Subdural haemorrhages in infants: population based study
S Jayawant, A Rawlinson, F Gibbon, J Price, J Schulte, P Sharples, J R Silbert, A M Kemp

Abstract

Objectives To identify the incidence, clinical outcome, and associated factors of subdural haemorrhage in children under 2 years of age, and to determine how such cases were investigated and how many were due to child abuse.

Design Population based case series.

Setting South Wales and south west England.

Subjects Children under 2 years of age who had a subdural haemorrhage. We excluded neonates who developed subdural haemorrhage during their stay on a neonatal unit and infants who developed a subdural haemorrhage after infection or neurosurgical intervention.

Main outcome measures Incidence and clinical outcome of subdural haemorrhage in infants, the number of cases caused by child abuse, the investigations such children received, and associated risk factors.

Results Thirty three children (23 boys and 10 girls) were identified with subdural haemorrhage. The incidence was 12.8/100 000 children/ year (95% confidence interval 5.4 to 20.2). Twenty eight cases (85%) were under 1 year of age. The incidence of subdural haemorrhage in children under 1 year of age was 21.0/100 000 children/year and was therefore higher than in the older children. The clinical outcome was poor: nine infants died and 15 had profound disability. Only 22 infants had the basic investigations of a full blood count, coagulation screen, computed tomography or magnetic resonance imaging, skeletal survey or bone scan, and ophthalmological examination. In retrospect, 27 cases (82%) were highly suggestive of abuse.

Conclusion Subdural haemorrhage is common in infancy and carries a poor prognosis; three quarters of such infants die or have profound disability. Most cases are due to child abuse, but in a few the cause is unknown. Some children with subdural haemorrhage do not undergo appropriate investigations. We believe the clinical investigation of such children should include a full multidisciplinary social assessment, an ophthalmic examination, a skeletal survey supplemented with a bone scan or a skeletal survey repeated at around 10 days, a coagulation screen, and computed tomography or magnetic resonance imaging. Previous physical abuse in an infant is a significant risk factor for subdural haemorrhage and must be taken seriously by child protection agencies.

Introduction

Subdural haemorrhage in infants and young children presents major challenges in diagnosis to doctors, social workers, and courts. It has been recognised as a form of severe child abuse as far back as 1860, but little is known about the epidemiology or prognosis of the condition.1-4 In clinical practice, it is often difficult to deduce whether a subdural haematoma in an infant is caused by accident or abuse.5 The shaken baby syndrome is well described both clinically and pathologically, but there are few epidemiological accounts of this condition that is associated with death and disability.6

We performed a population based case series study of children under the age of 2 years who had a

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infants. The Confidential Enquiry into Sudden Deaths in wards taking paediatric patients in the study area, and 851.0, 852.1, 767.0, 336.1, admission books of hospital diseases, 9th revision) inpatient coding: 432.1, 852.0, cases from ICD-9 (international classification of conferences. Details were also obtained from the minutes of case gations, neurological follow up after 1 year, and the subdural haemorrhage, its clinical presentation, investi-
surveillance system. A return card method similar to the British Paediatric Welsh Paediatric Surveillance System. This system uses incidence of subdural haemorrhage in children under 1 year of age was 21.0/100 000 children/year. In one case the injury had arisen from a major road accident. The child had multiple skull fractures and had papilloedema, and two had papilloedema and venous dilation.
In one case the injury had arisen from a major road traffic accident. The child had multiple skull fractures but no retinal haemorrhages. In 14 cases a clear history of shaking was obtained, although this was never the first explanation put forward. In 18 cases there was no history of shaking, and two of these cases gave no explanation at all. It was common that carers proposed

Results
We identified 33 cases (23 (69.7%) boys and 10 (30.3%) girls) of subdural haemorrhage in children. The incidence of subdural haemorrhage in children under 2 years of age was 12.8/100 000 children/year (95% confidence interval 5.4 to 20.2). The age range was 3 weeks to 17 months (median age 3 months). Twenty eight cases occurred in the first year of life. The incidence of subdural haemorrhage in children under 1 year of age was 21.0/100 000 children/year (confidence interval 7.5 to 34.4). The risk of a child developing a subdural haemorrhage by 1 year of age was 1:4761 children.
The clinical outcome of cases with subdural haemorrhage was poor. Nine infants (27.3%) died and 15 (45.5%) had profound disability (table 1). Nine infants (27.3%) were reported as normal after 1 year of follow up. No infant had a developmental abnormality identi-
several different explanations for the injury; three different explanations were given in 10 cases, and two possible causes were given in eight cases. In eight cases carers denied any trauma and attributed the symptoms to some sort of infantile illness. Traumatic explanations were proposed in the remaining cases. These were not definitive, with explanations that the injury had arisen from seemingly minor traumatic events that had recently occurred.

Four of the infants (12.1%) had previously suffered from physical abuse, and all of these children died. Of 17 cases (51.5%) with siblings there was a history of previous sibling abuse in six (35.3%) and concurrent abuse in two (11.8%). Criminal proceedings were undertaken in 14 cases (42.4%), which resulted in nine prosecutions. The alleged perpetrators were the male cohabitants in 5 cases (35.7%), the biological father in 6 cases (42.9%), and the mother in 3 cases (21.4%).

Child abuse was confirmed in 21 cases (63.6%) from the proceedings of child protection agencies and by the court of Her Majesty’s coroner. We suggest that in a further six cases (18.2%) there were findings that were highly suggestive of child abuse. These included fractures, coexisting trauma, and a family history of abuse. In five cases (15.1%) there was no clear evidence of abuse. The histories in these cases only mentioned minor trauma or malaise, and there were no other injuries or social concerns (table 2). Three of these cases had not been fully investigated.

We conclude that there were 27 cases (81.8%) that were highly suggestive of abuse, giving an incidence of non-accidental subdural haemorrhage in infants under 2 years of age of 10.13/100 000 children/year (95% confidence interval 5.33 to 19.25). For 1996 and 1997 we identified 17 children under 2 years of age with a subdural haemorrhage secondary to physical child abuse in Wales (population under 2 years of age 68 286).13 There were 13 boys and four girls; fractures were recorded in nine cases (52.9%) and bruises in eight cases (47.0%). This gives an incidence of non-accidental subdural haemorrhage of 12.45/100 000 children/year for children under 2 years of age (6.43 to 24.09). This is very similar to the figure we obtained for South Wales and south west England.

### Discussion

Subdural haemorrhage is common in infancy, particularly in the first year of life. We believe our case ascertainment is complete, and continued surveillance of non-accidental subdural haemorrhage in children in Wales confirms the incidence. Our paper provides the only population based case series of which we are currently aware. We show that the majority of subdural haemorrhages in children under 2 years of age are due to child abuse. We also show that the outlook for these children is poor, with a quarter dying and a half having profound disability. This confirms previous research findings.10–12

The age range and the male predominance also confirm the findings of other studies.13–14 It has been postulated that many parents believe that boys can withstand rougher handling, or cultural expectation is such that boys are expected to cry less often than girls.15

There are a number of theories as to why babies are vulnerable to subdural haemorrhage. As babies have a large head and weak neck muscles, it is likely that the whiplash mechanism sets up shearing forces within the cranium that are sufficient to tear the blood vessels that cross the relatively wide subdural space, resulting in bleeding.13–16 It is also likely that the small size of the infant allows it to be picked up and shaken more easily than a heavier child. There are proponents of the shaken baby syndrome who suggest that shaking alone is insufficient to generate the acceleration-deceleration forces that are necessary to cause a subdural haematoma.17–20

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>Explanation</th>
<th>Investigations</th>
<th>Finding</th>
<th>Outcome</th>
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</thead>
<tbody>
<tr>
<td>7</td>
<td>Fell from bouncy chair</td>
<td>Ophthalmoscopy</td>
<td>Retinal haemorrhage</td>
<td>Died</td>
</tr>
<tr>
<td>7</td>
<td>Feverish and unwell</td>
<td>Ophthalmoscopy</td>
<td>Normal</td>
<td>Disabled</td>
</tr>
<tr>
<td>2</td>
<td>No explanation</td>
<td>Ophthalmoscopy</td>
<td>No findings</td>
<td>Dead on arrival</td>
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<tr>
<td>1</td>
<td>No explanation</td>
<td>—</td>
<td>—</td>
<td>Normal</td>
</tr>
<tr>
<td>4</td>
<td>Unwell</td>
<td>Ophthalmoscopy</td>
<td>Normal</td>
<td>Disabled</td>
</tr>
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Suggested mandatory investigations in cases of subdural haemorrhage in infants

- Full multidisciplinary social assessment
- Ophthalmoscopy by an ophthalmologist
- Skeletal survey supplemented with a bone scan or a repeat survey at around 10 days
- Coagulation screen
- Radiological assessment by computed tomography or magnetic resonance imaging

The correlation between fractures, multiple injuries, and subdural haemorrhages suggests that considerable violence must be involved around the time that a subdural haemorrhage is sustained. Our study confirms that a shaking injury was inflicted in many cases of subdural haemorrhage, but that subdural haemorrhages can also arise from severe trauma such as a road traffic accident.

Our study shows the clear relation between subdural haemorrhage and fractures, other traumatic injury, retinal haemorrhages, and a previous history of child abuse in the family. The coexistence of any of these factors should alert the paediatrician to the likelihood of child abuse. We are concerned, however, that a significant number of cases were not fully investigated. Vital coexisting features of child abuse may therefore be missed in the initial assessment. We recommend that certain investigations should be mandatory in the assessment of all children under 2 years of age with a subdural haemorrhage (box). Decisions about whether child abuse has occurred must then be made after consideration of all these investigation together with the multiagency child protection team.

The majority of the subdural haemorrhages in our cases were diagnosed from computed tomograms. Magnetic resonance imaging may be the investigation...
of choice, however, as it has the capability of recognising small subdural haemorrhages not easily seen on computed tomograms. Magnetic resonance imaging can detect shearing injuries within the brain and indicate the age of the haemorrhage.21 Coagulation abnormalities were excluded in all cases tested. A subdural haemorrhage may rarely present in a child with a clotting disorder.22 In several of our cases there had been a significant fall in serum haemoglobin concentration at presentation. This implies that the bleed may have occurred more than 24 hours previously.

Retinal examination was performed by an ophthalmologist in less than half the cases. Three studies quote an 80% association between retinal haemorrhages and subdural haemorrhage in children.3 15 24 Our findings are confirmatory.

Previous child abuse in the family is a significant risk factor for subdural haemorrhage in children; all the children who had been previously abused died. Child protection agencies must therefore give high priority to the protection of all current and future children in such families.

It has been suggested that the public may not recognise how harmful shaking is to a baby. The Louise Woodward case in the United States, and more recent cases in the United Kingdom, have resulted in considerable media coverage of this subject. It is therefore important to alert the public to the dangers of shaking a baby, as the National Society for the Protection of Children has recognised in its “Never Shake a Baby Campaign.”3 21 25 Professional agencies dealing in child health and child protection agencies must heighten their awareness of both the diagnosis and prevention of this condition.

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Competing interest: None declared.

Corrections

Obituary

The wife of Dr Jonathan (“John”) James Mercer Kew (26 September, p 890) is called Jocelyn and not Mitch.

Secondary prevention in acute myocardial infarction

In this fortnightly review by Rajendra H Mehta and Kim A Eagle (14 March, pp 838-42), two errors occurred in table 3. Firstly, in the results for the first trial in the “selective” group (Pfeffer et al) the values for relative risk of death should have been 0.19 (0.03 to 0.32); P = 0.019 [not 0.21 (0.05 to 0.25); P = 0.014]. The published values related to the reduction in cardiovascular mortality, not total mortality. Secondly, in the results for the last trial in the selective group (Ambrossini et al) the values for relative risk of death should have been 0.25 (0.11 to 0.60); P = 0.19 [not 0.34 (0.08 to 0.34); P = 0.018].

The published values related to the combined end point of death or congestive heart failure.

Mammography and the politics of randomised controlled trials

The following information should have been included at the end of this paper by Jane Wells (31 October, pp 1224-9). The author spent six months at the University of Maryland at Baltimore, during which time her salary was paid by the Anglia and Oxford Regional Health Authority. The author thanks Kay Dickersin for advice and help during this stay in Baltimore and for comments on an earlier draft of the paper.