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This edition of Hazard examines injuries from playground equipment in children under 15 years of age, and expands on earlier Hazard editions which focused on playground equipment injuries in specific settings. Also in this issue we update the progress on child resistant cigarette lighters.

Childhood injuries from playground equipment

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Summary

Play is integral to children's development of motor and social skills, and while playing on playground equipment is an activity enjoyed by children, it can be hazardous.

In eight years in Victoria, there were 8298 children hospitalised in public hospitals as a result of falls from playground equipment from one level to another. The average annual rate for public hospital admission was 114/100,000. The majority of admissions were for upper limb fractures (75%). Almost two thirds of admitted children were aged 5-9 years.

Playground equipment related injuries accounted for 6% of all injuries presenting to emergency departments, as recorded by the Victorian Injury Surveillance System (VISS). Children in the 5-9 year age group still dominated (almost 60% of all presentations). Half of all injuries recorded by VISS were fractures. Sixty percent of all injuries were to the upper limbs. Head, face and scalp injuries were slightly more common than upper limb injuries in children under 5 years. Overall 22% of children presenting with playground equipment related injuries required hospital admission.

Falls were the most common event leading to injury, accounting for 76% of emergency department presentations, and 83% of admissions. Half of these falls were from heights over one metre, and there was a higher proportion of fractures associated with these falls.

Climbing equipment was implicated in 35%, slides in 19%, and swings in 18% of all cases.

To maximise the safety of children's playgrounds, all equipment must, as a minimum, comply with existing Australian Standards, and be regularly inspected, maintained, and repaired. Compliance with the Standards now also includes the installation of impact absorbing surfaces in the fall zones of equipment. A reduction in the fall height of equipment needs also to be introduced, preferably to 1.5 metres.

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Introduction

Deaths due to playground equipment are rare in Australia. However, injuries from equipment are a significant problem for children. Each year in Victoria there are around 1,000 children admitted to hospital after having fallen from playground equipment. This represents about two-thirds of all playground equipment related admissions. Approximately 6% of all childhood injuries, and 13% of all 5-9 year old injuries, presenting to emergency departments, as recorded by the Victorian Injury Surveillance System (VISS), involve playground equipment. Further attention needs to be directed to this childhood injury problem, with the specific focus of playground safety directed at reducing moderate to serious injuries, such as arm fractures and head injuries.

This report includes only those injuries which involved playground equipment. Other injuries occurring in playgrounds were excluded. The data cover children aged 0-14 years.

Exposure data

Surveillance data alone provides information on the frequency of injuries on different types of playground equipment. These absolute numbers are important to understand the extent of the problem. Currently, there is no available information on the amount of time children spend playing on different types of equipment in Victoria. Without information on children's exposure to different equipment types, it is not possible to determine accurately which types of equipment are more risky.

Hospital Admissions

(Victorian Inpatient Minimum Dataset - VIMD)

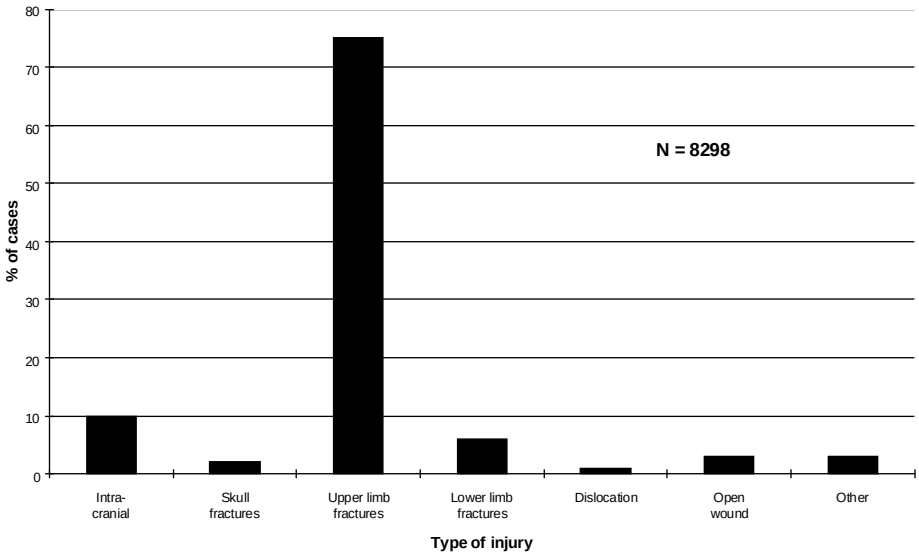
An investigation of Victorian public hospital admissions for playground related injuries, over the period July 1987 to June 1995, detected 8298 cases of falls from playground equipment from one level to another. There is only one external cause of injury code (E-code, 884.0 'Falls from playground equipment') which identifies playground equipment on the data system. It is estimated from admission data collected by VISS that this constitutes 66% of playground equipment related injuries requiring hospitalisation. The average annual admission rate for playground equipment falls was 114/100,000 for children aged less than 15 years. Children aged 5 to 9 years had a higher admission rate of 214/100,000.

Incidence rates for playground equipment-related injury in children reported in the literature vary, which may be due to the use of different definitions and inclusion criteria or real differences. King (1989) reported an admission rate of 70/100,000 in the UK, while in New Zealand the playground equipment hospitalised injury rate in children was reported by Chalmers (1990) to be 108/100,000 children per year.

The highest injury incidence in this study was in the 5-9 year age group, comprising 64% of all cases. A similar age peak for admissions has also been noted in New Zealand and the UK [Chalmers 1990, Mott 1994]. The remaining 36% of admissions were equally divided between the 0-4 and 10-14 year old age groups. On average, 56% of cases were male. Injuries were mainly reported to have occurred at places for recreation (32%), public buildings/institutions e.g. schools (23%), and homes (10%).

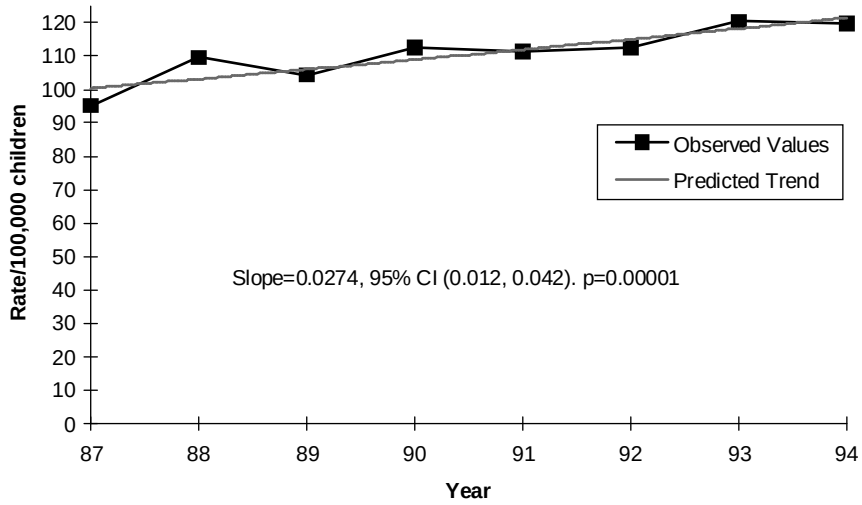
Fractures were the most frequently reported injury (80% of cases), followed by intracranial injuries (10%), open wounds (4%), and dislocations (2%). Figure 1 shows that although head injuries and lower limb fractures may be more severe, the vast majority of hospitalised injuries are upper limb fractures.

Falls from playground equipment, major injury type, and body regions affected, for hospital admissions. Victoria, July 1987 to June 1995 **Figure 1**



Source: Victorian Inpatient Minimum Dataset, July 1987 to June 1995

Falls from playground equipment, annual public hospital admission rate and trend. Victoria, July 1987 to June 1995 **Figure 2**



Source: Victorian Inpatient Minimum Dataset, July 1987 to June 1995

The majority of patients spent one day in hospital (58%), and a smaller proportion (22%) stayed for two or more days. The remaining 20% stayed less than one day. The injuries tended to occur during the warmer months, peaking in March.

Figure 2 shows the injury rate for hospitalisation per 100,000 children per year, plus the predicted trend line. There is a statistically significant increasing trend in the admission rate of playground equipment fall-related injuries over the 8 year period. However, this increase should be viewed with caution due to changes in the funding mechanisms for Victorian hospitals in July 1993. Around this time, and subsequently, there may have been changes in the hospitals' admission policies and practices which may have contributed to an increase in the number of admissions.

Victorian private hospital admissions were also analysed for playground injuries using the same E-code (884.0). Over a 3 year period (July 1992 - June 1995) 284 admissions were recorded. Injury patterns for private hospital admissions were similar to those for public hospital admissions.

Deaths
(Victorian Coroner's Facilitation System)

There were no deaths relating to playground equipment recorded on the Victorian Coroner's database in the five year period July 1989 to June 1994.

Emergency Department Presentations
(Victorian Injury Surveillance System)

The Victorian Injury Surveillance System (VISS) collected detailed injury information on child injury from five campuses of four Victorian public hospitals - Royal Children's Hospital, Western Hospital and Preston and Northcote Community Hospital for the period 1989 to 1993, and from the Latrobe Regional Hospital (Traralgon and Moe campuses) for the period July 1991 to June 1996. Information on almost 85,000 cases of child injury was collected.

During these periods, VISS recorded 5120 cases of injury to children, aged under 15 years, related to playground equipment, which represented 6% of all childhood injuries recorded by VISS.

Almost 60% of injured children were aged 5-9 years. Six year olds were the most commonly injured, accounting for 14% of injured children (Figure 3). Fifty-six percent of injured children were male.

More than a third of injury occurred in the hours between 12:00 and 3:00 pm. The most common months for injury were March (12% of total) and November (10%).

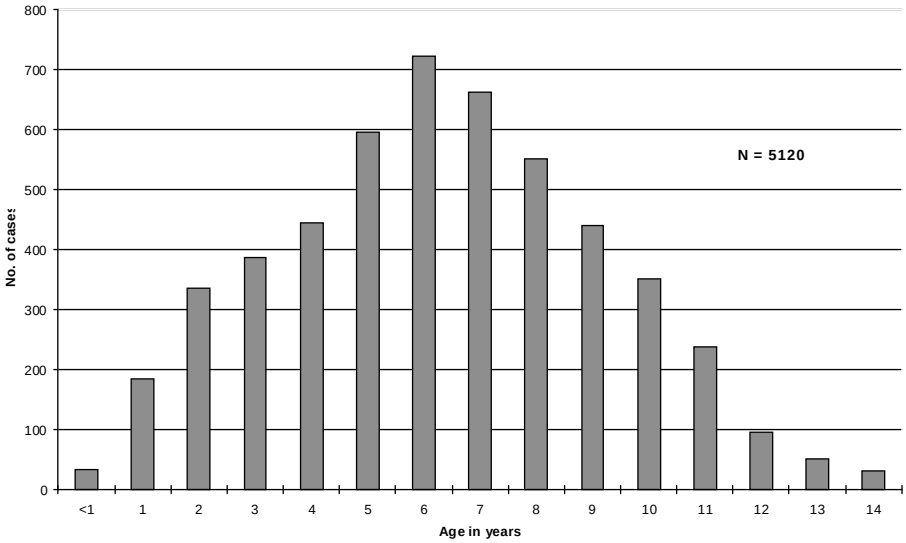
Severity, body region, and nature of injury

The proportion of playground equipment injury cases requiring admission to hospital was 22%. This is slightly higher than the overall proportion of children admitted to hospital with any injury (17%), as recorded by VISS in the same period. This suggests a greater severity of playground equipment injuries. Another 26% of children with playground equipment injuries required referral to an outpatients clinic. Sixty-nine percent of children admitted had a limb fracture, and 21% had head, face, or scalp injuries.

Although most injury prevention activity is directed at head injury,

Playground equipment injuries by age - Emergency department presentations at selected hospitals

Figure 3



Source: VISS - RCH, WH, PANCH 1989 to 1993, LRH July 1991 to June 1996

limb fractures have been found in many studies to be a far more frequent cause of hospitalisation [King 1989, Chalmers 1990, Ball 1991, Kotch 1993, Mayr 1995, Chalmers 1996].

Of injuries recorded by VISS, almost half were fractures, particularly to the radius/ulna (26% of the total), humerus (6%), elbow and wrist (5% each) and tibia/fibula (3%). Of the 2352 cases of upper limb fractures recorded, 32% were admitted to hospital. Other common injuries were: bruising (13%), lacerations (11%), strains/sprains (9%) and concussion (5%). It should be noted that VISS may record up to 3 separate injuries per case.

As shown in figure 4 most of the injuries were to the limbs (71%), and to the head, face and scalp (24%).

Head, face and scalp injuries were more common than upper limb injuries in children aged less than 5 years, representing 43% of injury in this age group (upper limb injury accounted for 34%). They most commonly sustained face and scalp lacerations (18% of under 5 year old injury total), concussion (17%), face and scalp bruising (12%), and jaw/lip lacerations (9%). Of these who were admitted with head injuries, 80% resulted from falls (half of which were from 1 metre and above), and 14% were hit by moving equipment, usually a swing.

Location

The most common locations for playground equipment injury were school playgrounds, public parks or playgrounds, and residential locations (See table 1). Children aged less than 5 years were most often injured in public playgrounds and parks or their own home. More than half the injuries to school aged children (5-14 years) were in school playgrounds (Table 1).

Events leading to injury

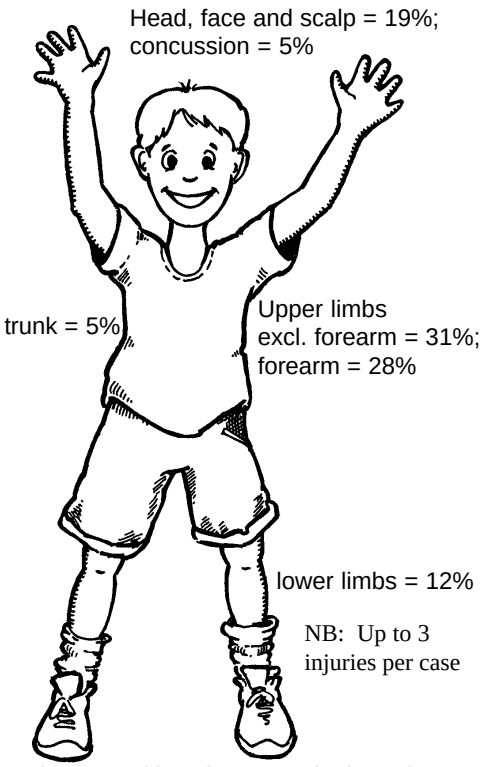
Falls are the most common event leading to injury associated with playground equipment [Chalmers 1990, Ball 1991, Mott 1994]. In this study, falls which were the result of a child being pushed from the equipment, or a child jumping from equipment, are considered separately. Table 2 shows the most common events leading to playground equipment related injury.

Falls (n = 3886)

More than three quarters of VISS hospital emergency department presentations for playground equipment injury were the result of unintentional falls. Eighty-three percent of admissions were due to falls. This is comparable with other studies [Chalmers 1990, Ball 1991, Mott 1994]. Falls were mostly from climbing equipment (39% of total), slides (19%) and swings (14%). Admitted cases followed a similar pattern.

Playground equipment injuries by body region

Figure 4



Source: VISS - RCH, WH, PANCH 1989 to 1993, LRH July 1991 to June 1996

Playground equipment injuries by age and location Table 1 - Emergency department presentations at selected hospitals

Location	0-4 years		5-9 years		10-14 years		All ages total	
	n=1384	(%)	n=2968	(%)	n=768	(%)	n=5120	(%)
School playground	69	(5)	1666	(56)	379	(49)	2114	(41)
Public playground/ park	408	(30)	520	(18)	181	(24)	1109	(22)
Own home yard	314	(23)	253	(9)	61	(8)	628	(12)
Other home yard	116	(8)	129	(4)	29	(4)	274	(5)
Daycare/kindergarten playground	197	(14)	39	(1)	3	(0)	239	(5)
Private enterprise	110	(8)	98	(3)	28	(4)	236	(5)
Other	82	(6)	104	(4)	42	(5)	228	(4)
Unspecified	88	(6)	159	(5)	45	(6)	292	(6)

Source: VISS - RCH, WH, PANCH 1989 to 1993, LRH July 1991 to June 1996.

Playground equipment injuries by events leading to injury - Emergency department presentations at selected hospitals Table 2

Event leading to injury	Presentations n = 5120	(%)	Admissions n = 1105	(%)	% of cases requiring admission
Falls	*3886	(76)	915	(83)	(24)
- same level	*732*	*(14)*	*143*	*(13)*	*(20)*
- level up to 1 metre	*992*	*(19)*	*205*	*(19)*	*(21)*
- 1 metre or above	*1948*	*(38)*	*519*	*(47)*	*(27)*
Pushed by other child	265	(5)	57	(5)	(22)
Jumped from equipment	239	(5)	42	(4)	(18)
Struck by moving equipment	156	(3)	22	(2)	(14)
Caught in equipment	91	(2)	23	(2)	(25)
Hit against equipment whilst using	68	(1)	3	(0.5)	(4)
Collided with stationary equipment	45	(1)	2	(0.5)	(4)
Equipment broke, tipped, collapsed	44	(1)	15	(1)	(34)
Other	326	(6)	26	(2)	(8)
TOTAL	**5120**	**(100)**	**1105**	**(100)**	**(22)**

NB: * A second mechanism of injury was noted in 65 fall cases. Thirty-six were also struck by equipment and 29 were also caught in equipment. Fall height was not recorded for 214 presentations and 48 admitted cases.
Source: VISS - RCH, WH, PANCH 1989 to 1993, LRH July 1991 to June 1996.

Fall height data were available for 95% of all fall cases. As some VISS data on fall heights are based on interpretation of the narrative, rather than an actual height being specified, the variable used for fall heights should be considered a proxy measure. It is still useful, however, as the following discussion shows there is a clear relationship between fall height and severity of injury. Half of the falls, recorded by VISS, were from a height in excess of one metre. A further 26% were from a level up to one metre, and the remainder were falls on the same level.

Fall height and injury severity

According to recent reports one of the most important factors influencing injury severity is the height of the fall [Chalmers 1996, Mayr 1996].

A comparison of cases of falls from differing heights - i.e. same level, a level up to one metre, and one metre and above - has been undertaken. This found that falls from one metre and above were most likely to involve children 5 to 9 years old (68%). The proportion of cases admitted was found to increase as the height of the fall increased (20% vs 21% and 27%). In addition, approximately half of all children admitted to hospital with any playground equipment injury fell from one metre or above (table 2).

A comparison of injury types found fractures (particularly to the radius/ ulna) were more likely to have occurred in children falling from one metre and above (62% vs 44% and 48%). Upper limb injuries in general were more common in falls from 1 metre and above. Table 3 shows these comparisons in greater detail. These findings indicate that injury severity increases with increased fall heights (of one metre or greater). Falls from one metre and above most commonly occurred at school (56%).

Other events leading to injury

Pushed by other child (n = 289)

A further 289 children (5% of all playground equipment cases) were pushed from equipment by another child, the majority of which resulted in falls. Thirty-seven percent were pushed from slides, and another 25% from climbing equipment. Seventy-two percent of injured children were aged 5-9 years. These cases were most common in schools (62%).

Fall height and injury severity - Emergency department presentations at selected hospitals — Table 3

	same level n=764* n (%)	up to 1m n=1039* n (%)	1m and above n=2059* n (%)
Body region injured			
Head /face	191 (25)	265 (26)	353 (17)
Upper limbs	422 (55)	603 (58)	1455 (71)
Lower limbs	86 (11)	109 (10)	163 (8)
Trunk	53 (7)	46 (4)	77 (4)
Nature of injury			
Fractures	336 (44)	499 (48)	1282 (62)
- radius/ulna	*176 (23)*	*238 (23)*	*721 (35)*
Bruising	105 (14)	136 (13)	219 (11)
Sprain/strain	80 (10)	100 (10)	160 (8)
Concussion	26 (3)	62 (6)	128 (6)
Lacerations	12 (16)	109 (10)	96 (5)

* represents number of injuries (not cases) as VISS can record up to 3 injuries per case.
Source: VISS - RCH, WH, PANCH 1989 to 1993, LRH July 1991 to June 1996

Thirty percent of all injuries were fractures of the forearm.

Jumped from equipment (n = 239)
Five percent of children were injured when they jumped from the equipment on which they were playing. Jumps were most often from swings and climbing equipment (21% of total each). Again most children injured were aged 5-9 years. These incidents occurred similarly at schools, homes and public playgrounds. Half of all injuries were fractures.

Struck by moving equipment (n = 192)
A small number of children (n = 36) fell, mostly from the piece of equipment, prior to being struck by it. Almost two-thirds of injured children struck by moving equipment were aged under 5 years. Swings were implicated in 77% of these cases, and see-saws in another 16%. More than three quarters of the injuries in this group were to the head, face and scalp, predominantly lacerations and bruising. More than half of cases (54%) occurred in residential locations, usually the child's own home.

A New Zealand study of hospitalised injuries found that swings were more likely to hit younger children (e.g. under 5 years), often in the head [Chalmers 1990]. This was supported by VISS data which found 86% of children aged 0-4 years, who were hit by a swing, sustained injuries to the head, face and scalp.

Type of equipment

The type of equipment involved in injury varies according to the child's age and exposure, as well as the risks associated with the specific equipment types. In almost 90% of VISS cases the type of playground equipment implicated in the injury was noted. Nearly two-thirds of all cases involved climbing equipment, slides, or swings.

Swings and slides were more frequently involved in injury to children aged 0-4 years, while climbing equipment was more often involved in injuries to children aged 5-14 years (table 4). Similar findings were reported from New Zealand for hospitalised injury cases [Chalmers 1990]. This difference may be partly explained by the varying exposure of children to different equipment types at home, childcare, school or public parks.

Climbing equipment (n = 1789)
Overall, climbing equipment has been reported to be associated with a disproportionate number of playground injuries compared to other types of equipment [Werner 1982, Chalmers 1990, Sacks 1990]. This relates to the higher risk of falls from such equipment and the high risk of injury in the event of a fall. The dangers of climbing equipment are created by their design, mainly by the height, which can easily be controlled [Reddy, 1996].

More than a third of the total number of playground equipment injuries recorded by VISS related to climbing equipment, 80% of which were monkey bars. Almost three quarters of the injured children were aged 5-9 years. The overall proportion requiring admission was 24%, with almost another third referred to an outpatients clinic.

Fractures accounted for more than 60% of climbing equipment related injury, particularly of the radius/ulna (34% of total cases), humerus (8%), wrist (7%) and elbow (6%). Concussion accounted for another 3% of injuries. Almost three quarters of all injuries were to the upper limbs. Of all cases 62% fell from one metre or above.

Almost 70% of climbing equipment injuries occurred in school playgrounds, and another 13% in public parks or playgrounds.

Playground equipment injuries by age group and equipment involved - Emergency department presentations at selected hospitals

Table 4

Equipment	0-4 years		5-9 years		10-14 years		All ages total	
	n=1384	(%)	n=2968	(%)	n=768	(%)	n=5120	%
Climbing equipment	209	(15)	1318	(44)	262	(34)	1789	(35)
Slide and sliding board	423	(31)	459	(16)	119	(15)	1001	(19)
Swing and swing set	393	(28)	429	(15)	124	(16)	946	(18)
Flying fox	16	(1)	127	(4)	55	(7)	198	(4)
Tree/play/cubby house	59	(4)	70	(2)	20	(3)	149	(3)
See saw or teeter board	44	(3)	56	(2)	26	(3)	126	(3)
Bars, beams or rings	14	(1)	53	(2)	22	(3)	89	(2)
Adventure playground, fort or tower	5	(0.4)	59	(2)	13	(2)	77	(1)
Pole	11	(1)	32	(1)	12	(2)	55	(1)
Ladder, rope or chain	24	(2)	20	(0.7)	6	(1)	50	(1)
Roundabout	9	(0.6)	15	(0.5)	10	(1)	34	(1)
Other specified	26	(2)	25	(0.8)	6	(1)	57	(1)
Not specified	151	(11)	305	(10)	93	(12)	549	(11)

Source: VISS - RCH, WH, PANCH 1989 to 1993, LRH July 1991 to June 1996

An examination of the narratives of the admitted cases showed that more than 90% of cases related to a fall from climbing equipment. Most (70%) simply stated that the victim fell e.g. *"Climbing metal frame play equipment, fell 4 metres, hitting back of head on gravel"*, a further 20% slipped and fell e.g. *"Climbing on monkey bars, slipped and fell onto tanbark underneath"* and 4% were pushed off or bumped by another child e.g. *"Sitting on monkeybars, was pushed off and landed on ground"*. Of the remaining cases another 4% of injured children knocked against the equipment on which they were playing, and 2% jumped from it.

A report analysed climbing frame-related injuries from various European countries using the EHLASS (European Home and Leisure Accidents Surveillance System). Climbing frame injuries were found to predominantly involve the upper arm (up to 65%), followed by the head. A high proportion of fractures was also reported (up to 58% in the Netherlands) [Reddy, 1996].

Slides and sliding boards (n = 1001)

Almost a third of injuries to pre-school age children involved slides (see table 4). Children in this age group accounted for 42% of the total of slide injuries, with children aged 5-9 making up another 46% of the total. The proportion of admissions for slide injuries was 21%, with another quarter of injured children needing review at an outpatient clinic.

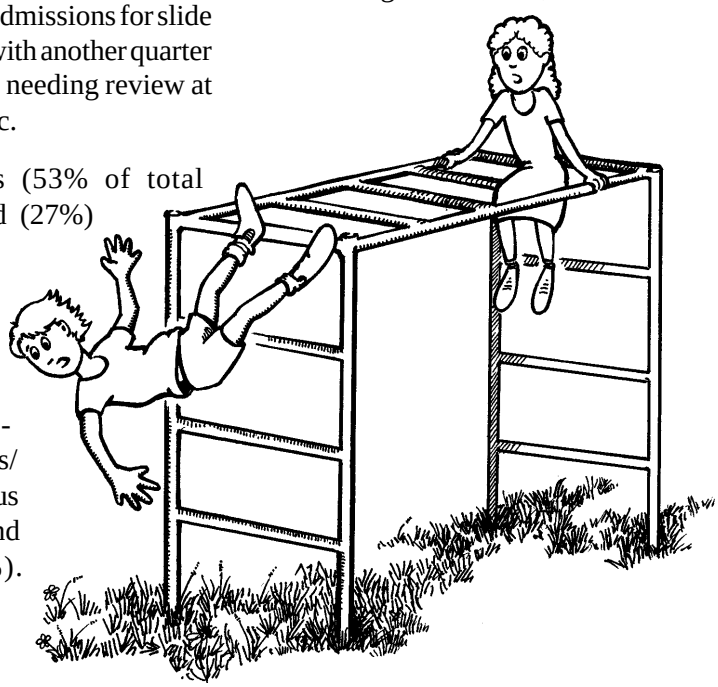
The upper limbs (53% of total injuries) and head (27%) were the most commonly injured body parts. Fractures were common (47% of total injuries), particularly to the radius/ulna (20%), humerus (6%), wrist (5%) and tibia/fibula (4%). Concussion accounted for another 8% of the total.

Thirty percent of slide injuries occurred at public parks and playgrounds, 25% at school playgrounds, 16% in home backyards and 13% at areas of public enterprise.

An examination of the narratives for admitted cases showed that two thirds (n = 136) related to falls from the slide e.g. *"In playground, descending slide, patient fell off halfway down, landed on tanbark"*. Another 9% of injured children were pushed from the slide e.g. *"Child playing on highest point of slide when pushed from behind, she fell off"*, 7% were injured after undertaking unconventional play e.g. *"Running down the slide, tripped, fell off, hit head on sleeper"* and 6% slipped or fell while climbing the ladder of the slide. Eleven percent of cases noted that the child fell (in four cases they were pushed) from the top of the ladder. Of all cases 40% fell from one metre or above.

Swings and swing sets (n = 946)

Children 5-9 years accounted for 45% of all swing related cases, and a further



42% were aged 0-4 years. Nineteen percent of injured children required admission, and a further 21% were referred to an outpatient clinic.

More than half occurred in a residential home (their own or an others'), another 23% in public parks or playgrounds and 9% in school playgrounds. Six percent of all cases related to swing sets.

A higher proportion of head injuries was evident in children injured by swings compared to children injured on slides and climbing equipment (36% vs 27% and 14% respectively). The most common swing related injuries were fractures (37%), lacerations (21%) and bruising (15%). The most common types of swing related injuries were radius/ulna fractures (19% of total), face/scalp lacerations (8%) and concussion (5%).

An examination of the narratives of the admitted cases showed that 65% of cases related to falls from swings, 59% of narratives simply stated that the victim fell e.g. *"Playing on a swing, fell off and landed on sand"*, the other 6% stated that the child slipped from the swing e.g. *"Slipped forward from swing, and hit face first on ground"*. Ten percent of children were struck by a swing e.g. *"Standing behind swing set pushing swing, swing swung back hitting child"* or *"Playing with brother on swing, ran in front of swing whilst in motion, hit by swing"*; 7% caught a body part in or under the swing, usually either fingers or feet; and 5% jumped from the swing e.g. *"Jumped from a moving swing and landed on grass"*.

Even though swings make up the greatest proportion of 'struck by' injuries, other studies support our finding that the majority of swing-related injuries, about 70%, are the result of falls [Kotch 1993, Mulder 1995].

Undersurfacing

The surfacing under the equipment on which injury occurred was noted in only 13% of cases, therefore detailed analysis was not possible. Most (90% of these cases) noted the use of loose-fill undersurfacing, mostly tan bark or mulch, though depth was not stated. Another 8% noted sand, and 1% safety mats. Three cases of injury, all at residential locations, noted the use of a mattress under the piece of equipment.

Hazard identification

Injury from playground equipment is largely associated with: inappropriate design and layout; incorrect installation; inadequate maintenance; lack of age and ability related apparatus; lack of adult supervision; misuse of equipment [King 1989], and failure of equipment to meet Standards.

Hazards are common in playgrounds, and injury risk increases as the hazards increase [Sacks 1990]. One U.S. survey found hazards in 84% of the child care centres visited [Sacks 1990]. A survey of 240 NSW public playgrounds (covering 862 pieces of playground equipment) found that none met all the safety criteria assessed [Kidsafe 1995]. About 6% of all equipment was considered dangerous, and 14.2% of playgrounds had at least one dangerous piece of equipment. Less than half (45.4%) of the equipment had appropriate undersurfacing, and in only 12.8% of cases was the undersurfacing of sufficient depth [Kidsafe 1995]. Such hazards and non-compliance with Standards are major issues in determining playground safety. Unfortunately, the lack of finer detail in the VISS data precludes the assessment of specific hazards or the presence of undersurfacing material. Table 5 lists the major hazards of playground equipment which could contribute to injury.

Playground management

It is crucial that all playground providers have a routine for managing their playgrounds, and that a maintenance program is planned from the start and incorporated into the overall budget. Neither a lack of funds, nor ignorance of maintenance procedures, will provide protection in the event of a legal liability case.

Playground management consists of an area and equipment inventory, routine site and equipment inspection and maintenance, and repair of worn or damaged equipment. A comprehensive program needs to be drawn up, and the use of registers and checklists is recommended. All equipment should comply with Australian Standards and this should be documented. Equipment not complying should be removed or rebuilt [Leeds 1996].

Inspection of play areas, equipment and undersurfacing should occur regularly. This should include mowing, removing rubbish, raking and topping up of undersurfacing, and checking over equipment. In-depth inspections, by a qualified person should also be included in the management plan. The frequency of these inspections will depend on the type of equipment (e.g. presence of moving parts), the proneness to vandalism, and the frequency of the playground's use. This needs to be decided by the playground providers, in conjunction with manufacturer's guidelines [Leeds 1996].

The new standard on playground maintenance will be published in early 1997. This will indicate an acceptable

Playground hazard identification - checklist Table 5

- ***Fall height***
  Excessive height of equipment increases the risk of injury in the event of a fall. While the design Standards state equipment must not be over 2.5 metres, research shows that injury risk increases markedly if falls occur above 1.5 metres [Chalmers 1996].
- ***Surfaces under equipment***
  Impact absorbing surfaces under and around equipment can reduce the severity of injury in the event of a fall. These surfaces should be present in all fall zones where equipment is over 50cm high. Loose fill material needs to be a minimum of 20cm deep, and 20% greater in areas of heavy traffic, e.g. swings [AS/NZS 4422, 1996].
- ***Fall zones***
  Impact absorbing surfaces needs to be under equipment and extend out to at least 2.5m beyond the edges of the equipment (1.9m in early childhood settings). For swings and moving equipment it needs to be greater - length of chain plus 2.5m in directions of swing movement. Hard objects must be removed from the fall zone.
- ***Entrapment hazards***
  Gaps in equipment may result in entrapment of body parts. Small openings can trap hands and fingers, and need to be over 7cm and under 12.5cm in width. Larger openings can trap the head and neck, and must be greater than 23cm or less than 12.5cm (according to a specific head and neck entrapment test in the Standard) [AS 1924-2, 1981].
- ***Overcrowding and equipment spacing***
  There needs to be at least 2.5m between pieces of equipment to ensure adequate fall zones and to reduce collision risk. Swings must be in a separate area with barriers to prevent traffic flow across the swing's path. Quiet and active play areas need to be separated.
- ***Pinch or crush points, sharp edges and corners***
  Moving parts which could pinch or crush must not be accessible to children. Wood must be smooth to avoid splinters, and metal edges rolled or capped to prevent cuts and bruises.
- ***Protrusions and projections***
  Clothing can become entangled on bolt ends and hooks, and such protrusions must be removed. Drawstrings on hoods and jackets should always be removed/avoided due to the risk of strangulation.
- ***Trip hazards***
  Exposed concrete footings, tree roots, rocks, edging material, and retaining walls can cause tripping, and also pose a risk if hit during a fall.
- ***Platforms without guardrails or protective barriers***
  To prevent falls, platforms need protective barriers, 90cm high for public, and 70cm high for preschool and domestic playgrounds (or as per relevant Standard). These must have vertical infills (to prevent climbing) and be spaced to avoid entrapment.
- ***Lack of maintenance***
  Poor maintenance can contribute to injury, e.g. through missing, worn or broken parts, exposed bolts, instability of equipment, or low depth of loose fill undersurfacing.
- ***Rail size for child's grip***
  Rails need to be small enough for a child to be able to grip, and should be between 1.9cm and 3.8cm in diameter.
- ***Place for parents and supervisors***
  Provision of seating, strategically placed, for parents or child carers to supervise and watch children is important.
- ***Equipment that is not recommended***
  Certain equipment, due to high injury risk, is no longer recommended in children's playgrounds. This includes: plank, boat, and cradle swings; roundabouts; maypoles; climbing rockets (difficult to remove child from inside frame); old machinery (e.g. tractors); rope swings (strangulation risk); and trampolines.

Source: *NSW Playground Safety Network. (1996) "Is it safe?. How many hazards are hidden in your playground?'. US Consumer Product Safety Commission. (1994) "Handbook for public playground safety". Pub. No. 325. Washington DC.*

minimum for playground management requirements. Assistance from organisations such as the Playground and Recreation Association of Victoria (PRAV), or in NSW, Kidsafe, can provide advice and assistance on playground management issues.

Legal Liability

Local governments, schools and child care centres have a responsibility to ensure that their playgrounds are safe. This can be addressed by a risk management approach including: adherence to design guidelines as minimum standards; use of age appropriate equipment; regular inspection and maintenance of equipment; completion and retention of equipment inventories; supervision, where appropriate; and, for some settings, availability of first aid.

If the equipment does not conform to safety standards, or cannot be regularly inspected and maintained, then it should be removed. Due to legal implications playground providers should resist community pressures to keep hazardous equipment.

Design and manufacturing Standards

The Australian Standards for playground equipment are voluntary design and manufacturing guidelines. Until this year Australia has relied on a 1981 Standard, *Playground equipment for parks, schools and domestic use* AS 1924. This Standard, although specific in certain areas, is out of date and deficient in parts, particularly on the issue of equipment undersurfacing [Australian Standards 1981, 1982].

For several years now there has been much debate over the content of a new playground standard. A previous draft standard from 1991 was deemed, after public comment, to be too

complex and impractical to implement. As there is no international playground equipment standard, the standards committee then took a European, Committee European de Normalisation (CEN), Standard as the starting point for the development of the new standard. After receiving public comment on this document, the committee is now in the process of revising and redrafting this standard to suit the needs of Australia and New Zealand (it is a joint standard between the two countries). The first part of the new standard has been published and relates to equipment undersurfacing [AS/NZS 4422: 1996]. The next part to be published will cover equipment installation, inspection, maintenance, and operation. Further parts will relate more to specific structural components and equipment types, and to the needs of less able children.

Impact absorbing surfaces

Impact absorbing surfaces, undersurfacing, soft surfacing, or "soft fall" needs to be present within the fall zone of any playground equipment over 50cm in height. Despite previous debate on the need for soft fall, there is now widespread acceptance that adequate impact absorbing surfaces under and around equipment, from which a child may fall, can reduce the effect of the fall. The new Standard [AS/NZS 4422, 1996] sets out the criteria for assessing different undersurfaces using the head injury criteria (HIC) and g values. This criteria is based on the likelihood of brain injury following an impact of the skull on the surface. The test gives a "critical fall height" for a surface, which represents the upper height limit of the surface's effectiveness in reducing severe head injury.

Asphalt and concrete are not recommended surfaces (unless as a base for synthetic surface materials) and have been associated with higher injury rates [Sosin 1993]. Well maintained grass, sandy soils and mulch may only be used under and around equipment with a fall height under 50 cm. For fall heights over 50 cm, surfacing must meet the impact absorbing criteria set out in the Standard. These surfaces can be loose-fill or synthetic materials (Table 6). It should be noted that with increasing platform height, guard-railing or enclosures should also be used.

Impact absorbing surfaces are designed to prevent severe head injury (concussion and brain injury) and their efficacy in preventing other injuries has yet to be determined. Mott (1994) found that limb fractures occurred on bark surfaces, although maintenance and depth was not taken into account in her study. It is also possible that children may engage in riskier behaviours, or that supervision is less rigorous, when such surfaces are present [Briss 1995]. Despite this, recent evidence from New Zealand [Chalmers 1996] found that children falling on non-impact absorbing surfaces had twice the risk of injury compared to those who fell on impact absorbing surfaces. Further work is still required to determine the effectiveness of impact absorbing surfaces in preventing upper limb fractures.

Summary of impact absorbing surfaces - loose-fill and synthetic materials **Table 6**

Surface	Comments	Examples	Advantages	Disadvantages
Loose-fill material - *organic* - *inorganic*	Impact absorbing properties determined by type and depth. Should not be installed over concrete or asphalt. Minimum depth of 20cm where impact absorption is required, additional 20% in areas of heavy traffic. Additional material should be installed to allow for deterioration and compaction.	Inorganic: • Sand • Pea gravel Organic: • Wood chips • Bark mulch	• low initial cost • ease of installation • readily available Inorganic: • won't pulverise • nonflammable	• displaces with wear/wind. • needs regular inspection and maintenance. • requires containment method. • good drainage required. • reduction of impact absorption if wet, freezes, or combines with dirt. • compacts with use. • decomposes (organic). • conceals rubbish. • flammable (organic). • may be ingested. • adheres to clothing.
Unitary synthetic material	Range of different material with differing shock absorbing properties. Rubber or rubber-like material held in place with binder, poured on site or in form of tiles. Expected life up to 10 years.	• Flexitec® (rubber pavers) • Softfall® (foam) • Polyflex® Soft-Fall (rubber "wet pour")	• low maintenance. • easy to clean. • consistent shock absorbency. • not displaced with wear. • good drainage. • doesn't conceal rubbish. • accessible for the disabled. • some can be laid directly onto concrete/asphalt.	• high initial cost. • often need level surfaces for laying. • curling of rubber tiles may cause tripping. • may be flammable. • may be subject to vandalism.

***Source**: US Consumer Product Safety Commission. (1994) "Handbook for public playground safety". Pub. No. 325. Washington DC. Australian/New Zealand Standard (1996) Playground surfacing - Specifications, requirements and test method. AS/NZS 4422: 1996, Standards Australia and Standards New Zealand.*

Fall Height

The height of equipment is a major factor influencing the risk of injury. As the height of equipment increases so does the risk and severity of injury in the event of a fall [Briss 1995, Chalmers 1996]. This is understandable because, due to elementary physics, as height doubles the energy produced in the event of a fall quadruples. The 1981 Australian Standard states that the maximum fall height of equipment should not be over 2.5m, although the equipment can be up to 6m high (e.g. a roof).

A recent case-control study from New Zealand has shown that the risk of injury in the event of a fall from playground equipment increased dramatically for heights over 1.5 metres [Chalmers 1996]. After adjusting for various factors (such as child's age, weight, and the presence of impact absorbing surfaces), children falling from over 1.5m were found to have four times the risk of injury compared to those falling from 1.5m and below, odds ratio (OR)=4.1 (2.3-7.6). The risk of injury increased with increasing fall height, to the extent that children who fell from over 2.25m had 13 times the risk of injury compared to those who fell from 0.75cm or below, OR=12.9 (2.9-57.7). Although injury risk was greatest for falls from a height onto non-impact absorbing surfaces, a high fall height was a more important predictor of injury risk than the presence of impact absorbing surfaces.

From the study's results, Chalmers (1996) estimated the possible reductions in the number of playground injuries with various height modifications. These estimates were only for injuries occurring at school and child care playgrounds and if public playgrounds were included would be even greater. They found that, as few falls occur from above 2.5m, compliance with this Standard requirement would result in a 3.6% reduction in the number of injured children attending emergency departments. However, if in addition impact absorbing surfaces were added, there could be a 13.5% reduction in the frequency of injury. The most powerful finding was that if the fall height was reduced to 1.5m, and undersurfacing was present, then the estimated reduction in emergency department attendances would be in the order of 45%.

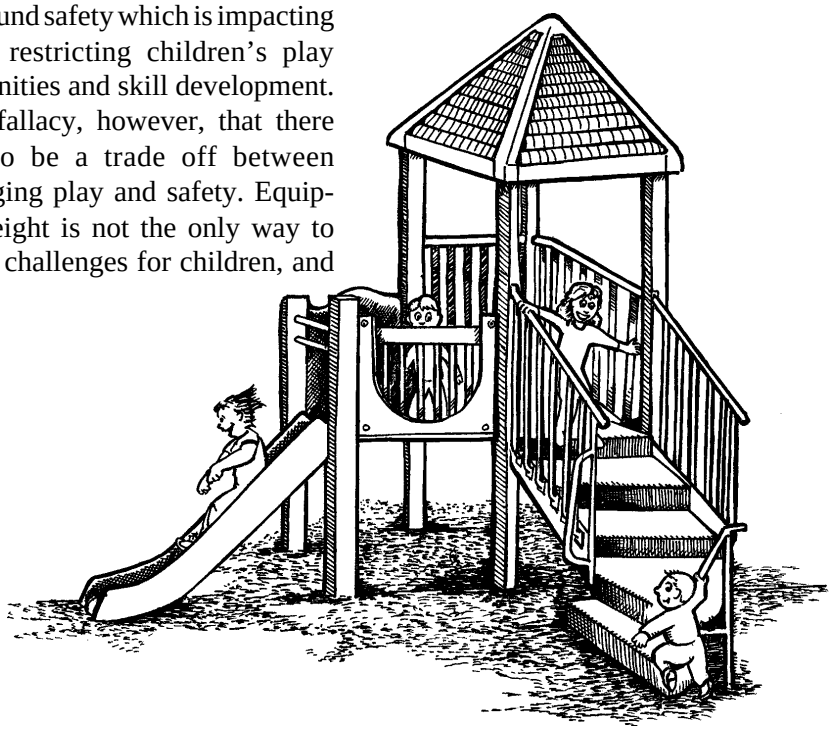
Although VISS data is based on fall heights of one metre and above (rather than 1.5m), it supports Chalmers' findings, as falls from a height of one metre and above accounted for 39% of all emergency department presentations, and 47% of all admissions, relating to playground equipment.

Playground Design

Some people involved in designing playgrounds have expressed the view that there is an over-emphasis on playground safety which is impacting on and restricting children's play opportunities and skill development. It is a fallacy, however, that there needs to be a trade off between challenging play and safety. Equipment height is not the only way to provide challenges for children, and if height is necessary it could be provided within an enclosed area. A lower fall height (e.g. of 1.5m) for climbing equipment is not impossible to adopt, and designers need to be inventive and address this challenge. For example a piece of equipment 2.5 metres high could be so designed that any fall from near the top is broken after falling not more than 1.5 metres. Playground landscapes can also play their part in reducing fall heights by employing mounding and tunnelling.

Playground providers should aim for the safest possible equipment, particularly due to the potential risk of litigation. Many manufacturers are already acting responsibly and producing equipment with reduced fall heights.

Age-specific equipment can be adopted in the child care or kindergarten setting where only young children are present. For the public playground, however, age-segregated play sites are not feasible as young children will still access the sites deemed for older children. The only



logical solution is to provide equipment which is safe for all ages. In the discussion on safe design of playgrounds it should be remembered that fixed structures are only one element of the outdoor play experience for children. The play environment needs to draw on other possibilities, for instance by using natural landscaping and plants in which children can imaginatively construct their own adventures and games.

Conclusion

Playground equipment is a major cause of injury in children. The majority of play equipment injuries result from falls from climbing equipment. The risk of injury and the severity of the injury, in the event of a fall, increases with the height of the equipment. Arm fractures are the major injury associated with playground equipment. This must be addressed in prevention strategies.

To maximise the safety of children, playground equipment must comply with appropriate Australian Standards, and be regularly inspected, maintained and repaired. Compliance with the Standards now also includes the installation of impact absorbing surfaces in the fall zones of equipment. Such surfaces may help to reduce the severity of injury in the event of a fall. However, if the burden of injuries to children from playground equipment (particularly climbing equipment) is to be lessened, then a reduction in the allowable maximum fall height of equipment needs to be considered. Such design changes in products have historically proved to be one of the most effective mechanisms of childhood injury prevention.

Further research is needed in two main areas. Children's exposure to playground equipment needs to be determined in order to know the relative risk of injury from different types of equipment. While a test for head injury addresses the most potentially serious injury, it only addresses part of the problem. Arm fractures are a much more common cause of morbidity, and a test for the likelihood of arm fractures, when impacting a surface, needs to be developed. From this, safe fall heights and appropriate undersurfacing could be determined which will aid in preventing such fractures.

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Dr. David Chalmers, Deputy Director, Injury Prevention Research Unit, Department of Preventive and Social Medicine, University of Otago, Dunedin, New Zealand.

Mr. Gerard Leeds, Executive Officer, Playgrounds and Recreation Association of Victoria (PRAV). 346 Albert St. Brunswick, Victoria.

Ms. Meron Clark, Executive Officer, Playground Committee, Australian Standards.

Recommendations

- Reduce the maximum fall height for new equipment to a lower level (preferably 1.5 metres).
- Compliance of existing equipment with the current Australian Standard (AS 1924, 1981) as a minimum, until the new Standard is published.
- Correctly install, anchor, site, and space all equipment.
- Regularly inspect and maintain existing equipment and impact absorbing materials. Ensure equipment inventories and checklists are maintained.
- Remove hazardous equipment.
- Use impact absorbing surfaces in fall zones of all equipment (as per AS/NZ 4422 1996).
- Place swings in a separate area with barriers to prevent traffic flow across their path.
- Design equipment which takes into account a child's behaviour and potential misuse of equipment (e.g climbing on to the top of a roof).
- Supervise children at playgrounds to ensure crowd control and prevent unsafe practices.
- Increase community awareness and public education of the risks of injuries from playground equipment. This should include parents, schools, child care centres, and local government.
- Encourage parents to become active in ensuring that their local playground is as safe as possible.
- Train supervisors at school and child care centres in first aid.
- Seek advice on playground management from knowledgeable organisations e.g. PRAV (03) 9388 1066, or in NSW, Kidsafe (02) 9848 2805.

Research

- Develop a test for predicting the likelihood of limb fractures in the event of a fall.
- Evaluate the efficacy of impact absorbing surfaces in preventing limb fractures.
- Quantify children's exposure to different equipment types (e.g. by observational studies) to assess the risks of certain equipment for different aged children.
- Include controls in future studies in order to accurately determine injury risk.

Child resistant cigarette lighters: a success story

Joan Ozanne-Smith

Disposable cigarette lighters contribute to childhood deaths, serious burn injuries and property damage in our community.

In September 1996 the Federal Minister for Small Business and Consumer Affairs announced a unanimous agreement by Australia's Consumer Affairs Ministers to adopt a national mandatory safety standard requiring that all disposable cigarette lighters have child resistant features. From March 1997 the importation of non child-resistant lighters into Australia will be banned and it will be unlawful to sell them from July 1997. Recent information indicates that child resistant cigarette lighters currently represent only 4% of the Australian market.

VISS has played a fundamental role in achieving this breakthrough for child safety. Over a period of several years, VISS had supplied updated data and information on disposable cigarette lighter injuries to the Federal Bureau of Consumer Affairs, the Victorian Coroner, interested lighter companies and safety organisations. This information has also been disseminated in Hazard (editions 12; 21; and 25) and through the media.

In May 1996, a Victorian Coroner, investigating the deaths of 2 year old twin boys, recommended that state and federal governments give consideration to the proposal that only child resistant cigarette lighters be available for sale in Australia, or at least in Victoria. In making this recommendation the Coroner drew heavily on VISS research. As a result, the issue of child resistant cigarette lighters was placed on the agenda of the September 1996 meeting of the Ministerial Council of Consumer Affairs with the support of the Victorian Attorney General. VISS consulted the U.S. Consumer Product Safety Commission and provided full documentation to the Ministerial Council of the U.S. experience in implementing a similar mandatory safety standard in 1993. The documentation included the results of regulatory impact studies and benefit/cost estimates.

This result represents the culmination of the work of VISS together with the Metropolitan Fire Brigade, Coronial Services, Kidsafe and other safety organisations. It fulfills a goal of the National and Victorian injury prevention strategies.

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Sports injury countermeasure reviews

Monash University Accident Research Centre, in conjunction with Sport and Recreation Victoria, have recently launched three detailed reviews of countermeasures for alpine skiing, cross country skiing and snowboarding.

Fact sheets describing key recommendations have also been prepared. Detailed reports are available at a cost of $15.00 (including postage and handling).

For further information please contact the Accident Research Centre on (03) 9905 1808.

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National Injury Surveillance Unit

The advice and technical back-up provided by NISU is of fundamental importance to VISS.

How to Access VISS Data:

VISS collects and tabulates information on injury problems in order to lead to the development of prevention strategies and their implementation. VISS analyses are publicly available for teaching, research and prevention purposes. Requests for information should be directed to the VISS Co-ordinator or the Director by contacting them at the VISS office.

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