Non-accidental injury

Vic Larcher

INTRODUCTION

The rigorous investigation and management of actual or possible abuse in children requires the systematic, comprehensible and timely documentation of concerns, and evidence that they have been properly addressed (Laming, 2003). All professionals having contact with children should be aware of the possibility of abuse, know what to do if they suspect it and must be responsible and accountable for their actions. This article will be concerned mainly with physical abuse, especially the types which may present to accident and emergency departments.

EPIDEMIOLOGICAL FACTORS

In the UK 1–2% children (<18 years of age) are abused each year (Meadow, 1989). Serious injury occurs in 1 in 1000 children (mainly under 2 years of age) and 1 in 10 000 die (Meadow, 1989; Hobbs, 1993); death is uncommon after 1 year (Hobbs, 1993). These figures are likely to underestimate the true extent of abuse. Parents inflict most abuse; men are more frequently the abusers and are more likely to injure children fatally. There are associations with poor parenting, domestic violence and animal maltreatment.

AWARENESS

All disclosures of abuse by children must be investigated.

Awareness means being alert to the possibility of abuse which can occur irrespective of race, religion, social class or cultural background. The following are indicators of the possibility of abuse:

1. Delay or failure in seeking medical help
2. Vague, temporally and factually inconsistent histories
3. Histories incompatible with the child's injuries and/or their known and verified state of development (or that of the alleged perpetrator)
4. Abnormal parental affect, e.g. unconcerned, hostile or non-cooperative
5. Abnormal appearance of the child, e.g. frozen watchfulness, abnormal interaction with parents
6. Injuries of differing ages.

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ASSESSMENT AND EVALUATION

Meticulous and detailed history and examination are essential. Therefore:

- Take a full history from the child if possible, in the absence of parent or carer if deemed necessary or desirable. Include past and present medical problems, development and behaviour, as well as social history and family details
- Obtain formal consent for examination from a person with parental responsibility
- Obtain the child's agreement and respect his/her wishes where possible, giving clear explanations of what you intend to do in language he/she can understand. Evaluate the child's demeanour and the response to the carer and to yourself
- Measure and record weight, height and head circumference and plot their centiles
- Perform a thorough physical examination. Remember to include hair, nails, mouth, nose and fundi, and also inaccessible places, e.g. behind ears under hairline. Comment on developmental and emotional state
- Record site, size, colour, shape and stage of healing of each injury and the explanation for it.

Some patterns of injury (*Figure 1*), e.g fingertip bruises, knuckle prints or slap marks, are specifically associated with abuse. There is statistical correlation between site and size of bruising and the likelihood of abuse (Dunstan et al, 2002).

Use of objects may leave characteristic 'brand' marks, e.g. linear marks (sticks), buckle marks (belts) and looped scars (electrical cords) (*Figure 2a*) (Johnson and Showers, 1985; Meadow, 1989; Hobbs, 1993).

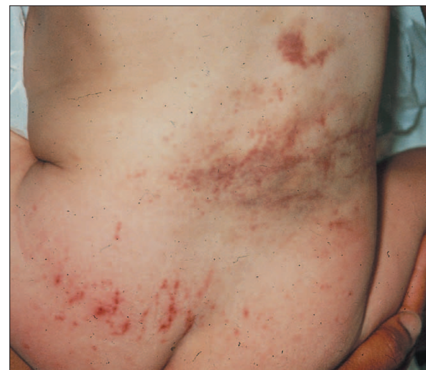
Imprints of bites may yield useful forensic information about the perpetrator. 'Love bites' suggest the possibility of sexual abuse. Direct trauma may only produce marks over bony prominences, e.g. spinous processes. The degree of force necessary to produce any injury depends on a number of complex variables involving the child, the abuser and any implement used. In assessing causation the developmental capabilities of the child must be considered.

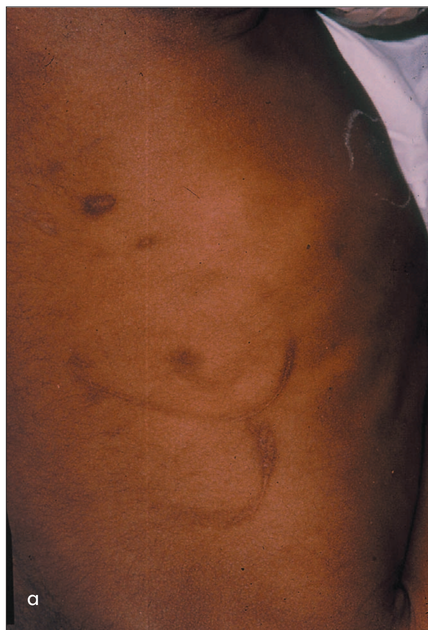
Aging of bruises is imprecise but bruises <24 hours old do not show yellow colouration and red colouration may persist for a week (Stephenson and Bialas, 1996). Non-visible bruises and those in pigmented skin may be demonstrated by ultraviolet light.

HEAD INJURY AND SHAKEN BABY SYNDROME

Serious head injury is the commonest cause of death in abused children but is seldom produced by accidental falls (Jayawant et al, 1998). The association between subdural haematomas (SDH) and long bone fractures is well recognized but other fractures, e.g ribs and skull, may be present (Carty and Ratcliffe, 1995). SDH may result from shaking alone.

Figure 1. Back of toddler, showing the imprint of a recent slap. Note the pattern of bruising in which the outline of the fingers of the assailant can be seen.





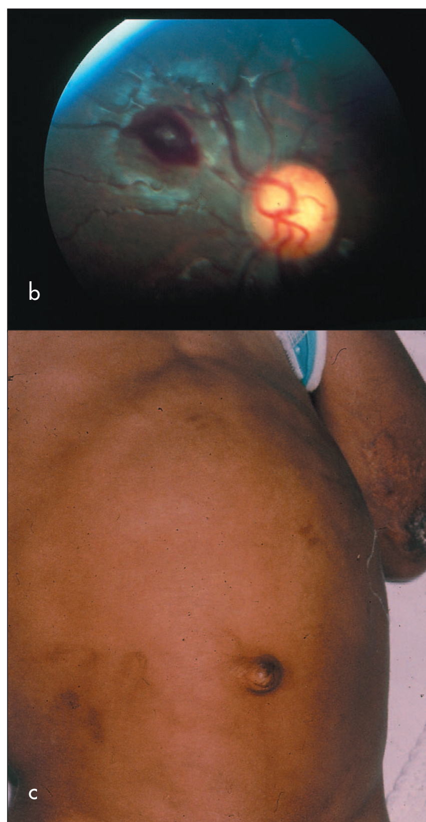


Figure 2. A 4-year-old male was brought to an accident and emergency department in a semi-comatose state by two relatives who gave misleading information about his identity and history. Because of this he was transferred to a paediatric intensive care unit for ventilatory support and further evaluation. Examination confirmed injuries of differing ages and causes including (a) brand marks. Note the impression left by the use of looped cords or chain and the marks left by a straight object, e.g a stick, as well as old chicken pox scars and scars from cigarette burns. b. A subdural haemorrhage was confirmed by computed tomography (CT) scan and ophthalmological evaluation showed the presence of a retinal haemorrhage. Although he recovered consciousness within 48 hours, he remained pyrexial and developed increasing abdominal distension associated with tenderness to palpation. c. This shows marks suggesting the imprint of an object – possibly the toe of a shoe – in the right iliac fossa and there is clear eversion of the umbilicus. Serum amylase was raised and the diagnosis of a pancreatic pseudocyst was confirmed before laparotomy by ultrasound and CT scans. The child also had an old fracture of the humerus, as well as facial injuries. He made a good clinical recovery but has significant learning difficulties.

A high incidence of widespread microscopic neuronal hypoxic brain damage has been reported in children with non-accidental head injury, suggesting that the mechanism of injury leading to presentation with apnoea is damage to the brainstem respiratory centre as a result of cervical flexion and/or extension during shaking episodes (Geddes et al, 2001; Kemp et al, 2003).

The degree of force necessary to produce such changes is disputed but the finding of other injuries, which may be multiple and of differing ages, suggests that significant force has been used. The amount of force necessary to produce hypoxic brain injury, even in the absence of any other injury, is unlikely to be produced in normal child care or play.

Clinical presentations of shaking injuries include irritability, lethargy, vomiting, convulsions, apnoea, shock and fluctuating levels of consciousness resulting from cerebral irritation, oedema and intracerebral haemorrhage. Perpetrators may never disclose shaking and injuries presenting with subtle changes may escape detection.

Physical evidence of abuse may be lacking, although those of neglect may be present. Retinal haemorrhages occur in 58–89% cases; formal ophthalmological examination is mandatory (Ewing-Cobbs et al, 1998) (*Figure 2b*). Such haemorrhages may occur in association with cardiopulmonary resuscitation, convulsions or neurological conditions, but this is rare. Other investigations should include full blood count, clotting studies, radiological skeletal survey, computed tomography (CT) and magnetic resonance imaging (MRI) scans.

Neurodevelopmental outcome is poor for those presenting with apnoea who have diffuse brain swelling or hypoxic–ischaemic damage.

ABDOMINAL INJURY

Blunt abdominal trauma is the second commonest cause of death in abused children (Champion et al, 2002). It may produce haematomas, bleeding, rupture or tearing of viscera, and rupture of major blood vessels. Pancreatic rupture and pseudocyst formation may occur. It is rare to sustain such injuries in traffic accidents or falls from <2 m (Cripps and Cooper, 1997).

Presenting features depend on nature and severity of injury, but include abdominal pain, distension, vomiting and passage of blood in stools or urine. There may be fever, features of shock or dehydration, and the abdomen may be distended and silent. Abdominal wall bruising may be absent but other features of abuse or neglect may be present (*Figure 2c*).

Investigations include serial haematocrits to monitor blood loss, serum electrolytes, liver function tests, amylase and urine microscopy. Radiologically a chest X-ray may show pneumothoraces, rib fractures or pleural effusion. Abdominal X-rays (erect and supine) may demonstrate the presence of free air or free fluid. Both ultrasound and CT scans with and without contrast are useful. Surgical exploration may be necessary.

When the child's clinical condition permits a detailed search for other clinicopathological features of abuse should take place. Conversely the development of abdominal symptoms in an abused child requires prompt surgical evaluation.

LONG BONE FRACTURES

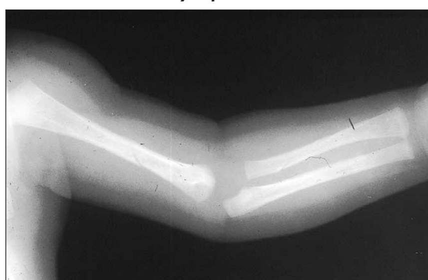
Annual incidence of all fractures resulting from abuse has been calculated as 4/10 000 in children under

18 months and 0.4/10 000 in children aged 19–60 months (Worlock et al, 1986). Abused infants tend to have metaphyseal and epiphyseal fractures produced by shearing or twisting forces while over 1-year-olds have diaphyseal injury often of a spiral or oblique type. Long bone fractures as a result of abuse are often at the distal end. Unexplained fractures in preambulant children are highly suspicious (Carty, 1993). A careful history of the event from witnesses and assessment of the child's developmental capacity are essential, together with a review of any factors that might affect bone density. Full examination is mandatory.

The humerus is the most commonly fractured bone in abuse cases with a reported 67–100% of humeral fractures in under 15-month-olds being the result of abuse (Worlock et al, 1986; Kowal-Vern et al, 1992; Leventhal et al, 1993). Spiral or oblique fractures are especially suspicious (*Figure 3*). Rib fractures occur in 5–26% of abused children, with 90% of abuse-related fractures occurring under 2 years of age (Carty, 1993; England and Sundberg, 1996). Such fractures, especially if multiple, are regarded as pathognomonic of abuse in the absence of a history of major trauma. They are particularly associated with the shaken infant syndrome where they are caused by squeezing. Resuscitation seldom produces rib fractures in infants or young children.

A skeletal survey should be carried out in the under 2-year-old child who presents with a suspicious fracture. Thereafter skeletal survey is at the discretion of the clinician. X-rays should be reported by an experienced paediatric radiologist. If the survey is negative and clinical suspicions remain, bone scintigraphy may be helpful in demonstrating soft tissue trauma or subtle fractures not visible by conventional radiography (Mandelstam et al, 2003).

Figure 3. A recent oblique fracture of the humerus in a 7-week-old infant. There was originally no explanation offered for the injury; skeletal survey showed no other bony injuries.



Increased bone fragility, e.g as a result of osteogenesis imperfecta, and metabolic bone disease may both produce an increased propensity to fracture and may be identified on clinical and radiological grounds. There is currently no completely specific biochemical or genetic test for osteogenesis imperfecta. There is very little scientific or clinical evidence for the entity of temporary brittle bone disease. In cases where increased bone fragility may be possible a detailed verified family history is necessary, together with a multidisciplinary assessment.

FABRICATED OR INDUCED ILLNESS BY CARER

Although there is clinical and forensic evidence that some parents use medical means to abuse children, identification of fabricated or induced illness (FII) remains controversial (Southall et al, 1997; Royal College of Paediatrics and Child Health, 2002). The reported salient features of FII are:

1. Illness in a child fabricated by a parent or carer
2. Repeated and persistent presentation of a child often for medical assessment and care
3. The perpetrator denies the aetiology of the child's illness
4. Acute symptoms and signs in the child cease when they are removed from the care of the perpetrator.

Illness may be induced or fabricated by:

- False reporting (exaggeration or actual fabrication of symptoms)
- Active fabrication of symptoms and signs (e.g. falsification of records, interference with specimens)
- Interference with child, e.g. poisoning or suffocation.

Escalation may occur and other forms of abuse (especially emotional) are reported. Morbidity may also result from direct parental intervention and/or procedures undertaken to investigate or treat a child's supposed illness. Comorbidity among siblings and adverse outcomes in later childhood have been reported.

The annual incidence of serious FII is reported as 0.5 per 100 000 children under 16 years of age and 2.8 per 100 000 in infants (0–1 years of age) with a median age of 20 months (McClure et al, 1996). The incidence of minor forms, resulting in excessive seeking of health care or abnormal illness behaviour, has been estimated at 45 per 100 000 children under 16 years of age (Royal College of Paediatrics and Child Health, 2002).

Concerns may arise when:

1. No correlation exists between reported symptoms or signs and any medical condition from which the child is suffering
2. Physical examination and investigation do not corroborate reports
3. There is inexplicably poor response to standard therapy
4. New symptoms are continually reported
5. Reported symptoms or signs do not occur in the absence of the carer
6. Repeated presentations to different units occur
7. The child's daily activities are more curtailed than would be expected for the medical disorder from which the child is said to suffer (*Figure 4*) (Department of Health, 2001).

Careful consideration and review of possible explanations for these circumstances should include appropriate medical tests, consultation with colleagues (including those from other disciplines) and meticulous chronological recording of any events. It is important to prevent tampering with the child or the records or samples. Further specialist advice and testing may be necessary to attempt to resolve and elucidate discrepancies.

If FII by carer is a possible explanation and in consequence the child's health is or is likely to be impaired referral to social services is necessary. Parents should be informed and give

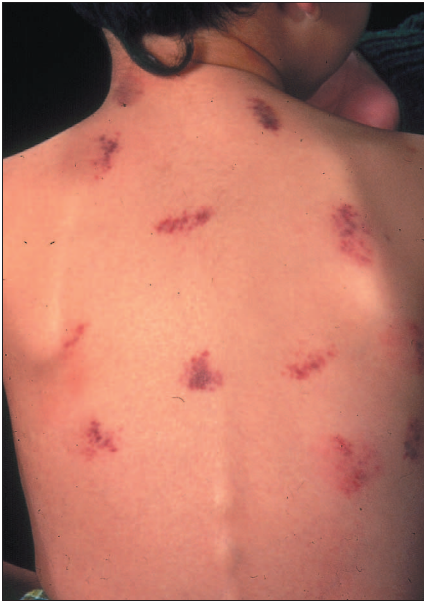


Figure 4. This boy presented with clinical and histological features suggestive of vasculitis. He failed to respond to conventional aggressive therapy with steroids and azathioprine and new lesions only appeared when he was in the presence of his mother. The lesions resolved entirely on separation from his carer despite the withdrawal of all immunosuppressant therapy.

their agreement but not if this is likely to increase the risk of harm to the child.

POISONING

In unexplained, bizarre or serious clinical presentations fulfilling the above criteria the possibility of poisoning should be considered. As well as detailed clinical examination appropriate samples of blood, urine stomach contents, feeds and body fluids should be collected under chain of evidence conditions*. Consider in particular use of salt, insulin and prescription or over-the-counter drugs.

ASPHYXIATION OR SUFFOCATION

Asphyxiation is difficult to detect; there may be no signs of violence even at autopsy, which should ideally be performed by a paediatric pathologist. The presence of facial bruising, bleeding from nose or mouth, and petechiae around the neck or face are all suspicious in the absence of resuscitation attempts. All sudden unexplained deaths in infancy must be reported to the coroner. Some areas have detailed protocols for the investigation of such deaths, which include the medical assessments necessary to establish causation. These include exclusion of metabolic and inherited disease and skeletal injuries, as well as multidisciplinary assessment (Moore et al, 2000). **HM**

*Chain of evidence conditions are where every contact leaves a trace. This means that the specimen is placed in a sealed bag and at every stage in its journey from the patient to the laboratory all those who handle it sign to record that they have done so. The purpose of this is to avoid suspicion that the evidence has been tampered with.

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KEY POINTS

- Concerns about abuse of children must be investigated with the same care and rigour as any serious medical condition.
- Histories which are vague, inconsistent, incongruous or non-existent should arouse suspicion, as should delay in presentation and injuries of different ages.
- Hypoxic ischaemic brain injury, presenting as apnoeic attacks, fits or coma, may result from shaking of babies. The presence of other injuries, e.g. rib and other fractures and retinal haemorrhages, is highly suspicious of abuse.
- Abdominal injury as a result of abuse may be difficult to recognize but serious in outcome.
- Rib, humeral and metaphyseal fractures are highly suspicious, especially in non-ambulant children.
- Fabricated or induced illness by carer may present with repeated attendances with non-verifiable or exaggerated complaints which may respond poorly to standard therapy.
- Evaluation of all concerns requires a meticulous multidisciplinary, multiagency approach.