FATAL POISONING IN CHILDHOOD, ENGLAND & WALES 1968-2000

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Abstract

We analysed deaths certified as due to poisoning in England & Wales, 1968-2000, in children aged < 10 years by age, sex, circumstances of death, intent, and agents involved. The number of deaths fell from 165 (20.6 per million children) in 1968 to 30 (4.6 per million) in 2000, a decrease of approximately 80 %. The age-specific death rates were similar in boys and girls. The rate was initially much higher, and fell more, in those aged < 5 years. Most deaths (n = 1923) occurred in fires, and had been attributed to inhaling combustion products. A small number (n = 104) occurred in fires resulting from motor vehicle and other transport accidents. From 1979 (use of ICD-9) the coding of some of these deaths changed from poisoning with carbon monoxide to poisoning with 'other gases, fumes or vapours'. These 'fire deaths' do not appear as poisonings in mortality statistics based on a single underlying cause of death, and cannot be tabulated as poisoning in many countries. Fire deaths and deaths coded to accidental, deliberate, or undetermined poisoning (n = 702) decreased substantially with time, and by 2000 numbered 14 and 10, respectively. Accidental deaths declined from 151 in 1968 to 23 in 2000, but homicides and open verdicts varied from 5-20 per year, with no clear trend. Deaths attributed to carbon monoxide and to 'other gases, fumes or vapours' (mostly fire-related) totalled 2431 (84 % of all poisoning deaths). Overall, 10 % of these deaths were either certified as homicides or open verdicts. However, homicide or open verdict was recorded in half of the 47 fatal opiate poisonings. Opioids have now superseded antidepressants as the commonest agents encountered in fatal poisoning with drugs in children.

Keywords: Fatal poisoning-Children; International Classification of Diseases: Fatal Poisoning; Non-accidental poisoning-Children

Introduction

In developed countries acute poisoning in adolescents and in adults is now largely associated with deliberate self-poisoning or substance abuse. This is especially true as regards fatal poisoning [1]. However, in children aged < 10 years the picture is quite different. Children aged < 5 years may put small items into their mouths [2], a characteristic which predisposes to accidental poisoning. Most (80-85 %) such incidents occur in the child's home [3], and in some instances the substances involved either have not been stored in their usual place, or have been taken out of their original container [4]. A child may also be poisoned by an adult who administers a toxic substance by mistake, and sometimes a parent or other person may poison a child deliberately, on occasions with fatal consequences [5]. Rarely prescribing or other clinical errors may result in death. Older, emotionally disturbed children may deliberately poison themselves [6,7], a phenomenon that is said to occur more commonly during school term-time than at Christmas or during summer holidays [8,9] and to be markedly predominant in girls [10].

National mortality data are an important source for monitoring the effect of some public health measures, although with poisoning care is needed if the available data are to be interpreted correctly [1,11]. Although much attention has been paid to the dangers of poisoning with household products, environmental contaminants, and drugs in children, deaths in fires attributed to the inhalation of products of combustion (carbon monoxide and/or other fire gases) rather than burns may predominate in fatal poisoning statistics in this age group. However, carbon monoxide may also feature in accidental deaths in children due, for example, to improperly ventilated gas and other fires, and may also be used in homicides. Using secondary cause in addition to underlying cause of death identifies a larger number of poisoning deaths. Therefore, we analysed fatal poisoning in England & Wales in children aged < 10 years (coded according to the 8th and 9th revisions of the International Classification of Diseases, ICD) by calendar year, age, sex, circumstances of death, intent, and agents involved. The period of study began with the first use of the 8th revision of the ICD (ICD-8) to code mortality data in England & Wales (1968), and ended in 2000 with the last use of the 9th revision (ICD-9) [1].

Methods

We studied trends in fatal poisoning (ICD-8: N960-N989; ICD-9: 960-989) in children aged < 10 years in England & Wales, 1968-2000, using the Office for National Statistics electronic mortality database. This does not include stillbirths and neonatal deaths (deaths in children aged under 28 days). The certification and coding of poisoning deaths has been described [1,11,12]. Until 1993 annual mortality data were published by year of registration, but the data presented here are tabulated by year of death and thus differ slightly from published figures for this period. Most deaths occurred as a result of an acute poisoning episode, but deaths from, for example, chronic lead poisoning are also included. The data include iatrogenic poisoning if the death was certified as poisoning due to toxic effects of drug(s). Age specific mortality rates were calculated using Office for National Statistics mid-year population estimates. Directly age-standardised rates have been calculated using the European Standard Population.

Results and Discussion

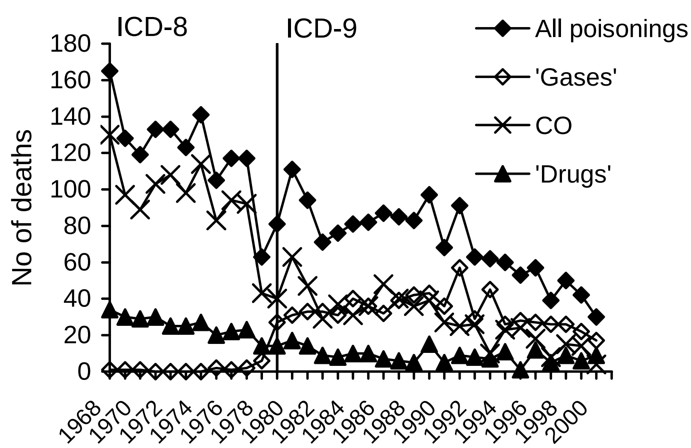
For the purposes of discussing fatal poisoning in childhood, study of incidents involving those aged < 10 years is appropriate since the incidence of substance abuse and suicide is very low in this age group. Further subdivision into those aged <1, 1-4, and 5-9 years may be appropriate on the basis of the likely mechanism of exposure and severity of poisoning in children of different ages.

Fatal Poisoning in Children in England & Wales

(i) Overview

Deaths from acute poisoning in children aged < 10 years in England & Wales declined from 169 in 1968 to 30 in 2000, a fall of 82 % (Figure 1). It is clear that with the introduction of ICD-9 (1979) there was a shift in the coding of some deaths from poisoning with carbon monoxide to poisoning with 'other gases, fumes or vapours'. This is attributable to a change in the way deaths attributed to the inhalation of combustion products were coded and may reflect a more realistic view of the situation where blood carbon monoxide was relatively low, and where there were no burns or other external injuries that could account for death. These deaths are tabulated as due to fire and flames, and not to poisoning, in mortality statistics based on a single underlying cause of death. Many countries only code the underlying cause and so cannot count these deaths as poisonings in any of their tabulations. Coding of fatal poisoning from 'drugs, and other solid and liquid substances', which have declined steadily in children in England & Wales since 1968, was unaffected by the introduction of ICD-9 (Figure 1).

Figure 1. Fatal poisoning, age < 10 years: England & Wales, 1968-2000 (ICD-8: N960-989 all poisonings, N986 carbon monoxide (CO), N987 other gases, fumes or vapours ('gases'), N960-989 less N986/7 'drugs'; ICD-9: 960-989 all poisonings, 986 carbon monoxide (CO), 987 other gases, fumes or vapours ('gases'), 960-989 less 986/7 'drugs'; n = 2907



(ii) Mortality Rates by Age and Sex

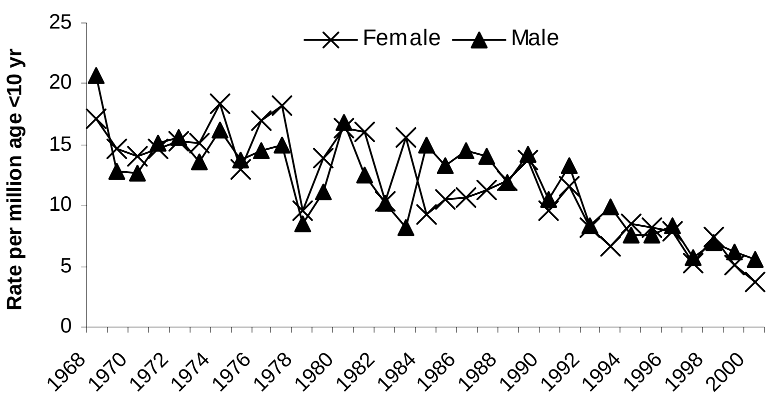
Males predominate in fatal poisoning statistics in adolescents and adults in England and Wales [suicides 66 % male, drug abuse-related deaths 83 % male (most thought to be accidents), volatile substance abuse-related deaths (90 % male - UK data - almost all assumed to be accidents) [1]. In non-fatal poisoning in children, where poisoning is largely accidental, boys often also slightly predominate [10,13,14].

Table 1 shows numbers of poisoning deaths in children aged < 10 years in England & Wales by age group (<1, 1-4, and 5-9 years) and sex. Although there are slightly larger numbers of deaths in boys than girls in each age group, the mortality rates per million population for each individual year are not significantly different by sex (Figure 2). In subsequent analyses data from boys and girls were therefore combined.

Table 1. Fatal poisoning, age < 10 years: England & Wales, 1968-2000 (ICD-8: N960-989 all poisonings; ICD-9: 960-989 all poisonings). Numbers of deaths by age group and sex

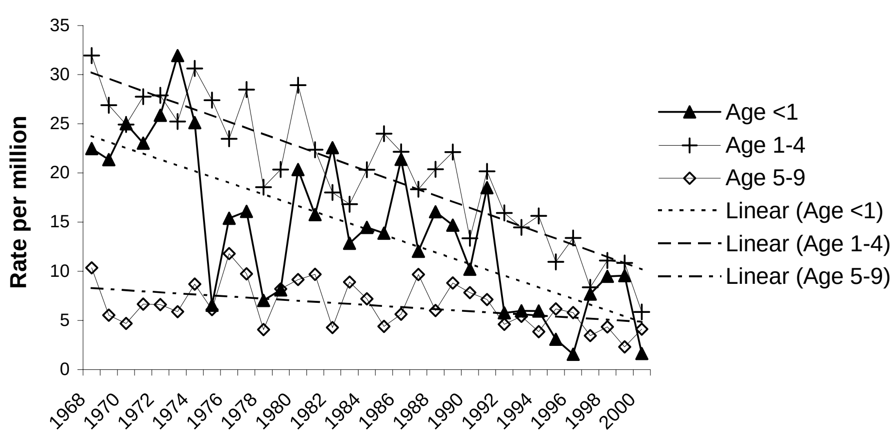
Age (yr)	Male	Female	All
<1	164	155	*319*
1-4	1031	799	*1830*
5-9	408	350	*758*
0-9	*1603*	*1304*	*2907*

Figure 2. Fatal poisoning, age < 10 years: England & Wales, 1968-2000 (ICD-8: N960-989 all poisonings; ICD-9: 960-989 all poisonings). Age standardised mortality rate by sex



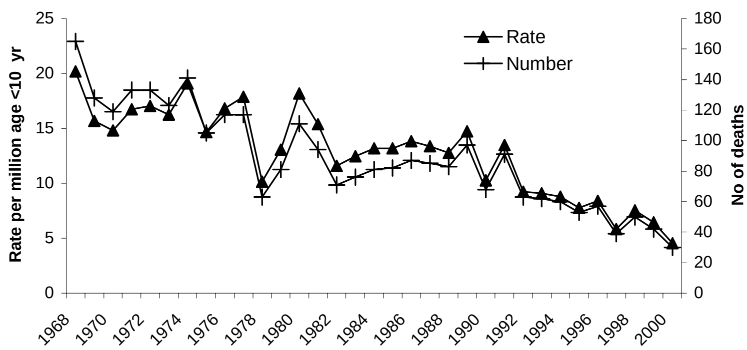
Age-specific mortality rates by year of death for the 3 age groups (<1, 1-4, and 5-9 years) are shown in Figure 3. The number of deaths underlying some data points are small. Nevertheless, it is clear that the death rates in children aged < 1 year and 1-4 years have fallen markedly since 1968 (demonstrated by the 5-year moving average lines shown on the figure) whereas the rate in those aged 5-9 years, although falling, has decreased much more slowly.

Figure 3. Fatal poisoning, age < 10 years: England & Wales, 1968-2000 (ICD-8: N960-989 all poisonings; ICD-9: 960-989 all poisonings). Age specific mortality rate by age group (yr), with trend lines of best fit



Age-standardised mortality rates and number of deaths by year of death are shown in Figure 4. Death rates fell by 77 % (from 20.6 per million children age < 10 years in 1968 to 4.6 per million in 2000). Nevertheless, it is clear that the annual number of deaths and the mortality rate correspond closely, so we used numbers of deaths in subsequent analyses.

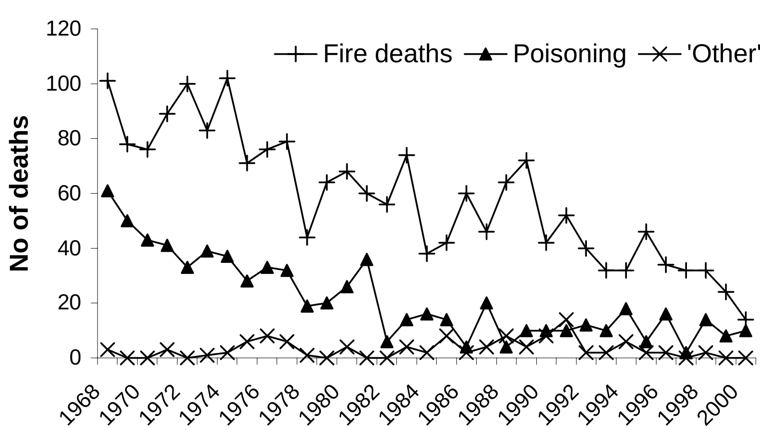
Figure 4. Fatal poisoning, age < 10 years: England & Wales, 1968-2000 (ICD-8: N960-989 all poisonings; ICD-9: 960-989 all poisonings). Age standardised mortality rate and annual number of deaths



(iii) Mechanism and Intent

Figure 5 shows that most poisoning deaths were attributed to poisoning *per se* (n = 702) or to the inhalation of combustion products in fires (‘fire deaths’, n = 1923), with a small number each year occurring as a result of fires resulting from motor vehicle and other transport accidents (‘other’, n = 104). It can be seen that both ‘poisonings’ and ‘fire deaths’ decreased substantially, and although ‘fire deaths’ predominated throughout the period studied, in 2000 the numbers of ‘fire deaths’ and ‘poisonings’ were almost the same (14 and 10, respectively).

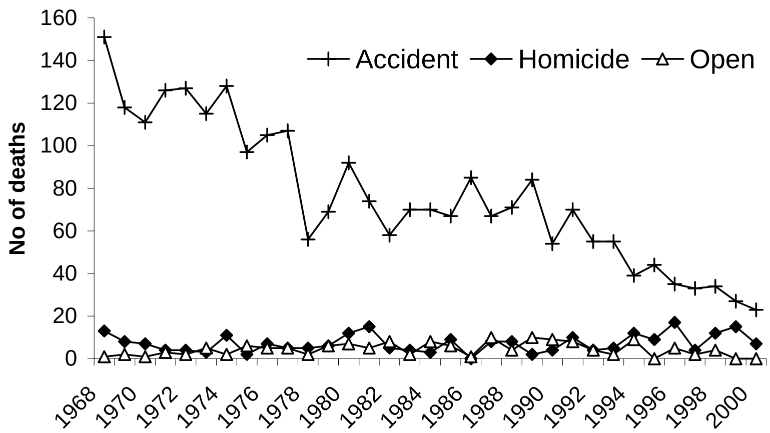
Figure 5. Fatal poisoning, age < 10 years: England & Wales, 1968-2000 (ICD-8: N960-989 all poisonings; ICD-9: 960-989 all poisonings). Annual number of deaths by underlying cause of death (see text for explanation of legends)



The number of deaths attributed to accidental poisoning, homicide (murder or manslaughter), and those in which an open verdict was recorded are shown by year of death in Figure 6. Annual numbers of deaths attributed to accidental poisoning declined steadily (from 151 in 1968 to 23 in

2000). In contrast, homicides and open verdicts remained between 5-20 per year 1968-2000. Similar results were obtained when all unintentional (ICD-9 E800-949) and intentional + ‘undetermined intent’ (E950-999) injury deaths in England & Wales in people aged < 20 years were compared [15]. Intentional + ‘undetermined intent’ injuries accounted for 13 and 25 % of injury and poisoning deaths in 1980 and in 1995, respectively.

Figure 6. Fatal poisoning, age < 10 years: England & Wales, 1968-2000 (ICD-8: N960-989 all poisonings; ICD-9: 960-989 all poisonings). Annual number of deaths by verdict



(iv) Agent and Intent

It is sometimes difficult to extract precise information on the agents encountered in fatal poisonings using the ICD code for the underlying and secondary causes of death [1]. In part this is because the death certificate may not indicate which of several substances was primarily responsible for the death, but a further factor is that the ICD is not designed to record all the poisons involved when two of more poisons belonging to different pharmacological categories are mentioned on the death certificate. However, poisoning in children in Western countries is usually associated with exposure to a single agent except in the case of ‘fire gases’ [16], and thus ICD codes can provide some useful information as to poisoning with particular agents and intent provided that the ICD code to which they are assigned is relatively specific.

Lead is a poison that possesses its own ICD nature of injury code -19 deaths (all accidental) were attributed to lead poisoning during the period studied (Table 2). Only one such death has been certified since 1984. Carbon monoxide poisoning too and has its own ICD code. Furthermore, poisoning with ‘other gases, fumes or vapours’ (ICD-9, 987.0-9), although it includes a range of uncommon poisons such as hydrogen cyanide, in children is highly likely to indicate inhalation of combustion products as discussed above. In all 2431 (84 %) deaths in the period under study were allocated to these two latter categories (Table 2). The proportion of deaths allocated to these codes was different using ICD-8 as compared to ICD-9 (Figure 1), but study of the underlying cause of death reveals that the proportion of deaths in fires and from other causes allocated to these codes was similar over time. The data are summarized in Table 3. Most deaths occurred as a result of accidental fires although some were arson (i.e. homicide), but a relatively high proportion (8.3 and 8.8 %, respectively) of carbon monoxide-related deaths were had underlying causes indicating accidental poisoning and homicide poisoning.

Table 2. Fatal poisoning, age < 10 years: England & Wales, 1968-2000. Numbers of deaths by agent and intent

Agent (ICD-8/ICD-9 code)	*Homicide*	*Open verdict*	*Accident*	*Total*
Antidepressants (N969.0/969.0)	4	4	70	*78*
Barbiturates (N967.0/967.0)	1	1	31	*33*
Opiates (N965.0/965.0)	19	4	24	*47*
Salicylates (N965.1/965.1)	0	0	40	*40*
Other drugs *	21	3	171	*195*
Carbon monoxide (N986/986)	109	22	1560	*1691*
Other gases, fumes or vapours (N987/987)	55	33	652	*740*
Lead (N984/984)	0	0	19	*19*
Other non-drugs #	6	1	57	*64*
Total (N960-989/960-989))	*215*	*68*	*2624*	*2907*

* Codes N960-979/960-979 less any above
# Codes N980-989/980-989 less any above

Table 3. Fatal poisoning from carbon monoxide (n = 1691) and from 'other gases, fumes, or vapours' (n = 740), age < 10 years: England & Wales, 1968-2000. Percentages of deaths by agent (ICD codes as Table 2) and underlying cause

Underlying cause *(ICD-8/ICD-9 code only given separately where different)*	***Carbon monoxide (%)***	***'Other gases, fumes, or vapours' (%)***
Transport accidents (E800-E849)	0.8	0.7
Accidental poisoning (E850-E879/E850-E869)	8.3	1.5
'Accidental fire and flames' (E890-E899)	78.7	86.0
Assault by poisoning (E962)	7.0	-
Assault by means other than poisoning (E960-E969, excluding E962) (includes arson E968.0)	1.8	4.9
Open verdict - poisoning by gases (E981-E982)	0.7	0.6
Open verdict – fire (E988.1)	0.7	3.5
Inquest adjourned/probable homicide (did not exist until 1978 when law changed)	1.7	2.8
Other	0.3	-

Data on fatal poisoning with (one or more) antidepressants, barbiturates, opiates (includes heroin, methadone, pethidine, and other opioids, but excludes dextropropoxyphene), and salicylates and intent are given in Table 2. Together these 4 groups accounted for 198 (50 %) of the 393 fatalities attributed to poisoning with drugs. Any deaths certified as due to poisoning with a compound in one of these categories and a compound in any other category will have been coded as a 'mixed poisoning' and thus will be recorded under 'other drugs' (Table 2). However, our analysis of the text of death certificates (stored by the Office for National Statistics electronically since 1993) [1,11] showed that this is quite rare in children. Hence it is likely that the data presented in Table 2 are largely accurate as regards death from these drugs during the period of study.

With carbon monoxide, ‘other gases, fumes or vapours’, and most of the other groups of poisons studied, homicide or an open verdict was recorded in approximately 10 % of deaths (Table 2). With opiates (n = 47), however, homicide or an open verdict was recorded in 23 (49 %) deaths. Presumably this finding reflects not only the toxicity of opioids in young children, but also the availability of these agents in certain homes. In recent years opiates either alone or with alcohol (14 deaths, 1968-83; 33 deaths, 1984-2000) have superseded antidepressants either alone or with alcohol (56 and 22 deaths, respectively) as the commonest agents encountered in fatal poisoning with drugs in children. In contrast to the increase in opiate-related deaths, deaths from barbiturates and from salicylates have declined markedly in this age group (two deaths from barbiturate poisoning and one from salicylate poisoning, 1984-2000).

Retrieving information on drugs and other poisons not having their own ICD code is not possible using the ICD in any revision. For example, it is not possible using ICD-9 codes to distinguish between different antidepressant drugs, or between heroin and methadone, which are both coded as ‘opiates/opioids’. Text from death certificates can be used to explore the substances involved in more detail. The compounds recorded in deaths in children 1993-2000 included amoxapine, carbamazepine, chloroquine, cyanide, dextropropoxyphene, dothiepin, heroin/morphine, ferrous sulphate, insulin, methadone, paracetamol (acetaminophen), potassium chloride, quinine, sodium chloride, and sodium nitroprusside. Only 1 death had more than 1 drug mentioned on the death certificate.

With paracetamol serious accidental poisoning is very rare in young children. The amount ingested is usually small, and hepatic sulphation capacity and glutathione stores are increased compared to those of adults. Serious liver damage and death have only been reported in children after chronic paracetamol poisoning [17-20]. On the other hand, childhood deaths from aspirin poisoning, which were often due to overdosage in therapeutic use [21], are now virtually non-existent in England & Wales because aspirin is no longer licensed for use in children except for some specific indications. Of the remaining solid and liquid preparations encountered in fatalities in children, tricyclic antidepressants (especially dothiepin, which was implicated in 7 deaths 1993-2000), iron, and opioids account for a relatively large number of deaths. Mortality and morbidity from ingestion of methadone syrup in the home has been of particular concern [22,23], and this is reflected in our data (8 methadone-related deaths 1993-2000). Finally, in the US products found in the home such as petroleum distillates, pesticides, and cleaning and polishing agents are still substantial causes of poisoning [24]. However, non-medicinal products now account for relatively few deaths in children in England & Wales (Table 4).

Table 4. Fatal poisoning, age < 10 years: England & Wales, 1984-2000. Numbers of deaths by year and agent (ICD-8/9 codes: As Table 2)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Drugs	9	8	6	5	5	12	4	9	6	6	10	0	9	5	7	5	9
Carbon monoxide	31	36	48	40	36	39	27	25	26	10	23	24	18	8	15	14	4
Other gases, fumes or vapours	40	36	32	39	42	43	36	57	29	45	26	28	27	26	26	22	17
Other non-drugs	1	2	1	1	0	3	1	0	2	1	1	1	3	0	2	1	0
Total	81	82	87	85	83	97	68	91	63	62	60	53	57	39	50	42	30

General Discussion

Overall injury and poisoning (all intents) is the leading single cause of death in children in England & Wales [25]. Poisoning is also an important cause of hospitalisation in children. Data on hospital admissions in England as a result of a suspected or confirmed episode of acute poisoning (ICD-10 T36-65 [26]) show that in the three administrative years from April 1998-March 2001, 13,496, 13,012, and 11,277 children aged 0-14 years, respectively, were admitted annually [27]. These figures have been declining for some time even when adjusted for the population at risk [13] - the corresponding figure for April 1989-March 1990 was 17,632, for example [28] - and may reflect changes in factors such as admissions policy rather than the incidence of suspected poisoning. Many paediatric poisoning 'episodes' are suspected occurrences ('poisoning scares') rather than serious poisoning incidents [4,24,29].

A survey of 14 Accident & Emergency departments in England & Wales in 1982-4 found that, in those aged < 5 years, analgesics accounted for some 20 % of poisoning incidents; a further 40 % of children had ingested other pharmaceutical preparations. Iron, tricyclic antidepressants, benzodiazepines, paracetamol, and oral contraceptives were commonly reported. Others had been exposed to household products (bleaches, detergents and disinfectants, and petroleum distillates such as turpentine substitute), alcohol, and garden plants and seeds [16]. In developing countries the pattern is rather different as might be expected, with accidental poisoning due to hydrocarbons (especially paraffin), pesticides, traditional medicines, plants, and snake-bite and insect sting being more common [30-32].

The marked decrease in fatal poisoning in children in England & Wales since 1968 (Figure 1) together with the decease in poisoning-related hospital admissions that has occurred in recent years does confirm the overall success of a range of initiatives such as those aimed at improving safety in the home. The fall in fatal accidental poisoning, to a large extent due to the large fall in the numbers of deaths in fires (Figure 5), is perhaps not unexpected given the enormous resources devoted to fire safety precautions and use of safer forms of heating instead of open fires or paraffin heaters. Factors which may have helped reduce mortality (and also morbidity) from poisoning by drugs and household products in this age group include: (i) the widespread introduction of child resistant closures (CRCs) [4, 10, 33-34], (ii) greater emphasis on safety in the home including improvements in the design, installation, and servicing of gas appliances aimed at minimizing the risk of carbon monoxide poisoning, (iii) improved access to poisons information, (iv) improved treatment, (v) the withdrawal of hazardous preparations such as Safapryn (paracetamol and enteric coated aspirin), (vi) the increased use of blister packaging and introduction of new packaging materials [4], (vii) changes in prescribing patterns with a trend towards using drugs with lower acute toxicity in children [10], and (viii) the introduction of measures which make it more difficult to poison people using domestic motor vehicle exhaust such as the increased use of catalytic converters and the alteration in the diameter of exhaust pipes so they do not fit domestic vacuum cleaner hose [1]. Corresponding factors as regards fire safety include the increased use of domestic smoke and carbon monoxide alarms.

Homicidal poisoning is, of course, unlikely to be influenced greatly by the above factors, and indeed homicide or an open verdict is now recorded in an increasing proportion of fatal poisonings in children in England & Wales simply because accidental poisoning is so much less common (Figure 6). This being said the question of the diagnosis of poisoning in the absence of a reliable history from the parents/caretakers or circumstantial evidence from the scene remains a difficult challenge, and one which is as always dependent on the suspicion of poisoning being raised in the mind of the clinician, pathologist, police, or other investigating body.

A number of factors mean that serious poisoning in children, once diagnosed, is usually subject to careful investigation [35]. In this context, the potential for deliberate poisoning of children by health-care workers cannot be ignored [36]. Serial homicide by either nurses or doctors, which often involves poisoning and sometimes involves murder of children, has been reported [37-39]. In 1991 nurse Beverly Allitt was convicted of murdering 4 children on a paediatric ward at Grantham Hospital in England, at least one by use of insulin [40,41]. Lignocaine was also administered to some patients and may have contributed to some deaths. It should be explained that these latter deaths are almost certainly not recorded as homicides in national mortality data since they were all initially registered as deaths from natural causes, most after coroner's autopsies and some after inquests, and will have been tabulated as such in the years in which they were registered. Even if they were subsequently re-registered as homicides, it was not possible to change the basic annual data at that time. Of course there is also the possibility that some homicidal poisonings were either missed completely or certified as accidents. For these reasons the data on homicidal poisoning presented here are probably an underestimate of the true picture.

Monitoring of trends in mortality from poisoning has been enhanced by changes to the ICD, with ICD-10 allowing more detail on the specific poisons involved to be coded using the nature of injury (T) codes. However, this is only of benefit in countries which code more than purely the underlying cause of death. In fact, in ICD-10, the underlying cause of death gives less detail than in ICD-9 [42]. In England and Wales, the nature of injury (secondary cause) has been recorded electronically since 1959 and multiple cause information has been available routinely since 1993. Thus, advantage can be taken of the additional information provided by the ICD-10 T codes. In addition, the electronic storage of the text of death certificates has facilitated more detailed research on poisoning mortality, particularly in deaths related to drug poisoning. At the Office for National Statistics, a specific database to examine the substances involved in these deaths in more detail than allowed by the ICD has been set up and data from 1993 onwards are stored. This allows mentions of specific substances to be examined, even if more than 1 substance was involved in the death. Results of these analyses are reported annually [43].

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