Research Square

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Fireplace-Related Injuries in Children with Special Emphasis on Neurotrauma: A Retrospective Study from a Paediatric Tertiary Care Centre in the United Kingdom

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Abstract

Purpose

Paediatric fireplace-associated trauma is an infrequent but potentially life-threatening accident. Though, fireplace is a part of most households in regions with long winters, fireplace associated trauma is not studied extensively. This study examines the demography and clinical characteristics of children sustaining fireplace injuries, with special attention to neurosurgical injuries.

Methods

This is a single-centre retrospective observational study carried out at a tertiary care paediatric centre, encompassing all paediatric admissions with fireplace-related accidents between January 2020 and December 2025. Patient demographics, mechanism, type and severity of injury, treatment modality, complications, hospital stay and outcome were systematically recorded and descriptively analysed.

Results

204 paediatric patients were admitted with head injury during the study period, 15(7.4%) of whom were following fireplace accidents. Boys comprised the majority(66.7%) of the cohort, with a mean age of 3 years. Structural collapse of the fireplace onto the child was the predominant mechanism(73%). Multisystem involvement was documented in 15(66.7%) patients, with cranial injury being predominant(47%). 3 patients sustained severe head injury, two of whom died. Surgical management was required in 10 patients, requiring a total of 21 surgeries. The median hospital stay was 2 days with mean intensive care unit(ICU) occupancy of 2.8 days. There were 2 mortalities(13.3%) with 2 patients(13.3%) requiring prolonged rehabilitation.

Conclusion

Although fireplace injuries constitute a small proportion of paediatric trauma admissions, they cause considerable morbidity and mortality due to multisystem involvement. Mandatory anchorage of freestanding fireplace structures and investment in caregiver-targeted safety education can reduce the incidence of these preventable accidents.

Introduction

Domestic environments harbour a diverse range of hazards for young children, and fireplaces represent an often-overlooked structural risk within the home. Positioned at or near floor level and frequently unsecured, these fixtures are accessible to toddlers who routinely engage in exploratory climbing behaviour. Although building regulations in the United Kingdom mandate the installation of protective

barriers around active hearths, compliance is inconsistent, and accidents involving non-operational fireplace structures fall outside the scope of many existing safety guidelines.

A trend of considerable relevance to injury prevention is the widespread adoption of marble and stone fireplace surrounds as replacements for the lighter timber mantels that characterised older housing stock. These contemporary fixtures carry substantially greater mass, and when insufficiently anchored to the wall, are susceptible to sudden collapse when subjected to the weight of a climbing child. The resulting injury pattern, characterised by compressive and blunt force mechanisms rather than thermal exposure, differs markedly from the burns-related injuries traditionally associated with fireplace incidents.

Despite this recognised risk, the academic literature addressing fireplace-related injury as a distinct paediatric trauma category remains sparse. Published work has predominantly grouped such cases within broader household injury datasets, which obscures the specific clinical profile, neurosurgical demands, and outcome characteristics of this patient population. The present study addresses this gap through a dedicated retrospective analysis of fireplace-related paediatric injuries managed at Alder Hey Children's Hospital, Liverpool, one of the United Kingdom's(UK) principal paediatric neurosurgical referral centres, across a five-year study window.

Materials and Methods

This investigation was conducted as a single-centre retrospective observational study at Alder Hey Children's Hospital, Liverpool, UK, a designated paediatric tertiary referral centre serving the North West of England. The study period extended from 1 January 2020 to 31 December 2025. Inclusion criteria were: age under 18 years and hospital admission for trauma directly attributable to a fireplace-related accident. Cases in which the fireplace constituted an incidental finding rather than the primary injury mechanism were excluded from the analysis.

Data were obtained through retrospective interrogation of the hospital's electronic patient record system. The following variables were extracted: age, biological sex, mechanism of injury, anatomical distribution and severity of injuries, operative or non-operative treatment pathway, specific surgical procedures performed, inpatient duration, length of high-dependency and ICU stay, complications arising during admission, and clinical status at discharge. Severity of traumatic brain injury was graded according to the Glasgow Coma Scale (GCS) score recorded at the time of initial clinical assessment: mild injury corresponded to GCS 13–15, moderate to GCS 9–12, and severe to GCS 8 or below.

All variables were subjected to descriptive statistical analysis. This study constitutes a retrospective clinical audit of de-identified patient data and was conducted in conformity with local institutional research governance requirements. Given the retrospective and non-interventional nature of the study, formal submission to a research ethics committee was not mandated under applicable institutional policy.

Review of Literature:

Unintentional injury sustained within the home is a major contributor to paediatric morbidity and mortality in high-income countries. Children below the age of five years bear a disproportionate share of this burden, reflecting the convergence of increasing physical mobility, active environmental exploration, and incompletely developed hazard awareness at this developmental stage [1].

A substantial body of evidence implicates modifiable household and caregiver factors in the occurrence of paediatric home injuries. Systematic review evidence synthesised by Kendrick and colleagues demonstrated that structured parenting programmes incorporating safety education content produced measurable reductions in injury occurrence among young children [2]. Complementary work by Morrongiello et al. drew attention to the role of caregiver behavioural strategies in mitigating in-home injury risk among toddlers, noting that active supervision and environmental modification produced the most consistent protective effects [3]. A multicentre case-control study conducted by LeBlanc and colleagues corroborated these observations by establishing a quantifiable inverse relationship between the adoption of home safety practices and the likelihood of injury in children under five years [4].

Injury attributable to unstable or poorly secured domestic fixtures has received specific attention in the literature. An analysis of United States emergency department data by McKenzie et al. identified a substantial volume of paediatric attendances attributable to household furniture-related trauma, with collapsing or tipping fixtures among the implicated mechanisms [5]. A subsequent national data linkage study by Lu and colleagues confirmed the persistence of this risk, specifically highlighting furniture and television tip-over injuries as an ongoing cause of significant childhood trauma [6]. The Consumer Product Safety Commission has similarly documented fireplaces and hearth structures as potential sources of blunt injury and burn trauma in children, particularly where protective guarding is absent [7].

Thermal contact injuries involving glass-fronted gas fireplace panels represent a distinct and well-characterised injury subset. Dunst et al. reported an accumulation of palm contact burns in toddlers attributed to inadvertent contact with heated glass enclosures [9], while Zettel and colleagues documented comparable injuries in a Canadian paediatric cohort, both series highlighting the thermal hazard posed by gas fireplace technology [10]. These thermal mechanisms are epidemiologically and pathophysiologically distinct from the crush and blunt force injuries that dominate the present study cohort.

The neurosurgical dimension of paediatric trauma is of particular importance given the vulnerability of the developing brain to mechanical injury. Dewan and colleagues conducted a comprehensive international review of paediatric traumatic brain injury epidemiology and identified neurosurgical intervention as a necessary component of management in a clinically significant proportion of cases, with injury severity and rapidity of specialist care among the principal determinants of outcome [8]. A subsequent global burden analysis by the same group estimated an annual worldwide incidence

exceeding 27 million paediatric traumatic brain injury episodes, underscoring the magnitude of this public health problem [16].

The most directly relevant published evidence comes from Hammig and Henry, whose retrospective analysis of United States national surveillance data constitutes the largest study to date specifically examining fireplace-associated paediatric injuries. Their findings indicated that cranial and facial regions were the most commonly affected anatomical sites, while thermal injuries, although present, accounted for only a minority of recorded cases [1]. Critically, that study did not capture the neurosurgical management burden or outcomes associated with these injuries, and no comparable investigation has been published within a United Kingdom paediatric neurosurgical context.

Falls, across a variety of mechanisms, constitute the single most frequent cause of unintentional injury among children in domestic settings [11,12]. Climbing-related fireplace accidents are appropriately considered within this mechanistic category, and existing fall prevention literature provides relevant contextual guidance. Healthcare provider-delivered safety counselling, particularly when delivered at routine well-child consultations, has been shown to be associated with demonstrable improvements in caregiver safety practices [13,14]. Unplanned presentations to emergency departments have likewise been proposed as a clinically opportune setting for injury prevention education, allowing targeted advice to be delivered at a time when the relevance of safety information is likely to be heightened for attending families [15].

The evidence base reviewed above confirms both the public health importance of paediatric home injury prevention and the absence of focused investigation into fireplace-related trauma as a discrete clinical entity within UK paediatric neurosurgical practice. The current study was designed to address this gap.

Results

During the five-year study interval from January 2020 to December 2025, 15 children were admitted to Alder Hey Children's Hospital with injuries sustained in a fireplace-related accident. This cohort represented 7.4% of the 204 total paediatric head injury admissions recorded at the institution during the same period. Ten patients were male (66.7%), yielding a male-to-female ratio of 2:1. The mean age at admission was 3 years, with 2 years being the most frequently observed age at presentation (Table 1).

Structural collapse of the fireplace onto the child was the predominant mechanism of injury, responsible for 11 of the 15 cases (73%). The four remaining patients (27%) sustained injuries as a direct consequence of falling from a height whilst attempting to scale the fireplace surround (Table 1).

Concurrent injury across multiple anatomical systems was documented in 10 patients (66.7%). Cranial injury was the most prevalent finding across the cohort, present in seven children (47%). Abdominal injury was identified in five patients (33%), while thoracic involvement was recorded in four (27%). Facial and limb injuries were each present in three patients (20%). Given the multisystem nature of many presentations, cumulative injury percentages exceed 100% (Table 1).

Table 1
Demographics, Mechanism, and Pattern of Injuries in Children with Fireplace-Related Trauma (2020–2025)

Category	Variable	Result
Study Population	Total paediatric head injury admissions	204
	Fireplace-related injuries	15 (7.4%)
Demographics	Male	10 (66.7%)
	Female	5 (33.3%)
	Male:Female ratio	2:1
	Mean age at presentation	3 years
	Most common age (mode)	2 years
Mechanism of Injury	Fireplace fell onto child	11 (73%)
	Fall while climbing fireplace	4 (27%)
Injury Pattern*	Head injury	7 (47%)
	Abdominal injury	5 (33%)
	Chest injury	4 (27%)
	Facial injury	3 (20%)
	Limb injury	3 (20%)
	Multisystem injury	10 (66.7%)

*Cumulative percentages exceed 100% owing to multisystem injury involvement.

Surgical intervention was required in 10 patients (67.6%), with a cumulative total of 21 operative procedures undertaken across this group. Five patients underwent neurosurgical procedures for management of cranial injuries. Formal thoracotomy was performed in four children with significant chest trauma, and exploratory laparotomy was necessary in five patients with abdominal injuries. A single case of major vascular injury necessitated primary vascular reconstruction. Soft-tissue lacerations involving the face (n = 3) and limbs (n = 3) were managed by primary surgical repair under the care of the respective subspecialty teams. The remaining five patients (33.3%) were managed without operative intervention; this group included two children with mild head injuries and one child who sustained a spinal injury managed conservatively (Table 2).

Within the head-injured subgroup, the mean GCS score recorded at the time of admission was 10. Neuroimaging demonstrated intracranial haemorrhage in two cases, skull vault fractures in three patients (of whom two had evidence of cortical depression), and scalp soft-tissue injury in two further cases. Three children met criteria for severe traumatic brain injury on the basis of GCS scores of 8 or

below. Of these, two underwent neurosurgical intervention: both required invasive intracranial pressure(ICP) monitoring, one via insertion of a parenchymal ICP probe and the other via external ventricular drain placement; the latter patient subsequently developed communicating hydrocephalus attributable to intraventricular haemorrhage and required implantation of a permanent ventriculoperitoneal shunt. The third patient in this severity category harboured a frontal depressed skull fracture requiring craniotomy with surgical elevation (Table 2).

Table 2
Management, Surgical Procedures, and Head Injury Characteristics in Children with Fireplace-Related Trauma (n = 15)

Category	**Variable**	**No. of Patients (%) / No.**
Overall Management	Operative management	10 (67.6%)
	Non-operative management	5 (33.3%)
	Total surgical procedures	21
Surgical Procedures	Primary repair of lacerations (face/limb)	6
	Thoracotomy	4
	Laparotomy	5
	Vascular repair	1
Patterns of Head Injury	Intracranial bleed	2
	Skull fracture	3
	Depressed skull fracture	2
	Scalp soft-tissue injury	2
Head Injury Severity	Severe head injury	3
	Moderate head injury	2
	Mild head injury	2
Neurosurgical Interventions	ICP monitoring (ICP probe/EVD)	2
	Ventriculoperitoneal shunt	1
	Craniotomy with elevation of depressed fracture	1

Significant complications arose in multiple patients during the course of hospital stay. Haemodynamic compromise secondary to hypovolaemic shock was documented in four children, each of whom received blood product transfusion as part of their resuscitation. Endotracheal intubation for the

purposes of airway protection or ventilatory support was required in six cases. Two patients died during the acute inpatient episode; both deaths were attributable to circulatory failure in the context of refractory hypovolaemic shock (Table 3).

Inpatient stay extended from a minimum of one day to a maximum of 120 days across the cohort, with a median duration of 2 days and an arithmetic mean of 16.3 days. Three children required prolonged admissions in excess of 45 days. Among the two patients who underwent invasive ICP monitoring, inpatient durations of 45 and 120 days were recorded respectively; the third patient with severe head injury experienced a more favourable clinical course and was discharged at day 3. The median duration of occupancy in intensive care or high-dependency facilities was 1 day, with a mean of 2.8 days. At the point of discharge, two children were transferred to specialist neurorehabilitation services (Table 3).

Table 3
Complications, Critical Care Requirements, and Outcomes in Children with Fireplace-Related Trauma (n = 15)

Category	Variable	Result
Complications/Morbidity	Intubation for airway/respiratory support	6
	Blood transfusion required	4
	Hypovolemic shock	4
	Mortality	2 (13.3%)
Hospital Stay	Length of stay (range)	1-120 days
	Median/Mean hospital stay	2/16.3 days
Severe Head Injury Subgroup (n = 3)	Mean hospital stay	63.3 days
Critical Care Stay	ICU/HDU stay (Median)	1 day
	Mean ICU/HDU stay	2.8 days
Outcome	Discharged to Home	11 (73.3%)
	Discharged to Neurorehabilitation	2 (13.3%)
	Deaths	2 (13.3%)

Discussion

This case series characterises the clinical profile of fireplace-related injury in children presenting to a dedicated paediatric neurosurgical centre, and reinforces the view that, despite its relatively low incidence, this injury category exerts a disproportionate burden on surgical and critical care resources. The multisystem nature of many presentations, the high operative rate, and the occurrence of two fatalities within a cohort of only 15 patients collectively attest to the severity of harm these accidents are capable of producing.

The over-representation of male patients (66.7%) and the concentration of cases in the second and third years of life are consistent with broad epidemiological trends observed in general paediatric injury surveillance. Male children in this age group characteristically display greater propensity for physical risk-taking, combined with the motor capability to initiate climbing activities but without the cognitive maturity to appraise associated danger [5,6]. This developmental mismatch is well recognised as a driver of home injury incidence and should inform the targeting of prevention messaging towards caregivers of young male children.

A feature of considerable interest in this dataset is the complete absence of thermal injury. This stands in contrast to the experience of Hammig and Henry, in whose United States series approximately one in ten children sustained a burn [1]. Several factors are likely to account for this divergence. In contemporary British households, space heating is almost universally provided by gas-fired central heating systems or electric radiators, rendering the traditional open fireplace largely ornamental. As a consequence, the majority of fireplace-related accidents in this cohort occurred when the structure was cold and inactive. The refractory lining materials used within fireboxes further limit thermal energy dissipation to external surfaces. Additionally, injuries in this series predominantly arose from sudden collapse of the structure rather than from sustained contact with the hearth, reducing the opportunity for thermal exposure irrespective of functional status. This pattern is mechanistically analogous to furniture tip-over injuries [5,6] and underscores the importance of structural stability as the primary prevention target in this setting.

Cranial injury emerged as the most prevalent injury type (47%), a finding that accords with the established pattern of head injury predominance in paediatric blunt trauma. The anatomical consequences of a heavy fireplace structure falling directly onto a small child are predictable: the calvarium, thorax, and abdomen intercept the descending mass before the extremities, which accounts for the relatively low frequency of limb injury (20%) compared with truncal and head involvement. This topographic distribution distinguishes fireplace collapse injuries from other childhood fall mechanisms and carries direct implications for the initial clinical assessment priorities in affected children.

The need for operative intervention in more than two thirds of patients in this series reflects the severity and anatomical breadth of the injuries sustained. The generation of 21 surgical procedures across 10 patients illustrates the resource intensity of managing this injury pattern and highlights the importance of access to multidisciplinary surgical expertise, encompassing neurosurgery, paediatric surgery, cardiothoracic surgery, vascular surgery, and plastic surgery, at the treating institution. The 13.3% mortality rate recorded in this cohort is substantially higher than that reported for general paediatric trauma populations and warrants particular attention in public health discourse.

The dominant mechanism identified in this series, namely the forward or lateral collapse of the fireplace structure onto the child (73% of cases), points unambiguously to inadequate wall fixation as the key modifiable antecedent. The proliferation of heavy natural stone and marble fireplace (Fig. 1) surrounds within domestic refurbishment markets over the past two decades has materially increased the mass of

structures to which children may be exposed, with correspondingly greater injury potential should anchorage fail. A regulatory framework mandating secure wall fixation for all non-structural fireplace installations, analogous to existing standards for television and furniture anti-topple devices, would address this risk directly.

Preventive intervention must also engage caregivers at the level of behavioural change. Evidence from randomised and observational studies consistently supports the integration of home safety counselling into routine paediatric health surveillance contacts, demonstrating that anticipatory guidance delivered during well-child appointments can produce durable improvements in household safety practices [13,14]. The acute care encounter has additionally been proposed as a setting with particular preventive potential: families attending emergency departments following an injury may be especially receptive to safety information at that moment [15]. Both settings offer practical platforms for disseminating specific guidance on fireplace hazard recognition and mitigation.

Several limitations inherent to this study should be acknowledged. The small absolute cohort size reflects the low absolute incidence of this injury type rather than any methodological deficiency but restricts the statistical inferences that can be drawn. As a retrospective single-centre audit, the findings are susceptible to referral bias, with the tertiary neurosurgical context of the reporting institution likely enriching the case-mix with more severely injured patients relative to the general population of affected children. Prospective multicentre data collection, ideally coordinated through a national paediatric trauma registry, would provide a more representative characterisation of the epidemiology and clinical trajectory of this injury category.

Conclusion

Fireplace-related injury in children, whilst uncommon on an absolute basis, is associated with a substantial risk of serious harm spanning multiple organ systems, with cranial injury constituting both the most frequent and most clinically consequential component. Unlike the thermal injury patterns historically linked to fireplace exposure, the injuries encountered in this series were overwhelmingly mechanical in nature, arising principally from the collapse of inadequately secured heavy structures onto small children. A high proportion of affected patients require operative management, and the case fatality rate in this cohort underscores the potential lethality of this mechanism. Structural safety regulation mandating secure fixture installation, combined with proactive caregiver education delivered through established healthcare contacts, offers the most promising pathway to reducing the incidence of these preventable injuries. Collaborative multicentre investigation is warranted to substantiate these findings and to inform evidence-based national prevention policy.

Declarations

Ethics Approval:

This study was conducted as a retrospective clinical audit of anonymised patient data in accordance with local institutional research governance policy. Formal ethical committee review was not required.

Informed Consent:

Not applicable. This study involved retrospective analysis of anonymised data only.

Conflict of Interest:

The authors declare that they have no conflicts of interest relevant to this work.

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Author Contribution

Y.K and M.J.M were involved in data collection, primary manuscript writing, manuscript submission and statistical analysis.A.K.S was responsible for the idea behind the research, manuscript critical review and statistical analysis.J.E, C.P and V.V were involved in critical review, editing and correction of the manuscript.M.M and K.B were involved in critical review and editing.

Data Availability

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request. Data are located in controlled access data storage at Alder Hey Children's Hospital, Liverpool.

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Figures



Figure 1

A modern marble fireplace with the hearth