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Victorian Injury
Surveillance System
Monash University
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This edition of Hazard adopts a systems approach to injury associated with housing structures. Interventions which will prevent many of these injuries are best incorporated at the design stage, before building or renovation. Injuries associated with housing structures have been analysed and recommendations made for prevention.

Safe Home Design

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Summary

The home is the most common location for injury representing 49% of child and 29% of adult emergency department presentations on the Victorian Injury Surveillance System (VISS) database. Of these, at least 30% and 26% respectively were related to structures, fixtures and other features incorporated into a home at the design, building or renovation stage. In Victoria each year there are 50,000 new homes and 100,000 renovations requiring permits. If these homes incorporated safety features the potential for injury reduction would be high and long lasting.

The most frequent and easily identifiable structural causes of injury on the VISS database include floors, concrete and paving, stairs/steps, doors and domestic architectural glass. The most severe injuries were associated with electrical circuits, bath and shower scalds or fire/flame/smoke (all ages), poisoning storage (children) and floors (adult falls).

A series of safety display homes have demonstrated a systems approach to preventing injury associated with home structures. These homes combine both design change and education, incorporating up to 60 safety features, the most popular of which have been poisons cabinets, uninterrupted vision from the kitchen into the backyard, a driveway clear of play areas, safe kitchen design and non-slip bath and shower bases.

Research, advocacy by community groups and professionals and policy development by relevant authorities have resulted in legislation of safety features including the regulation of bathroom hot water to 50°C, smoke detectors, pool fencing and toughened glass for lower level windows. Each of these features has been incorporated into the Australian Building Code or the Building Code of Victoria.

Safe Home Design

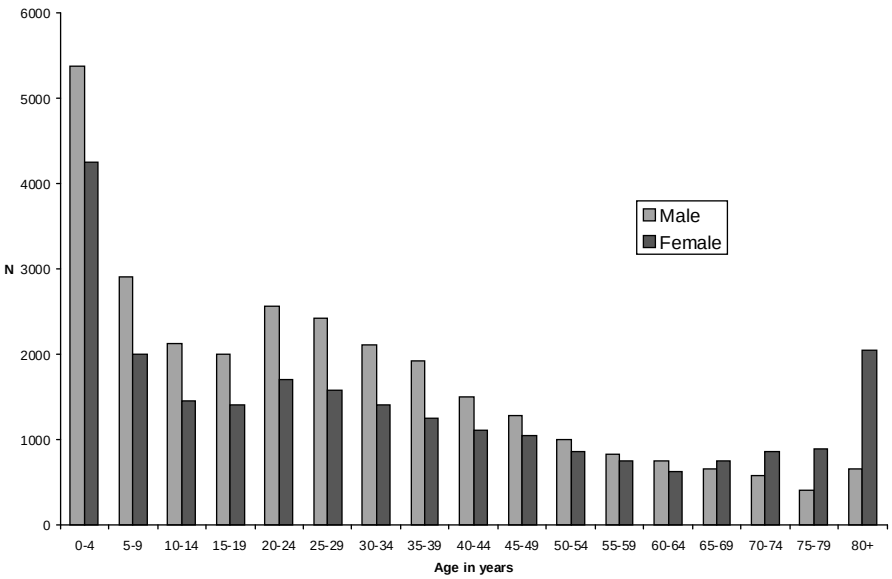
This edition of Hazard identifies structural design features of the home which are associated with injury and makes recommendations for modifications of these features at the design stage, before construction or renovation. There are 50,000 new homes and 100,000 renovations requiring permits each year in Victoria. If these homes incorporated safety features, often at little or no additional cost, the potential for injury reduction would be high and long lasting. By modifying the environment, injury risk can be reduced without relying on human behaviour, at a stage which is most cost effective. If a culture of safety develops among the home building industry and its clients, safety features could become widespread. To date, many of the findings from injury data and research have not been widely implemented despite public access to several safety display homes and a pro-active Victorian State Government which fosters safe home design.

Home injuries overview

The home is the most common location for injury. On the VISS database[1] 41,314 child cases (49% of total child injury emergency department presentations) and 20,692 adult cases (29% of total adult cases) occurred in the home. Of these at least 30% and 26% respectively were related to structures, fixtures and other features incorporated into a home at the design, building or renovation stage.

A systems approach for safer design is highlighted as well as specific recommendations for each of the major structural features. An analysis of the VISS database for the most frequent causes of injury related to structural features of the home is summarised in Table 1. This is supplemented, where relevant, by data from the new Victorian Emergency Minimum Dataset (VEMD) database[2] which contains 152,254 cases from 24 Victorian public hospitals, July 1996 to June 1997.

Injury in the home by age and sex – Emergency Department Presentations July 1996 to June 1997. (N = 54,552) **Figure 1**



Source: VISS - Victorian Emergency Minimum Dataset (VEMD), July 1996 to June 1997

Figure 1 provides an overview of recent home injury data by age and sex from the VEMD database. At almost all ages there are more males presenting to hospital than females. Under 5 years, 20 to 29 years and over 80 years are peak age groups for home injury. The high proportions of injuries for the under 5 age group and the elderly partly reflects the relative proportions of time spent in the home rather than the risk associated with these factors necessarily being higher eg. children under 5 years and adults over 65 years accounted for 63% and 21% respectively of child and adult stair/step injuries in the home but only 49% and 16% respectively of child and adult stair/step injuries in all locations.

Structural factors in home injury

The most frequent and most easily identified structural factors in the VISS database were floors, concrete and paving, doors, stairs/steps, fences and fence posts, bath and shower bases, domestic architectural glass, structural tiles, bench tops, early childhood poisoning (access from cupboards and shelves) and bathroom

[1] VISS database – emergency department presentations to Royal Children's Hospital 1988 to 1993, Western Hospital, Preston and Northcote Community Hospital 1989 to 1993, Royal Melbourne Hospital March 1992 to February 1994 and Latrobe Regional Hospital July 1991 to June 1996.

[2] VEMD database – emergency department presentations commencing from October 1995: Austin and Repatriation Medical Centre, Ballarat Base Hospital, The Bendigo Hospital Campus, Box Hill Hospital, Echuca Base Hospital, The Geelong Hospital, Goulburn Valley Base Hospital, Maroondah Hospital, Mildura Base Hospital, Preston and Northcote Community Hospital, Royal Children's Hospital, St Vincent's Public Hospital, Wangaratta Base Hospital, Warrnambool and District Base Hospital, Western Hospital, The Williamstown Hospital and Wimmera Base Hospital. November 1995: Dandenong Hospital. December 1995: Royal Victorian Eye and Ear Hospital and Mornington Peninsula Hospital. January 1996: Latrobe Regional Hospital. July 1996: The Alfred Hospital and Monash Medical Centre. September 1996: The Angliss Hospital.

hot water (Table 1). These factors were also frequently identified in the VEMD database although floor and concrete were probably underestimated, as identification was solely reliant on the provision of detailed injury narratives. There were other causes which could not be so easily identified from the data eg scalds and collisions because of poorly designed kitchens; injuries to children in play areas because of poor visual contact between work areas (kitchen, laundry) and play areas (yard, family room); collisions and impacts because of poorly positioned doorway openings; falls due to poor lighting; less than optimal supervision of children during phone calls due to the absence of cordless phones, etc.

The VISS database identifies the presence of two types of structural factors. These factors can be associated with the event leading to injury eg. "Slipped on wet **flooring surface**" and/or the direct cause of the injury eg. "Tripped and fell, hitting head on **floor**". For a case to be attributed to a particular injury cause eg. flooring it must have been identified at least once with that factor. Between 2 and 4 factors can be identified per case (Table 1).

Injury Causes

The following analysis is based on the factors identified in Table 1. For the purposes of this analysis children are defined as persons aged up to 15 years and adults, persons aged 15 years and over. This section does not include prevention strategies and detailed recommendations. These are discussed later in the article.

Floors (n=4046 child, 1583 adult)

Ninety percent of floor related injury, to both adults and children, was associated with falls.

Children under 5 years of age accounted for 69% of floor related child injury, with a peak at 1 year (20% of total). The frequency of floor related injury to adults increased with the increasing age of the injured person. Seventeen percent of adults injured in this way were aged 70-79 years and 23% of the total were over 80 years of age. While floor related injury to persons aged 70+ therefore accounted for 40% of total adult floor injury they represent only 11% of the Victorian adult population (ABS, 1997). Females were over-represented in the adult sample, especially those aged over 70 years (70% of injured adults were female, 80% of those injured over 70 years).This female over-representation can be partly accounted for by demographics (they represent 59% of the over 70 population).

One third of child falls were from a height, up to one metre, onto the flooring surface. This scenario was particularly common in children in the 0-4 age group (40% of total for this age group). Most of the falls from a height result from falls from a furniture item onto the floor eg. *"Playing on the bed, fell off, hit head on floor"* or *" Climbed onto high stool, lent on stool, fell, landed face down on slate floor"*. Beds, bunkbeds, chairs, cots, high chairs, couches, baby change tables, tables and cabinets were most often associated with these falls. Falls from a height requiring admission were mostly associated with beds, chairs, bunk beds and tables, and nursery furniture in very young children.

Almost 80% of adult floor injury was associated with falls and were mostly slips (30% of adult floor total) or falls on the same level (27%). Older adults (65+ years) fell on the same level (26% of 65+ total) and slipped (20%).

Fourteen percent of child and 40% of adults sustaining floor related injuries required hospital admission. When considering the oldest group, 80+ years, 73% required hospital admission.

Fractures were the most common injury for both adults and children (41% adult and 27% of child floor related injury). Adult fractures were most often to the hip and femur (16% of total injuries and 45% of admitted cases). This proportion increased with the age of the injured person accounting for 35% of injuries and 57% of admissions in the 80+ age group. Other common adult injury included wrist fractures (4%), lacerations to the face and scalp (4%), radius/ulna fractures (3%) and ankle sprain/strain

Injuries related to structural features: causes by frequency and severity — Table 1

(Emergency Department Presentations and Hospital Admissions)

Injury cause	Child pres. (<15 years)	Child adm. as % pres.	Adult pres. (>=15 years)	Adult adm. as % pres.
Floors	4046	14%	1583	40%
Concrete & paving	2434	15%	878	20%
Non-glass, doors	1779	21%	408	9%
Stairs/steps/ ramps/railings	1305	12%	1012	16%
Fences/fence posts	840	16%	179	13%
Baths & showers (excl. scalds)	612	25%	258	17%
Domestic architectural glass	505	23%	490	15%
Structural tiles	438	14%	124	23%
Kitchen benches	371	25%	63	11%
Child poisoning, <5 years (access from cupboards & shelves)	307	43%	na	na
Bath and shower hot water scalds	215	45%	15	44%
Porches & balconies	167	24%	58	21%
Gates	144	42%	45	13%
Electrical circuits	77	48%	54	33%
Flame/fire/smoke	74	45%	116	29%
Child falls over 1m from windows	24	42%	na	na

Source: VISS database - RCH, WH, PANCH 1989-93, LRH July 1991 to June 1996.
NB: Between 2 and 4 factors can be noted per case.

(3%). Fractures are a common result of falls to the floor among the elderly due to the decline in bone strength and lack of fat padding in areas where the body contacts with the surface (O'Reilly, 1995).

Fractures in children were common to the arm, particularly radius/ulna (8% of total child fractures from this cause), clavicle, elbow and humerus (each 3% of total). Injury to the head, face and scalp were slightly more common than upper limb injury (38% vs 37%); concussion (10% of all child injury from this cause), and bruising or lacerations to the face and scalp (11%).

While it is recognised in the relevant Australian Standard (AS/NZS 3661.2:1994) that completely non slip surfaces are not realistically obtainable, the Standard stresses that much improvement can be made by using the material and treatments as outlined in the Standard.

The Victorian Kidsafe display home has slip-resistant surfacing in the kitchen, family room and bathroom featuring tiles which have a high friction surface to provide better grip (Kidsafe Winter, 1996).

Structural (floor and wall) tiles (n=438 child, 124 adult)

A further 438 child and 124 adult injury were associated with structural tiles. Despite the fact that many of these are floor tiles, less than 1% of the total number of structural tile injuries overlap with the dataset on floor injury. Thus the following analysis is almost totally independent from that of floor injury above.

Children under 5 years of age accounted for 75% of structural tile related child injury, with a peak at 1 year (26% of total). Nineteen percent of injured adults were 30-39 years of age and 15% were aged in excess of 80 years. As with other floor injuries females were over-represented in the adult sample accounting for 64% of injured adults from this cause.

For both child and adult cases, the living or sleeping areas were the most common site of tile related injuries (38% and 31% respectively). Structural tile related injury in the kitchen (33% child, 19% adult) and the bathroom, laundry and toilet (14% child, 26% adult) were also common.

Slips were the most common event leading to injury (30% child, 60% adult). Another quarter of child injury was the result of a fall from up to one metre. As with other floor injury this indicates a fall from a furniture item onto the tiled surface eg. *"Playing, fell off couch, landed on floor tiles"*.

Child injury was mostly to the head, face or scalp (65% of total child tile injuries). Concussion (16%) and bruising or lacerations to the face and scalp (each 11%) were particularly common.

Almost a third of adult injury were fractures, particularly of the wrist (7% of adult injury total), hip (7%) and femur (6%).

Concrete and paving (n=2434 child, 878 adult)

Of the injuries associated with concrete and paving, 94% of child and 92% of adult injury occurred outside the home in the garden, garage or yard. The remaining few cases involved falls onto concrete flooring inside the home, eg. laundry.

Two percent of the total child cases involved falls from inside the home (mostly windows or doors) onto an outdoor concrete surface.

Sixty-eight percent of child and 77% of adult cases were associated with falls. Children mostly fell on the same level (20% child cases) or from a level up to one metre (18%). Adults mostly slipped (27% adult cases) or fell from a level up to one metre (18%).

Factors most often associated with child injury included bicycles (10% of child concrete and paving injuries), steps or stairs (10%), fences or fence posts (6%), rollerskating or rollerblading (5%) and skateboards (3%).

Factors most often associated with adult injury from this cause were steps and stairs (18% of adult total), ladders (8%), roofs (4%), water (4%) and dogs (3%).

Fifteen percent of child and 20% of adult cases required hospitalisation. Child injuries were predominantly to the head (48% of child concrete related injury total). Common injuries included concussion (11%), face and scalp lacerations (9%), face and scalp bruising (8%) and radius/ ulna fracture (8%).

Fractures accounted for one third of the total of injuries to adults, particularly to the wrist and radius/ulna (each 4%). Other relatively common injuries were ankle strain/sprain (8%) and face and scalp lacerations (4%).

Non-glass, door related injuries (n=1779 child, 408 adults)

Door related injuries occurred with particular frequency to under 5 year olds (70% of child door related cases), notably one year olds (27%). They were usually finger jams (50%, n=890) eg. *"Fingers jammed in door whilst playing"*, or injuries caused by the victim hitting against the door (36%, n=640) eg. *"Playing with brother, couldn't stop running, hit head on edge of door"*. Of finger jams, the typical injuries were lacerations (29% of cases), crushing (27%), amputations (18%) or bruising (18%). One third were admitted to hospital, emphasising the severity of these injuries. Of the injuries caused by the victim hitting against the door, the most common were face and scalp lacerations and bruising (50% cases). Only 8% were admitted, showing these injuries were generally less severe.

Injuries to adults were less severe. Adults were more likely than young children to collide with a door (51% hit against door) than have finger jams (22% caught in door). Injuries were most often lacerations (33%), especially to the fingers, scalp, face and foot; fractures (18%), especially to the hand and bruising (15%), also particularly to the hand. Adult finger jams were less severe than children's (5% admitted), presumably due to adult fingers being more robust.

Child finger jam injuries more often involved another person (35%), especially another child (28%) eg. *"Playing with older brother. Fighting over closing of door. Slammed finger in door"*. This involvement was more frequent in a Dutch study where in three quarters of younger child cases the door was closed by another person (Venema, 1995). In the VISS data, there were 37 child and 8 adult cases where sliding doors were noted eg. *"Playing near sliding door, mum opened door, finger got caught"*. These had relatively low admission rates (22% and 13% respectively).

A follow-up study by MUARC of Victorian child finger jam injuries (identified from the VISS database) found the hinge side of the door to have caused 60% of the injuries. The hinge side, which has greater potential for serious injury, was more common for the under 5 age group, the closing side for older age groups (Ozanne-Smith, 1993). These figures are consistent with those of the Dutch study (75% of under 12 year olds were injured in the hinge side). Some respondents mentioned the door slamming or closing with force. However in most cases the entrapment resulted from the normal act of closing the door.

The Dutch study "Entrapment between doors in houses" surveyed victims of door entrapment identified by PORS (Dutch Home and Leisure Accident System). The survey revealed that in 84% of the injuries only one finger was involved. The thumb was injured most often, followed by the middle and little fingers. In two thirds of cases only the finger tip was involved. In the survey almost two thirds of the respondents (63%) reported long-lasting consequences in the form of deformation, decreasing flexibility and sensitivity. Most finger jams involved people standing in the door-way or passing the door, holding onto the door or the door-jamb, while the door was being closed by themselves or another person. Almost half of the Dutch entrapment cases involved street doors.

The study recommended investigation into rounded edges on the closing hinge sides of doors or compression material on the hinge door jam, which can be incorporated at the building stage. Such a compression material has been trialed in Australia in the Latrobe Valley safety house ("safe edge" doors). Development of a test method for these countermeasures still has a long way to go. Biomechanical studies need to be conducted in order to develop a test finger with which entrapment forces and their effects on human fingers can be studied. (Venema, 1995).

Stairs/steps/ramps/railings (n=1305 child, 1012 adults)

For both adults and children, falls accounted for almost 80% of stair/step related injury. Over half (56%) of child injury cases involving stairs and steps in the home were to children aged 3 years and under with a peak at one year (22% of child injuries). At this age, children are developing their motor skills and exploring their environment.

At almost all adult ages, there were more women than men presenting to emergency departments with injuries from stairs and steps. The female male ratio became more pronounced as age increased (15-19 years 1: 1, 80+ years 3: 1) as did the severity of injury (15-19 years 1% admitted, 80+ years 45% admitted). The over-representation of elderly females can be partly explained by demographics (for 80+ years, 2 females:1 male). Injuries were most commonly fractures (31% injuries), particularly to the lower legs and arms, ankle sprain/strains (19%) and lacerations to the face and scalp (4%). Fractured hips and femurs, 5% of total adult cases were admitted in 94% of cases.

Falls more often occurred when descending than ascending stairs, particularly for adults (descending to ascending ratios were 4:1 for adults, 2.2:1 for children). This was also noted by the North Coast Public Health Unit. When descending, adults were more likely to slip, children to fall to another level. When ascending, adults were most likely to trip, children to slip, trip or fall to another level.

Injuries to children under 5 years were predominantly caused by falling, particularly up to one metre eg. *"Playing with brother climbed railing and fell. Landed on the corner of a step"*. *"Child crawled through the handrail banister, fell onto toys on concrete floor"*.

Children most often received injuries to the head especially face and scalp lacerations and bruising and concussion. This injury pattern presumably relates to the larger size of children's heads and therefore higher centres of gravity than adults. Slips were the dominant cause of stair and step injury in other age groups, usually causing injury to the lower leg, particularly ankle sprain/strains and to a lesser extent ankle and metatarsal fractures. eg. *"Walking down steps, slipped. Inversion injury to ankle after falling down steps"*. There were also frequent radius, ulna and wrist fractures. In the elderly (over 65 years) trips were almost as common as slips and fractured hips, femurs and ribs, with high admission rates, were the dominant injuries for this age group. eg. *"Tripped on back door step and landed on hip"*.

Fences and fence posts (excluding gates) (n=840 child, 179 adult)

Fences injuries are most common in the 5-9 age group (40% of child total). Thirty-six percent of child injury from fences and fence posts indicated that the child was climbing on the fence when the injury occurred.

Fifty-nine percent of child and 30% of adult injury was associated with a fall. Of these forty-two percent of child and 13% of adult injury involved a fall from a height. Almost a quarter of the total of child injury were falls from over one metre eg. *"Climbing a fence, slipped and fell 5 feet, landed head first on concrete"*.

Common injury to children included radius/ulna fractures (9%), face and scalp lacerations (8%) or concussion (5%). Injuries common among adults included finger lacerations (5% of adult total), ankle strain/sprain (5%), metatarsal

fractures (3%) and concussion (3%). Sixteen percent of children and 13% of adults required hospitalisation.

While only a small number of child cases, 7%, involved a child climbing a pool fence, five of the six resulted in death by drowning. *Hazard* 30 reported on drowning in home swimming pools. Even in cases where fencing was in place, injury and death could still occur when children climbed the fence, often using objects to assist them, or the pool gate was left open or in need of repair eg. *"Climbed over pool fence using bike, found face down in water, immersed for 10 minutes"* or *"Playing with other kids, one left pool gate open, child found face down in pool"*.

Gates (n=144 child, 45 adult)

Running into a gate (42% child, 24% adult) or being caught in the gate (22% child, 24% adult) were the most common causes of these injuries eg. *"Chasing a cat, child ran into gate"* or *"Shutting the gate, fingers caught in gate"*. More than a quarter of injured children were climbing, playing or swinging on the gate when the injury occurred.

Of the children who were caught in gates, 75% sustained finger injuries, particularly crushing injury and fractures, 42% of which required hospitalisation.

Overall, fingers were the region most often associated with gate injury (22% child and 23% adult injuries respectively).

Gates can be used to prevent access to hazards. However it was not possible to accurately identify injuries which may have been associated with access to hazards as the result of an ineffective gate.

Baths and showers (n=612 child, 258 adult)

In proportion to the amount of time in use, the bathroom is the most dangerous room in the home for children (Kidsafe, 1992). Seventy percent of child injury in this location was in the under 5 age group with almost two-thirds of admitted cases related to either scalds or near drowning.

Scalds were more common in children (40% of child bath/shower injury) than adults (6% of adult bath/shower injury). *[A discussion of hot water scalds is provided elsewhere in this article]*. Adults were more likely to sustain lacerations (27% of adult bath and shower related injury total) and fractures (17%).

Of drownings/near drownings in the 0-4 age group in Victoria, 13% of deaths, 19% of hospital admissions and 10% of emergency department presentation cases occur in the bath (*Hazard* 30, March 1997).

Fall injury is common in the bathroom due to the combination of water and potentially slippery surfaces. Of bath and shower related injuries, 51% of adult and 46% of child cases were associated with slips, eg. *"Drying self with towel, slipped on water on the tiled floor of the shower"* or *"Having a bath, slipped when getting out, landed on the floor"*.

The main dangers associated with baths are falls while getting in or out, drowning and scalds (Dept of Housing and Construction, 1985).

Domestic architectural glass (n=505 children, 490 adults) (glass windows, doors, bath and shower enclosures)

Two thirds of child domestic architectural glass injuries were to males, most commonly 1 to 3 years of age. Lacerations were the most common injury (76% of injuries), particularly to the face, scalp and lower arm. Falls led to 24% of the injuries occurring, glass collapsing/caving in 8%, injuries from practical jokes/ horseplay 5% and fighting, quarrelling 4%.

One half of adult injuries occurred to 15-29 year old males. One quarter of these were the result of falls, 21% fights. As for children, lacerations accounted for a high proportion of the injuries (83%).

See *Hazard* 22 (March 1995) for further information on domestic architectural glass.

Kitchen benches (n=371 child, 63 adult)

The majority of child injuries associated with kitchen benches were in the 0-4 age group (87% of child total).

Almost half of the injuries in this age group were the result of burns from hot beverages (18% of total) or hot water (11%) and ingestions of medications (17%). The resulting injury associated with these 3 scenarios accounted for 63% of hospitalisations associated with kitchen benches in this age group.

Most of the remaining cases were associated with either falls from the bench, falls from a chair/stool against the bench and falls into a bench eg. *"Sitting on kitchen bench dangling legs, lost balance and fell"* or *"Playing in kitchen, fell over striking head on bench"*.

Young children accessing poisons from cabinets and shelves (n=307 cases)

Drugs and medications (n=260) and other poisons (n=47) were, according to VISS injury descriptions, frequently accessed by under 5 year olds from cabinets and shelves. Children, particularly two year old boys, often climb so that placing poisons out of reach from floor level is not sufficient to prevent access, eg. *"Climbed onto kitchen bench, got into medicine cabinet and swallowed medication"*. Of a wide variety of medications accessed from cabinets and shelves, paracetamol was the most frequent. A high proportion (45%) of cases accessing poison in this way were admitted to hospital.

Toddlers, particularly those aged 13-17 months are typically mobile and motor skills are sufficiently developed to open most cupboards, chemicals stored close to the ground being most vulnerable, eg. *"Opened laundry cupboard door. Took out rat poison and ate some"*.

According to an ABS 'Safety in the home' survey (ABS, 1992) the poisons most commonly kept in homes with under five year olds were paracetamol, cough and

cold medications, other prescription medicines; household cleaners such as disinfectants and bleach; volatile solvents and insecticides.

See *Hazard* 27 and 28 for further information on early childhood poisoning.

Bathroom hot water scalds (n=215 child, 17 adult)

The skin of infants and young children burns more deeply and more quickly and at lower temperatures than that of most adults (Wilson, 1991). In addition, the relative surface area affected in a child is much greater than for an adult for a similar exposure. At 60° C it takes one second for hot water to cause a full thickness burn in a child, which needs surgery and skin grafting. At 50°C it takes 5 minutes for hot water to cause a full thickness burn (Moritz, Henriques, 1947). Other than children, high risk groups for tap water scalds are older people, who also have sensitive skin, and people with disabilities.

In the 1992 ABS 'Safety in the Home' survey 79% of Melbourne householders, with children under 5 years of age, estimated that, at its hottest, their tap water was hot enough to scald a child (ABS, 1992). A Kidsafe Quiz given to 6,000 parents at babyshows around Australia found that most respondents believed that the tap water in their home was hot enough to scald a child. However one third were substantially wrong about the time it takes to be scalded from domestic hot water and 21% thought a scald would take 10 times as long as it actually would (Scott, 1996).

The most frequent age group for bath scalds was under four years, particularly one year (75% of child scalds under 4 years, 36% one year). Forty-three percent were immersed, immersed themselves or fell into the hot bath water, the remainder were splashed, sprayed or sprinkled. In a few cases the tap or shower malfunctioned eg. *"Running bath, hot tap fell off at pipe spraying water"* or there was a reduction in the supply of cold water eg. *"Having shower when water suddenly went too hot and burned child"*, *"Playing with hand held bath hose when washing machine turned off increasing hot water supply"*. The majority of burns were partial thickness to the legs (39% of injuries), arms (28%) and trunk (24%).

A combination of factors contributed to child bath and shower scalds – the level of supervision, the actions of others (siblings or adults) and in all cases the temperature of the water as it left the tap. The severity of all of these child scalds would have been considerably less if the temperature of the hot water had been only 50°C.

Fire, flame, smoke (n=74 child, 116 adult)

Younger children (0-4 years) were over-represented (51% of child total) in fire, flame, smoke related injury and required an admission rate of 50%. Older children (5-14 years) and adults had admission rates of 39% and 29%, respectively.

Fire, flame and smoke injuries in the home were associated cooking (5% child, 30% adult), gas appliance explosion, eg. hot water service, heater or stove, (7% child, 13% adult), clothing ignition (12% child, 3% adult) or with house fires of unknown origin (27% child, 18% adult). Playing with cigarette lighters and matches were associated with 12% of child injury cases, two thirds of which were aged less than 5 years.

The most common causes of injury were burns (73% child, 68% adult) and smoke inhalation (26% child, 22% adult). Smoke inhalation was most prevalent in younger children (34% of 0-4 years total).

Use of smoke detectors was not routinely reported in VISS cases. However, statistics supplied by the Australian Bureau of Statistics in September 1996 indicate that domestic smoke alarms are installed in 71.6% of Victorian homes (ABS, 1996).

Installation rates were 88% and 89% in former Shire of Bulla and Melton homes respectively for 1996 (Ozanne-Smith et al, 1997) compared with 67% and 66% , respectively in 1993 (Ozanne-Smith et al, 1994).

An amendment to Victoria's building regulations, announced in 1995, will make it compulsory to have at least one battery operated smoke alarm in all existing Victorian flats, units and homes by the end of 1998 (Bremner, 1996).

A report produced by the combined Metropolitan Fire Brigade (MFB), Country Fire Authority (CFA) and Tasmanian Fire Service (TFS) claims that 522 lives were saved, where these 3 services attended calls in the period April 1992 to December 1996, directly as the result of the operation of installed smoke alarms (Taylor, 1997).

At least, 16% of injured adults and 11% of injured children recorded by VISS were asleep when the fire began. The toxic gas and smoke associated with fires actually numb the senses, leaving you even more sound asleep (MFB, undated pamphlet). In addition research shows that children are further at risk as the current alarm signal of smoke detectors, in some instances, is not detectable by sleeping children (Bruck, 1997).

Electrical (n=77 child, 54 adult)

In these cases the mechanism of injury was exposure to mains or other electrical current. In 22% of cases, there was a failure or malfunction. Electrical shock was sustained in 80% of cases. Burns were sustained by 71% of children and 24% of adults. For adults, hairdryers, eg. *"Blow drying hair. Faulty wiring on hair dryer. Wires touched"* and for children table lamps eg. *"Whilst playing child turned light on bedhead on. No globe in socket, inserted fingers"* were the most common household items from which the shocks and burns were received. There was also a wide variety of other electrical products involved eg washing machines, sewing machines.

There were 225 Victorian public hospital admissions for injuries resulting from domestic wiring and appliances over the five-year period 1991/92 to 1995/96. Of these two thirds were to persons aged over 18 years.

Over a different 5 year period (1989/90 to 1993/94), there was a total of 47 deaths from electrocutions in the home. Of these, 19 were self-inflicted, 20 unintentional, the remainder unknown intent or assaultive. Due to the 40% self-inflicted and 17% injured while working, 25-39 years was the most common age group for fatalities (43% of victims). Two thirds of deaths occurred inside a house, one third in the garden or garage. A variety of devices were involved eg hair dryer, welding equipment. Twenty-two percent involved defective equipment or wiring eg. *"repairing an air-conditioning duct when drill shorted out. Drill was faulty and the deceased bare footed"*, 20% repair of electrical equipment eg. *"attempting to repair a bar heater"* and 13% of electrocutions were exacerbated by the presence of water eg. *"hair dryer fell into bathtub"*.

Child falls over one metre from windows (n=21)

Children falling from windows were most commonly under 5 years and playing at the time. Almost 60% landed on concrete or paving. A little under three-quarters of injuries were to the head, particularly concussion (29% all injuries). Of total cases, almost half were admitted to hospital. The skull (vault) fractures were the most serious.

Porches and balconies (n=167 child, 58 adult)

Twenty-two percent (n=37) of child and 12% (n=7) of adult porch and balcony injuries related to falls from over 1 metre. Forty-one percent of children injured during these falls required hospital admission.

Sixteen percent of child falls from over one metre occurred when the child was climbing on the porch or balcony, eg. *"Climbing over the balcony, fell, hitting back of head on bricks"*. Young children (0-4 years of age) accounted for 59% of children injured in falls from a height over 1 metre and required admission in 55% of instances. Head, face and scalp injury were most common in children (58% of child porch/balcony total), particularly concussion (17%) and face/scalp lacerations (11%).

The most common cause of adult porch and balcony injury was slips (41%).

Kitchen (n=3741 child, 2325 adult)

The kitchen is the location of 9% of child and 11% of adult injuries in the home. Preparation and cooking of food provides opportunity for spills which may result in slips (6% child, 9% adult) and, when heat is involved, scalds (17% child, 10% adult). Good kitchen design minimises access to the 'hazard triangle' ie, the area between the fridge, stove and sink, by minimising cross traffic, thus lessening the risk of injury (figure 2).

Prevention

A Systems Approach

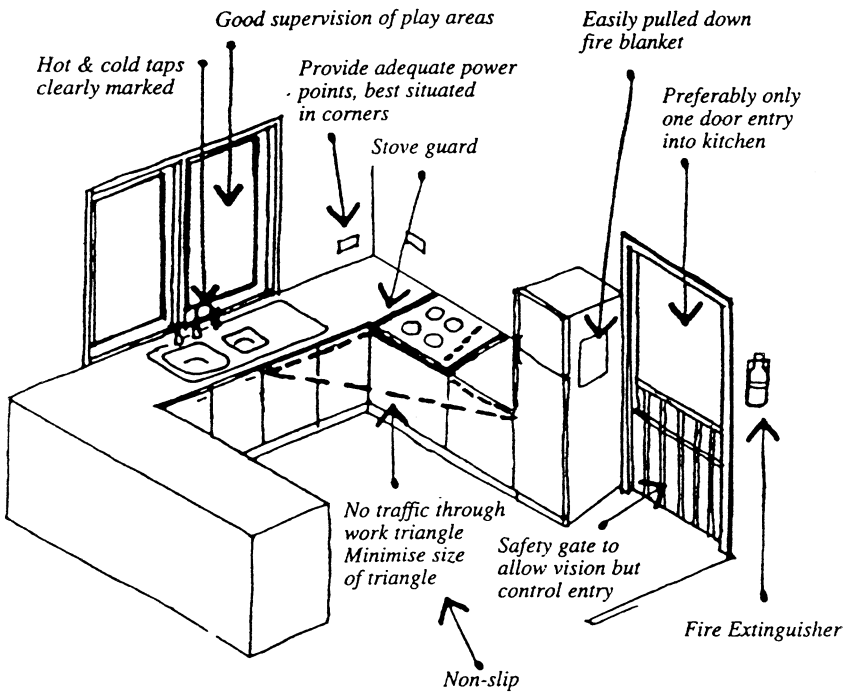
Intervention strategies fall into several major groups. These are legislation/regulation (accompanied by enforcement), environmental/design changes and education/behaviour change. Since injury in the home is not exclusive to any specific discipline or sector a multi-disciplinary, multi-sectoral approach is often required for injury prevention. A systems approach is appropriate to designing and building-in safety features. Associated community awareness and action may result from education, incentives, advocacy or as the result of penalties or disincentives.

Safety Houses

A series of safety display homes have demonstrated a systems approach. These homes combine both design changes in structures and fixtures and education, some incorporating up to 60 safety features.

Telfer and Telfer Homes have designed and constructed three Safe Living display homes, which have received accreditation by the City of Hume Safe Living Program. These homes have been winners of the 1993 and 1995 Housing Association (Vic) TOP HOME Awards and the James Hardie Design Award 1993. Though not currently displaying, a "Safe Home", Telfer and Telfer Homes have incorporated some degree of safety features into approxi-

Safe Kitchen Design **Figure 2**



Source: Is your Home Kidsafe?

Kidsafe Victoria Safety House **Figure 3**

mately 40 of their homes. The most popular features are poisons cabinets, secure driveway access, power points at one metre height, minimum surface level change, the kitchen hazard triangle minimised, full view from the kitchen to outdoor play areas, non-slip baths and showers, safety locks to bathroom cupboards and self-closing front doors (Telfer, P, personal communication, 1997).

There has been one safety display home in the Latrobe Valley built by Glenhaven homes. A Kidsafe Victoria home, built by Unique Homes, is currently on display at Roxburgh Park (figure 3), an Urban Lands Authority estate, and another is currently being built at Berwick (AV Jennings). Hopefully other large building companies will embrace safe design, thus assisting in making the practice widespread. These homes, at varying prices, are all attractive, thus demonstrating that safety does not mean compromising on aesthetics.

For the Kidsafe Victoria home, industry has donated safety products, as it has for the Child Safety Centre (CSC) kitchen and bathroom display models at the Royal Children's Hospital, Melbourne. The latter form an essential part of the CSC's education program.

Approximately ten years ago Kidsafe (CAPFA) organised a national architecture competition for safe home design, funded by the Paul Newman Foundation. Subsequent to this competition several safety houses were constructed around Australia in negotiation with the Master Builders Association and the Housing Industry Association. Currently there are Kidsafe homes in NSW (ground floor in a building at Westmead Hospital) and WA (converted older home). In Queensland there is the "No ouch" house, part of the 'Safe as Houses' project.

Cost of safety features

Estimations of additional cost for a safety house vary between $1,500 and $5,000. However some features are required by building codes, some are cost neutral, some are of minimal cost, others are a greater cost. For most safety features, a reduction in cost could be anticipated as consumer demand and sales increase. Retrofitting is possible but structural features are generally cheaper to install when building or renovating.

Cost-neutral features at the building or renovation stage are:

- Design of kitchens and half glass in laundry doors to allow maximum supervision of children's play areas
- Minimisation of the "hazard triangle" (between the stove, refrigerator and sink) to reduce the need to carry hot substances /liquids through this area.
- Rounded edges and corners on all benches
- Power points positioned in bench corners so appliances and their cords can be concentrated
- Avoidance of steps and changes in floor levels
- Towel rails next to the bath or shower serving also as grab rails, securely fixed to wall studs
- Power points placed out of reach of children.

Small marginal cost differential

- Sensor light for stairs and steps
- Slip resistant bath/shower surfaces
- Slip resistant floor surfaces
- Child resistant cabinet for medicines and poisons
- Nightlights in passageways and bathroom/toilets
- Cordless telephones to facilitate supervision of children at all times

(Adapted from *Is your home Kidsafe*?, personal communication Dr Arlie McQueen, Kidsafe Victoria)

Legislation

Advocacy by community groups and organisations in recent years in Victoria, and some other states, has resulted in legislation of safety features. Education and enforcement have then followed. Examples are regulation of bathroom hot water to 50°C, smoke detectors, pool fencing and toughened glass for lower level windows. These have been incorporated into the Australian Building Code or the Building Code Victoria (Dept of Planning).

Future directions

A key strategy of the Victorian injury prevention strategy "Taking Injury Prevention Forward" is: "To promote the concept of safe home design beyond display homes to all homes, new and existing".

Further implementation strategies are required, and barriers to widespread implementation should be identified and addressed.

General Recommendations

- Amendments to regulations/codes where necessary: including implementing the Australian Standard Guidelines for Safe Housing AS 4226-1994, eg. reducing gaps in balustrade, mandation of safety switch
- Reduction in price of safety items through sales tax concessions, government subsidies, bulk purchases etc.
- Relevant authorities, builders, architects, Building Control Commission, developers, manufacturers, contractors be made aware of safety design features through forums, student courses, workshops, unions and industry groups
- Increase in consumer awareness through community service advertisements for safety display homes, consumer organisations and by commissioning Kidsafe and the Child Safety Centre to publicise a systems approach to safe home design through existing networks
- A rating system for safe home design, eg. City of Hume
- Examine upgrading of existing housing stock (at renovation) and replacement of individual fixtures eg flooring, hot water system, shower-base, bath, shower screen, cupboards, windows

Specific Prevention

Floors

- Flooring surfaces should meet the current Australian and New Zealand Standard for Slip Resistance of Pedestrian Surfaces (AS/NZS 3661.2:1994)
- Non-slip flooring surfaces, such as non-slip tiles or vinyl or matt-finish cork, should be used where possible, particularly for potentially wet surfaces.* Textured surfaces with a granulated effect of raised areas 1.2mm diameter and a similar distance apart are most effective (Day et al, 1994)
- Liquid brush on products should be used on flooring surfaces to make floor tiles non-slip without altering the appearance of the surface *
- Slippery surfacing in the homes of the elderly should be replaced, where appropriate, with full carpeting*. Short pile on quality underlay provides the best cushioning against falls (O'Reilly, 1995)
- Dangerous 'slip zones' found at the entrance to tiled areas should be eliminated*
- Non-slip flooring should be used in the laundry to assist in preventing slips associated with overflowing washing machines *

** North Coast Public Health Unit, 1995*

Structural tiles

- Slip resistant tiles, which have a high friction surface, should be promoted to reduce the likelihood of slips and reduce the number of injuries associated with structural tiles
- Existing tiled surfaces can be treated and edged

Concrete and paving

- Mark the leading edge of outside steps; textured safety paint is suitable for both inside and outside*
- Liquid brush-on products may be used on concrete surfaces to make them non-slip without altering the appearance of the surface* or the surface can be textured when laid
- Pavers or bricks should be properly aligned to prevent trips*
- Paved areas and external steps should be slip-resistant and should be designed so that surface water drains away (Kidsafe, 1992; Page, 1986)
- Pebbles, scoria, and single steps in surrounds of concrete and paved areas should be avoided (Safe Living Program undated, Page, 1986) and landscaping materials which may make paths slippery should be confined*

** North Coast Public Health Unit 1995*

Doors

- To prevent collision doors should be hung so that, when opened, they don't encroach into the space where a child may be playing. It is better for them to open against a wall
- For existing buildings finger safe guards should be installed on the hinge side of the door (see figure 4)
- This product should be more widely available, eg a hardware chain
- Slow-release rather than spring operated closers should be installed to prevent slamming doors

Other methods, not incorporated at the building stage, rely on human behaviour and may be less effective eg cabin hooks to hold doors open, towels draped over the top of a door, wedges placed under doors, warning signs.

Stairs/steps

- Changes in floor level should be minimised
- There should be no steps or stairs between the kitchen and the dining space, or the bedrooms and a toilet
- Sensor lighting should be installed at the top of steps and stairs, or 2-way switching at the top and bottom
- A rail is necessary on both sides. Ideally the rail should extend a little beyond the end of the stairs at both the top and bottom. The width of the rail should be of a size which can be gripped firmly by small children
- Closed-in stairs are preferable to open ones. If they are carpeted, the carpet should be well secured

Figure 4

- Non-slip, highly visible edging strips are required for both resistance and improved visibility
- Doors should not open onto stairs or outward onto landings
- Any glass at the foot of flights of stairs should be safety glass
- If possible, flights of stairs should be kept short by using landings
- Balustrades should be difficult to climb (vertical railings are preferred) and should not be an entrapment hazard. The balustrade height must exceed the centre of gravity of most adults (1100mm)
- Currently in Part 3.9.2 of the Building Code of Australia (Balustrades) a 125mm sphere is not permitted to pass through gaps between the verticals. A gap of 100mm is considered a more appropriate standard to prevent falls, entrapment and strangulation risk for children falling between the verticals. However, further investigation needs to be undertaken to ensure that 100mm is sufficiently small to prevent entrapment or strangulation hazards for smaller, crawling, infants (Scott personal communication, 1997)
- Compliance with the additional guidelines for stairs/steps outlined in Section 11 of Australian Standard Guidelines for Safe Housing AS 4226-1994 should be required. The publication provides guidelines for visibility, lighting, pitch (over 38° is hazardous), risers, treads, stair width (min 900mm), handrails, balustrades and stair gates
- Current materials research may result in the development of impact absorbing material suitable for use on steps and stairs (Hanagud et al., 1989)

Fencing

- Backyard pools and spas should be fenced in accordance with AS1926 (legally required as from July 1997 in Victoria). Isolation fencing (that separates the pool from other areas) is best, including a self-closing and latching gate (Ashby, 1997)
- Play areas should be enclosed by a fence complying with AS 1926 or a fence at least 1500mm high, which should be constructed to discourage climbing, ie, no horizontal rails which can be used as foot or handholds, and in such a way that it would not be possible for a child to squeeze through or become entrapped (Kidsafe, 1992; Page, 1986; Ozturk, 1991)
- Play areas need to be fenced off, by a barrier or fence (AS 4226-1994), from vehicle manoeuvring areas (driveways, garages and carports). On farms play areas need to be restricted from farm animals, machinery and water hazards

Gates

- Gates should prevent access to hazards such as pools, roads and driveways. They should be self-closing and the latches located out of the reach of young children
- Gates should not have horizontal rails which can assist children to climb (Page, 1986)
- Interventions similar to those designed for doors should be investigated for the prevention of finger jam injuries in gates

Bath and shower slips

- Baths should be rendered non-slip or non-slip adhesive strips or shapes fixed to the base of the bath or shower*
- Slip-resistant surfacing is required for bathroom tiles (high friction surface) to provide better grip (Kidsafe, Winter 1996; O'Reilly, 1995)
- Shower bases should fit flush with the bathroom floor* (Safe Living Program)
- Firmly mounted horizontal grab rails and vertical poles that act as a pivot point and allow turning through 90° when entering or leaving the bath are valuable in preventing slipping (Dept of Housing and Construction, 1985).
- Solid walls are required on two sides of the shower, where grab bars can be fitted
- All towel rails should be grab rails (Page, 1986; O'Reilly, 1995; Kidsafe, 1995)
- Glass shower screens should be made of laminated glass (Kidsafe, Winter 1996; Kidsafe, 1992)
- Soap holders should be recessed*
- Hot and cold taps should be marked and have a standard setting, hot on the left, cold on the right (Kidsafe, 1992)
- Deep baths are generally not recommended for older persons as they may find difficulty getting out. Ideally the bath should not be deep, should have a flat (not curved) bottom and the base should be the same level as the floor (Dept of Housing and Construction, 1985).
- Combination bath and shower enclosures are not recommended as they are more difficult to access and increase opportunities for slips and trips

** North Coast Public Health Unit 1995*

Domestic architectural glass

Most glass in domestic settings in Australia is of the annealed variety, which breaks with relatively low impact into jagged pieces. Alternatively, toughened or safety glass breaks less readily into small pieces with blunt edges. All Australian states and territories except South Australia have adopted the 1989 revision of the Australian Standard (AS 1288) "Glass in Buildings – Selection and Installation" for new and renovated homes. Victoria adopted the Standard in April 1991. It requires that safety glazing materials (toughened glass, laminated glass or organic glass) be used in some domestic situations eg low level bedroom glass. Since 1996 there has been some modification to this building code permitting greater flexibility for designers and builders in regard to Performance Requirements (Clause 1.0.3). These can be achieved by complying with 'Deemed -to-Satisfy' Provisions or by formulating an Alternative Solution.

- Low level glass should be replaced with safety glass whenever glass is replaced in existing homes
- Strategies should be sought to reduce price differentials between safety and annealed glass

Kitchen Benches

- Rounded edges and corners are necessary on benches (City of Hume, undated)
- Adequate bench top working space is required to prevent spillage of materials onto the floor (City of Hume, undated)
- It should be ensured that bench surfaces next to cookers are level with the cooker surface and of sufficiently good fit not to cause spillage if pans are slid across (Page, 1986)

Young children accessing poisons from cabinets and shelves

- Poisons, including non-pharmaceuticals, should be stored in locked child proof cupboards or cabinets. These should be built into the home at the building or renovation stage

Hot water scalds

Kidsafe Victoria's "Hot water burns like fire" campaign (in part based on NSW Health's earlier campaign) raised awareness of the potential for scald injuries. Many organisations from the government, non-government and private sectors contributed to the campaign. The key players were Kidsafe Victoria, Dept Human Services, The Plumbers Board, Gas and Fuel, Rinnai Australia (a hot water system manufacturer) and United Energy. In September 1994, a new clause was inserted into the Australian Standard (AS3500.4) which addresses hot water supply systems: "All new hot water installations shall deliver hot water not exceeding 50°C in residential buildings at the outlet of all sanitary fixtures used primarily for personal hygiene purposes (ie bathrooms and ensuites)". From March 1998, as a result of advocacy from injury prevention organisations, it will be mandatory in Victoria for plumbers to install a system (heater, pipes and taps) that meet the new clause in the Standard (AS/NZ S 3500.5). Another stage of the campaign is being planned to coincide with this development.

The method for achieving 50°C can be negotiated between the plumber and consumer.

Possibilities are:

- turning down the thermostat on hot water services (gas);
- installing a tempering valve to the bathroom pipes (recommended for electric hot water services);
- installing a thermostatic mixing valve;
- installing antiscald devices in taps, child resistant taps, tap covers or single lever mixing taps which prevent hot water being turned on to the full.

Temperature cards have been available free from Gasmart stores to measure the temperature of hot water and will possibly be available again to coincide with the introduction of the new plumbing code in Victoria (ASNZ 3500.5) in March 1998.

Fire, flame, smoke

- Mains powered smoke detectors, with battery backup and emergency lights, should be fitted throughout the home, particularly outside adult bedrooms, living areas, hallways and on additional storeys
- Smoke detector alarms should be inside children's bedrooms and interconnected to adult sleeping areas (Bruck, 1997 personal communication)
- Since smoke rises, detectors should be mounted high on a wall or in the ceiling, but not near windows or door where drafts could affect detector sensitivity (MFB, undated)
- Research should be undertaken into increasing the effectiveness of smoke detectors to wake sleeping children
- Residential sprinkler systems are now recommended as an effective fire prevention device. Installation into existing residences is costly. Thus installation at the time of construction of new homes, especially new estate areas, should be considered
- A sensor should be developed to detect excess amounts of gas to prevent lighting of a leaking appliance (Penny, 1992)
- Heaters should have an adequate fixed guard to prevent contact with hot parts and ignition of flowing garments (AS 4226-1994, Dept of Housing and Construction 1985)

Electricity

- Power points and appliances should be positioned out of reach of children
- Electrical safety switches, also known as earth leakage circuit breakers (ELCB) or residual current devices (RCD) should be installed. These have been tested and approved by AS-3190-1994. Safety switches prevent electrocution only. It is surge arresters which prevent electrical fires or damage from power surges
- Kitchen appliances should be kept in one corner of the kitchen or on a shelf to concentrate cords

Windows (child falls)

- Windows with openings less than 1.2m above the floor should be designed or modified so that a child cannot open them more than 100mm or protected by a grill or mesh
- Upper-level windows allowing a clear opening of over 100mm square, where the sill is under 1200mm from the floor, should be fitted with removable security stays for child safety, that can be released by an adult in the case of fire

Porches and balconies

- Exterior decking and balconies should be protected with a handrail and balustrade at least 1000mm high, detailed to prevent climbing, including no horizontal railings (Australian Standard, Guidelines for safe housing design, AS 4226-1994). However they should preferably be at a height that teenagers cannot lean over and fall from them
- Gaps between balustrades, as with stairs, should not be more than 100mm, to prevent falls and entrapment

Kitchen design

- The "hazard triangle", between the fridge, stove and sink should be minimised (figure 2)

Available resources

Archicentre Home safety checklist (Royal Australian Institute of Architects, Archicentre, Kidsafe, Asthma Foundation).

Kidsafe Victoria pamphlets (figure 5):

- Is your home Kidsafe?
- Hot water burns like fire
- Protect your family. Smoke alarms save lives.
- Safepool
- Kidsafe Homes Project

Figure 5

Standards Australia

- Guidelines for Safe Housing Design, AS 4226 – 1994.

Office of the Chief Electrical Inspector

- Safety Switches Help save Lives

Finger safe guards can be purchased from the Child Safety Centre at the Royal Children's Hospital and Kidsafe Victoria at a cost of $20.00 (small) and $25.00 (large) and the manufacturer, ATP Fabrications (Ph: 03 9482 4661).

For further information contact:

Kidsafe Victoria: 03 96701319

Child Safety Centre, Royal Children's Hospital, Melbourne. 03 9345 5522

Building Control Commission: 03 9285 6400

Your local electrical contractor or the Office of the Chief Electrical Inspector 03 9203 9730

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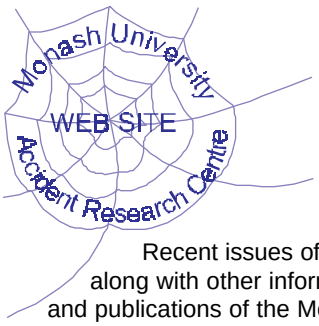

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