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A Review of 2,517 Childhood Injuries seen in a Singapore Emergency Department in 1999 – Mechanisms and Injury Prevention Suggestions

M E H Ong, S B S Ooi, P G Manning

ABSTRACT

Background: Childhood Injuries cause significant mortality and morbidity in Singapore. With injury surveillance, patterns of repeated injury can be identified and injury prevention strategies devised.

Methods: We conducted a retrospective study of all children aged 12 and below seen for trauma in an Emergency Department over one year. Data captured in the real-time computer system was studied with regards to patient profile, mechanism of injury and patient disposition. Clinical summaries were extracted with follow-up telephone interviews done.

Results: Two thousand five hundred and seventeen children aged 12 and below were seen for accidental trauma in 1999, accounting for 37.1% of the total attendance for that age. Mean age was 7.7 years with males making up 62.7%.

Home injuries (56.4%) were the most common, followed by road-related (14.4%), sports (8.2%) and playground injuries (7.4%). 48.5% sustained head and face injuries. Pre-school children (age <5) were more likely to sustain home injuries (p<0.0001), a higher proportion of head injuries (p<0.0001), foreign bodies, burns and poisoning compared to school-going children (age 6-12), who were more likely to sustain injuries in road accidents, sports, at playgrounds or schools, with more limb, trunk and multi-trauma.

We highlight drownings, falls from height, roll-over falls from beds, slamming door injuries, the low use of child car restraints, bicycle injuries and playground falls as areas of concern.

Conclusion: Several injury prevention strategies have been suggested and it is hoped these may contribute to addressing preventable childhood injuries in Singapore. We also advocate the establishment of a national childhood injury surveillance database.

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INTRODUCTION

Childhood injuries cause significant mortality and morbidity in Singapore each year. In the 1990's, accidental injuries accounted for 10-17% of all yearly deaths in Singapore children aged one to 14 years old and was the third to fourth commonest cause of death in this age group for each year during that decade[1]. Mortality is but the tip of the proverbial iceberg. Major trauma is a leading cause of admissions to Paediatric Intensive Care Units[2] and the second leading cause of out-of-hospital cardiac arrests in children[3]. In Singapore, major infectious diseases of childhood have been successfully tackled and excellent perinatal care is readily available. Thus injury prevention offers the greatest opportunity to reduce childhood mortality and morbidity today. Indeed, worldwide, injury prevention has been a major concern in recent years[4,5].

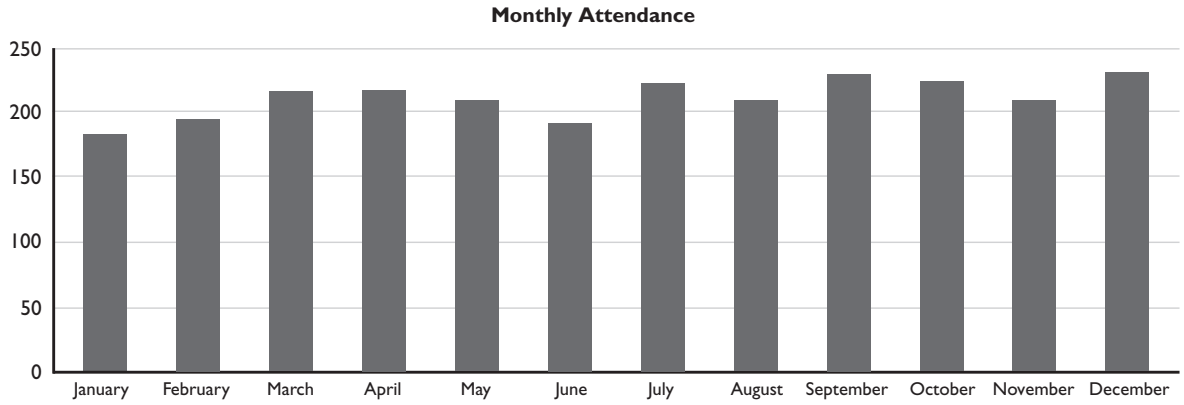
An Accident and Emergency based child accident surveillance system has been found to be practical and useful in monitoring and devising injury prevention strategies[6,7]. Furthermore, with the advent of real-time computerised consultation and data capture at many Accident and Emergency departments in Singapore since the late 90's, a powerful tool is in place for injury surveillance[8].

The aim of this study is to identify injury trends and patterns of recurrent injuries that may be amenable for prevention. The target study population are children below 12 years age, attending the Emergency Department for trauma related injuries over a period of one year.

METHODS

The National University Hospital (NUH) is one of two public sector institutions providing tertiary level paediatric care in Singapore. A one-year retrospective study was conducted for all children

Fig. 1 Childhood trauma cases seen per month.



below and including the age of 12 presenting to the Emergency Department with trauma. This includes accidental as well as proven or suspected non-accidental injuries. The period of study was 1 Jan 1999 to 31 Dec 1999.

Data captured in the real-time computer system was analysed with regards to patient age, sex, race, triage priority, mechanism of injury, diagnosis based on ICD-9 coding and patient disposition. Clinical summaries were extracted for every patient and follow-up telephone interviews were conducted where vital data was missing. For example, mechanism of injury is captured in the database as "fall, assault, road traffic accident etc". This is not specific enough for our analysis. Thus each clinical summary had to be extracted and the text studied to derive the circumstances of the injury (e.g. fall from bed, stairs, high chair etc). In many cases telephone interviews were necessary to derive "must have" data, for example: use of child restraints/ seat-belts in vehicle collisions. Despite our best efforts, a small percentage (3.6%) of the injury mechanisms remain unclear, especially where there were no eye-witnesses to the event. These have been classified as "unknown".

Patients were classified according to five age groups: aged <1 month, 1 to 3 months, 3 months to <2 years, 2 to <5 years of age, and 6 to 12 years of age. This was to allow easier analysis of data. Neonates are represented by those aged <1 month. Babies aged one to three months are unable to turn over. Mobile infants and toddlers are represented in the group aged three months to two years. Age 2 to 5 years represent the pre-schoolers and 6 to 12 years are the school-going children. Subanalysis was performed to compare mechanisms of injury in pre-schoolers (<5 years) against school-going children (6 to 12 years). Children aged above 12 were not included in this study as teenage injuries represent a separate sub-group, with distinct injury patterns. Also it should be noted that NUH has a walk-in paediatrics evening clinic from 7 to 11 pm daily. Thus a proportion of non-trauma emergencies would not be seen at the Accident and Emergency (A&E) and trauma emergencies may be over-represented in the A&E caseload.

Table I. Singapore Patient Acuity Category (PAC) Scale.

PAC Scale 1	Resuscitation. Cardiovascular collapse or imminent danger of collapse. Required to be attended to without a moment's delay.
	Example: Multiple major trauma, Shock due to trauma, penetrating chest or abdominal injuries etc.
PAC Scale 2	Non-resuscitation. Major Emergency. Ill and non-ambulant. Severe symptoms, trolley based.
	Example: Major limb fractures, major joint dislocations, spinal cord injury, trunk injury with stable vital signs etc.
PAC Scale 3	Minor Emergency. Ambulant. Mild to moderate symptoms.
	Example: Closed, isolated extremity fractures, superficial injuries, foreign bodies of nose, throat, eyes etc.
PAC Scale 4	Non Emergency.
	Example: Old scars, old trauma with residual disability etc.

Severity was assessed using the four-point Singapore Patient Acuity Category Scale (PACS) (Table I). This scale is currently in use in all public sector hospital Emergency Departments in Singapore .

Data tables were generated by the EMDS (Emergency Medicine Department System) (Eutech Cybernetics) and "crystal report". Statistical Package for Social Sciences v 10.0 was used for simple calculation of frequencies, percentages and means. Statistical analysis was performed using the Chi-Square test or Mann Whitney U test for non-parametric data. Fisher's exact test was used for small samples.

Table II. Injury types by mechanism.

Type	Age <5 years (%)	Age 6-12 years (%)	Total (%)	P-value
Home	802 (79.41)	618 (41.01)	1420 (56.42)	<0.0001
RTA	51 (5.05)	135 (8.96)	186 (7.39)	0.0002
Non-traffic Road	49 (4.85)	128 (8.49)	177 (7.03)	0.0004
Sports	13 (1.29)	193 (12.81)	206 (8.18)	<0.0001
Playground	35 (3.47)	151 (10.02)	186 (7.39)	<0.0001
Schools	21 (2.08)	145 (9.62)	166 (6.60)	<0.0001
Abuse	11 (1.09)	30 (1.99)	41 (1.63)	0.1070
Others	28 (2.77)	107 (7.10)	135 (5.36)	<0.0001

RESULTS

Two thousand five hundred and seventeen children aged 12 and below attended the National University Hospital Emergency Department for trauma in 1999. This accounted for 37.1% of the total attendance in patients aged 12 and below during this period. The monthly breakdown shows no definite correlation with school or holiday seasons but attendance is noted to be higher in the second half of the year and peaks in December (Fig. 1). There were 1,507 patients from the six to 12 years group (43.1%), followed by 2 to <5 years (34.4%) and 3 months to <2 years (22.7%). There were no patients seen for trauma under three months of age. The mean age of patients in our study was 6.8 years, with a median of 7.0 years and a standard deviation of 3.2 years.

Males made up 62.7% of all cases. The racial distribution of our study cohort resembled the general population with 62.8% Chinese, 19.0% Malays, 11.3% Indians and 7.0% other races. The majority of patients were assessed to be PAC Scale 3 (86.9%) followed by PAC Scale 2 (11.4%), PAC Scale 1 (1.1%) (resuscitation) and PAC Scale 4 (0.5%) (non-emergency).

Home injuries (56.4%) were the most common. This was followed by road-related injuries including road traffic injuries (7.4%) and non-traffic road injuries (7.0%). Non-traffic injuries included falls from bicycles, not involving collisions and pedestrian mishaps. Sports and recreational injuries contributed 8.2% and playground injuries 7.4%. Injuries occurring in schools contributed 6.6% with the remainder (5.4%) occurring in various public areas. The occurrence of non-accidental injury in this study was 1.6%.

Table III. Injury types by age.

Type	Age <5 years (%)	Age 6-12 years (%)	Total (%)	P-value
Head and face	616 (60.99)	604 (40.08)	1220 (48.47)	<0.0001
Upper limb	246 (24.36)	547 (36.30)	793 (31.51)	<0.0001
Lower limb	65 (6.44)	228 (15.13)	293 (11.64)	<0.0001
Trunk/multi-trauma	5 (0.50)	51 (3.38)	56 (2.22)	<0.0001
Others (neck, genitals etc)	5 (0.50)	33 (2.19)	38 (1.51)	0.0004
Foreign bodies	40 (3.96)	26 (1.73)	66 (2.62)	0.0008
Burns/scalds	23 (2.28)	10 (0.66)	33 (1.31)	0.0009
Poisoning	8 (0.79)	3 (0.20)	11 (0.44)	0.0331
Drowning/near-drowning	2 (0.20)	5 (0.33)	7 (0.28)	0.7090

Table IV. Injury by mechanism and type.

Type(%)	Home	RTA	Non-traffic	Sports	Playground	School	Others
Head and face	769 (54.2)	112 (60.2)	66 (37.3)	67 (32.5)	35 (18.8)	86 (51.8)	85 (50.9)
Upper limb	403 (28.4)	10 (5.4)	60 (33.9)	99 (48.1)	131 (70.4)	45 (37.3)	45 (26.9)
Lower limb	113 (8.0)	37 (19.9)	47 (26.6)	32 (15.5)	12 (6.5)	26 (10.2)	26 (15.6)
Trunk/multi-trauma	15 (1.1)	21 (11.3)	2 (1.1)	3 (1.5)	4 (2.1)	3 (1.8)	8 (4.8)
Others (neck, genitals etc)	14 (1.0)	6 (3.2)	2 (1.1)	5 (2.4)	3 (1.6)	1 (0.6)	7 (4.2)
Foreign bodies	63 (4.4)	0	0	0	0	3 (1.8)	0
Burns/scalds	31 (2.2)	0	0	0	1 (0.5)	1 (0.6)	0
Poisoning	10 (0.7)	0	0	0	0	1 (0.6)	0
Drowning/near-drowning	2 (0.1)	0	0	0	0	0	5 (3.0)

RTA-Road Traffic Accidents, Non-traffic-Non-traffic road accidents(including bicycles), Others-Including outside the home and public places.

Pre-school children (age <5) were more likely to sustain home injuries compared to school-going children (p<0.0001). In contrast, school-going children were more likely to sustain injuries in road accidents, sports, at playgrounds or schools (see Table II).

Head and face injuries (48.5%) were the most common. This was followed by limb injuries, foreign bodies, trunk injuries, burns, poisoning and drowning/ near-drowning (Table III). Skull fractures occurred in 2.5% of all head injuries. Preschool children sustained a higher proportion of head injuries (p<0.0001), foreign bodies, burns and poisoning. However school-going children sustained more limb, trunk and multi-trauma.

Analysis by type and mechanism (Table IV) revealed that head injuries were commonest in home, road-related and school accidents while limb injuries were commonest in sports and playground injuries. For limb injuries, upper limb injuries were commoner than lower limb except for road-traffic accidents. Proportionately more multiple-trauma occurred with road-traffic accidents than other accidents.

Analysis of patient disposition revealed that the admission rate for all ages was 21.5% (Table V). School-going children were more likely to be admitted (p=0.04) or referred to a specialist clinic (p<0.0001) while pre-schoolers were more likely to be discharged (p<0.0001).

There were three deaths in this study. Of these, two occurred from drowning and one from a fall from height. Of the two drowning deaths, one occurred in a toddler falling into a half-filled pail of water. The other was in a child who was swimming unsupervised in a private pool. There were another seven near-drownings in our study including two other incidents involving pails at home. Most of the pool near-drownings occurred in private pools.

Table V. Analysis by disposition and age.

Disposition	Age <5 year (%)	Age 6-12 year (%)	P-value
Admit	197 (19.5)	345 (22.9)	0.0427
Refer SOC	251 (24.9)	521 (34.6)	<0.0001
Refer GP/OPS	176 (17.4)	264 (17.5)	0.9522
Refer other hospital	3 (0.3)	0.0	0.0645
Discharged	373 (36.9)	371 (24.6)	<0.0001
AOR	9 (0.9)	4 (0.3)	0.0446
Died	1 (0.1)	2 (0.1)	1.0000

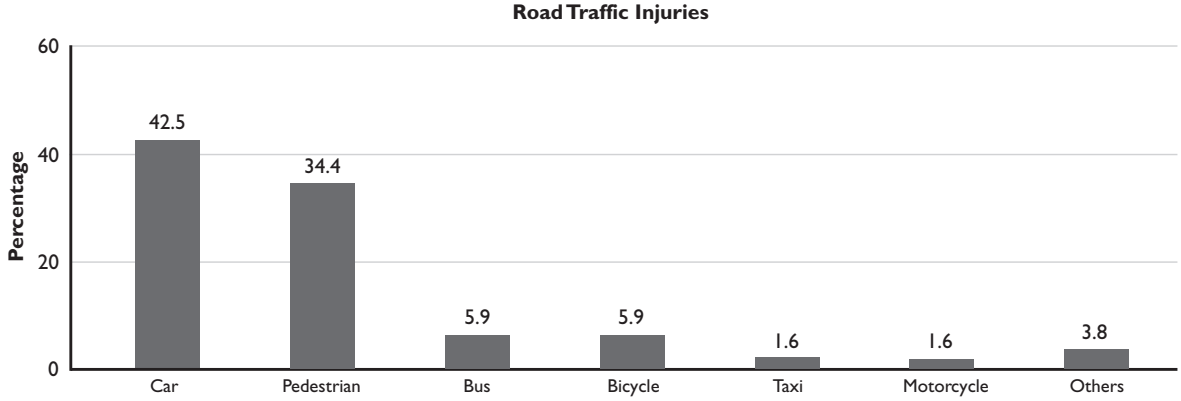
SOC-specialist outpatient clinic, GP-general practitioner, OPS-outpatient service (polyclinic), AOR-at own risk discharge

Falling from an open window resulted in the other mortality. In our study there were 17 cases of children falling from windows or balconies. Of these, five were from a height of two stories or more, resulting in serious multiple injuries and the one death. These usually occurred in children aged five and above climbing onto windows and ledges.

Regarding home injuries, sub-analysis showed that falls were the most common cause, making up 66% of these injuries. This was followed by mechanical injuries (14.3%) including knocks, lacerations, pulled elbows and being hit by falling objects. Slamming door injuries (6.1%), foreign bodies (4.4%), burns/scalds (2.0%), accidental poisonings (0.8%) and drowning/near-drowning (0.4%) were other important causes. The remainder (6.0%) consisted of a mixed group including choking, animal/insect bites etc.

Regarding falls at home, causes included slipping (26.0%), falls from bed (18.3%), chairs (7.7%), stairs (5.1%), in the toilet (4.1%) and walker devices (0.5%). In 9.7% of the cases, the mechanism was unclear, usually because no witnesses were present and the child was presumed to have fallen. These have been classified under "unknown". There were 50 cases of roll-over falls from beds in infants (age

Fig. 2 Distribution in Road Traffic Injuries.



<2 years). We also found double-decker beds to be associated with 31.7% of falls from beds in children above five years. There were also two patients with head injuries due to sarong cradles.

Injuries from slamming doors contributed to 6.1% of home injuries. These occurred in all ages but proportionately more in the under age two group. They usually resulted in finger and hand injuries, with many partial amputations and open fractures.

Foreign bodies caused 4.4% of home injuries, including foreign bodies in the eyes, ears, throat, stomach and nose.

Burns contributed 2% of home injuries, scalds (83.9%) being the commonest, followed by flame burns (9.6%) and hot irons (6.5%). Most of these occurred in children reaching out and spilling cups or kettles containing hot water.

Car collisions (42.5%) caused the highest number of road-traffic injuries in this study, followed closely by pedestrian injuries (Fig. 2). Injuries tended to be on the head and face (55.9%), followed by limbs (27.4%) and trunk (16.7%). Those in passenger vehicles were more often seated at the rear (66%). Most disturbingly, only 6.1% were properly seated in a child restraint. 9.3% of patients had been in adult seat-belts not entirely suitable for young children and 84.5% were not restrained in any way at all.

There were 171 bicycle related injuries in this study, of which 6.7% involved collision with motor vehicles and 29.4% resulted in fractures. There were also 13 cases of bicycle spoke injuries, where lacerations occur when a foot is caught in the bicycle spokes.

There were 186 cases of playground injuries in this study. The more common ones were falls from the monkey bars, swings, slides and see-saw. There were 59 cases of falls from monkey bars, mostly with injuries to the upper limb and head.

There were 193 cases of sports/recreational injuries in this study, the more common being associated with ball games, gymnastics, roller blading/skating and athletics.

DISCUSSION

Despite increased efforts at public education in recent years, many childhood injuries occur that are completely preventable. Trauma accounted for 37.1% of presentations to the Emergency Department in children 12 and under during the study period. This is much higher than in previous studies (12%) but the case bias has been mentioned previously[8]. The male predominance noted has been similarly reported in other countries[9,10].

Most of the patients seen had mild to moderate injuries (86.9% PACS 3). There were 28 PACS 1 (resuscitation) patients and three deaths. Although this may represent a small figure, it is impossible to quantify the social, economic and emotional loss involved, nor the long term consequences to survivors.

0.5% of cases were also judged to be non-emergency by the presenting doctors. These were usually children either with very minor injuries or injuries >24 hours after presentation, not requiring further investigation or treatment. All of these cases could probably have been adequately treated by primary health-care providers. Continuing public education is required regarding which injuries are emergencies and which can be adequately treated by a general practitioner.

Pre-school children (age <5) were more likely to sustain home injuries ($p<0.0001$), compared to school-going children (age 6-12), probably because they spend more time at home. They also have a higher proportion of head injuries ($p<0.0001$), due to their relatively larger head to body ratio. They are more prone to foreign bodies, burns and poisoning due to lower awareness. School-going children (age 6-12), were more likely to sustain injuries in road accidents, sports, at playgrounds or schools, as this is where they spend more time, with more limb, trunk and multi-trauma.

Home injuries were the commonest (56.4%) in our study. This is comparable to previous studies. For example, in New South Wales, Australia, 55.5% of cases were home injuries[9]. However, we found the overall incidence of road related, sports and playground injuries to be higher than previously reported for Singapore[8]. This could be because of the older age profile of our study population. Non-accidental injuries were diagnosed or suspected in 1.6% of cases. This is a cause for concern but is beyond the scope of this study.

Regarding home drownings, many Singaporean families have a habit of keeping pails of water at home. Unfortunately inquisitive toddlers may accidentally slip head first into these pails and drown. It only requires a few centimeters of water for a child to drown[11]. More public education is required regarding not leaving pails of water in the home or at least to cover them and ensure that children do not have unsupervised access to them. It is also interesting to note that the one pool drowning and most near-drownings occurred in private pools, where life-guards are unlikely to be available. In the United Kingdom and Australia, reported drowning rates were 1.5/100,000 per year[12,13]. Legislation regarding fencing of all private swimming pools to prevent unsupervised

access has been found to be helpful and should be considered here[14].

Singapore is a land of many high-rise buildings. Accidental falls from windows and ledges can and should be prevented. We strongly recommend legislation requiring all high-rise buildings to have suitable grilles for all windows and balconies. Similar legislation has already been successfully implemented in several cities in the United States of America. The best known example is the "Children Can't Fly" programme in New York City that has seen a 96% decrease in accidental falls from windows since 1979[15]. An encouraging local initiative is the recent campaign by Tanjong Pagar Constituency to install window grilles free of charge for 113 low income families living in one or two-room flats.

Home is generally thought to be a safe environment for children; however there are many potential hazards that exist. In this study the most common type of home injury was falls of various types contributing 66% of all home injuries. These type of falls commonly result in head injuries[16,17].

There were 50 cases of roll-over falls from beds in infants. We found that Singapore families have a habit of nursing infants in adult beds rather than cots. The problem usually occurs when the infant reaches five to seven months of age, when they roll-over and fall off the bed. This usually results in head injuries. This problem has been noted in other Asian communities[18] and more public education is needed to stop this dangerous practice and encourage the use of cots. We also note that double-decker beds seem to be associated more falls from the bed. More study is needed into this area. We also note two patients with head injuries due to sarong cradles. These devices are known to be associated with severe head injuries yet continue to be in popular use[19].

Falls from high chairs tend to occur when the infant is not restrained and attempts to stand up in the chair[20]. Thus children should always have the seat-belt fastened while in the high-chair. Falls from stairs can be prevented by installing safety gates to prevent unsupervised use of them by children. Likewise non-slip mats or tiles should be used in the bathroom to prevent unnecessary falls.

Injuries from slamming doors are another area of concern, especially in the under-two-year-olds. They are in the exploratory stage but are unable to appreciate the potential dangers. We recommend all doors at home to have latches or self-closing hinges to prevent slamming. Another suggestion would be "Australian" door knobs, which are placed higher, at adult shoulder level, out of the reach of young children.

The more common foreign bodies involved the eyes, ears, throat, stomach and nose. In one study eye trauma related to foreign bodies was found to contribute 14% of paediatric eye admissions[21] and indeed, small objects that could become foreign bodies should be kept out of reach of small children[22]. Care should also be taken to choose age appropriate toys, avoiding those with small parts that can become foreign bodies[23].

Home scaldings usually occur in children reaching out and spilling cups or kettles containing hot water[24,25]. Public education combined with home visits has been found to be useful in reducing the incidence of paediatric scalds[26]. Care should be taken not to leave hot water on readily accessible table-tops and appropriate child guards used for cooker-hoods and ovens.

Car collisions (42.5%) caused the highest number of road-traffic injuries in this study. This is in contrast to previous studies which showed pedestrian injuries to be the more common and more severe[27,28]. Statistics on seat-belt and child restraint use has been difficult to obtain. This study seems to indicate that use of appropriate child restraint devices is very low. This is despite current legislation requiring use of child restraints in children less than eight years. However, enforcement of this law seems to be lax and furthermore, there are many loop-holes and exceptions in the law. We feel that a revision is timely together with stricter enforcement. Also civilian volunteer reporting schemes may be helpful, where a violation of seat-belt laws are notified to a hotline, which will then send educational material to the offenders.

Regarding bicycle injuries, more education is required regarding riding of bicycles along roads and use of safety equipment. It is our opinion that mandatory use of helmets , especially at bicycle rental facilities will be helpful[29]. Bicycle spoke injuries occur when the pillion or rider gets his foot entangled in the spokes resulting in foot lacerations[30]. Wearing of proper shoes for cycling can easily prevent such injuries; however we notice that wearing slippers/ sandals while cycling is fairly common here.

As for playground injuries, we highlight 59 cases of falls from monkey bars. These usually occurred in young children barely tall enough to climb onto the bars, which are usually at least 1.5 metres high. While attempting to swing from these bars, they fall to the ground. This results in injuries to the outstretched hand and head injuries. Injuries could be prevented by designing the bars to be placed lower and using

foam material for the flooring of playgrounds, rather than the concrete and sand that are commonly seen.

Sports and recreational injuries seem to be less common in Asian studies compared with the West[31]. However we note an association with increasing popularity of "trend" sports like skateboarding, roller-blading and now skate-scooters. We expect that these injuries would be even more common among the teenagers, which were not covered by this study.

Public education efforts regarding child safety could involve the media (print, radio and television), hospital and community based resources. We note the effective role of the Child Safety Centre in KK Women's and Children's Hospital targeting expectant mothers. We also note that in our study, injuries were frequent in the school-going age. Safety talks and exhibitions can be targeted for school children and their parents.

Limitations of this study included incomplete or incorrect data entry, problems with coding and data capture. As data entry is real-time, several inconsistencies were noted in them, thus much time was spent checking entries and even verifying data by phone interview. This can be attributed to the demands of emergency patient care and unfamiliarity with the software. Also the system only allows one main diagnosis and a limited number of secondary diagnoses. Thus a patient with multiple injuries may not be adequately reflected. Problems also exist with ICD-9 coding, which may not reflect unusual diagnosis. Furthermore at the emergency level, information from subsequent investigations may not be available and diagnosis codes may represent a clinical judgement on the part of the physician involved. As the data entry templates were not originally designed with injury surveillance in mind, there was much difficulty extracting relevant information, especially with regard to injury mechanisms; also the system does not cater for classification of injuries by E code. Finally, analysis of the data by the age groupings chosen was not entirely satisfactory, as different children have different development rates. Nevertheless, keeping in mind the complexity of the data involved, the groupings chosen seemed the most reasonable to allow meaningful analysis of the data.

Despite these limitations, we feel that injury surveillance is important and a worthwhile venture. We feel perhaps, the time is right to establish a nationwide injury surveillance database[32,33]. This will require much co-ordination, effort and resources; indeed this study has shown that a full-time co-ordinator and researcher is required for it to work. As most Emergency Departments in Singapore are now computerised, existing Emergency Department systems can be tailored to collect childhood injury data in a universal injury template. This can then be collated in a National Registry for regular analysis. Perhaps with co-ordination even data from primary health care providers can be included. All this will greatly aid our efforts at promoting safety and injury prevention.

CONCLUSION

Childhood injuries contribute significant morbidity and mortality every year in Singapore. Studies have shown that perhaps up to 47% of accidental injuries are easily preventable[4]. We highlight drownings, falls from height, roll-over falls from beds, slamming door injuries, foreign bodies, the low use of child car restraints, bicycle injuries and playground falls from monkey bars as areas of concern. We also advocate the establishment of a national childhood injury surveillance database . Several other injury prevention strategies have been suggested and it is hoped these may contribute to addressing preventable childhood injuries in Singapore.

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