

Can child fatalities in house fires be prevented?

Tim Squires, A Busuttil

Abstract

Objectives—To analyse all child deaths in house fires in Scotland between 1980 and 1990.

Methods—Retrospective study of all child house fire fatalities based on the 'sudden death' investigation instigated by the procurator fiscal in whose jurisdiction the death occurred. The necropsy, toxicology, police, and fire brigade reports were examined in each case.

Results—There were 168 child deaths occurring in 118 house fires. In the 0–5 years age group 40% of deaths occurred in fires started as a direct result of the actions of children. The careless disposal of smoking materials was the most frequent cause of fatal fires killing older children. Upholstery and bedding were common materials of first ignition, accounting for over half the incidents. The majority of children were dead before the arrival of the emergency services and most died as a result of the inhalation of smoke.

Conclusions—This survey emphasises the importance of 'self escape' which, particularly in the case of young children, requires the assistance of adult carers. The number of fires started as a result of children playing with sources of ignition raises important questions of supervision and the provision of a safe environment. There is, we contend, a need to highlight the importance of individual behaviour and responsibility while recognising the need to develop measures that are relevant to, and effective in, a particular socioeconomic context.

(*Injury Prevention* 1996; 2: 109–113)

Keywords: fire, child fatalities.

The policy statement *Scotland's Health: A Challenge To Us All* designated accident prevention as a priority area for action to improve the nation's health.¹ Deaths in fires were noted to be a particular cause for concern. In Scotland the majority of fire deaths occur in the home. The elderly and the young are the most vulnerable age groups.^{2–4} There were 168 deaths in house fires involving children below the age of 17 between 1980 and 1990; this age group accounts for 15.4% of all house fire deaths. Based on this figure, house fires are the fifth leading cause of death from age 1–15 years and account for approximately 7% of all deaths in that age group.² This study focuses on the ways in which fires and fire deaths are related to

aspects of individual behaviour. It argues that modification of behaviour is an essential aspect of achieving reductions in the fatality rate. The analysis takes place against the background of the well documented association between higher accident rates and socioeconomic deprivation.^{5–7}

Methods

Eight Scottish fire brigades reported 1647 fire fatalities during the period 1980 to 1990. These fatalities resulted from a range of events including house fires, road traffic accidents, fires at a place of employment, and deliberate acts of ignition. A total of 1248 files were identified, traced, and examined. The study used records kept by the procurators fiscal — Scottish law officers primarily responsible for raising and prosecuting criminal proceedings in the Scottish courts. These officials also have a common law duty to investigate all sudden, suspicious, or unexplained deaths occurring within their jurisdiction.⁸ Data were collated from copies of the police, postmortem, toxicology and, where available, fire brigade fatal fire investigation reports.

The police report provided a summary of the circumstances of the deceased and other family members and described the events leading to the fire. Cause of death and relevant necropsy findings were obtained from the pathologist's report, and a toxicologist frequently reported the carboxyhaemoglobin saturation. The body burn surface area (BBSA) was either reported by the certifying doctor or was estimated from the necropsy report. The 'rule of 9s',⁹ which divides the body into regions (for example arm, chest, abdomen, leg (front), head = 9%) was used as an approximate severity measure. As part of their investigation into the death, the police and procurators fiscal interviewed family members and other witnesses; some qualitative evidence from these statements is also considered in this study.

The procurator fiscal will usually instruct that a toxicological analysis for a body fluid-alcohol concentration is performed in the majority of adult fatalities. There is, however, no mechanism in the medicolegal investigation of fire death in Scotland for obtaining body-alcohol concentrations from adult survivors. This means that there are no objective data to ascertain precisely how many adult carers of children were intoxicated at the time of the fire unless all adult carers also died.

This project studied the physical factors associated with individual fire incidents and casualties. Data that could be used to investigate the association with deprivation were not a direct concern of this study. However, to place the fires studied into the wider

Forensic Medicine
Unit, University of
Edinburgh Medical
School
T Squires
A Busuttil

Correspondence to:
Tim Squires, Forensic
Medicine Unit, University of
Edinburgh Medical School,
Teviot Place, Edinburgh
EH8 9AG, UK.

Population and house fire fatality rates by age and sex, Scotland 1980–90

Age (years)	Males			Females		
	Population	Mean fatalities/year*	Rate	Population	Mean fatalities/year*	Rate
<2	67.05	2.09	3.12	63.60	2.00	3.14
2–4	98.85	3.09	3.13	93.80	2.55	2.72
5–7	101.65	1.18	1.16	96.90	0.91	0.94
8–10	113.10	0.55	0.49	107.95	0.82	0.76
11–13	114.05	0.45	0.39	107.90	0.45	0.42
14–16	120.10	0.64	0.53	114.45	0.55	0.48
All (0–16)	614.80	8.00	1.30	584.60	7.27	1.24

*Population × 1000, mean 1980–90, rates/100 000.

socioeconomic context, when available, housing tenure was recorded.

Results

The incidence rates of house fire fatalities by age and sex are shown in the table; there is no significant difference between the rates by sex. However, it is evident that the very young have a much higher rate than older age groups.

The 168 child deaths occurred in 118 fire incidents, an average of 1.4 child fatalities per house fire. Most fires occurred between midnight and midday, with 42 incidents (37%) in the six hours after midnight and 41 (36%) between 6 am and noon. The other fires were distributed evenly between noon and midnight.

Sixty four fires occurred in properties rented from the local housing authority, two were in owner occupied homes and eight were in homes rented from a housing association or a private landlord. In 44 cases the owner of the house was not recorded.

In 11 incidents there were no survivors. This includes three fires in which a single child was alone in the house when the fire started. In 107 (91%) incidents there was at least one surviving occupant. Sixty three were single fatality fires and 55 involved multiple deaths. In 29 (25%), an adult occupant of the household was also killed.

The figure shows the number of child fatalities by the cause of fire and age group. Over 40% of deaths in the 0–5 age group occur in fires started as a direct result of the actions of children. Two thirds of the children who died in these fires were boys, but whether the fire was started by a child who died or by a surviving child often remained open to speculation. Fire brigade investigations indicated that the majority of fires started by younger children involved matches or cigarette lighters, or access to open coal or electric fires. There was no evidence to suggest that any of these fires were started 'deliberately' in the sense that the child intended to cause a significant fire. In the older age group, the main cause was the careless disposal of smoking materials (presumably by adult members of the household).

Fires started by electrical appliances, particularly electric heaters (frequently in the child's bedroom, either providing room heating or a source for drying clothing) accounted for approximately 20% of incidents. Electric blankets were not a significant cause of child fatalities,

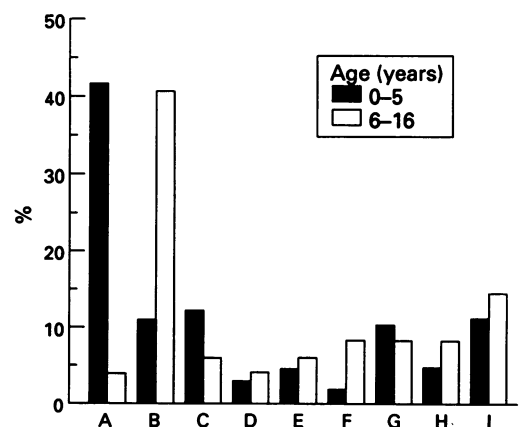
accounting for only three incidents. However, five 'chip pan' fires (cooking related fires involving the combustion of hot fats or oils) resulted in a child fatality. Faulty electrical equipment and wiring caused four fires in this series.

In over half the incidents with a known material of first ignition, the fire initially involved upholstery (43.3%) or bedding (10.3%). In seven (7.2%) cases, the fire first developed by igniting the child's clothing.

Approximately three quarters of children died as a result of the inhalation of smoke and products of combustion. Although these death certificates almost invariably stated the primary (Ia) cause of death in general terms, such as 'smoke inhalation', carbon monoxide is the most prevalent toxic gas in a house fire. Toxicology for carboxyhaemoglobin was reported in 102 cases, with a mean (SD) carboxyhaemoglobin saturation of 51.7 (22.3%) and a range of 4% to 88%.

In the 144 cases in which the area of the burn had been ascertained, the mean (SD) BBSA was 59.9 (38.7%). No burn injury was reported in 13 cases, and 24 cases were reported as involving less than 9% BBSA. Whether these burns were inflicted antemortem or post-mortem was not reported in the majority of cases, reflecting the difficulty of distinguishing between a burn inflicted during life and that occurring as a result of continued exposure to high temperatures after death.

Eleven children (6.5%) were reported to have been alive at the time of first contact with a doctor. Over 90% of fatalities were, therefore, already dead before treatment could commence. There was no statistically significant difference between the reported BBSA in the patients who survived the initial incident and those pronounced dead at the time of first contact with a doctor (over 80% of these at the scene of the fire). The mean BBSA in patients admitted to hospital was 61.9%. The significance of this figure, however, lies in the fact that it refers to antemortem burn injury. One victim who survived less than one hour after the fire had a BBSA less than 9%. Only



Fatalities by cause of fire and age, Scotland 1980–90. A: children playing (matches etc); B: disposal of smoking materials; C: electric heater; D: electric blankets; E: other electrical appliances; F: electrical wiring fault; G: non-electric space heaters; H: 'chip pan' fires; I: other/not specified.

one case with a longer term survival (> 48 hours) had a BBSA less than 18%: the remaining cases had BBSA in excess of 54% as assessed by the 'rule of 9s'.

There was some evidence indicating that the children who were killed tended not to make any attempt to escape the fire. Preambulatory children were unable to escape unassisted and older children often appeared to be reluctant to leave the perceived safety of their bedroom or other room. According to the summaries of the incidents by the procurators fiscal, several parents reported that their children had been unwilling to jump from first floor bedrooms despite the presence of their parents below the window.

There was no evidence from this survey that the quality of medical treatment was compromised because of the delayed arrival of the emergency services at the scene. Further, there was no evidence that the standard of medical treatment was deficient, either in terms of the initial resuscitation, during transfer, or after admission to hospital. The 10 patients who survived longer than 48 hours had poor prognoses, with nine cases having BBSA in excess of half the body surface.

Discussion

Fatalities in house fires can be prevented in three ways: preventing the onset of the fire, early detection coupled with escape in the event of fire, and prompt emergency medical treatment of casualties.

FIRE PREVENTION

Preventing the outbreak of fire is the cornerstone of primary prevention. The majority of fires in which children are killed are a direct consequence of human activity: it follows that modification of behaviour is likely to lead to a decrease in the number of fires and, consequently, the number of fatalities.

BEHAVIOUR OF CHILDREN

Preventing the causal link between the behaviour of children and the outbreak of fire is, we contend, a function of three factors: supervision, environment, and awareness of risk.

To the extent that young children can be made aware of fire risk, there is a priority to educate, and the Scottish fire brigades have been active in this area. However, research has indicated that children have a limited concept of 'risk' and risky behaviour. The study of McWhirter and Weston showed that only 5% of children cited 'risks at home' when asked to identify hazardous situations which, although not evidence that children are unaware of the risks associated with certain types of behaviour, suggests that the child's perception of risk is at odds with what might be termed the calculated scientific risk.¹⁰ Given that the potential for risk awareness is low, the emphasis shifts from children's behaviour to the quality of supervision provided by their adult carers.

Supervision of young children is a complex issue. There is an ill defined distinction between permitting a child legitimate and essential freedoms and inadequate care.¹¹ Margolin identified cases in which carers had been cited for neglect because they failed to provide adequate supervision to prevent the onset of fire.¹² The unfortunate fact, however, is that a child can easily initiate a sequence of events that will inevitably lead to a serious fire incident in a very short time, and it is unreasonable, and arguably undesirable or impossible, to expect carers to remain in constant visual contact with children 24 hours a day.

The fact that continuous direct supervision is not feasible emphasises the importance of ensuring that the 'unsupervised' child is in a safe environment. This is particularly important considering the high proportion of fires killing young children that are caused by children playing with matches or open coal fires, gas, or electrical heaters. Although the simple expedient of denying children access to matches would undoubtedly reduce the fatality rate, the provision of safety equipment, such as fire guards through loan or cheap secondhand purchase schemes, might also prove valuable in this respect and should be further promoted and evaluated. Safety related publications such as those published by the Child Accident Prevention Trust and the Health Education Board are widely distributed and offer advice on safety equipment and procedures.^{13 14} These examples of safety literature were found by one of the authors in the paediatric unit of a large hospital, and it is reasonable to suppose that they are available to all socioeconomic groups. However, the availability of leaflets giving advice does not guarantee either that high risk groups will read the literature or, even if they do, that economic circumstances will permit them to implement the recommended effective safety measures.

Legislation, such as that governing foam filled furniture is also important, but the effects of such provisions are long term and cannot be evaluated in a study of this kind. The evidence of the materials of first ignition suggests that efforts to improve the fire retardant qualities of domestic fabrics should be encouraged, particularly by promoting the fire retardancy standard BS 5852.¹⁵ It should be emphasised however, that preventing the manufacture and sale of hazardous materials does not automatically persuade people to replace older and less safe furniture and furnishings. Furniture that is inherently unsafe is likely to remain in circulation, particularly in lower socioeconomic communities, for several years, and the availability of expensive yet 'safe' new items is possibly largely irrelevant. There are crucial economic issues involved in this area that should be addressed by appropriate agencies. Reports from the United States suggest that legislation does make a difference in the fire fatality rate.^{16 17}

Supervision of young children, and ensuring safe home environments, is the responsibility of adult carers. To that extent, therefore, fires caused by children are related to the behaviour

of adults and, particularly, parents. The adult carers' role in initiating fires killing children is most evident in those fires ignited as a result of the careless disposal of smoking materials.

ADULT BEHAVIOUR

The high blood alcohol concentrations observed in fire fatalities, and reported elsewhere,¹⁸ does not establish a causal relationship between alcohol intoxication and the outbreak of fire. It does, nevertheless, highlight the well established association between alcohol and fire (particularly fires resulting from the careless disposal of smoking materials).¹⁹⁻²²

EARLY DETECTION AND ESCAPE

If adult carers were to alter their behaviour, particularly with respect to alcohol consumption and supervision (including the provision of a safe environment), the child fatality rate in house fires would be substantially reduced. There is no unequivocal evidence, however, to suggest that previous education and prevention campaigns have resulted in long term significant decreases in the number of fatalities, and it is necessary to accept that house fires will occur and therefore to also focus on the detection and escape aspects of safety.

The most important toxic gas in a domestic fire is carbon monoxide, which can lead to incapacitation and death within a few minutes.^{23,24} In addition to other toxic substances, such as hydrogen cyanide, it is likely that the atmosphere will also contain particles that severely reduce visibility and make escape more difficult.²⁵ Early detection of fire is, therefore, critical, and the value of a functional, correctly sited smoke alarm in this respect is well established.²⁶⁻²⁸ A smoke alarm is a passive safety device and serves only to alert the occupants of a house that a potentially dangerous situation *already* exists within the building. The efficacy of a smoke alarm in this respect is contingent on its being correctly sited and adequately maintained. Although there are obvious opportunities to control the installation of an alarm by legislation and statutory powers, it is difficult to ensure compliance with any regulatory system governing maintenance.

The anecdotal evidence that children are unlikely to escape unassisted tends to confirm other reports.²⁹ Although a retrospective survey of this kind can only identify the factors associated with failure to escape, it is reasonable to extrapolate: given that the majority of the child fatalities were dead before the arrival at the scene of the emergency services, parental assistance would have been a prerequisite for escape. This raises the general issue of the provision of escape routes in the home: are parents educated adequately regarding the correct procedures in the event of fires? Although it was not possible to evaluate precisely the extent to which alcohol intoxication rendered adult carers incapable of assisting children, behaviour under stress and incapacitation are relevant to successful

escape.³⁰ The reduction in neuromuscular coordination and higher cerebral function associated with alcohol is also clearly a factor.³¹

TREATMENT OF CASUALTIES

Improvements in medical care can have only a marginal role in further reducing the fatality rate because the majority of fatalities are dead before the arrival of the emergency services.

IMPLICATIONS FOR PREVENTION

The efforts of fire brigades are paramount in keeping the number of child fatalities down to the numbers quoted in this report: without the effective work of the fire and other emergency services the fatality rate would be significantly higher. However, the primary intention of this survey is to highlight the difficulties associated with achieving *further* reductions in the child fatality rate, particularly given the fact that the large majority of these fatalities were dead before the arrival of emergency services. That important finding serves to emphasise the importance of the parental role in rescue and escape.

What this research is not able to do is to comment on the differences between fatal and non-fatal fires involving children, nor on the factors that enable some children to survive while others die. This deficiency emphasises the need for further research to compare fatal and non-fatal house fires.

Fatal house fires are generally reported as being tragic 'accidents': this assignation is conceptually ambiguous because it disguises the causal link between the outbreak of fire and human behaviour. The term 'accident' conveys a notion of unpredictability³² whereas the evidence suggests that the majority of child fatalities in house fires tend to occur in *predictable* circumstances and this, in turn, suggests that they are *preventable*. The emphasis on prevention lies with those who have *de facto* control over the home environment, and in the case of child fatalities, this usually means parents. The notion of apportioning blame to individuals and making them solely responsible for their own health has been widely criticised as being merely 'victim blaming'.³³ This also has implications for labelling individuals belonging to lower socioeconomic groups as being 'high risk' while failing to take all the social and economic circumstances into account. To the extent that housing tenure is a measure of socioeconomic status, the majority of this series lived in areas of above average deprivation. This confirms other fire related research that has identified that the child fatality rate is highest among the lower socioeconomic groups.²⁷ More generally, areas of higher deprivation and disadvantaged groups are known to have higher accident rates.^{6,7} This social gradient means that solutions appropriate to one social class might not be relevant to another.³ It is not reasonable, for example, to expect low income families to replace home furnishings simply on the grounds of safety.

We emphasise that our findings raise socioeconomic issues that require political solutions at both national and community levels. We also contend, however, that it remains necessary to identify those areas in which individual behaviour is a significant factor and continue to address these concerns by educational preventative strategies.

- 1 The Scottish Office. *Scotland's health: a challenge to us all*. Edinburgh: HMSO, 1992.
- 2 Registrar General Scotland. *Annual report*. Edinburgh: General Register Office, 1990 (annual).
- 3 Yoshida M, Adachi J, Watabiki T, Tatsuno Y, Ishida N. A study on house fire victims: age, carboxyhaemoglobin, hydrogen cyanide and hemolysis. *Forensic Sci Int* 1991; 52: 13-20.
- 4 Scottish Office Interdepartmental Working Party on Accidents. *Scottish accident statistics*. Edinburgh: Scottish Office, 1994.
- 5 Pankhurst L. The Child Accident Prevention Trust (UK). *Injury Prevention* 1995; 1: 49-52.
- 6 Carstairs V, Morris R. Deprivation and health in Scotland. *Health Bull (Edinb)* 1990; 48: 162-75.
- 7 Roberts I, Pless B. Social policy as a cause of childhood accidents: the children of lone mothers. *BMJ* 1995; 311: 925-8.
- 8 Carmichael IHB. *Sudden deaths and fatal accident inquiries*. 2nd Ed. Edinburgh: W Green, 1993.
- 9 Hope RA, Longmore JM, Hodgetts TJ, Ramrakha PS. *Oxford handbook of clinical medicine*. 3rd Ed. Oxford: Oxford University Press, 1993.
- 10 McWhirter J, Weston R. Sharks, cliffs and jagged rocks: children's concepts of risk. *Health Education* 1994; 2: 8-11.
- 11 Feldman KW, Monastersky C, Feldman GK. When is childhood drowning neglect? *Child Abuse Negl* 1993; 17: 329-36.
- 12 Margolin L. Fatal child neglect. *Child Welfare* 1990; LXIX: 309-19.
- 13 Child Accident Prevention Trust. *Keep them safe: a guide to child safety equipment*. London: CAPT, 1990.
- 14 Health Education Board for Scotland. *Play it safe: a guide to preventing children's accidents*. Edinburgh: HEBS, 1992.
- 15 Schedules 4,5 Part 1, Furniture and Furnishings (Fire) (Safety) Regulations 1988.
- 16 Tinsworth DK. *Hazard data related to the flammability of wearing apparel*. Washington DC: US Consumer Product Safety Commission, April 1985.
- 17 Harwood B, Hall J. What kills in fires: smoke inhalation or burns? *Fire Journal* 1989; May/June: 29-34.
- 18 Squires TJ, Busuttill A. Child fatalities in Scottish house fires 1980-1990: a case of child neglect? *Child Abuse Negl* 1995; 19: 865-73.
- 19 Theilade P. Carbon monoxide poisoning: five-years' experience in a defined population. *Am J Forensic Med Pathol* 1990; 11: 219-25.
- 20 Anderson RA, Willetts P, Cheng KN, Harland WA. Fire deaths in the United Kingdom 1976-82. *Fire and Materials* 1983; 7: 67-72.
- 21 Trier H. Fire fatalities and deaths from burns in Denmark in 1980. *Med Sci Law* 1983; 2: 116-20.
- 22 Teige B, Lundevall J, Fleischer E. Carboxyhaemoglobin concentrations in fire victims and in cases of fatal carbon monoxide poisoning. *Z Rechtsmedizin* 1977; 80: 17-21.
- 23 Clark RJ, Beeley JM. Smoke inhalation. *Br J Hosp Med* 1989; 41: 252-8.
- 24 Anderson RA, Watson AA, Harland WA. Fire deaths in the Glasgow area: II The role of carbon monoxide. *Med Sci Law* 1981; 21: 288-94.
- 25 Building Research Establishment. *Toxic effects of fires. Digest 300*. Borehamwood: Fire Research Station, 1985.
- 26 Runyan CW, Bangdiwala SI, Linzer MA, Sacks JJ, Butts J. Risk factors for fatal residential fires. *N Engl J Med* 1992; 327: 859-87.
- 27 O'Shea JS. House-fire and drowning deaths among children and young adults. *Am J Forensic Med Pathol* 1991; 12: 33-5.
- 28 Gorman RL, Charney E, Holtzman NA, Roberts KB. A successful city-wide smoke detector giveaway program. *Pediatrics* 1985; 75: 14-8.
- 29 Fornes P, Lecomte D, Imbert M, Lambert P, Baud FJ, Julien H. An analysis of the factors implicated in fire deaths in children. *Journal of Clinical Forensic Medicine* 1994; 1: 79-82.
- 30 Hill IR. Incapacitation and fires. *Am J Forensic Med Pathol* 1989; 10: 49-53.
- 31 Glencross D, Hansen J, Piek J. The effects of alcohol on preparation for expected and unexpected events. *Drug and Alcohol Review* 1995; 14: 171-7.
- 32 Evans L. Medical accidents: no such thing? *BMJ* 1993; 307: 1438-9.
- 33 Crawford R. You are dangerous to your health: the ideology and politics of victim blaming. *Int J Health Serv* 1977; 7: 663-80.

Child dies buried under snowman

A report from Zurich that appeared in the *Cape Times* (4 January 1996) describes the death of a toddler who suffocated after her father accidentally buried her in a snowman. 'My husband didn't see her when he was rolling the snowball to make the snowman', said the mother, who assumed the child fell asleep on the ground.

Elmer's school safety game

For National Safe School week last year (1995) the Canada Safety Council produced a safety game — using a die with coins or buttons for markers, and you move around the board and you must 'remember to follow the rules along the path to get through safely'. (*Editor's note: I have some questions: is there any reason to think that a single child played this game? If so, is there any reason to believe that it improved safety awareness, let alone practises? As if this were not enough, what in the world does a square 'You picked up after yourself in the classroom: advance 2 spaces' have to do with safety? Why is it 'rewarded' to the same degree as 'You always wear a helmet when you ride your bike'.)*

Police cannot run red lights

After a child was killed by a police car in Montreal in 1990, the police were ordered to stop for traffic lights. Despite this, three women were seriously injured recently when a cruiser slammed into their car, apparently speeding through a traffic signal.