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Review

A systematic review of the features that indicate intentional scalds in children

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ABSTRACT

Background: Most intentional burns are scalds, and distinguishing these from unintentional causes is challenging.
Aim: To conduct a systematic review to identify distinguishing features of intentional and unintentional scalds.
Methods: We performed an all language literature search of 12 databases1950–2006. Studies were reviewed by two paediatric/burns specialists, using standardised methodology. Included: Primary studies of validated intentional or accidental scalds in children 0–18 years and ranked by confirmation of intentional or unintentional origin. Excluded: neglectful scalds; management or complications; studies of mixed burn type or mixed adult and child data.
Results: 258 studies were reviewed, and 26 included. Five comparative studies ranked highly for confirmation of intentional/unintentional cause of injury. The distinguishing characteristics were defined based on best evidence. Intentional scalds were commonly immersion injuries, caused by hot tap water, affecting the extremities, buttocks or perineum or both. The scalds were symmetrical with clear upper margins, and associated with old fractures and unrelated injuries. Unintentional scalds were more commonly due to spill injuries of other hot liquids, affecting the upper body with irregular margins and depth.
Conclusions: We propose an evidence based triage tool to aid in distinguishing intentional from unintentional scalds, requiring prospective validation.

Contents

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1. Introduction

Severe burns are reported in an estimated 10–12% of children who have suffered from physical abuse [1,2]. Studies give widely varying estimates that 1–35% of children admitted to burns units have suffered from intentional burns. The highest incidence figures are reported in the USA [1,3–7], where the majority of studies have been conducted, and the lowest figures are from the UK [8–10].

Burns and scalds are amongst the commonest causes of fatal child abuse [11,12] and are one of the most painful injuries a child can sustain. They can cause long-term scarring, as well as physical and psychological disabilities. It is well recognised that physical abuse is an ongoing process, recurrent abuse occurs in up to 70% of children who are physically abused [13–15]. The severity of these injuries often escalates, early diagnosis and recognition of intentional thermal injury is therefore essential to inform effective management.

Scalds are the commonest thermal injury in childhood (66% [16]) however differentiating between an intentional and accidental aetiology is challenging. Children who sustained scalds may present to clinical services in primary care, accident and emergency departments, paediatric dermatology and burns units. Clinicians in each of these disciplines have different levels of experience in the field, therefore a clear understanding of the distinguishing features of accidental and intentional scalds would facilitate appropriate referrals for child protection assessment when necessary.

The features of any scald are defined by their causal and physical characteristics. Causal factors include the thermal agent, mechanism and intent of the injury. The physical appearance of the scald can be described in terms of: the *pattern* with regards to the *depth* of the burn (superficial, deep dermal, full thickness or mixed), which may be uniform across the scald or variegate, and the *outline* [3,18,22], the *distribution*, referring to the affected body part [17,18], and the *extent* of the scald according to the total body surface area (TBSA) affected. A child can sustain a scald from any hot liquid [3,19–21], and can come into contact with it from three different mechanisms, i.e. a spill, flow or immersion incident [3,12,20,21].

Abusive scalds due to neglect outnumber those due to intentional injury by a factor of 9:1 [9]. These were excluded from this review however as their clinical features mimic accidental scalds [9,23,24], and the diagnosis relies upon an assessment of the circumstances of the injury and a judgement as to whether thresholds of neglect have been met in terms of levels of exposure to the hazard, appropriate levels of supervision or treatment. The identification of an intentional scald relies upon the hypothesis that it will have a different appearance and different characteristics to a scald that has been sustained accidentally. We have performed a systematic review of the international scientific literature to test this hypothesis.

2. Materials and methods

This systematic review addressed the question ''What are the clinical and associated features of intentional and unintentional scalds in children?''

2.1. Search criteria

We performed an all language literature search of 12 databases for original articles and conference abstracts published from 1950 through to October 2006 (Fig. 1). In addition we hand searched bibliographies, study references and checked relevant internet sites. We used keywords listed in Fig. 2.

2.2. Inclusion criteria

We included primary studies of children aged 0–18 years with confirmed intentional scalds (Table 1) and/or validated unintentional scalds where child abuse had been actively excluded (Table 2) and where the causal, physical and social features of the scald were detailed.

We excluded review articles, personal practice, studies on scald management or outcome, scalds that were due to neglect, studies that combined scald and contact burn data or mixed child and adult data, where child specific scald data could not be extracted.

2.3. Validity assessment

Our specialist review team (Welsh Child Protection Systematic Review Group) consisted of child health professionals with expertise in child protection and critical appraisal, and plastic surgeons with expertise in burns. Each reviewer completed standardised training in critical appraisal methodology. Two members of the team independently reviewed each article; a third review was undertaken if there was disagreement between the initial reviewers. A consensus was then reached based on agreement between two of the three reviewers.

2.4. Grading of evidence

All included studies were critically appraised using data extraction sheets, critical appraisal forms and evidence sheets

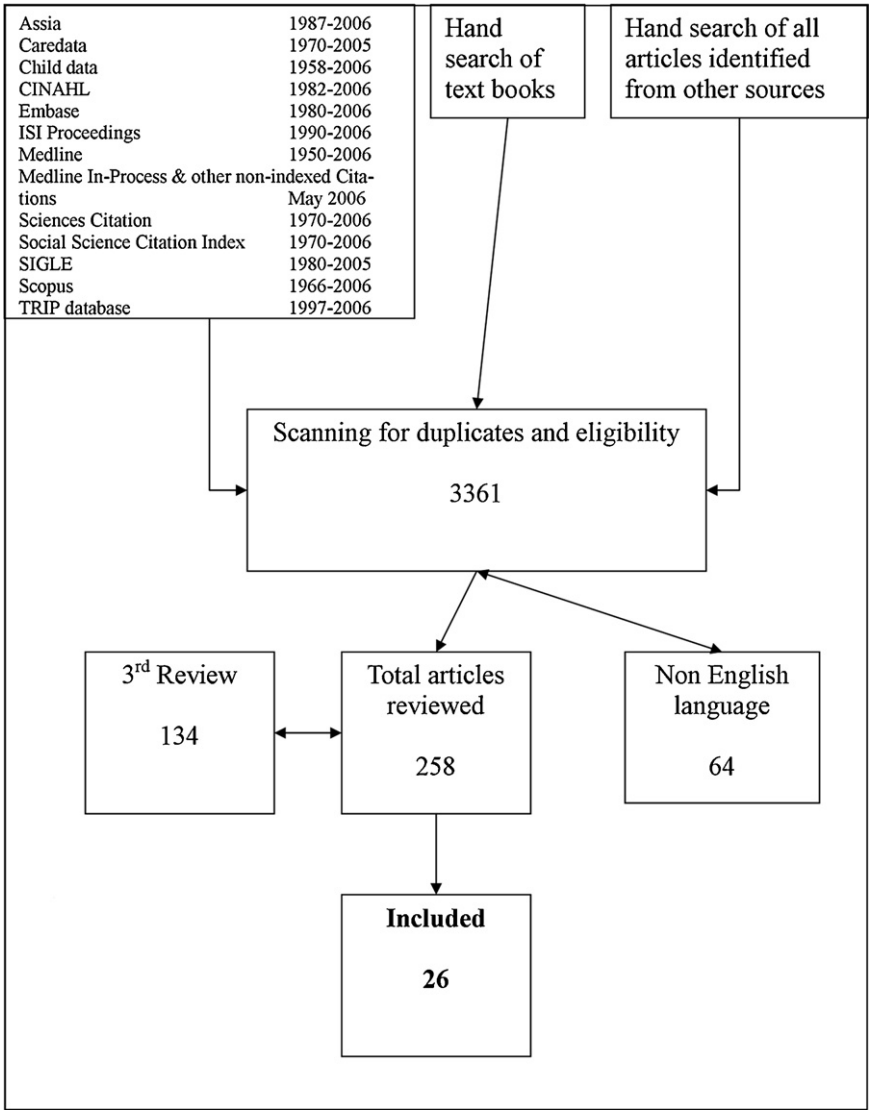

Fig. 1 – Search strategy to October 2006.

based on NHS Centre for Reviews and Dissemination [25]. Studies were graded for quality on the basis of study design, criteria used to define abuse, and verification of an accidental cause. We only included studies where we were confident that abuse had been confirmed or excluded as relevant. The ranking system for confirmation of abuse in relation to the intentional scalds follows that published previously (see Table 1) [26]. Our ranking of accidental injuries was novel to this review (Table 2) and was developed to ensure that child abuse had been actively excluded with a high degree of confidence. We only included studies with a ranking of abuse of 1–3, and an accidental ranking of A or B.

We analysed the included studies to identify the features of the mechanism, agent, pattern and distribution of injury and compared these parameters for intentional and accidental injury. We set a ''gold standard'' for included studies, namely studies that contained comparative data (tier 1) and had a high ranking for confirmation of abuse (rank 1 and 2) and unintentional cause (rank A and B). We used these to identify distinguishing features of intentional and accidental scalds. The remaining studies (tier 2) were of a lower evidence level, because they contained non-comparative data, or only ranked three for abuse or did not address some of the related features in detail. We used data from these tier 2 studies to confirm/validate our findings and to identify features of intentional scalds that were only supported by a lower evidence level.

3. Results

Overall, 26 observational, retrospective studies were included, representing 587 children, 183 of whom sustained intentional scalds. Twenty-one studies had an abuse ranking of one or two, 19 of which were based on hospital or burns unit admissions. The study designs included: 1 case–control [20], 8 cross-sectional [3,6,11,12,21,22,27,28], and 17 case series and case studies [5,17,18,29–42]. Five comparative studies [3,12,20,22,32], met our ''gold standard'' and included data

Thermal Study Keywords	Child abuse keywords
Burn: or scald:	Child:
Immersion	Child abuse
Cigarette burn:	Child protection
Inflicted burn:	(battered child or shaken baby or battered baby)
Electric: burn:	Child maltreatment
Spill injur:	(child adj3 maltreatment)
Splash injur:.	(child adj3 physical abuse)
Contact burn:	non-accidental injur:
Flame burn:	soft tissue injur:
Patterned injur:	physical abuse
Doughnut pattern	physical punishment
Waterline pattern	
Branding injur:	**Accidental Keywords**
Blister	accidental injur:
Pour Burn:	accidental burn:
Dry contact burn:	unintentional burn:
mirror image burn:	unintentional injur:
stocking burn:	accidental scald:
rope burn:	unintentional scald:
glove burn	
(Accidental or non-accidental burn:)	**Dating, Healing Keywords**
(burn adj5 child:)	(depth adj3 burn)
thermal injury	(depth adj3 burn injur:)
intentional injur: or intentional burn:	(progression adj3 burn)
chemical burn:	burn progression
splash burn:	Time factors/
flash burn:	(dating adj burn)
friction burn:	(age: adj3 burn)
blast burn: or blast injur:	(healing time adj3 burn)
caustic burn.	
(child: adj3 burn:).	**Skin Disorder Keywords**
(iron adj3 burn	Dermatitis
(tub: adj3 burn:)	Dermatological dis:
(bath adj3 burn:)	Skin dis:
(tap water adj3 burn)	Impetigo
(radiant heat adj3 burn:)	Erythema multiforme
(radiator adj3 burn:)	Parvovirus infection or erythema infectiosum
(pullover adj3 burn)	Dermatomyositis or dermatitis herpeti- formis
(caustic adj3 burn:)	
Dunking syndrome	

Fig. 2 – Keywords used in database search.

on 24 children with intentional and 398 with unintentional scalds. Meta-analysis of comparative data however was not feasible due to the high degree of heterogeneity between studies. The remainder of the studies were of a lower evidence level (tier 2) and represented 159 intentional and 6 accidental cases in total.

In studies where the data was broken down by gender [3,22] (10 intentional:80 accidental scalds) there was no significant difference between intentional (F:M 1:1) and unintentional (F:M 1:1.2) scalds. Although detailed figures were lacking, Hobbs noted an excess of boys in each group, in the intentional cases the male to female ratio was 2:1. Daria et al. studied children under five years and showed that the mean age of intentional scalds was 18 months (range 14–32 months, S.D. 6.7), and unintentional was 17.1 months (range 6–29 months, S.D. 6.9) [3]. No study addressed diagnostic features of intentional scalds in a population of children with disability, two single cases of intentional scalds are noted in older children with severe learning difficulties [6,40].

3.1. *Features of intentional scalds supported by highest level of evidence*

Fifteen distinguishing features of intentional scalds were identified from tier 1 comparative data, fourteen of these were corroborated by tier 2, lower evidence studies and six intentional scald features were notably absent in studies that had looked for these feature in children with accidental scalds. All features are listed in Table 3.

Forced immersion scald injuries were consistently described as the commonest *mechanism* of intentional injury. The thermal *agent* was predominantly hot tap water. In contrast to the other studies however Dressler and Hozid in his small series of four childhood scalds (one intentional, and three unintentional scalds) describes an intentional scald from a flowing water injury to face and upper trunk from the child's head being held under running tap water in the bath [32].

The *patterns* of intentional scalds were predominantly lesions with clear upper margins which had a symmetrical appearance on either side of the body. Their *distribution* typically involved the lower body without head or neck involvement. The commonest affected areas were bilateral lower extremities, buttocks and perineal area or combinations of these. However, in tier 2 data, upper extremity intentional scalds were also described [6,34,41], as well as single upper or lower limb involvement [6,28,30,41] and more rarely facial immersion scalds [3,29].

The explanation for injury was often not compatible with the injury sustained, for example it was not unusual to obtain a history of a flow mechanism where the child had turned on the

Table 1 – Ranking of the definitions of child abuse

Ranking	Criteria used to define abuse
1	Abuse confirmed at case conference or civil, family or criminal court proceedings or admitted by perpetrator
2	Abuse confirmed by stated criteria including multidisciplinary assessment
3	Diagnosis of abuse defined by stated criteria
4	Abuse stated as occurring, but no supporting detail given as to how it was determined
5	Abuse stated simply as "suspected", no details on whether it was confirmed or not

Table 2 – Ranking of accidental scald

Ranking	Level of certainty unintentional cause established and abuse excluded
A	Scene of incident recreated or forensic police investigation of scene or criminal investigation ruled out abuse as a cause
B	Efforts specifically made to exclude abuse as a cause for burn through multidisciplinary investigation or social services investigation of home circumstances
C	No mention of how burn was deemed to be accidental, how abuse was excluded, or no mention that abuse was considered as possible aetiology

tap water when the scald pattern is clearly that of immersion. Children with intentional scalds often had more associated injuries at the time of presentation than those with accidental scalds. These included bruising, lacerations, or swellings. Co-existing recent or old fractures were recorded in children with intentional scalds. These were either apparent during examination or occult and detected on skeletal survey, although skeletal surveys had not been performed in all series of children with unintentional scalds [17]. Characteristics of the child that were positively associated with intentional scalds were a passive, introverted, fearful child, a past history of frequent unintentional injuries, or physical abuse, domestic violence within the household or a sibling blamed for causing the injury.

3.2. *Features of intentional injuries supported by lower levels of evidence*

Thirteen additional associated features were noted exclusively in the tier 2, non-comparative data of intentional injuries. These features included skin fold sparing which was reported for example at the back of the knee in immersion scalds. Central sparing of the buttocks, sometimes referred to as a 'doughnut ring pattern' was also described in immersion injury where the skin was in contact with the cooler surface of the vessel that the child was immersed in. Scalds were of uniform depth and reported in a glove and stocking distribution on one or two limbs.

Table 3 – Features of intentional injury supported by the highest level of evidence

Intentional scald must be excluded	Supporting studies	
	Tier 1 (comparative data)	Tier 2 (non-comparative data)
Mechanism		
Immersion	[3]	[3,5,6,11,21,27–29,31,33–36,38–42]
Agent		
Hot tap water	[3,12,20,32]	[6,11,28,30]
Pattern		
Clear upper margins	[3,22]	[3,11,29,39,42]
Scald symmetry (extremities)	[22]	[6,11,18,34,38]
Distribution		
Isolated scald lower extremities	[3]	[6,11]
Isolated scald buttock/perineum	[3]	[5,6,28,38,42]
Combination of buttock/perineum and lower extremities	[3]	[5,6,30,33,38,40]
Clinical features		
History incompatible with examination findings	[3,12,20,22]	[3,5,11,18,28,29,31,34,38,41]
Associated unrelated injury	[3,12,22]	[3,5,6,18,28,29,35,38,40,41]
Co-existing fractures	[12,22]	[5,18,35,38]
Historical/social features		
Passive, introverted, fearful child	[12]	[5,17,18,31,35,38]
Numerous prior accidental injuries	[12]	[3,5,18,28,37,38]
Sibling blamed for scald	[22]	[3,28,34,42]
Previous abuse	[12]	[3,36]
Domestic violence	[12]	

Table 4 – Features of intentional injuries supported by lower levels of evidence

Intentional scald should be considered	Supporting studies
	Tier 2 only (non-comparative)
Pattern	
Skin fold sparing	[3,5,11,31,39,42]
Uniform scald depth	[29,34,41]
Central sparing buttocks	[5,6]
Distribution	
Glove and stocking distribution 1 limb glove/stocking	[6,11,28,30,34,41]
Clinical features	
Previous burn injury	[3,5,6,28,36,37,41]
Neglect/faltering growth	[28,31,34,35,40,41]
History inconsistent with assessed development	[31,34]
Historical/social features	
Trigger, such as: soiling/ enuresis/misbehaviour	[3,35,36,38–41]
Differing historical accounts	[3,34,42]
Lack of parental concern	[5,35]
Unrelated adult presenting child	[29]
Child known to social services	[18,35]

Table 5 – Features of accidental scalds supported by the highest level of evidence

Intentional scald unlikely	Supporting studies	
	Tier 1 (comparative data)	Tier 2 (non-comparative data)
Mechanism		
Spill injury	[3,12,20,32]	[17]
Flowing water injury	[3,22,32]	[18]
Agent		
Non-tap water (hot beverage)	[3,20,32]	[17]
Pattern		
Irregular margin and burn depth	[22,32]	[18]
Lack stocking distribution		
Distribution		
Asymmetric involvement lower limbs	[32]	[18]
Head, neck and trunk or face and upper body	[20]	[17]

A past history or evidence of a previous burn, neglect or faltering growth were reported in victims of intentional injury. The causal explanation was often inconsistent with the developmental ability of the child. There was an association with a trigger event such as soiling, enuresis or minor misbehaviour by the child prior to the scald and often differing accounts of the cause of injury were given. A lack of parental concern was often evident and children could be presented for medical care by an unrelated adult. Families were often known to social services. These features are detailed in Table 4.

3.3. *Features of accidental scalds supported by the highest level of evidence*

Seven features of accidental scalds, were described in the five tier 1 studies [3,12,20,22,32], and supported by two, tier 2, studies [17,18]. These features are detailed in Table 5.

In contrast to intentional scalds the predominant mechanism in unintentional scalds was a spill injury often caused when the child pulled a container of hot liquid off a table top or stove. Accidental flowing water injuries were described in three studies. Accidental hot water immersion scalds were described, but these were uncommon and noted only by Daria et al. in 4% (7/146) of his case series of scalds and a single case by Dressler [3,32]. The agent in the majority were hot beverages/liquids, in contrast to the intentional scalds. The pattern of unintentional scalds involved irregular margins and burn depth, and a lack of stocking distribution or symmetry. The distribution of unintentional spill injuries typically involved the upper body, i.e. head, neck and trunk or face and upper body.

3.4. *Non-distinguishing features*

The total body surface area (TBSA) affected by the scald was only detailed in one recent tier 1 study [3], which showed that there was no difference between intentional and unintentional cause (intentional: mean 13.3%, S.D. 8.1%, range 6–27% unintentional: mean was 11.8%, S.D. 20.4%, range 2–80%). Tier 2 studies supported this finding [17,18,30].

No tier 1 study evaluated the time from injury to presentation for medical attention. In studies of intentional scalds, the time delay varied from two hours to 12 days [3,6,31,35,39], the only specific data relating to this in unintentional scalds showed a time delay of 15 h in one case [32]. Daria et al. noted that three of the children with tap water inflicted craniofacial scalds died, and suggested that this was due to preventable burn shock, had they been treated more rapidly [3].

4. Discussion

This review summarises the best available scientific evidence in this field. We have shown that there are clear differences between the clinical features of intentional and unintentional scalds.

The strength of evidence is clearly compromised by the limited number of good quality tier 1 studies containing comparative data, the relatively small number of children included in the studies, the retrospective design and the lack of consistency between studies in terms of study design, case selection and the variety of features detailed. These limitations prevented a formal meta-analysis. However, we must acknowledge the difficulties of research in this field. Optimal studies would involve large multicentred, prospective comparative or cohort designs, which have yet to be conducted. Five tier 1 studies with a high ranking for surety of diagnosis (intentional or unintentional) where the data could be extracted in full, enabled us to draw up a list of distinguishing features. We were reassured that ninety five percent of the

discriminating findings identified in these studies were further reinforced by tier 2, non-comparative studies which also had a high ranking for aetiology. Although we identified and excluded a number of case series that described unintentional scalds, only two small studies met our ranking for exclusion of abuse [17,18]. Examples of an intentional and accidental scald are shown below (Figs. 3 and 4).

Studies confirmed that children present with a combination of features and no single clinical feature can be used to distinguish intentional from unintentional scalds. We formulated a list of associated features into a prototype triage tool with the characteristics weighted by the strength of the evidence behind them. A previous studyt by Hight et al. [4] proposed a generic burn abuse triage tool. However, Hight, like many other studies, does not separate the physical features of scalds from other types of burns e.g. contact household burns or cigarette burns, nor does it differentiate between intentional and neglectful scalds. As the clinical features of both contact burns, and scalds due to neglect, are significantly different to those of intentional scalds [9,23,24], it is impossible to draw meaningful conclusions from such heterogeneous data. In addition, it was often unclear either how abuse was diagnosed or unintentional cause confirmed, further undermining many existing recommendations [4,7,19].

Fig. 3 – A case of intentional scald, showing bilateral lower limb and perineal/buttock involvement, clear upper margins and uniform depth.

Fig. 4 – A case of accidental scald, caused by pulling down a hot liquid, showing irregular margins and variable depth.

There is no evidence to suggest that either the age or the gender of the child, or the TBSA affected, distinguished intentional from unintentional scalds. Although professionals experienced in paediatric scald management may feel confident dating a scald, there are no published studies within the peer reviewed literature to validate this practice. Therefore the comment that a ''burn is older than the history given'' cannot at this stage be scientifically substantiated, and cannot be included in a triage tool. We could not validate delayed presentation of the child with a scald as an indicator of intentional scalds. It is a feature that must be carefully assessed as it may otherwise reflect parental underestimation of the burn severity initially, difficulties in accessing care or inadequate first aid provided in the home [32].

The clear upper margins of intentional scalds are thought to be consistent with a child being held still in hot water, see Fig. 4 for typical example. In contrast the irregular edge and depth of accidental spill burns (see typical example Fig. 5) reflect a child who moves away from the painful heat source and the fact that the hot liquid cools as it flows away from the first point of contact [24]. The absence of splash marks have often been attributed to intentional scalds [23]. However, the risk of sustaining a scald is proportional to both the temperature of the liquid and the amount of contact time [43]. Feldman et al. proposes that splash marks do not occur if the temperature of the water is below 54 °C/130 °F because burning at this temperature is not instantaneous [44]. In lower water temperatures therefore, the absence of splash-marks neither supports nor refutes intentional injury.

Distinguishing an intentional from an unintentional scald requires a detailed history of the preceding events, mechanism and thermal agent as well as a clinical and social history. For instance, unintentional scalds sustained when a child is in a ''baby-walker'' may show a distinctive pattern (head, forearms, hands, thighs and lower legs), consistent with the environment and the mechanism by which it took place [24]. The clinician must include a full clinical assessment of the distribution and pattern of the scald and perform any clinical investigations indicated. The association of occult fractures, reinforces the recommendations that any child less than two years of age, with suspected physical abuse (such as a scald), should be considered for full skeletal survey [45]. There is very limited data describing an association between sexual abuse and intentional burns [46,47], and these studies do not offer details specifically relating to scalds. This association was not detailed in the tier 1 studies.

Key questions to guide interpretation of findings include the following:

- Does the description of how the burn was caused fit with this child's stage of development?
- Does the pattern of the burn fit with the description of cause given?
- Is the description of how this burn occurred consistent with the environment where it took place?
- Do the clinical features of the burn fit with the mechanism described?

If uncertainty about causality remains, a home visit and/or consideration for forensic scene examination can provide

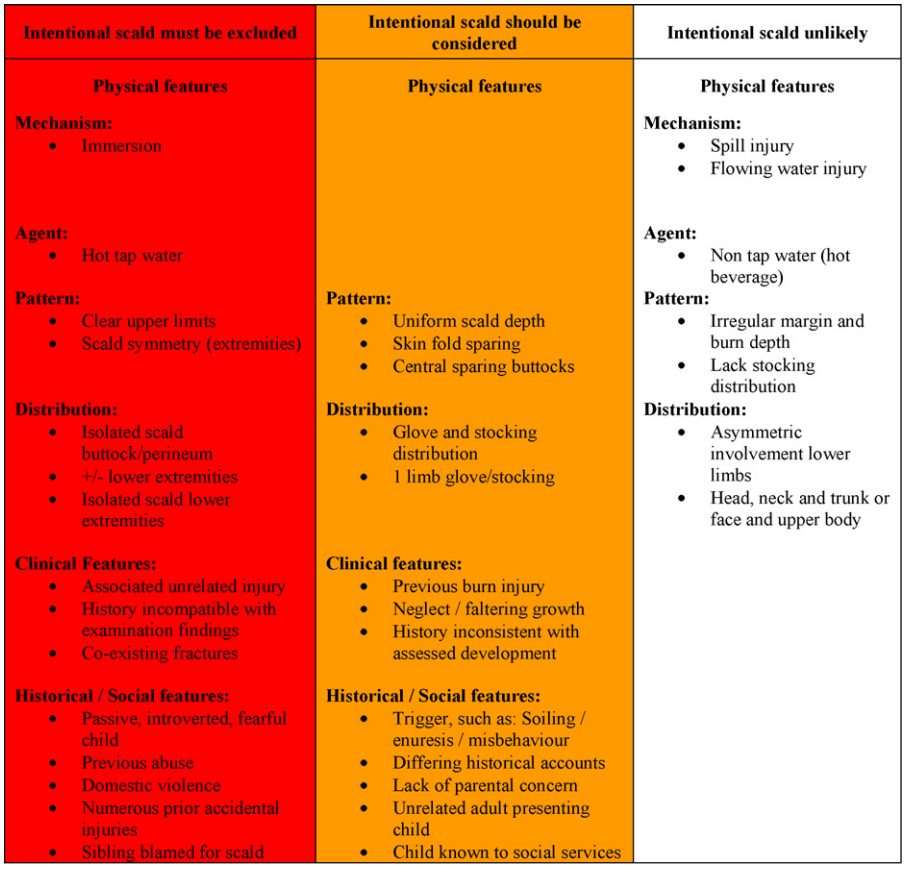

Fig. 5 – Prototype triage tool for diagnosis of intentional scalds.

Table 6 – Prototype triage tool for diagnosis of intentional scalds

Intentional scald must be excluded	Intentional scald should be considered	Intentional scald unlikely
Mechanism		
Immersion		Spill injury
		Flowing water injury
Agent		
Hot tap water		Non-tap water (hot beverage)
Pattern		
Clear upper limits	Uniform scald depth	Irregular margin and burn depth
Scald symmetry (extremities)	Skin fold sparing	Lack stocking distribution
	Central sparing buttocks	
Distribution		
Isolated scald buttock/perineum	Glove and stocking distribution	Asymmetric involvement lower limbs
+/− lower extremities	1 limb glove/stocking	Head, neck and trunk or face and upper body
Isolated scald lower extremities		
Clinical features		
Associated unrelated injury	Previous burn injury	
History incompatible with examination findings	Neglect/faltering growth	
Co-existing fractures	History inconsistent with assessed development	
Historical/social features		
Passive, introverted, fearful child	Trigger, such as: Soiling/enuresis/ misbehaviour	
Previous abuse	Differing historical accounts	
Domestic violence	Lack of parental concern	
Numerous prior accidental injuries	Unrelated adult presenting child	
Sibling blamed for scald	Child known to social services	

valuable information to validate explanations, offer opportunity for preventative advice or contribute further to diagnostic surety. It is vital that the information from these assessments are interpreted by a clinician who is aware of the pattern and distribution of the scald, the fine and gross motor developmental level of the child and can correlate the likelihood of explanations offered to the scene of the incident. This assessment should include the room the incident occurred in. For example spill injury would typically be expected in a kitchen from oven or counter, or low lying beverage in lounge or bedroom. These scenarios would give directional depth and flow indicators within the scald depending on the height of hot liquid source and the position of the child. Likewise, as Allasio and Fischer showed, the age at which a child can climb into a bath unaided can vary widely (from 10 to 18 months), so establishing the relevant developmental parameter for the individual child is essential [48]. It is important to establish the water temperature in the home in the context of the burn curve that predicts the severity of scald in relation to temperature and time of skin contact. This data is published for adults [43] and is estimated that it takes a quarter of the time to sustain a scald to a child e.g. it takes less than one second for a child to sustain a full thickness burn from water of 60 °C [32].

Giving due consideration to the strengths and limitations of the scientific literature, we have proposed a prototype triage tool for children with scalds (Table 6). If those features found in the left hand column are present (either singly or in combination), then abuse should be actively excluded as a cause. If the features in the middle section are present, abuse should be considered, and if only the features in the white column are present abuse is less likely. This tool is based on current published evidence, but needs a prospective study to fully validate and refine these criteria. Further high quality comparative studies in this field should also include children presenting with scalds that do not require admission, as this group are significantly underrepresented in the current literature. As with all other areas of physical abuse that we have reviewed [45,49], disabled children are sadly lacking from the children studied, and this also needs to be redressed in future work.

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Conflict of interest

None of the authors have any conflict of interest.

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