

## PAPERS AND SHORT REPORTS

## Febrile convulsions in a national cohort followed up from birth. I—Prevalence and recurrence in the first five years of life

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### Abstract

Of 13 135 children followed up from birth to the age of 5 years, 303 (2.3%) had febrile convulsions. Prior neurological abnormality had been noted in 13. Of the 290 remaining children, 57 (20%) presented with a complex convulsion, and 103 children (35%) went on to have further febrile convulsions.

The risk of further febrile convulsions varied with the age at first convulsion and the presence of a history of convulsive disorders in relatives. There were no significant differences between the sexes.

### Introduction

When parents witness their child's first febrile convulsion they are understandably shocked and in many cases think that the child may die.<sup>1</sup> They can confidently be told that febrile convulsions are common but can they be reassured that the attacks are benign?

The Child Health and Education Study followed up a cohort of 16 004 neonatal survivors born in one week in 1970. Members of this cohort who had one or more febrile convulsions were compared with their peers when aged 5 years in terms of behavioural progress and scores for tests of intellectual performance. Because this study provided information on all the children in a defined population it avoided an inherent bias found in many previously published reports on the progress of

children with febrile convulsions who attended only a particular clinic or clinician.

Here we describe the prevalence and natural history of febrile convulsions in the cohort followed up in the Child Health and Education Study. In a second article we will describe the epidemiological associations and the growth and development of the children affected.

### Subjects and methods

The Child Health and Education Study began in April 1970 as the British Births Survey.<sup>2,3</sup> Full information about pregnancy, delivery, and the early neonatal period for all infants born in one week was obtained from the hospital records by the midwife attending the delivery. Questionnaire's were filled in on each infant's progress up to the age of 7 days.

Local health visitors attempted to contact and interview the 16 004 children who had survived the neonatal period when the children were 5 years old. They interviewed the parents of 13 135 (80%) of the children who were born in the week 5-11 April 1970 and still resident in Great Britain and completed questionnaires concerning the medical history and social background of the children. They also administered educational tests and measured height and head circumference.

One of the questions asked of the parents was, "Has your child ever suffered from fits, convulsions, or any other episode during which he/she became unconscious or abnormal movements occurred in any part of the body?" An answer to this question was obtained for 13 038 children. In 767 cases the answer was yes, and the health visitor recorded further information about the event including a description of the attack and subsequent action taken by the parents (such as general practitioner contacted, admission to hospital). To validate the questions for all 767 cases a questionnaire was sent in 1978 to the general practitioners who were currently looking after these children. If the child had been referred to hospital an attempt was also made to obtain copies of the hospital records. This validation exercise was very successful: a completed questionnaire was received from 86% of the general practitioners, and in 97% of referred cases hospital records were received.

On the basis of the information obtained (the five year questionnaire, the general practice questionnaire, and the hospital records) 303 children were reckoned to have suffered from febrile convulsions.

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In a further 19 cases the questionnaire suggested that the children might have had a febrile convulsion, but the information was too vague for the children to be included in this study.

As used here, the term febrile convulsion is synonymous with febrile seizure; the definition is that used by the Consensus Development Conference held at the National Institutes of Health in 1980: "An event in infancy or childhood, usually occurring between 3 months and 5 years of age, associated with fever but without evidence of intracranial infection or defined cause."<sup>4</sup> Seizures with fever in children who had suffered a previous non-febrile seizure were excluded. For the present study we decided that children with evidence of a febrile convulsion at less than 3 months of age should be included; in the event there was only one such infant.

#### TYPES OF FEBRILE CONVULSION

(1) *Complex febrile convulsions*—Those children whose first febrile convulsion lasted for more than 15 minutes or whose first seizure was focal or multiple (more than one convulsion in each episode of fever) were classified as having complex febrile convulsions. These were the criteria for complex febrile convulsions used by Ellenberg and Nelson.<sup>5</sup>

(2) *Simple febrile convulsions*—Those children whose first attack was not complex as described above were said to have simple febrile convulsions.

(For the purpose of analysing the overall frequency of febrile convulsions per child, patients having more than one febrile convulsion during a single episode of fever were counted as having one episode of febrile convulsions: the individual convulsions within that episode were not counted separately.)

Thirteen children were known to have had a neurological abnormality that preceded the first febrile convulsion. Of these children, six had previously been diagnosed as suffering from cerebral palsy, one had hydrocephalus, one had infantile spasms, one had the Prader-Willi syndrome, one was a galactosaemia heterozygote, and three had non-specific retardation of development. These children were considered as a separate group.

#### STATISTICAL ANALYSIS

Appropriate methods of statistical analysis were used, including the  $\chi^2$  test with Yates's correction and Armitage's test for trend.<sup>6</sup>

### Results

#### PREVALENCE

Information on history of convulsions was available for all but 97 of the 13 135 children included in the five year survey. Three hundred and three of the remaining 13 038 (2.3%) children were considered definitely to have had a febrile convulsion. Of these, neurological abnormality had been identified before the first febrile convulsion in 13 (4.3%). In 57 (18.8%) the first attack was complex and in 233 (76.9%) simple.

#### MEDICAL MANAGEMENT

Of the 233 children with simple febrile convulsions, 130 (56%) were admitted to hospital as a result of the first febrile convulsion. In all, 40 patients (31% of those admitted) underwent lumbar puncture, 11 (8%) skull x ray examination, and six (5%) electroencephalography.

Forty seven (83%) of the 57 children with complex febrile convulsions were admitted to hospital on the first occasion. Of these, 22 (47%) underwent lumbar puncture, six (13%) skull x ray examination, and three (6%) electroencephalography.

#### AGE AT ONSET

Half the children with febrile convulsions had their first attack during the second year of life (table I) and 259 (nearly 90%) before their third birthday. There were no significant differences in this respect between children with simple and those with complex convulsions. Table I does not include the children with previous neurological

TABLE I—Age at onset by type of first febrile convulsion (simple or complex), excluding children with prior neurological abnormalities. (Number (%) of children shown)

Age at first convulsion (years)	Simple	Complex	Total
<1	39 (16.7)	14 (24.6)	53 (18.3)
1	112 (48.1)	32 (56.1)	144 (49.6)
2	56 (24.0)	6 (10.5)	62 (21.4)
3	17 (7.3)	3 (5.3)	20 (6.9)
≥4	9 (3.9)	2 (3.5)	11 (3.8)
Total	233	57	290

$\chi^2 = 6.3$ ,  $df = 4$ , NS.

abnormalities, but the pattern was similar, one having his first convulsion during the first year of life, six during the second, three during the third, two during the fourth and one during the fifth.

#### FREQUENCY OF ATTACKS

To assess the overall frequency of attacks the number of episodes of febrile convulsions was counted. Most of the children (64%) had only a single attack, and a further 39 (13%) had only two attacks. The maximum number was 15 febrile convulsions.

Table II shows that there was no significant difference in frequency of subsequent convulsions between children whose initial convulsion was complex and those whose initial convulsion was simple. The earlier

TABLE II—Number (%) of children to have one, two, three, four, five to six, or seven or more episodes of febrile convulsions, by type of first febrile convulsion. (Children with prior neurological abnormality omitted)

No of febrile convulsions	Simple	Complex	Total
1	155 (66.5)	32 (56.1)	187 (64.5)
2	28 (12.0)	11 (19.3)	39 (13.4)
3	20 (8.6)	6 (10.5)	26 (9.0)
4	10 (4.3)	2 (3.5)	12 (4.1)
5-6	12 (5.2)	3 (5.3)	15 (5.2)
>7	8 (3.4)	3 (5.3)	11 (3.8)
Total	233	57	290

$\chi^2 = 3.2$ ;  $df = 5$ ; NS.

TABLE III—Age at first febrile convulsion by number of febrile convulsions before 5 years old. (Number (%) of children shown; those with prior neurological abnormality omitted)

Age at first convulsion (years)	No of febrile convulsions				Total
	1	2	3	≥4	
<1	28 (52.8)	10 (18.9)	2 (3.8)	13 (24.5)	53
1	87 (60.4)	18 (12.5)	20 (13.9)	19 (13.2)	144
2	45 (72.6)	8 (12.9)	3 (4.8)	6 (9.7)	62
3	17 (85.0)	2 (10.0)	1 (5.0)	0	20
4	10 (90.9)	1 (9.1)	0	0	11
Total	187 (64.5)	39 (13.4)	26 (9.0)	38 (13.1)	290

(1 v ≥2:  $\chi^2$  with trend = 12.8;  $p < 0.001$ ;  $\chi^2$  for departure from trend = 0.2).

the first febrile convulsion, however, the more febrile convulsions the child was likely to have (table III): almost a quarter of the children whose first seizure occurred in the first year of life had had at least three more attacks by the age of 5 compared with none of those whose first attack occurred at 3 or 4.

#### FAMILY HISTORY

In the whole sample a family history had been obtained for 228 children with febrile convulsions. Fifty nine (26%) children had a

positive family history, 42 of febrile convulsions (including five who also had a family history of epilepsy) and 22 of epilepsy (including the five who also had a family history of febrile convulsions). The positive family history was found in one or more parents or siblings in 44 children (75%), one or both grandparents in four (7%), one or more first cousins in five (8%), and an uncle or aunt in six (10%).

The type of initial convulsions varied with family history (table IV). Of those with no family history, only 28 (17%) initially had a complex convulsion compared with 20 (34%) of those with a positive family history ( $\chi^2$  with Yates's correction = 6.89;  $p < 0.01$ ).

TABLE IV—Number (%) of children with febrile convulsions to have a family history of febrile convulsions or epilepsy, or both. (Children with prior neurological abnormality omitted)

Family history	First convulsion		Total
	Simple	Complex	
Febrile convulsions, no epilepsy	23 (12.8)	14 (29.2)	37 (16.2)
Febrile convulsions and epilepsy	3 (1.7)	2 (4.2)	5 (2.2)
Epilepsy	13 (7.2)	4 (8.3)	17 (7.5)
None	141 (78.3)	28 (58.3)	169 (74.1)
All known	180	48	228

$\chi^2 = 9.5$ ;  $df = 3$ ;  $p < 0.05$ .

Table V shows the pattern for total number of convulsions. Of those children with no family history, only 50 (30%) had more than one fit, whereas, of the children with a positive family history, 33 (56%) had at least one further fit ( $\chi^2$  with Yates's correction = 12.0;  $p < 0.001$ ).

TABLE V—Number (%) of children having one, two, or three or more convulsions by history of convulsions in relatives. (Children with a prior neurological abnormality omitted)

No of convulsions in child	Family history			
	None	Febrile convulsions alone	Febrile convulsions and epilepsy	Epilepsy alone
1	119 (70.4)	17 (46.0)	1 (20)	8 (47.0)
2	16 (9.5)	8 (21.6)	1 (20)	2 (11.8)
$\geq 3$	34 (20.1)	12 (32.4)	3 (60)	7 (41.2)
All children	169	37	5	17

None v family history:  $\chi^2 = 13.1$ ;  $df = 2$ ;  $p < 0.01$ .

No significant differences were found between the various types of positive history or between the age at onset of convulsions and the type of family history.

#### SEX OF CHILD

One hundred and fifty six boys and 134 girls had convulsions. Overall the prevalence of febrile convulsions in the boys (2.29%) was not significantly different from that in the girls (2.12%). Of the children who had convulsions, 26 (17%) of the boys initially had a complex seizure compared with 31 (23%) of the girls (a difference that was again not significant).

The age at onset of both simple and complex febrile convulsions appeared to be slightly lower in the girls, with 83 (62%) having their first attack before their second birthday compared with 79 (51%) of the boys, but the difference was not significant ( $\chi^2$  with Yates's correction = 3.29).

Where a family history had been recorded the girls appeared to be more likely to have a positive history than the boys (table VI), but again, although suggestive, significance was not reached. There was no difference in the frequency of attacks between the sexes. Thus 56 (35.9%) of the boys and 47 (35.1%) of the girls had more than one attack, and 35 (22.4%) of the boys and 29 (21.6%) of the girls had more than three attacks.

#### CHILDREN WITH A PRIOR NEUROLOGICAL ABNORMALITY

The 13 children with a prior neurological abnormality differed from the other children with febrile convulsions in that none had a family history of convulsions (compared with 26% of the main sample). They were similar in other respects, however, in that six (46%) had more than one febrile convulsion and in seven (54%) the first convulsion occurred before the second birthday. Six of the children affected were boys and seven girls. We shall show in the subsequent paper that, not surprisingly, the children in this group were more likely to have an adverse outcome than the rest of the population.

#### PREDICTION OF FURTHER FEBRILE CONVULSIONS

Neither the type of first convulsion nor the sex of the child appeared to have any bearing on whether he or she had further convulsions. Only the age at onset and presence of a family history appeared to have a predictive value. Table VII shows that both effects are independent of one another, with the presence of family history roughly doubling the risk and an appreciable reduction in risk being seen if the first febrile convulsion occurred after the age of 2 years.

TABLE VI—Proportion of boys and girls with a family history of febrile convulsions or epilepsy. Number/total (%) shown. (Children with a prior neurological abnormality omitted)

Type of child's first febrile convulsion	Boys	Girls
Simple	18/101 (17.8)	21/79 (26.6)
Complex	11/26 (42.3)	9/22 (40.9)
Total	29/127 (22.8)	30/101 (29.7)

All differences between boys and girls non-significant.

TABLE VII—Proportion of children having further febrile convulsions by family history and age at first febrile convulsion. Number/total (%) shown. (Children with a prior neurological abnormality omitted)

Age at first convulsion (years)	Family history		
	Present	Absent	All known
< 1	10/13 (76.9)	9/26 (34.6)	19/39 (48.7)
1	17/29 (58.6)	30/86 (34.9)	47/115 (40.9)
2	8/14 (57.1)	9/37 (24.3)	17/51 (33.3)
$\geq 3$	0/5	2/20 (10.0)	2/25 (8.0)
p Value*	0.01	0.03	< 0.01

\*Trend test.

#### Discussion

##### PREVALENCE

In a review of all published reports Tsuboi claimed that the prevalence of a history of febrile convulsions varied from 0.1 to 15%.<sup>7</sup> Other reviews, such as that of Millichap,<sup>8</sup> have quoted a figure of around 2%. The most accurate figures are probably those derived from populations of children followed up longitudinally. Using the 1958 British birth cohort Ross *et al* found 2.4% of children to have had febrile convulsions,<sup>9</sup> whereas in California follow up of 18 500 children showed an incidence of 2% by the age of 5 years.<sup>10</sup> Our results are in remarkable accord (2.3%) with these. Nelson and Ellenberg reported a higher incidence: 3.5% in white and 4.2% in black children.<sup>11</sup> There were no racial differences in our data, but the numbers of children belonging to ethnic minorities were small (3% of the total).

In most studies boys have been said to be more likely than girls to have febrile convulsions,<sup>7 8 11-13</sup> but the reverse has also been reported.<sup>14</sup> In the Californian population study no difference in

incidence was seen between the sexes,<sup>10</sup> and the same was true in the present longitudinal study.

Ross *et al* found that over half (55%) of the children in the earlier national cohort who had had febrile convulsions had been treated entirely by their general practitioners.<sup>9</sup> In our cohort study, with identical methodology, we found that more children had been admitted to hospital and only 39% had been seen only at home. Not surprisingly, however, children were more likely to have been admitted after having had a complex seizure.

Discussion of the natural history of febrile convulsions is often biased by considering only those children with febrile convulsions who have been admitted to hospital. For example, in Wallace's series of patients, all of whom were admitted to hospital for careful study, 62% had complicated attacks—an unusually large proportion.<sup>15</sup> The more detailed information available after admission to hospital may allow relatively more children to be diagnosed as having had a complex febrile convulsion. Alternatively, the very nature of complex febrile convulsions may be such that it causes the extra concern precipitating admission to hospital. In our population study, of the 177 children whose first febrile convulsion resulted in admission to hospital, only 48 (27%) had a complex convulsion.

#### AGE AT ONSET AND INCIDENCE OF RECURRENCE

In our study about half the children had their first convulsion between 1 and 2 years of age, which correlates well with previous publications on the subject.<sup>8 10-14 16-19</sup>

Reports of the risk of recurrence of febrile convulsions have varied from a quarter<sup>19</sup> to a third<sup>11</sup> to almost a half.<sup>20</sup> Some authors have suggested a sex effect on recurrence and on the severity of attacks.<sup>19 20</sup> Our results accord with those of Nelson and Ellenberg<sup>11</sup>; about a third of the children had a recurrence, but there was no difference between the sexes. Girls were not significantly more likely to have complex rather than simple convulsions. Our finding that the younger the child at the first attack the more likely were further attacks has also been reported previously,<sup>11 20</sup> but we found no evidence to confirm the report that "the younger the infant the more frequent are severe convulsions."<sup>19</sup>

Some disagreement has occurred on the prognostic value of a complex first fit. Wallace stated that a greater proportion of children initially having a complex fit had another attack than did those initially having a simple fit.<sup>20</sup> On the other hand, Nelson and Ellenberg reported that the characteristics of the first febrile seizure were not useful in predicting recurrence.<sup>11</sup> Our data agree with their findings. Indeed, apart from the age at first convulsion the only finding relevant to risk of recurrence in our study concerned family history.

#### FAMILY HISTORY

Confusion exists in published reports even regarding the importance of a positive family history. W G Lennox found a history of epilepsy in 9% of "near relatives,"<sup>21</sup> and M A Lennox reported a family history of "convulsions" in 45% of children with febrile convulsions<sup>13</sup>; Peterman reported a family history

in 48%.<sup>17</sup> Interpretation of such findings is difficult without control data. In an important study Wallace found a positive history of convulsive disorders in siblings or parents in 38% of children with febrile convulsions, whereas in a control group admitted to hospital febrile but without fits such a positive family history was found in only 17%.<sup>21</sup> Lennox-Buchtal concludes that the genetic trait is autosomal dominant with incomplete penetrance.<sup>19</sup>

Wallace reported that a significant excess of complicated attacks occurred if both a family history of convulsive disorders and a perinatal abnormality were present.<sup>22</sup> In another paper she reported that a positive family history was significantly associated with increased recurrence in males only.<sup>20</sup> We have been unable to substantiate either claim, but a positive family history of febrile convulsions or epilepsy, or both, was found in a greater proportion of children initially having a complex rather than a simple febrile convulsion, and a larger proportion of children having three or more attacks of either type had such a family history.

In any study of febrile convulsions the question of whether a single seizure or several febrile seizures has an adverse effect on the child is highly relevant. In this paper we have shown that little appears to influence the type of convulsion or the number of convulsions apart from the presence of a family history and early age at onset. In our next paper we will examine the behaviour and intellectual development of the children affected.

#### References

- Baumer JH, David TJ, Valentine SJ, Roberts JE, Hughes BR. Many parents think their child is dying when having a first febrile convulsion. *Dev Med Child Neurol* 1981;**23**:462-4.
- Chamberlain R, Chamberlain G, Howlett B, Claireaux A. *British births 1970. Vol 1. The first week of life*. London: William Heinemann, 1975.
- Chamberlain G, Philipp E, Howlett B, Masters K. *British births 1970. Vol 2. Obstetric care*. London: William Heinemann, 1978.
- Summary of an NIH consensus statement. Febrile seizures: long-term management of children with fever-associated seizures. *Br Med J* 1980;**281**:277-9.
- Ellenberg JH, Nelson KB. Febrile seizures and later intellectual performance. *Arch Neurol* 1978;**35**:17-21.
- Armitage P. *Statistical methods in medical research*. Oxford: Blackwell Scientific Publications, 1971.
- Tsuboi T. Epidemiology of febrile and afebrile convulsions in children in Japan. *Neurology (Cleveland)* 1984;**34**:175-81.
- Millichap JG. *Febrile convulsions*. New York: Macmillan, 1968.
- Ross EM, Peckham CS, West PB, Butler NR. Epilepsy in childhood: findings from the National Child Development Study. *Br Med J* 1980;**280**:207-10.
- Van den Berg BJ, Yerushalmy J. Studies on convulsive disorders in young children. I. Incidence of febrile and non-febrile convulsions by age and other factors. *Pediatr Res* 1969;**3**:298-304.
- Nelson KB, Ellenberg JH. Prognosis in children with febrile seizures. *Pediatrics* 1978;**61**:720-7.
- Friderichsen C, Melchior J. Febrile convulsions in children, their frequency and prognosis. *Acta Paediatr Scand* 1954;**43**(suppl 100):307-17.
- Lennox MA. Febrile convulsions in childhood. A clinical and electro-encephalographic study. *Am J Dis Child* 1949;**78**:868-82.
- Lennox WG. Significance of febrile convulsions. *Pediatrics* 1953;**11**:341-57.
- Wallace SJ. Factors predisposing to a complicated initial febrile convulsion. *Arch Dis Child* 1975;**50**:943-7.
- Heijbl J, Blom S, Bergfors PG. Simple febrile convulsions. A prospective incidence study and an evaluation of investigations initially needed. *Neuropädiatrie* 1980;**11**:45-56.
- Peterman MG. Febrile convulsions. *J Pediatr* 1952;**41**:536-40.
- Oullette EM. The child who convulses with fever. *Pediatr Clin N Am* 1974;**21**:467-81.
- Lennox-Buchtal MA. A summing up: clinical session. In: Brazier MAB, Coccani F. *Brain dysfunction in infantile febrile convulsions*. New York: Raven Press, 1976:327-51.
- Wallace SJ. Recurrence of febrile convulsions. *Arch Dis Child* 1974;**49**:763-5.
- Wallace SJ. Neurological and intellectual deficits: convulsions with fever viewed as acute indications of life-long developmental defects. In: Brazier MAB, Coccani F. *Brain dysfunction in infantile febrile convulsions*. New York: Raven Press, 1976:259-77.
- Wallace SJ. Factors predisposing to a complicated initial febrile convulsion. *Arch Dis Child* 1975;**50**:943-7.

(Accepted 28 January 1985)