Fire Research Report

Hospitalisation for non-fatal injury as a result of unintentional domestic fire incidents: New Zealand 1996-2000

University of Otago

December 2002

This study highlights the difficulties of trying to link the New Zealand Fire Service Fire Incident Reporting System data on fire related injuries to that held in the New Zealand Health Information Service with links being found for very few records. The study population consists of inpatients discharged following first admission to a New Zealand hospital with a primary diagnosis of burn injury or smoke inhalation as a result of fire or flame in a private residential property.

The highest rates of inpatient treatment were for children aged under 5 years, young adults between 15 and 34 years, and older people over 74 years. The study finds high inpatient treatment rates for males, and particularly Maori. The most common scenario is clothing coming in contact with a heat source.

Mavis Duncanson, Papaarangi Reid, John Langley, and Alistair Woodward
New Zealand Fire Service Commission Research Report Number 33
ISBN Number 0-908920-92-X

Hospitalisation for non-fatal injury as a result of unintentional domestic fire incidents: Aotearoa New Zealand 1996-2000

December 2002

University of Otago
Fire Injury research team

Hospitalisation for non-fatal injury as a result of unintentional domestic fire incidents: Aotearoa New Zealand 1996-2000

Mavis Duncanson

Papaarangi Reid

John Langley

Alistair Woodward

Table of contents

Introduction

This report to the New Zealand Fire Service Commission describes features of unintentional fire incidents in Aotearoa New Zealand from 1996 to 2000 in which New Zealanders experienced non-fatal injury resulting in hospital inpatient admission.

The report is one of a series contracted for in the New Zealand Fire Service Commission Contestable Research Fund for the 2002-2003 research year. Previous work completed by the University of Otago Fire Injury research team since 1999 has included:

- An overview of fire mortality data
- Report on fire-related mortality among children aged under 15 years
- Report on fire-related mortality among young people and adults
- Report on fire-related mortality among adults aged over 64 years
- Report on child injury from fire and flame in the Auckland region
- Report on fire-related mortality in the workplace
- Report on relative socio-economic deprivation and fatal fire incidents
- Evaluation of Auahi Whakatüpato fire safety programme in eastern Bay of Plenty

Acknowledgements

The research was funded by the New Zealand Fire Service Commission Contestable Research Fund. Chris Lewis at the New Zealand Health Information Service, Nicola Dow at the Injury Prevention Research Unit, University of Otago, and Roger Chang and Gary Quigan of the New Zealand Fire Service provided the basic data for this research and were extremely helpful in answering numerous questions. The study was considered and approved by the Wellington Ethics Committee.

Executive summary

The study was undertaken to understand and identify factors associated with non-fatal injury of New Zealanders in domestic fire incidents, through careful and systematic evaluation of available data and documents. This aim was achieved through analysis of existing information from the New Zealand Health Information Service (NZHIS) and the New Zealand Fire Service Fire Incident Reporting System (FIRS) concerning domestic fire incidents resulting in non-fatal injury of New Zealand civilians. The report describes personal, fire related, and environmental factors relevant to prevention policy.

Linking of FIRS and NZHIS data was minimal, principally because of the lack of common data fields. Other data issues identified in this study include the lack of information concerning the presence or absence of domestic smoke alarms, and regarding use of alcohol by the injured persons.

The study population consisted of 862 inpatients discharged following a first admission to a New Zealand hospital with a primary diagnosis of burn injury or smoke inhalation occurring as a result of fire or flame in a private residential property in the years 1996-2000. Fires occurring in commercial premises (e.g. hotels, motels), institutions (e.g. rest homes, hospitals or prisons), workplaces including farms, and public places were excluded from the study as were intentional fires, intentional injury, and injury resulting from illegal activity.

The highest rates of inpatient treatment for injury from fire and flame were observed among children aged under 5 years, young people and adults aged 15-24 and 25-34 years, and older adults aged over 74 years. Male hospitalisation rates were twice the female rates, and rates for Mäori were two and a half times rates for nonMäori.

Fire characteristics were analysed in a subset of 512 inpatients where information regarding heat source and item ignited was available from NZHIS and/or FIRS data.

Almost half (47 per cent) of the 512 inpatients in the scenario subset were injured through direct contact or contact of clothing with a heat source, which was often not recorded. Flammable gas or liquid was involved in one fifth (115 inpatients, 22 per cent) of all admissions. The most common incident scenarios leading to hospital inpatient treatment were:

- Stovetop or oven igniting cooking materials
- Heater causing burn through direct contact or ignition of clothing
- Naked flame from matches, lighters or candles igniting bedding, upholstered furniture or other combustibles
- Outdoor fires for rubbish, warmth or cooking causing burns through direct contact or ignition of clothing, and
- Means of heating (electric or gas heater, solid fuel burner or open fire) igniting bedding, upholstered furniture, carpet or other combustibles

Addressing non-fatal injury from fire and flame will require intersectoral and cross-cultural collaboration and partnership. Involvement of the New Zealand Fire Service commission in the development of the New Zealand Injury Prevention Strategy: Rautaki Ärai Whara O Aotearoa will be important to improve data quality and ensure that fire-related injury is nationally recognised and addressed.

Recommendations

That the New Zealand Fire Service Commission considers, develops and adopts appropriate strategies to improve the collection of fire safety information in residential fire incidents, particularly regarding the presence or absence and functioning status of domestic smoke alarms or sprinklers.

That the New Zealand Fire Service Commission considers undertaking formal fire investigations (as conducted for fatal fire incidents) in selected events resulting in non-fatal injury to gain a more comprehensive picture of the circumstances associated with such injury.

That the New Zealand Fire Service Commission liaise with the New Zealand Health Information Service and Statistics New Zealand to investigate and address the current limited ability to link casualty and hospital inpatient data.

That the New Zealand Fire Service Commission make a strong submission on the draft New Zealand Injury prevention Strategy to ensure that fire-related injury is adequately addressed in the final strategy.

That the New Zealand Fire Service Commission continue to sponsor fire safety campaigns which focus on

- safe cooking practices,
- safe distances between heaters and combustibles,
- maintenance and safe use of other electric appliances,
- safe storage and use of smoking materials and prevention of child access to matches and lighters,
- installation and maintenance of domestic smoke alarms,

That in addition to the measures above, the New Zealand Fire Service Commission consider development of fire safety campaigns and strategies which focus on

- safe storage and use of flammable materials, and
- wearing of fitting clothing near heaters and stovetops.

That the New Zealand Fire Service Commission continue to support research and development of appropriate programmes to address ethnic disparities in fire-related injury rates, adequately supported by appointment of Mäori liaison staff in each fire region and ongoing training in cultural awareness for all fire-fighters.

Background

Non-fatal fire-related injury can be severe and result in long term disfigurement and disability (Keane, Jepson, Pickett, Robinson, & McCorkle, 1996; Kemp & Sibert, 1997). Even in the absence of injury, 70 per cent of fire survivors in an American study reported a need for assistance 14 weeks after the event (Keane, Brennan, & Pickett, 2000).

This research project approaches injury from fire and flame from a public health and injury prevention perspective. A public health perspective uses the science of epidemiology to describe the incidence and patterns of injury, and seeks to improve the health of population through the organised efforts of society. Injury prevention and treatment is a branch of public health that seeks to understand personal, mechanism related and environmental factors which affect the incidence and severity of human injury.

Fire-related injury is a leading cause of unintentional death from injury in the domestic location for New Zealanders aged 1-64 years (Duncanson, Reid, Langley, & Woodward, 2001). However, compared with other modes of injury (such as falls, cutting or piercing, and poisoning) fire-related injury is a less significant cause of hospital inpatient admission for injury, accounting for around one per cent of such admissions coded to the ICD-9 domestic location (see Table 1).

Table 1. Numbers and percentage of inpatients admitted as a result of unintentional injury in the domestic environment by age group and mode of injury, 1996-1998. Data source: New Zealand Health Information Service.

Age group / Mode of injury	0-14 years n (%)	15-64 years n (%)	Over 64 years n (%)	Total/ overall n (%)
Falls	3768 (41)	3044 (38)	9568 (83)	16380 (57)
Cutting/piercing	903 (10)	1768 (22)	282 (2)	2953 (10)
Accidental poisoning	1204 (13)	740 (9)	177 (2)	2121 (7)
Struck by or against	614 (7)	385 (5)	295 (3)	1294 (5)
Hot object or substance	871 (10)	269 (3)	78 (1)	1218 (4)
Overexertion	33 (<1)	422 (5)	519 (5)	974 (3)
Other transport (not crash)	437 (5)	142 (2)	58 (1)	637 (2)
Natural or environmental	204 (2)	206 (3)	98 (1)	508 (2)
Fire and flame	134 (1)	226 (3)	46 (<1)	406 (1)
Machinery	25 (<1)	143 (2)	64 (1)	232 (1)
Suffocation	128 (1)	54 (1)	36 (<1)	218 (1)
Drowning	66 (1)	3 (<1)	1 (<1)	70 (<1)
Other injury	712 (8)	568 (7)	256 (2)	1536 (5)
Total	**9099 (100)**	**7970 (100)**	**11478 (100)**	**28547 (100)**

This current study builds on previous analysis of factors associated with fatal unintentional domestic fire incidents, to examine factors associated with serious non-fatal injury from fire and flame requiring hospital inpatient treatment. Identification of such factors is a first step in developing strategies to improve household fire safety.

Study aim and objectives

The overall aim of the study was to understand and identify factors associated with non-fatal injury of New Zealanders in domestic fire incidents, through careful and systematic evaluation of available data and documents.

The specific objective of the study was to analyse existing information from the New Zealand Health Information Service and the New Zealand Fire Service concerning domestic fire incidents resulting in non-fatal injury of New Zealand civilians, and describe personal, fire related, and environmental factors relevant to prevention policy.

Methods

Definitions

Injury from fire and flame includes injuries caused by conflagration, smoke and fumes, accidental ignition of clothing from controlled fire at home, and other injuries caused by controlled fires. The domestic environment is taken to be a private residential dwelling (rented or owner-occupied, permanent or temporary) and the immediate environs. The definition includes fires occurring in mobile homes and caravans that were being lived in as a home (but not those being driven or towed, in outbuildings such as detached garages or sheds, outdoors, or in stationary vehicles on private residential property. The definition also includes outdoor fires on private residential sections of land.

Inclusion criteria

Inclusion criteria for the investigation of fatal domestic fire incidents were all inpatients discharged from a first admission to a New Zealand hospital with a primary diagnosis of burn injury or smoke inhalation occurring as a result of fire or flame in a private residential property in the years 1996-2000. Inpatients were identified from NZHIS hospitalisation data if the ICD-9 external cause of injury code indicated that the injury occurred as a result of unintentional fire and flame at home. Inpatients where the injury occurred in an unspecified location were also included if the event description indicated that the incident occurred in a private dwelling, or if the incident was linked with a FIRS record which indicated that the incident occurring in a private dwelling.

Exclusion criteria

Fires occurring in commercial premises (e.g. hotels, motels), institutions (e.g. rest homes, hospitals or prisons), workplaces including farms, and public places were excluded from the study as were intentional fires, intentional injury, and injury resulting from illegal activity. Cases where a medical condition resulted in a burn injury were also excluded (for example if a person fell into a fire while having an epileptic seizure), as were readmissions for the same injury.

Analysis

Analysis was based on the information contained in the NZHIS data, supplemented where possible by linkage to FIRS data. Rates were calculated using New Zealand census population data and intercensal population estimates. The sole Mäori denominator was used to calculate Mäori rates. Relative risks (RR) and confidence intervals were calculated using EpiInfo statistical software (CDC 1996).

Data sources

Hospital admissions for injury caused by fire and flame were identified from the New Zealand Health Information Service (NZHIS) morbidity database using International Classification of Disease 9th edition (ICD 9 CM) external cause of injury codes E890-899 (Accidents caused by fire and flames). These ICD-9 codes do not include deaths as a result of acts of suicide or homicide, or undetermined injury by burns or fire, which have different E codes.

Casualties with mild, moderate, and severe injuries recorded as a result of structure fire incidents and incidents in mobile property being used as a structure from 1995 to 2000 were obtained from the Fire Incident Reporting System (FIRS).

Data linkage

An iterative manual process was used to link hospitalisation inpatient data with casualty data from the New Zealand Fire Service. Linkage was attempted for all identified inpatients, rather than only on those coded as domestic, because it was expected there might be some incidents coded as non-domestic, which in fact occurred in private dwellings. This expectation was based on previous experience with mortality data, and personal communication with Shaun Stephenson, at the Injury Prevention Research Unit, which indicated that the 'unspecified' location is probably overused in injury coding. Linking was done manually using the variables by date of injury ± 1 day, name, street address, suburb, cause of the fire, age ± 5 years, and gender (as shown in Table 2.) Following this linking process the details of the inpatients were examined to determine whether they fitted the other criteria for inclusion. Primary diagnosis of burn injury or smoke inhalation was ascertained from the NZHIS diagnosis and diagnosis description fields. Nature of the dwelling was obtained from the FIRS data fields 'Incident type' and 'Specific property use'.

Table 2. Fields in New Zealand Health Information Service and Fire Incident Reporting System data used to link hospitalised inpatients and non-fatal casualties.

NZHIS field(s)	FIRS field(s)
Edate (date of injury event)	Date (date of fire incident)
Surname	Casualty name
Names 1, 2 and 3	
Address	#, Street
NMDS Domicile description	Suburb
Age	Age
Sex	Gender
Edesc (free text field describing injury event)	Heat source, item ignited, probable cause (3 separate fields)

Results

Data linkage

In the years 1996 to 2000, New Zealand Health Information Service data identified 1570 first admissions to hospital with an external cause of injury code indicating injury from fire and flame. The location of the incident was coded in the fifth digit in the external cause of injury code (0 = home, 1 = farm, 2 = mine or quarry, 3 = industrial place, 4 = place for recreation and sport, 5 = street or highway, 6 = public building, 7 = residential institution, 8 = other specified place, 9 = unspecified place). NZHIS data also contained a field 'edesc', which is a free text field containing a brief account of the incident resulting in injury. More recently this field seems to have been filled in automatically using the full text for the ICD 9 CM numerical code. However where the field is used as free text some useful information can be extracted, for example the entry 'INHALED SMOKE IN HOUSE FIRE' was interpreted as a domestic incident. In the same time period FIRS data recorded 1830 non-fatal casualties (excluding motor vehicle crash fires). Of the FIRS non-fatal casualties, 1512 were recorded as occurring in private residential structures (flats, apartments, houses and mobile homes). Using the process described previously (page 10), there were 93 linkages by date and name or street address, and 121 linkages by date and two or more other variables.

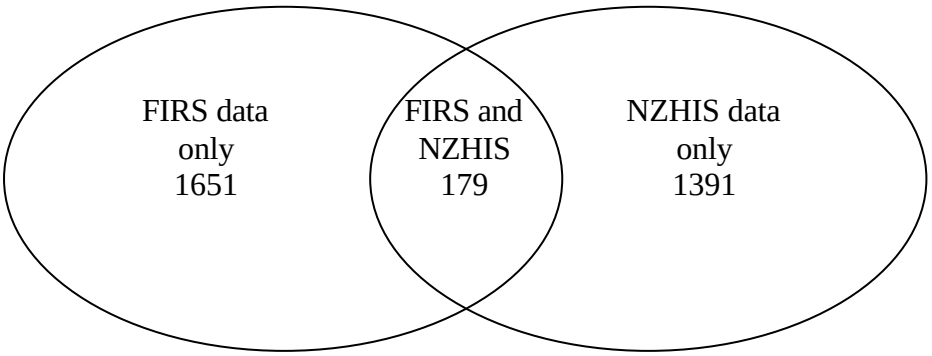

Figure 1. Data sources for identification of non-fatal injury as a result of injury from fire and flame in New Zealand 1996-2000.

As shown in Figure 1, there was minimal overlap between the NZHIS and FIRS datasets. The 179 linked records represented only 11 per cent of the 1570 hospitalisations as a result of injury from fire and flame recorded in NZHIS data, and 10 per cent of the 1830 non-fatal injury records in FIRS, in the study period. There are several possible explanations for this lack of overlap:

- The dataset capture different events. It was seen in the mortality data that not all fire-related fatalities were attended by the Fire Service. It is likely that even more non-fatal fire-related injuries are not attended by the Fire Service, as many injuries resulting in hospitalisation may occur in incidents where no or minor property damage occurs, therefore not resulting in a call out to the fire service. Conversely many injuries recorded by the Fire Service may not result in admission to hospital, and thus not be captured in NZHIS data.
- Deficiencies in the datasets may mean that some injuries are not recorded or are miscoded. Fire Service data are gathered at the scene and may not include all

injured persons. NZHIS data were obtained using the ICD-9 coding system. Miscoding of external cause of injury would mean eligible cases were not retrieved. For example if injury from fire and flame was coded as injury from some other cause, the inpatient would not have been identified from health data alone.

- The linking process may not recognise that two records refer to the same person. This failure of the linking process could occur where identifying information was missing from the FIRS data, or where the address of the fire incident (recorded in FIRS data) differs from the current residential address of the injured person (recorded in NZHIS data). Names were included in only 218 (14 per cent) of the 1512 FIRS private residential entries, and these records were often incomplete with surname or given name only. Although addresses were entered for all FIRS entries, linking of addresses proved to be difficult. The address at which the fire occurred might not be the usual residential address of the injured person (which is the address entered into NZHIS data). For example the injured person may have been injured while staying with relatives in Dunedin, but their usual residential address in Oamaru would be entered into the NZHIS data base. In addition if the injured person moved since the injury occurred, the NZHIS record contained the new and not the previous address. For example if a person was injured in their own home in Pukekohe in 1997, but subsequently moved live in Kaikohe, the latter address would be the one recorded in NZHIS data.

  FIRS data included a field 'familiarity', which detailed the length of time the casualty had resided in the affected dwelling. This field could potentially provide some additional information about whether the location of the fire was the usual residential address of the casualty. However there were missing entries in over 50 per cent of the non-fatal domestic casualties (816 casualties; 54 per cent). One fifth of the domestic casualties where the familiarity field was completed had been present in the dwelling for less than three months, and 12 per cent for less than one week.

As shown in Table 3, just over half of the inpatients (862, 55 per cent) were eligible for inclusion in the study. For linked cases the FIRS specific property type field was used to ascertain the location of the incident. In almost one quarter of the cases (375 inpatients, 24 per cent) the location of the incident was unspecified. It is probable that some of these cases were eligible, however this could not be confirmed using available data. Of the remainder, 250 injuries occurred in non-domestic settings such as farms, public places, workplaces, or residential institutions, and 35 inpatients (2 per cent) had a primary diagnosis other than injury. This latter group included incidents where a person made contact with a heat source in the course of an epileptic fit or stroke, or where the primary reason for admission a medical condition such as angina. It also included admissions for late stage complications of burn injuries (for example cellulitis and gangrene).

Table 3. Number and percentage of inpatients admitted to hospital in New Zealand 1996-2000 with external cause of injury code 890-899 by description of fire incident. Data sources New Zealand Health Information Service, New Zealand Fire Incident Reporting System.

Description of fire incident	n (%)
Domestic Fire	862 (55)
Outdoor Fire – location not specified	86 (5)
Occupational Fire	68 (4)
Public Place (Recreation/ Sport/ Street/ Highway/ Public Building)	38 (2)
Farm	33 (2)
Residential Institution	26 (2)
Intentional or medical event preceded fire incident	35 (2)
Other specified	47 (3)
Unspecified	375 (24)
Grand Total	**1570 (100)**

The scenario data subset

The key reason for the linkage was to obtain a more comprehensive data concerning the fire incidents resulting in non-fatal injury. Information concerning the heat source and item ignited was of particular interest in understanding fire incidents leading to hospital inpatient treatment. Information regarding heat sources and items ignited was determined from FIRS data for linked records, and from the event description free text field in NZHIS data. Only those records where either or both the heat source or item ignited was available were included; these 512 cases represented 59% of the 862 study inpatients.

The implications of using subsets for analysis depend principally on the extent to which the subset inpatients are similar to or differ from the complete data sets from which they are derived. Demographic details were used to compare the linked subset with the overall unintentional domestic fire-related injury hospitalisation data. As shown in Table 4 the inpatients in the two data sets were similar in terms of demographic details. Thus the analyses on the subset can, with caution, be applied to the whole dataset.

Table 4. Inpatients in unintentional domestic inpatient dataset and scenario data subset by median age, and percentage values for gender and ethnicity variables.

	NZHIS data set (n=862)	Scenario subset (n=512)
Median age	24	25
Gender:		
Male	69%	68%
Female	31%	32%
Ethnicity		
Mäori	22%	21%
Pacific	5%	6%
Other	71%	71%
Not stated	2%	2%

Personal characteristics

The demographic details in this section are derived from the complete unintentional domestic fire-related injury hospitalisation dataset. Age and gender data are from the full five years of the study (1996-2000). Due to the limited availability of sole Mäori denominator data the calculation of rates by ethnicity is limited to the first three years of the study (1996-1998). Changes to the collection of ethnicity data in health services, and a shift in the way in which citizens of Aotearoa New Zealand self-identify ethnicity since the 1996 census, mean that this denominator data may overstate any improvement in sole Mäori injury rates between 1991 and 1998 (personal communication Bill Boddington, Statistics New Zealand). The change in self identification of ethnicity has come about since a change to the 1996 census ethnicity question. The reworded question elicited responses of identification with multiple ethnic groups from individuals who previously identified as 'sole Mäori'. Thus in the 1996 census the 'sole Mäori' population was much smaller than previously, and the Mäori Ethnic Group population larger than previously. Even though the 2001 census returned to the use of the 1991 census ethnicity question, a shift in identification has persisted with a larger MEG population, and smaller sole Mäori population, than expected from extrapolating trends based ion the 1991 census.

Age, gender and ethnicity

As can be seen in Table 1, almost one third (32 per cent) of the 862 inpatients were children aged under 15 years, and over two thirds (71 per cent) of the inpatients were aged under 35 years. Nine per cent of inpatients were aged over 64 years. The highest hospitalisation rates for unintentional domestic injury from fire and flame were observed amongst children aged under 5 years, young people and adults aged 15-24 and 25-34 years, and older adults aged over 74 years. Age-standardised male hospitalisation rates for unintentional domestic fire-related injury were at least twice female hospitalisation rates (RR 2.2; 95%CI 1.9-2.5). The disparity between male and female hospitalisation rates was most marked among young people and adults aged 15-24 and 25-34 years, and was not statistically significant for adults aged 64-75 and over 75 years (Figure 2). Ethnicity data for unintentional domestic fire-related injury hospitalisations from 1996-1998 (using sole Mäori denominator) showed that Mäori hospitalisation rates were approximately two and a half times those of nonMäori (RR 2.4, 95%CI 1.9-2.9). The disparity between Maori and nonMäori hospitalisation rates for unintentional domestic fire-related injury was most marked for children aged under 15 years and adults aged 25-34 and 35-44 years. Numbers of Mäori inpatients aged 45-54 years, 55-64 years and over 65 years were too small in this three year period to calculate stable rates.

Table 5. Number and percentage of hospitalisations, age-specific and age standardised hospitalisation rates per 100,000 person years for unintentional domestic injury from fire and flame resulting in hospital impatient treatment Aotearoa New Zealand 1996-2000. Data source: NZHIS.

Age group (years)	Hospitalisations n (%)	Rate (95%CI)*
0-4	143 (17)	9.9 (8.3-11.5)
5-14	128 (15)	4.4 (3.6-5.1)
15-24	164(19)	6.1 (5.2-7.0)
25-34	170 (20)	5.9 (5.0-6.8)
35-44	99 (11)	3.4 (2.7-4.0)
45-54	43 (5)	1.8 (1.3-2.4)
55-64	39 (5)	2.4 (1.7-3.2)
65-74	25 (3)	2.0 (1.2-2.8)
75+	51 (6)	5.3 (3.9-6.8)
Total/Overall	**862 (100)**	**4.9 (4.6-5.2)#**

*Rate per 100,000 person years #Age-standardised rate per 100,000 person years

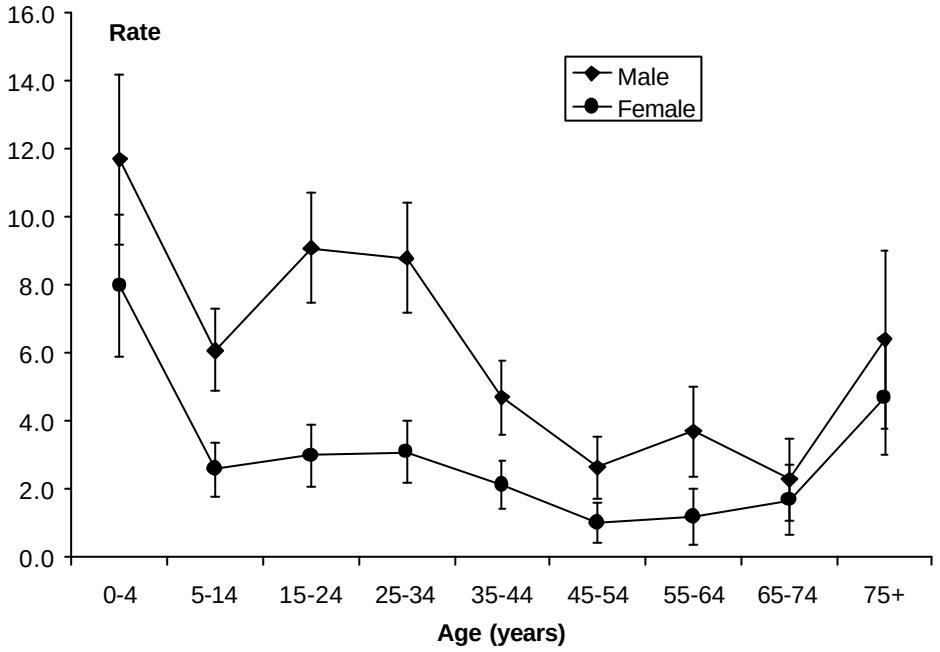

Figure 2. Age-specific hospitalisation rates per 100,000 person years for unintentional domestic fire-related injury in Aotearoa New Zealand 1996-2000 by gender. Data source NZHIS, Statistics New Zealand.

Fire characteristics

Heat source

The source of ignition was unable to be determined in 129 (25 per cent) of the 512 inpatients in the scenario data subset. Among incidents where the most likely cause was determined, the most common heat sources for unintentional domestic fire-related hospitalisations in Aotearoa New Zealand 1996-2000 were heating appliances (including electric heaters, gas heaters, solid fuel burners and open fires), stove tops or ovens, lighters or matches, and other electric appliances such as electric blankets, toasters or lamps (see Table 6). Outdoor fires, including the use of incinerators were associated with 31 hospitalisations, and outdoor cooking fires such as barbecues, hangi, and fish smokers were associated with a further 14 hospitalisations. Together these outdoor heat sources accounted for 9 per cent of the hospitalisations. Home use of service or maintenance equipment such a welding irons and gas torches (often associated with a workplace rather than a home), also contributed to the unintentional domestic fire-related injury toll.

Item ignited

The item ignited was available for almost all (90 per cent) of the 512 hospital admissions for unintentional domestic fire-related injury in the scenario data subset. Clothing ignitions (160 inpatients; 30 per cent) or direct contact with the heat source (43 inpatients; 8 per cent) accounted for over one third of such injuries. One fifth (115 inpatients, 22 per cent) of the 512 hospitalisations involved flammable gas or liquid - 60 (12%) directly and 55 (11%) also involving clothing. Cooking materials were the item ignited in a further 81 inpatients (16 per cent), with the use of cooking oil or fat noted in the event description field in almost half of these inpatients (34 inpatients; 42 per cent of cooking material ignitions). Other items first ignited were bedding materials and other bedroom combustibles, combustible materials in lounge including upholstered furniture, and interior finishings such as carpets, curtains or wall linings.

Table 6. Number and percentage of unintentional domestic fire-related hospitalisations by age group and presumed heat source, Aotearoa New Zealand 1996-2000. Data sources FIRS, NZHIS.

	Hospitalisations by age group n (%)			
Heat source	**Under 15**	**16-64**	**65+**	**Total**
Stove top/ oven	25 (17)	69 (22)	8 (17)	102 (20)
Heater/ solid fuel burner/ open fire	21 (14)	55 (17)	12 (25)	88 (17)
Lighter/ matches	28 (19)	36 (11)	2 (4)	66 (13)
Other electric appliance/ wiring	9 (6)	20 (6)	6 (13)	35 (7)
Outdoor fire	10 (7)	20 (6)	1 (2)	31 (6)
Other open flame	10 (7)	10 (3)	1 (2)	21 (4)
Cigarette	3 (2)	14 (4)	3 (6)	20 (4)
Outdoor cooking	7 (5)	4 (1)	3 (6)	14 (3)
Fuelled or power equipment	-	5 (2)	1 (2)	6 (1)
Unknown	33 (23)	85 (27)	11 (23)	129 (25)
Total	**146 (100)**	**318 (100)**	**48 (100)**	**512 (100)**

Table 7. Number and percentage of unintentional domestic fire-related hospitalisations by age group and item first ignited, Aotearoa New Zealand 1996-2000. Data sources FIRS, NZHIS.

	Hospitalisations n (%) by age group			
Item ignited	**Under 15**	**16-65**	**65+**	**Total**
Clothing	45 (31)	102 (32)	13 (27)	160 (31)
Cooking material	19 (13)	54 (17)	81 (17)	81 (16)
Flammable gas or liquid	23 (16)	34 (11)	3 (6)	60 (12)
Direct contact	17 (12)	21 (7)	5 (10)	43 (8)
Bedding/ combustibles bedroom	7 (5)	22 (7)	6 (13)	35 (7)
Other combustibles	10 (7)	20 (6)	2 (4)	32 (6)
Structural/ interior finishings	8 (5)	14 (4)	5 (10)	27 (5)
Upholstered furniture/ combustibles lounge	3 (2)	8 (3)	1 (2)	12 (2)
Non upholstered furniture	1 (1)	6 (2)	-	7 (1)
MV interior	2 (1)	3 (1)	-	5 (1)
Unknown	11 (8)	34 (11)	5 (10)	50 (10)
Grand Total	**146 (100)**	**318 (100)**	**48 (100)**	**512 (100)**

Fire scenarios resulting in non-fatal injury

Scenarios describing the heat source and item ignited were developed and ranked according to the number of casualties requiring hospitalisation. Scenarios could be broadly grouped into those where the casualty was in immediate contact with the heat source or item ignited, and those where neither the heat source nor the item ignited was in immediate contact with the casualty. Almost half (47 per cent) of the 512 inpatients in the scenario subset were injured through direct contact or contact of clothing with the heat source. In 18 cases a fall was noted as integral to the fire-related injury. For example the injured person fell into burning embers or fell against a solid fuel or electric heater. The largest single group of admissions was clothing ignitions with unspecified heat source (100 admissions, 20 per cent). Further incident scenarios for study inpatients are listed below.

- Stovetop or oven igniting cooking materials accounted for 79 hospitalisations (15 per cent). In two cases the heat source for ignition of cooking materials was unknown. Cooking with fat or oil was specifically mentioned in 34 (42 per cent) of the cooking fires.
- Heater causing burn through direct contact or ignition of clothing accounted for 49 (10 per cent) of hospitalisations.
- Naked flame from matches, lighters or candles igniting bedding, upholstered furniture, curtains or motor vehicle interiors accounted for 36 hospitalisations (7 per cent).
- Outdoor fires for rubbish, warmth or cooking causing burns through direct contact or ignition of clothing accounted for 30 hospitalisations (6 per cent). Misuse of flammable gas or liquid (most commonly petrol) was specifically mentioned in 21

(70 per cent) of the hospitalisations as a result of outdoor fires. There were an additional two incidents where barbecues ignited the exterior wall of the dwelling.

- Means of heating (electric or gas heater, solid fuel burner or open fire) igniting bedding, upholstered furniture, carpet or other combustibles accounted for 24 hospitalisations (5 per cent).
- Naked flame from matches, lighters or candles causing burn through direct contact or ignition of clothing accounted for 23 hospitalisations (4 per cent).
- Naked flame from matches or lighters igniting flammable gas or liquid accounted for 18 hospitalisations (4 per cent)
- Electrical appliances other than heaters (e.g. electric blankets or lamps) igniting bedding, upholstered furniture or other combustible accounted for 19 hospitalisations (4 per cent).
- Stovetops or toasters causing burns through ignition of clothing or direct contact accounted for 18 hospitalisations (4 per cent).
- Cigarettes igniting bedding, upholstered or non-upholstered furniture or other combustibles accounted for 14 hospitalisations (3 per cent).
- Means of heating igniting flammable gas or liquid accounted for 10 hospitalisations (2 per cent). It is probable that some of these were malfunctioning gas heaters, and in other cases solvents were being used in proximity to the heat source.
- Cigarettes caused burns through ignition of clothing or direct contact in 5 incidents (1 per cent)
- Fuelled equipment such as welding torches or electric grinders igniting flammable gas or liquids, or other combustibles, accounted for 3 hospitalisations (1 per cent).
- Stove tops igniting flammable liquids or other combustibles led to 3 admissions (1 per cent).

Environmental characteristics – physical

The physical environment influences the potential for an unintentional domestic fire to start, the spread of the fire and the ability of dwelling occupants to evacuate and avoid serious injury. Key aspects of the physical environment are the outdoor climate and the presence or absence of domestic smoke alarms which could alert dwelling occupants to fire in the initial stages.

Climate

Climate was inferred from the month of occurrence of the fire incidents resulting in unintentional domestic fire-related injury. Seasonal variation in hospitalisation rates for unintentional domestic injury from fire and flame was not marked, although there were slightly more study inpatient admissions in the winter months June-August, as shown in Figure 3.

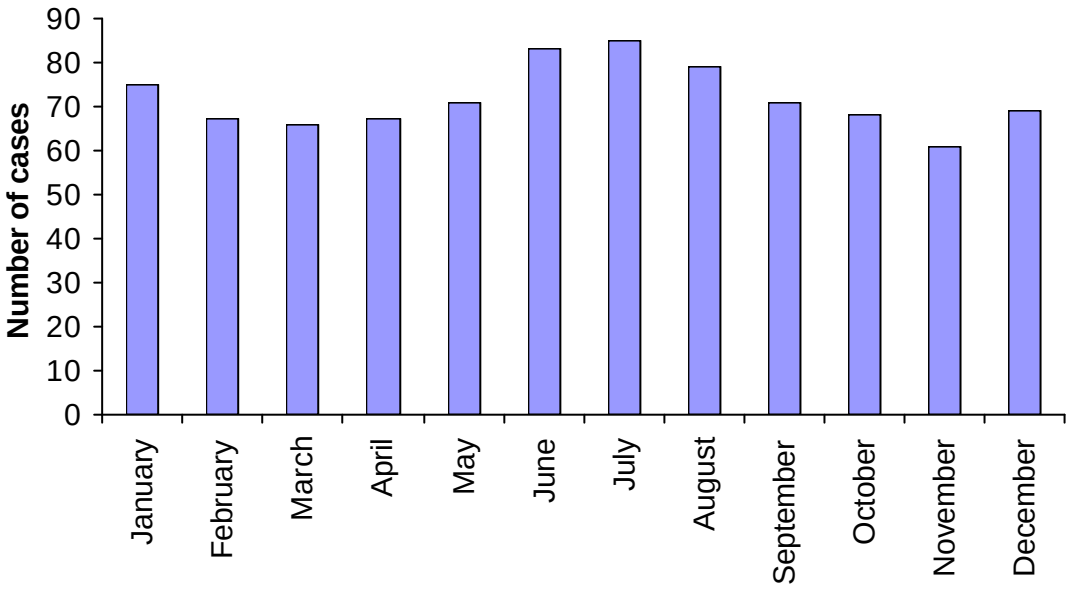

Figure 3. Month of injury resulting in hospital inpatient treatment of unintentional domestic injury from fire and flame Aotearoa New Zealand 1996-2000. Data source New Zealand Health Information Service.

Domestic smoke alarms

Data concerning the room of origin of the unintentional domestic fire incident, and data concerning smoke alarms, were available only in the FIRS database. The findings are therefore based only on the actual linked data (175 domestic inpatients). Information about the presence or absence of smoke alarms was entered in FIRS data for only eight inpatients, and mentioned in one NZHIS record. Domestic smoke alarms alerted occupants in 5 unintentional domestic fire incidents resulting in hospital inpatient treatment of a household member. In one further case an alarm operated but did not alert the occupants. There were three incidents where an alarm did not function. In the remaining 166 cases (95 per cent) no information about alarm presence or performance was recorded.

Environmental characteristics – social

Over half the 175 linked unintentional domestic fire-related injuries resulting in hospitalisation occurred on a weekend. Unintentional domestic fire-related injuries also occurred more commonly in the night and evening, with one fifth of the injuries occurring between midnight and 3 a.m., and one sixth between 9 p.m. and midnight (Figure 6).

Alcohol misuse

There was little information concerning alcohol involvement entered into the NZHIS injury records. However in 23 of the 862 study inpatients (4 per cent) a diagnosis indicating current misuse of alcohol was included in the record.

Tobacco use

As noted in the fire characteristics section, cigarettes were the heat source for 4 per cent of the hospitalisations in the scenario data subset. In 99 (11 per cent) of the 862 inpatients the NZHIS inpatient record included a diagnosis of current tobacco use. Although this does not necessarily imply that the tobacco use was relevant to the admission, nor to the event resulting in injury, it is an interesting observation. Tobacco use in a household increases the availability of matches and cigarette lighters, which were a principal heat source for unintentional domestic fire-related injury among children aged under 15 years.

Distance from Fire Service

As a measure of rurality and isolation the distance travelled by the nearest attending fire appliance was obtained from FIRS data for the 175 inpatients in the linked dataset. Almost three quarters of the unintentional domestic fire-related injury hospitalisations in the linked data subset occurred in incidents within 5 km of the nearest attending fire appliance (129 incidents; 72 per cent). A further 37 incidents (21 per cent) occurred between 5 and 9 kilometres from the attending fire appliance, and eight incidents (4 per cent) occurred between 10 and 25 kilometres of the nearest attending fire appliance.

Economic impact of non-fatal fire-related injury

From July 1994 to June 2001 the Accident Compensation Commission paid claims totalling over $NZ 9 million for injuries where the agent of injury was fire or flame (Accident Compensation Corporation, 2001). These data are for 'entitlement claims', i.e. claims where the injured person was entitled to compensation as a result of being unable to work for two weeks or more. The data do not include claims for medical costs only, nor claims related to non-earners. As shown in Table 8, over 60 per cent of the amount paid was for ongoing claims (i.e. claims for injury where the first entitlement claim was made in a previous calendar year). The average cost of each new claim was $2189 and for each ongoing claim $6059.

Table 8. Number and cost of all claims for injury from fire and flame July 1995 to June 2001. Data source Accident Compensation Corporation.

	New claims		Ongoing claims	
	Number of claims	**Cost ($000)**	**Number of claims**	**Cost ($000)**
1995/1996	277	546	146	818
1996/1997	281	547	164	1007
1997/1998	240	606	181	980
1998/1999	187	421	182	1190
1999/2000	143	323	186	1163
2000/2001	229	527	188	1186
Total	1357	2970	1047	6344

In the 2000/2001 corporate year ACC completed 1976 claims for injury from fire and flame. The total cost of these completed claims was $NZ 2,597,000. The duration (i.e. the time from the first claim to the final payment made by ACC) of the majority of these claims (1600 claims, 81 per cent) was under 8 weeks. The duration of a further 276 claims (11 per cent) was over 8 weeks but less than six months. The remaining claims had a duration from between six months and one year to over ten years. The 8 per cent of entitlement claims with duration over six months accounted for over half (53 per cent) of the total cost of completed claims.

Discussion

Data issues

This review of unintentional domestic fire-related injury highlights the importance of appropriate data collection in addressing issues associated with unintentional domestic fire-related injury in Aotearoa New Zealand. Although the datasets used in this study are the most reliable sources available, it is clear that there are areas for improvement, particularly in coding of NZHIS data and data entry in FIRS data. The most obvious issue was the high proportion of hospitalisations coded to an unspecified location. In such cases it is probable that there was insufficient information in the hospital record to allow more accurate coding. Overuse of non-specific Ecodes has been observed in previous research (LeMier, Cummings, & West, 2001). Accurate coding of hospital discharge data requires appropriate information in the hospital records and clear guidelines to promote uniformity of coding within and between hospitals (Langlois, Buechner, O'Connor, Nacar, & Smith, 1995). It is probable that some inpatients that were coded to an unspecified location did occur in private dwellings. Possible exclusion of such miscoded inpatients means that the hospitalisation rates for unintentional domestic fire-related injury calculated in this report should be viewed as conservative. The complex nature of burn injuries, and consequent classification difficulties, has long been recognised (Langley, 1984). (Smith & Langley, 1998) recommend the use of multiple cause injury coding and inclusion of free text narrative to optimise identification of complex injuries such as drowning and burns.

The New Zealand Fire Service recognises that FIRS non-fatal injury data are less reliable than fatality data (New Zealand Fire Service, 2002) Tables 40-40C). Accurate and comprehensive recording of non-fatal injury data is likely to remain problematic considering the demands on the time and energy of fire-fighters at the scene of a fire incident and on their return to the station. Nevertheless, the frequent lack of information about the presence or absence of a smoke alarm in FIRS is of concern, especially as installation and maintenance of domestic smoke alarms is a key fire safety strategy promoted throughout Aotearoa New Zealand. The most recent published statistics show that the type of detector alarm system is not recorded in 94 per cent of structure fires (New Zealand Fire Service, 2002) Table 16). The current FIRS data would be improved by unambiguous documentation of the presence or absence of smoke alarms at structural fire incidents. Inclusion of research reports in fire-fighter training modules to illustrate how such data can inform prevention strategy may encourage fire-fighters to collect good quality information.

Recommendations

That the New Zealand Fire Service Commission considers, develops and adopts appropriate strategies to improve the collection of fire safety information in residential fire incidents, particularly regarding the presence or absence and functioning status of domestic smoke alarms or sprinklers.

That the New Zealand Fire Service Commission considers undertaking formal fire investigations (as conducted for fatal fire incidents) in selected events resulting in non-fatal injury to gain a more comprehensive picture of the circumstances associated with such injury.

Difficulties in linking FIRS and NZHIS data illustrate the more general difficulties with the collection, analysis and interpretation of injury data in Aotearoa New Zealand and internationally (Alsop & Langley, 2001; Cryer et al., 2001). Injury data are collected and held by at least eight different agencies in New Zealand, with no co-ordination to allow a comprehensive picture of current injury incidence, or prevalence of post-injury disability. Such information is essential to identify factors associated with injury, and to plan, pilot, evaluate and implement effective injury prevention and control programmes. The Injury Prevention, Rehabilitation, and Compensation Act (2001) established the role of information manager to collect and aggregate injury-related information, facilitate access to injury-related information and unit record data, and consider and review current and future injury-related information requirements. The Government introduced a draft New Zealand Injury Prevention Strategy in October 2002. Both the strategy and support from the data manager have the potential to support and enhance the injury prevention aspects of the business of the New Zealand Fire Service Commission.

Recommendations

That the New Zealand Fire Service Commission liaise with the New Zealand Health Information Service and Statistics New Zealand to investigate and address the current limited ability to link casualty and hospital inpatient data.

That the New Zealand Fire Service Commission make a strong submission on the draft New Zealand Injury Prevention Strategy to ensure that fire-related injury is adequately addressed in the final strategy.

Undercounting of Mäori in health sector data has been recognised for many years (Graham, Jackson, Beaglehole, & de Boer, 1989; Te Ropu Rangahau Hauora a Eru Pomare (Eru Pomare Maori Health Research Centre), 2000; Tipene-Leach, Stewart, & Beaglehole, 1991). Since the 1996 census there also seems to have been a significant shift in the way New Zealanders understand ethnicity and identify with specific ethnic groups (personal communication, Bill Boddington, Statistics New Zealand, 2002). In this context it is important to recognise that measurement of disparities between Mäori and nonMäori is subject to considerable uncertainty. The twofold difference in hospitalisation rates for Maori compared with nonMäori is likely to be conservative, and does not necessarily indicate an improvement in Maori injury rates from previous studies.

Study implications

This review of unintentional domestic fire-related injury highlights clothing ignitions in all age groups, cooking related fires, and misuse of flammable liquids, as particular challenges to fire safety for New Zealand households. Other key issues with implications for prevention policy include:

- Safe means of heating
- Combustibility of bedding and upholstered furniture
- Safe use of electric appliances
- Safe storage and use of smoking materials with prevention of access by children to matches and lighters
- Installation and maintenance of domestic smoke alarms
- Equal access to fire safety information and protection

Clothing ignitions

In the current series clothing ignitions occurred in all age groups and the principal heat sources were heaters (including electric, gas, solid fuel and open fire), outdoor fires for cooking or heating, and stove tops. Lighters and matches were a significant heat source for clothing ignitions among children, and also adults aged 15-64 years. Misuse of flammable liquids was also common in clothing ignitions, especially in adults aged 15-64 years. Clothing of adults aged over 64 years was often ignited by heaters or cooking appliances.

Clothing ignitions have been recognised as an important mode of injury from fire and flame for children (Stanwick, 1985) and older adults (Rossignol, Locke, Boyle, & Burke, 1985; Turner, Leman, & Jordan, 1989; Ryan et al., 1997). Regulation of children's nightwear fabrics and styles to reduce risk of ignition was historically associated with a marked reduction in nightwear ignition burns in the USA and in New Zealand (McLoughlin, Clarke, Stahl, & Crawford, 1977, Laing & Bryant, 1991). Changes in heating patterns, a shift toward the wearing of pyjamas rather than night-dresses, and the regulatory changes were all important in this improvement in injury statistics (Laing & Bryant, 1991). Nevertheless in this series, almost one third of the child inpatients were injured as a result of clothing ignition. There is an apparent need for greater enforcement of existing regulations and a review of the value of extending the regulations beyond nightwear. Consumer awareness of the importance of fitting clothing styles when close to a heat source is important, particularly for older adults (Ryan et al., 1997).

Safe storage and use of flammable liquids

The observation that flammable gases or liquids were involved in at least one fifth of the unintentional domestic fire-related injury inpatients in the scenario data subset is consistent with the observation that one third of adult male admissions for burns over a two year period in the UK were associated with petrol use (Wilson & Bailie, 1995). Petrol burns require greater resuscitation efforts and more intensive treatment than non-petrol burns (Hankins, Hackett, & Varma, 1992, Cole, Herndon, Desai, & Abston, 1986). Although, as in the current series, the majority of petrol burns result from throwing petrol on an out door fire or barbecue, recreational sniffing of inflammable vapours also contributes to the injury toll (Cole, Herndon, Desai, & Abston, 1986). The safe storage and use of flammable liquids in New Zealand households is an area of fire safety that warrants further investigation and public education. As a first step it would be useful to find out how commonly flammable liquids are stored in private dwellings, and how they are used in the household. Data from Statistics New Zealand, combined with market information from garden tool retailers, indicate that approximately 50 per cent of households own lawnmowers or fuelled maintenance equipment. Chemicals such as mineral turpentine and methylated spirits may also be available for use in household renovations.

Safe cooking practices

In the current series 55 inpatients had injuries which resulted from incidents where food being prepared caught fire on a stove top. Use of fat or oil for cooking was noted in 80 per cent of the cooking related fires. The dangers of cooking with fat or oil have been well recognised (Home Office, 1999). In a UK study almost half of 1072 households reported deep frying of food regularly, and most of these fried food once a week or more. The potato chip was the food most frequently fried (Rowland & Roberts, 2002).

Potential intervention strategies include public safety campaigns to educate the public on how to avoid cooking fires, and how to extinguish such fires when they do occur. Rowland (2002) suggests an alternative strategy of promoting the consumption of oven ready or microwave chips.

Safe heating

Maintaining a warm home environment is important for the physical health and well being (Isaacs & Donn, 1993). However the means of achieving this must not increase risk of physical injury. Use of free-standing heaters is a characteristic of New Zealand homes, where central heating is unusual, which exposes household members to increased fire risk. In the USA heating fires are more frequent in rural areas, where central heating systems are less prevalent (U.S. Fire Administration, 2001a, 2001b). The ignitions of clothing and bedding by heaters in the current series reinforce the importance of including the "heater metre" rule (i.e. ensuring separation of one metre between heater and any combustibles) in Fire Service fire safety campaigns. Promotion of fixed wall mounted electric heaters, or oil –filled 'column' heaters to replace free-standing electric bar heaters is also likely to reduce unintentional domestic fire-related injury, especially among older New Zealanders.

Safe use of other electric appliances

The observation of unintentional domestic fire-related injures requiring hospitalisation where electric blankets or other appliances ignited the fire is a reminder of the importance of including maintenance of such appliances in any fire safety strategy. Such appliances were relatively more important as heat sources for injuries among older people. Fire safety campaigns in areas with a high proportion of seniors might beneficially include inspection of electric appliances used in the home.

Safe smoking practices

Use by children of matches and lighters was a significant factor in inpatient treatment for injury from fire and flame. Current New Zealand Fire service campaigns highlight the importance of safety with matches and lighters – a child in one of the commercials clearly indicates that, if found, such items should be handed to an adult. Although the information was not available in the present series, the mortality study indicated that use of matches and lighters by children occurred predominantly, but not exclusively, in smoking households. Although numbers were relatively small, the adoption of regulations concerning the ignition potential of manufactured cigarettes would also reduce the fire-related injury toll.

Smoke alarms

Lack of a smoke detector in a dwelling is an important risk factor for fatal fires (DiGuiseppi, Roberts, & Li, 1998; Runyan et al., 1992); Marshall et al., 1998). Yet identifying effective strategies to ensure full coverage of private dwellings with smoke alarms remains elusive. Legislation requiring smoke alarms in all private dwellings is associated with increased prevalence of alarm installation (McLoughlin, Marchone, Hanger, German, & Baker, 1985). Such legislation exists in many constituencies internationally (ISCAIP Smoke Detector Legislation Collaborators, 1999). A community approach to fire safety, such as that used in the Auahi Whakatüpato programme in Eastern Bay of Plenty, can greatly improve fire safety and reduce the cost to society of property damage, hospital treatment and the consequences of bereavement (Duncanson, Lawrence, & Simpson, 2000; Duncanson, Lawrence, Simpson, &

Woodward, 2000). However the validity of such uncontrolled results needs to be tested by more rigorous research methods. Systematic review of reported programmes to distribute alarms to private households indicated that such studies were uncontrolled, and the apparently positive results could be explained by chance, regression to the mean, or other factors rather than the distribution programme alone (DiGuiseppi & Higgins, 2000).

Prevalence of smoke detectors is inversely associated with socio-economic disadvantage (DiGuiseppi, Roberts, & Spiers, 1999; Forjuoh, Coben, Dearwater, & Weiss, 1997; Roberts, 1996). There is considerable benefit to society of having universal smoke alarm installation, above the benefit that accrues to individual households. The benefit-cost ratio for mandatory smoke alarm installation has been estimated at 9:1; that is 9 dollars of benefit for every dollar spent (Building Industry Authority, 1998). Comparison of four different distribution methods showed that door-to-door canvassing resulted in significantly more detectors being distributed to homes without detectors at a lower cost than advertising availability of alarms at specific fire stations (Douglas, Mallonee, & Istre, 1998). A randomised controlled trial of smoke alarm distribution in deprived London suburbs showed no difference between intervention and control groups in terms of smoke alarm installation, nor hospitalisation or death rates for injury from fire and flame, at follow-up two years after distribution (DiGuiseppi et al., 2002). Where alarms are installed, maintenance is critically important to ensure ongoing protection in the event of a fire incident. The type of alarm and the power source are important determinants of the medium term functioning of an alarm. In a British study ionisation alarms with lithium (long life) batteries were more likely than optical (photo-electric) alarms and alarms with zinc batteries to be functioning 15 months after installation (Rowland et al., 2002). Conversely photoelectric alarms have been found to be more effective in Alaska (Fazzini, Perkins, & Grossman, 2000).

Recommendation

That the New Zealand Fire Service Commission continue to sponsor fire safety campaigns which focus on

- safe cooking practices,
- safe distances between heaters and combustibles,
- maintenance and safe use of other electric appliances,
- safe storage and use of smoking materials, and prevention of child access to matches and lighters,
- installation and maintenance of domestic smoke alarms,

That in addition to the measures above, the New Zealand Fire Service Commission consider development of fire safety campaigns and strategies which focus on

- safe storage and use of flammable materials, and
- wearing of fitting clothing near heaters and stovetops.

Equal access to fire safety information and protection

The persisting ethnic disparities in hospitalisation rates for unintentional domestic fire-related injury highlight the importance of designing fire safety strategies to reach all population groups. The investment by the New Zealand Fire Service Commission in research to address this disparity (Thomas, Rayner, & Moroney, 2000), and the appointment of Iwi liaison officers in key fire regions are timely actions to begin addressing this issue. These measures need to need to be underpinned by continued development of bicultural awareness within the Fire Service at all levels, for example through hui for Mäori staff and cultural awareness training as undertaken in the 2001/2002 corporate year (New Zealand Fire Service, 2002). Fire safety information must be culturally appropriate, and appeal in particular to New Zealand households at high risk of fire-related injury. There is also a need for recognition of the ethnic diversity of the New Zealand population. Pacific peoples are believed to be undercounted in health data, and although numbers were small in the current study, Pacific peoples are represented in unintentional domestic fire-related injury statistics. Research in Australia has highlighted the importance of ensuring fire safety messages are accessible to immigrant cultures (Young, Camit, & Mihajlovic, 1999). It is important for the Fire Service to obtain appropriate cultural advice to improve fire safety for Pacific peoples and other ethnic minority groups.

Recommendation

That the New Zealand Fire Service Commission continue to support research and development of appropriate programmes to address ethnic disparities in fire-related injury rates, adequately supported by appointment of Mäori liaison staff in each fire region and ongoing training in cultural awareness for all fire-fighters.

Conclusion

This descriptive analysis has identified personal, fire-related and environmental factors associated with the 862 inpatients admitted for treatment of unintentional domestic fire-related injury from 1996 to 2000. Interventions to improve fire safety for New Zealand households will need to take into account a wide variety of factors including storage and use of flammable substances such as petrol in the home. Fire safety can be incorporated within many services available to New Zealand households, as evidenced by the Fire Safety ambassador programme initiated by the New Zealand Fire Service in conjunction with Plunket and other agencies. Intersectoral raising of awareness of fire risks and of effective intervention strategies is a key component in reducing the injury toll.

References

Accident Compensation Corporation. (2001). *Injury statistics* (Second ed.). Wellington: Accident Compensation Corporation.

Alsop, J., & Langley, J. (2001). Under-reporting of motor vehicle traffic crash victims in New Zealand. *Accident Analysis and Prevention, 33*, 353-359.

Building Industry Authority. (1998). *Economic evaluation of proposed change to Building Code regulations for smoke detectors*. Wellington: Building Industry Authority.

Cryer, P. C., Westrup, S., Cook, A. C., Ashwell, V., Bridger, P., & Clarke, C. (2001). Investigation of bias after data linkage of hospital admissions data to police road traffic crash reports. *Injury Prevention, 7*, 234-241.

DiGuiseppi, C., Edwards, P., Godward, C., Roberts, I., & Wade, A. (2000). Urban residential fire and flame injuries. *Injury Prevention, 6*, 250-254.

DiGuiseppi, C., & Higgins, J. P. T. (2000). Systematic review of controlled trials of interventions to promote smoke alarms. *Archives of Disease in Childhood, 82*, 341-348.

DiGuiseppi, C., Roberts, I., & Li, L. (1998). Smoke alarm ownership and house fire death rates in children. *Journal of Epidemiology and Community Health, 52*, 760-761.

DiGuiseppi, C., Roberts, I., & Spiers, N. (1999). Smoke alarm installation and function in inner London council housing. *Archives of Disease in Childhood, 81*, 400-403.

DiGuiseppi, C., Roberts, I., Wade, A., Sculpher, M., Edwards, P., Godward, C., Pan, H., & Slater, S. (2002). Incidence of fires and related injuries after giving out free smoke alarms: Cluster randomised controlled trial. *British Medical Journal, 325*, 995-997.

Douglas, M. R., Mallonee, S., & Istre, G. R. (1998). Comparison of community based smoke detector distribution methods in an urban community. *Injury Prevention, 4*, 28-32.

Duncanson, M., Lawrence, K., & Simpson, J. (2000). *Process and outcome evaluation of Auahi Whakatüpato smoke alarm installation project in the Eastern Bay of Plenty 1997-1999*. Wellington: New Zealand Fire Service Commission.

Duncanson, M., Lawrence, K., Simpson, J., & Woodward, A. (2000). *Follow-up survey of Auahi Whakatüpato smoke alarm installation project in the Eastern Bay of Plenty* (New Zealand Fire Service Commission Research Report number 7). Wellington: New Zealand Fire Service Commission.

Duncanson, M., Reid, P., Langley, J., & Woodward, A. (2001). *Overview of fire-related mortality data for Aotearoa New Zealand 1991-1997*. Wellington: New Zealand Fire Service Commission.

Fazzini, T. M., Perkins, R., & Grossman, D. (2000). Ionization and photoelectric smoke alarms in rural Alaskan homes. *Western Journal of Medicine, 173*, 89-92.

Forjuoh, S. N., Coben, J. H., Dearwater, S. R., & Weiss, H. B. (1997). Identifying homes with inadequate smoke detector protection from residential fires in Pennsylvania. *Journal of Burn Care & Rehabilitation, 18*, 86-91.

Graham, P., Jackson, R., Beaglehole, R., & de Boer, G. (1989). The validity of Maori mortality statistics. *New Zealand Medical Journal, 102*, 124-126.

Halbert, T. A. (1999). The fire-safe cigarette: The other tobacco war. *Business and Society Review, 102*, 25-36.

Home Office. (1999). Chip pan fire safety. London.

Isaacs, N., & Donn, M. (1993). Health and housing - seasonality in New Zealand mortality. *Australian Journal of Public Health, 17*, 68-70.

ISCAIP Smoke Detector Legislation Collaborators. (1999). International smoke detector legislation. *Injury Prevention, 5*, 254-255.

Keane, A., Brennan, A. M. W., & Pickett, M. (2000). A typology of residential fire survivors' multidimensional needs. *Western Journal of Nursing Research, 22*, 263-284.

Keane, A., Jepson, C., Pickett, M., Robinson, L., & McCorkle, R. (1996). Demographic characteristics, fire experiences, and distress of residential fire survivors. *Issues in Mental Health Nursing, 17*, 487-501.

Kemp, A., & Sibert, J. (1997). Childhood accidents: Epidemiology, trends and prevention. *Journal of Accident and Emergency Medicine, 14*, 316-320.

Langley, J. (1984). Description and classification of childhood burns. *Burns., 10*, 231-235.

Langlois, J. A., Buechner, J. S., O'Connor, E. A., Nacar, E. Q., & Smith, G. S. (1995). Improving the E coding of hospitalizations for injury: Do hospital records contain adequate information? *American Journal of Public Health, 85*, 1261-1265.

LeMier, M., Cummings, P., & West, T. A. (2001). Accuracy of external cause of injury codes reported in Washington State hospital discharge records. *Injury Prevention, 7*, 334-338.

McLoughlin, E., Marchone, M., Hanger, L., German, P. S., & Baker, S. P. (1985). Smoke detector legislation: Its effect on owner-occupied homes. *American Journal of Public Health, 75*, 858-862.

Mood, E. W. (1993). Fundamentals of healthful housing: their application in the 21st century. In R. Burridge & D. Ormandy (Eds.), *Unhealthy housing* (pp. 303-337). London: Chapman & Hall.

New Zealand Fire Service. (2002). *Emergency Incident Statistics: Edition for the 2000/2001 Corporate year*. Wellington: New Zealand Fire Service.

Roberts, I. (1996). Smoke alarm use: prevalence and household predictors. *Injury Prevention, 2*, 263-265.

Rowland, D., DiGuiseppi, C., Roberts, I., Curtis, K., Roberts, H., Ginnelly, L., Sculpher, M., & Wade, A. (2002). Prevalence of working smoke alarms in local authority inner city housing: Randomised controlled trial. *British Medical Journal, 325*, 998-1001.

Rowland, D., & Roberts, I. (2002). Potential public health importance of the oven ready chip. *Injury Prevention, 8*, 328-329.

Runyan, C. W., Bangdiwala, S. I., Linzer, M. A., Sacks, J. J., & Butts, J. (1992). Risk factors for fatal residential fires. *New England Journal of Medicine, 327*, 859-863.

Ryan, C. M., Thorpe, W., Mullin, P., Roberts, W., Tomkins, D., Kelleher, P., Sheridan, R., & Tomkins, R. (1997). A persistent hazard for older adults: Cooking related clothing ignition (letter). *Journal of the American Geriatrics Society, 45*, 1283-1285

Smith, G. S., & Langley, J. D. (1998). Drowning surveillance: how well do E codes identify submersion fatalities. *Injury Prevention, 4*, 135-139.

Te Ropu Rangahau Hauora a Eru Pomare (Eru Pomare Maori Health Research Centre). (2000). Counting for nothing: Understanding the issues in monitoring disparities. *Social Policy Journal of New Zealand 14*, 1-16.

Thomas, P., Rayner, K., & Moroney, M. (2000). *Determining effective fire safety strategies for Mäori* (Research Report 2). Wellington: New Zealand Fire Service Commission.

Tipene-Leach, D., Stewart, A., & Beaglehole, R. (1991). Coronary heart disease mortality in Auckland Maori and Europeans. *New Zealand Medical Journal, 104*, 55-57.

U.S. Fire Administration. (2001a). *Older adults and fire* (Topical Fire Research Series Volume 2; Issue 1). Emmitsburg, Maryland: Federal Emergency Management Agency.

U.S. Fire Administration. (2001b). *Portable heating fires in residential structures* (Topical Fire Research Series). Emmitsburg: Federal Emergency Management Agency.

Young, M., Camit, M., & Mihajlovic, M. (1999). A smoke alarm campaign in Arabic, Chinese and Vietnamese communities. *NSW Public Health Bulletin, 10*, 133-135.