelihood of future febrile seizures (outcome)? [therapy]

Search: PubMed: Clinical queries → therapy → sensitivity "seizures and fever and recurrence"

**Question 4:** In children with a first febrile seizure (patient/population, event), what is the likelihood of future febrile or afebrile seizures (outcome)? [prognosis]

Search: PubMed: Clinical queries → prognosis → sensitivity "seizures and fever and epilepsy".

**Results**

**Prevalence of meningitis**
In trying to determine the likelihood of meningitis, you are looking for cross sectional studies or follow up studies of children with seizures and fever that identify children who developed meningitis. Your “clinical queries” search nets 30 articles, most of which are informal reviews and letters. One article, a decision analysis, seems relevant.

Wears et al reviewed seven studies performed in urban hospital emergency rooms in the United States. All were retrospective surveys of charts documenting the disease outcome after a seizure with fever. Among 2100 such cases of seizures associated with fever the
overall prevalence of meningitis was 1.2%, ranging from 0–4% in the seven studies. It was not stated, however, whether all children underwent lumbar puncture in these emergency rooms, or whether meningitis was excluded on clinical grounds at follow up.

In the second study, 7% of the children who visited the emergency rooms of two Dutch hospitals with a first seizure associated with fever had either bacterial or viral meningitis. As this study was done in the hospital setting in a country where general practitioners manage up to 50% of all seizures with fever, its results may not apply to the situation where no family physician or general practitioner to evaluate the child before referral to hospital.

From these two studies it can be concluded that the prevalence of meningitis among children with seizures and fever in North American paediatric emergency wards is between 1% and 2% and, through selective referral, it may be as high as 7% in a European country. These figures indicate that a large number of “unnecessary” lumbar punctures would be done if lumbar puncture were to be carried out in all children with a seizure associated with fever.

Seizures in “well” children
Your next question is whether a seizure can be the sole manifestation of meningitis in a child who seems otherwise well. You are looking for studies that investigate the relations of various signs and symptoms with meningitis in children with seizures and fever, preferably in the form of likelihood ratios. One study provides sensitivity, specificity, and likelihood ratios for the various clinical indicators of meningitis. This study tried to identify criteria, based on age, specific clinical indicators, or the results of initial blood tests, that could serve as indications for performing lumbar puncture.

Meningitis was diagnosed in 23 (7%) of 309 children aged 3 months to 6 years with a first seizure associated with fever who were seen consecutively in the emergency rooms of two Dutch hospitals with a western part of the Netherlands. These 23 children were then compared with a reference group of 69 children with fever who were seen consecutively in the emergency rooms, or whether meningitis was excluded. These figures indicate that a large number of “unnecessary” lumbar punctures would be done if lumbar puncture were to be carried out in all children with a seizure associated with fever.

Discriminant factors
Several clinical signs and symptoms were examined for their ability to discriminate between children with and without meningitis. The clinical risk factors shown in table 1 were evaluated. The presence of one or more of the major signs—petechiae, nuchal rigidity, coma—identified 16 out of the 23 children with meningitis (70%). In the absence of meningitis, these major signs of the disease were not found; the likelihood ratio when any of these signs is present (LR + ) is therefore infinite (95% confidence interval 6.0 to ∞) and the probability of meningitis approaches 100% (31 to 100%). In the absence of meningeal irritation, petechiae, or complex features of the seizure there were no cases of meningitis in the study. A child’s age, sex, degree of fever, and results of routinely performed blood tests did not have any diagnostic value. The likelihood ratios of the negative and positive tests can separate children into two groups, a group in which the risk of meningitis is very high and lumbar puncture should be done regardless of other history or physical findings, and a group in which the risk of meningitis is low and the need for lumbar puncture will depend on other clinical findings.

Generalisability
The Dutch study was a retrospective review of the medical records of children presenting with a first episode of seizure and fever. The study population was limited to children aged 3 months to 6 years. The pre-test probability of meningitis would be likely to be different in another population of children. In addition, nuchal rigidity may not be as strong a predictor of meningitis in young as in older children; in this patient population the mean age was 18 months. However, these results indicate that it is very unusual for a child with meningitis to present with only a seizure. Also, a fair number of children without meningitis will present with the risk factors mentioned above—that is, the specificity of these “clinical tests” is far from 100%.

Value of prophylactic treatment
To determine whether prophylactic treatment with an antiepileptic drug or an antipyretic as compared with no treatment decreases the likelihood of future febrile seizures, you are looking for studies in which patients with febrile seizures were randomised to different treatment regimens and followed over time to see how many developed subsequent febrile seizures. Of the 55 articles that result from your search, five papers specifically address your question; they are either meta-analyses of randomised controlled trials or are reports of randomised controlled trials.

Newton assessed the efficacy of phenobarbitone and valproate for the prophylactic treatment of febrile convulsions by summarising the results from all eight British clinical trials that were done before 1988. Data

Table 1 Discriminating ability of combinations of clinical indicators of meningitis among children with a seizure associated with fever. Values are numbers (percentages) unless otherwise indicated

<table>
<thead>
<tr>
<th>Combination of indicators*</th>
<th>Cases (n=23)</th>
<th>Controls (n=69)</th>
<th>Absence of combinations</th>
<th>Presence of combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least one complex feature</td>
<td>17 (74)</td>
<td>26 (38)</td>
<td>0.4 (0.2 to 0.6)</td>
<td>1.9 (1.3 to 2.9)</td>
</tr>
<tr>
<td>At least one history feature</td>
<td>18 (78)</td>
<td>32 (46)</td>
<td>0.4 (0.2 to 0.9)</td>
<td>1.7 (1.2 to 2.4)</td>
</tr>
<tr>
<td>Either a complex or a history feature</td>
<td>23 (100)</td>
<td>45 (65)</td>
<td>0 (0 to 1)</td>
<td>1.3 (1.3 to 1.8)</td>
</tr>
<tr>
<td>At least one major sign</td>
<td>16 (70)</td>
<td>0</td>
<td>0.3 (0.2 to 0.6)</td>
<td>= (8.0 to ∞)</td>
</tr>
<tr>
<td>At least one minor sign, after exclusion of children with any major signs</td>
<td>57 (71)</td>
<td>24 (35)</td>
<td>0.4 (0.1 to 1.4)</td>
<td>2.1 (1.2 to 3.6)</td>
</tr>
</tbody>
</table>

*Features of complex seizures: partial, multiple, or prolonged seizure, (longer than 15 minutes). History features: febrile illness for at least three days, vomiting or drowsiness at home, a physician’s visit in the previous 48 hours. "Major" signs of meningitis: petechiae, definite nuchal rigidity, coma. "Minor" signs of meningitis: dubious nuchal rigidity, persisting drowsiness, convulsions or paresis or paralysis on examination in the emergency room.
were pooled and analysed on an intention to treat basis. The overall odds ratio of recurrent febrile seizures for treatment with phenobarbitone was 0.8 and for valproate 1.42. Neither of these results was statistically significant. The author therefore concluded that neither treatment is to be recommended.

A second meta-analysis summarised four published non-British, randomised placebo controlled trials that had been carried out using phenobarbitone to prevent febrile seizures. The risk of recurrences was lower in children receiving continuous phenobarbitone than placebo (odds ratio 0.54, 95% confidence interval 0.33 to 0.90). On average, eight children would have to be given continuous phenobarbitone prophylaxis for two years to prevent one febrile seizure (number needed to treat = 8.5-27). However, in view of the adverse effects of phenobarbitone, such as irritability, hyperactivity, somnolence, and possibly diminished cognitive development, the authors of this second review also concluded that phenobarbitone prophylaxis of febrile seizures cannot be recommended.

**Treatment in febrile periods only**

To avoid the adverse effects of giving antiepileptic drugs for prolonged periods, rapidly acting anticonvulsants given only during fever periods have been used in an attempt to reduce the risk of recurrent febrile seizures. Phenobarbitone given at times of fever has been proved ineffective, probably because of the delay in achieving appropriate serum and tissue concentrations. Thus far, only prophylactic diazepam, given orally or rectally, has been studied in placebo controlled trials.

**Diazepam**—Rosman et al conducted a randomised, double blind, placebo controlled trial among 406 children with a mean age of 24 months who had had at least one febrile seizure, comparing diazepam (0.33 mg per kg body weight), given orally every eight hours during febrile illnesses, with placebo. During a mean follow up of two years, the relative risk of subsequent febrile seizures per person year was 0.56 (0.38 to 0.81). Many parents did not give the treatment as directed, and an analysis restricted to children who had seizures while receiving the study drug showed an 82% reduction in the risk of febrile seizures with diazepam. Between 25% and 30% of the children in the study by Rosman were irritable, lethargic, or ataxic after taking diazepam, which might interfere with parents’ and clinicians’ ability to distinguish benign childhood febrile illness from more serious disease; one in every 3.5-4 children taking diazepam develops these symptoms (number needed to harm = 3.5-4). The decision to recommend this treatment will depend on balancing these potential harms against the potential benefits to each specific child, and on the family’s values.

**Ibuprofen**—To assess whether antipyrretic drugs given intermittently prevent recurrence of febrile seizures, a randomised placebo controlled trial was conducted in the Netherlands. Children aged 1 to 4 years who had at least one risk factor for recurrence of a febrile seizure (see below) were randomly assigned to receive either ibuprofen syrup, 5 mg per kg body weight per dose, or placebo every six hours during fever, defined as a temperature >38.4°C. Median follow up time was 12 months. The relative risks for recurrence in the two groups did not differ significantly.

**Prognosis after first seizure**

To address the parents’ concerns about the prognosis, you are looking for a large cohort of patients with first simple febrile seizures who have been followed over time to see how many develop recurrent febrile or non-febrile seizures. Your search strategy yields 157 articles, only two of which meet your study design criteria.

In a collaborative study, the individual data from five follow up studies that used similar definitions of febrile seizures and risk factors were pooled and reanalysed to estimate the risk of frequent recurrent seizures and occurrence of complex seizures in previously healthy, untreated children. Of a total of 2496 children with 1410 episodes of recurrent seizures, 32% had one, 15% two, and 7% three or more recurrent seizures after a first febrile seizure; 7% had a complex recurrence. The hazard of recurrent seizures was highest between the ages of 12 and 24 months. A history of febrile or unprovoked seizures in a first degree family member, a relatively low temperature at the first seizure, young age at onset (<12 months), a family history of unprovoked seizures, and a partial initial febrile seizure were all associated with an increased risk of subsequent complex seizures. Although complex features of the first seizure—that is, a seizure which is partial, is multiple, or lasts for more than 15 minutes—have long been thought to predict recurrence, the follow up studies included in this review showed that only multiple initial seizures are associated with an increased risk (1.6-fold) for a first recurrence. Prolonged or focal initial seizures were not associated with this increased risk, as long as they had not led to permanent neurological abnormalities.

Risk factors for the occurrence of unprovoked seizures were assessed in a cohort of 428 children followed prospectively for at least two years from their first febrile seizure. Unprovoked seizures occurred in 26 (6%). Neurodevelopmental abnormalities, complex febrile seizures, and a family history of epilepsy were...
associated with an increased risk of unprovoked seizures. Recurrent febrile seizures and brief duration of fever before the initial febrile seizure were also risk factors. A family history of febrile seizures, temperature and age at the time of the initial febrile seizure, sex, and race were not associated with unprovoked seizures. This high quality evaluation of predictors gives an insight into the risk of epilepsy and may be used to counsel patients. However, no studies have examined the possibility of preventing epilepsy by pharmacological interventions after a first or a second febrile seizure.15–16 The evidence you have gathered is summarised in table 2.

Applying the evidence

From the history and the physical examination you consider this child to be at a low risk of meningitis and you decide to observe him without a lumbar puncture. After resolution of the acute episode, you reassure the parents and counsel them at a follow up visit on the risk of future seizures. For this child, the probability of frequent or potentially threatening recurrences is low. You decide that the evidence does not support using a daily anticonvulsant like phenobarbitone or sodium valproate, and that intermittent diazepam or an antipyretic decrease the likelihood of recurrence. You know you will need to spend time with the parents to help them overcome the fears and anxiety that seizures provoke and to educate them about the clinical course of febrile seizures and their consequences. You know that they may still request treatment with anticonvulsants. This will depend on the values they place on different outcomes and the adverse effects of use of anticonvulsants. You counsel these parents that the risk of recurrence declines rapidly after six months from the previous seizure and that intermittent diazepam should be also given, and the parents should be instructed how to administer it in the rare event of a prolonged recurrence lasting >15 minutes.17–18 This approach, it has been suggested, also reduces parental fear.19–20

MO wrote the original chapter for Evidence Based Pediatrics and Child Health; VAM edited the chapter for publication in the BMJ and wjm (Western Journal of Medicine).

Competing interests: None declared.

Table 2 Summary of the evidence

<table>
<thead>
<tr>
<th>Question</th>
<th>Type of evidence</th>
<th>Result</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the probability of bacterial meningitis after a seizure associated with fever?</td>
<td>Summary of surveys of children seen in accident and emergency departments</td>
<td>0.2%-7.0% depending on health care system and setting</td>
<td>English and Dutch GP referral system will select children with a higher risk to present to accident and emergency departments</td>
</tr>
<tr>
<td>Can an unremarkable physical examination and history reliably exclude bacterial meningitis?</td>
<td>Case-control study evaluating risk factors</td>
<td>Meninigitis could be ruled out in the absence of focal, prolonged, or multiple seizures, suspicious findings on physical examination (pettechiae, signs of circulatory failure, etc), and abnormal neurological findings on physical examination (signs of meningeal irritation and various degrees of coma)</td>
<td>It is very unusual for a child with meningitis to present only with a seizure</td>
</tr>
<tr>
<td>Can prophylactic treatment with continuous antiepileptic drugs, intermittent oral diazepam, or an antipyretic decrease the likelihood of future febrile seizures?</td>
<td>Two systematic reviews of randomised trials, two randomised trials</td>
<td>Continuous antiepileptic drugs, intermittent diazepam, or antipyretics did not reduce the recurrence rate</td>
<td>Two meta-analyses with same results; lack of effectiveness and side effects limit the use of intermittent oral or rectal diazepam</td>
</tr>
<tr>
<td>What is the likelihood of future febrile seizures?</td>
<td>Synthesis of five cohort studies with risk factor analyses and a cohort study</td>
<td>The most important factor is the child’s age, having a first degree relative with febrile or unprovoked seizures increases the risk of recurrence</td>
<td>Variation in risk of recurrence is related to presence of risk factors. Complex features to the seizure do not predict recurrence of febrile seizures but are associated with an increased risk of epilepsy</td>
</tr>
</tbody>
</table>