Danger in Shopping Centres – A Study on Escalator-Related Injuries in Children in Singapore

Dear Editor,

The first escalator was patented in 1892 and installed in New York, serving as an amusement ride.[1] Today, it has evolved into a common means of transport, taking passengers from 1 level to the next.

In the United States, there are more than 10,000 escalator -related injuries annually.[2] In 2016, a young mother in China had barely managed to save her son before falling to her death as the escalator's floor plate gave way.[3] In Singapore, there were several newspaper reports of escalator-related injuries involving children in 2016.[4,5,6] These included a 5-year-old boy whose big toe was avulsed and a 6-year-old boy whose trapped foot had to be released with hydraulic tools.

Singapore is a highly urbanised country. Within a mere 719.1 km^2 land area, there are now more than 6000 registered escalators in Singapore. This number is expected to rise with the construction of new complexes.[7] This study aimed to describe the nature of escalator-related injuries involving children in Singapore.

Material and Methods

This is a retrospective study using data from the injury surveillance database at KK Women's and Children's Hospital, Singapore. The emergency department (ED) sees about 175,000 patients annually, of which an estimated 25,000 have trauma-related complaints. The injury surveillance database consists of prospectively collected data on the circumstances of injuries documented according to the International Classification of External Causes of Injury (ICECI) classification.[8] Information on circumstances surrounding the injury is obtained from the physician during the consultation. Important data fields have electronic validation checks in place to ensure completeness of data. The trauma coordinator performs quality checks at regular intervals to ensure that the data entered is accurate.

All patients below the age of 18 years who presented to the ED between January 2012 and December 2016 with an escalator-related injury were included. We ran a search for the diagnosis using both diagnostic codes and free-text inputs. Keywords such as "escalator" and "escalator-related" were used to perform the free-text search. Other keywords such as "shopping centres" and "shoes" were also included and filtered.

In this study, we subdivided the age of our patients based on their development. Infants refer to children aged 1 year and below; toddlers, between 1 and 3 years of age; preschool children between 3 and 6 years of age; primary school-going children, between 6 and 12 years of age; and secondary school-going children, above 12 years of age.

The sites of injury were grouped into broad anatomical categories of the head, neck and face region; thoracic region; abdominal region; upper extremities; and lower extremities. In cases where there was more than 1 anatomical site involved, we chose to document the site that sustained the injury of greater severity.

The types of injuries were grouped into superficial injuries (e.g. abrasions); contusions; open wounds (e.g. lacerations, punctures); fractures; dislocations; and head injuries.

Categorical data was presented using frequencies and percentages, while continuous data was presented using means (standard deviation, [SD]) or median (interquartile range [IQR]), depending on normality.

The study was given ethics approval by the local institutional review board.

Results

From January 2012 to December 2016, there were a total of 300 injuries related to the use of escalators. We see a rising trend in the number of incidents annually (Table 1). This is despite the number of annual ED attendances remaining almost the same.

The youngest patient was 1 month old and the oldest was 17 years old. The mean age was 5.9 years old (SD 3.6) (Table 2).

The most common mechanism of injury in our study was a fall (Table 2). Amongst infants, falls were the sole mechanism of injury.

Of the 111 entrapment injuries sustained, 8 (7.2%) required surgery. A majority 28/59 (47.5%) of the entrapment injuries occurred at the escalator skirting, followed by 13 (22%) between the steps, and 13 (22%) between the walls and the railing. Two incidents occurred at the comb plate of the escalator while 3 occurred at the handrails.

Shoes were the commonest objects (54/97 or 55.6%) involved. Of these, 31/54 (57.4%) were specified to be rubber clogs. Strollers (38/97 or 39.2%) were the next

Table 1. Incidence and Rates

	Escalator-Related Injuries	Trauma Attendances to the ED	Annual ED Attendance	Rates of Escalator-Related Injury Per 10,000 Trauma Cases
2012	35	23,007	175,632	15.2%
2013	45	25,753	175,996	17.5%
2014	65	27,137	172,909	23.9%
2015	70	28,295	174,429	24.7%
2016	85	26,719	184,722	31.8%

ED: Emergency department

group of objects that were associated with escalator-related injuries; 22/38 (57.9%) of those who sustained an injury associated with stroller use required inpatient admission. A majority of accidents occurred in shopping centres (Table 2).

Of the 10 patients attended to at the resuscitation bay, 5 sustained entrapment injuries, while 2 had severe falls. An 11- and a 9-year-old boy were attended to at the resuscitation bay for facial suffusion and cervical spine injury, respectively, as a result of head entrapment between a wall and the escalator railings.

The majority of injuries involved the lower extremities (178/300 or 59.3%), followed by the head, neck and facial region (79/300 or 26.3%) and the upper extremities (43/300 or 14.3%). Head injuries were the commonest amongst the infants, making up 40% (22/55) of all head injuries; 230/300 (76.7%) patients required procedures in the ED (Table 3).

A total of 49/300 (16.3%) children were hospitalised. Ten underwent surgical procedures under general anaesthesia, while the rest were admitted for inpatient observation. The surgical procedures included wound debridement and open reduction and internal fixation of fractures. The mean number of days of hospitalisation was 2.3 days (range 2.0-9.0). There were no deaths.

Discussion

While there has been an earlier publication on foot injuries associated with escalator use,[9] this study is the first to describe escalator-related injuries among children presenting to a tertiary institution. There is an increased rate of escalator-related injuries among children presenting to our institution, from 15.2% per 10,000 trauma cases seen in 2012 to 31.8% per 10,000 trauma cases seen in 2016 (Table 1).

From 2012 to 2016, Singapore's population increased from 5.3 million to 5.6 million. With population growth, more high-rise buildings will be constructed and the number of escalators in Singapore will increase. There is a need to evaluate if the current strategies put in place to prevent escalator-related injuries are sufficient, and whether more should be done to reduce the incidence of such injuries.

Table 2. Demographics and Circumstances of Injury (n = 300)

	Variables	Frequency	Percentage
Gender	Female	106	35.3%
	Male	194	64.7%
Race	Chinese	177	59.0%
	Malay	31	10.3%
	Indian	38	12.7%
	Others	54	18%
Mechanism of injury	Fall	174	58.0%
	Entrapment	111	37.0%
	Mechanical failure	2	0.7%
	Others (e.g. shaving injury)	13	4.3%
Objects involved	Not specified	203	67.7%
	Stroller	38	12.7%
	Crocs rubber clogs	31	10.3%
	Other shoes	23	7.7%
	Others (e.g. dropped toy)	5	1.7%
Location	Not specified	80	26.7%
	Shopping centres	153	51.0%
	MRT stations	30	10.0%
	Residential areas	1	0.3%
	Others (e.g.hospital compounds, airports, tourist attractions)	36	12.0%
Types of injuries	Open wounds	144	48.0%
	Contusions/sprains	57	19.0%
	Superficial injuries	54	18.0%
	Fractures	43	14.3%
	Others	2	0.7%
Body part involved	Head, neck, face	79	26.3%
	Upper extremities	43	14.3%
	Lower extremities	178	59.3%
	Foot	68	22.6%
	Toes	7	2.3%
	Knee	5	1.6%
	Leg	12	4.0%
	Shin	86	28.6%
Mode of transport to the ED	Walk-in	261	87.0%
	Ambulance	39	13.0%

ED: Emergency department; MRT: Mass rapid transit

In November 2016, the Building and Construction Authority of Singapore (BCA) put in place regulations to ensure that all escalators undergo regular maintenance checks. Escalators require a valid permit from the BCA to be operational. All incidents pertaining to escalators must be reported to the BCA.[10] Despite this, a well maintained

Table 3. Disposition and Outcomes

Investigations required (n = 300)	
X-rays	179 (59.4%)
CT scans	1 (0.3%)
Interventions required (n = 230)	
Toileting and suturing	134 (58.2%)
Wound cleaning	51 (22.2%)
Casting and immobilisation	38 (16.6%)
Nail bed repairs	4 (1.7%)
Manipulation and reduction	3 (1.3%)
Disposition (n = 300)	
Hospitalised for observation	38 (12.7%)
Hospitalised for surgery	10 (3.3%)
Discharged from ED	252 (84.0%)

CT: Computed tomography; ED: Emergency department

escalator will not completely reduce injuries caused by the improper use of escalators. In our study, only 2 children sustained injuries related to machinery fault.

From our study, 12.7% of escalator-related injuries involved prams and strollers, reinforcing results from another study[11] that more should be done to reduce the incidence of stroller-related injuries sustained on escalators.

Falls are the commonest mechanism of injury in our study, which is consistent with other studies.[11-13] While this leads to hospitalisation, entrapment injuries required longer hospital stays and complex surgical intervention. Wearing certain types of shoes, such as rubber clogs, could contribute to the increased risk of entrapment injuries as supported by a study published in 2010.[9] In our study, a large proportion of the cases had no specified objects involved. This group comprises cases that truly did not have an object involved as well as those that did not have objects specified due to incomplete documentation. This may lead to an underestimation of the number of injuries with objects involved.

We recognise the limitations to our study. This is a single-centre study and milder injuries may not present to the hospital leading lead to an underestimation of the incidence. Being a retrospective study, incomplete documentation may lead to missing data. Cases of machinery fault were likely to be underestimated because these were determined by chart review.

Conclusion and Recommendations

Efforts have been made to increase the awareness of safe escalator usage. Signs are placed at the entrance of most escalators in Singapore as a safety reminder. The effectiveness, however, is limited by the fact that these are frequently not read nor complied with. Moreover, education interventions require behavioural change amongst users in order to be effective.

We recommend making structural modifications to all escalators. Constructing a metal pole in the middle of the escalator entrance will deter parents from pushing strollers onto escalators. Reducing the gap between the steps and side-walls and fitting escalators with brush borders may reduce the incidence of entrapment injuries.

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