

New peril on our roads: a retrospective study of electric scooter-related injuries

Yee Kent Liew¹, MBBS, Choon Peng Jeremy Wee², MBBS, MRCSEd, Jen Heng Pek¹, MBBS, MCEM

INTRODUCTION The electric scooter has been gaining popularity locally as a commute mode. We aimed to understand the current landscape of electric scooter-related injuries in Singapore.

METHODS A retrospective review was performed of the medical records of patients seen from 2015 to 2016 at an emergency department (ED) in Singapore. Patient demographics, circumstances of the accident, injuries sustained and clinical progress were analysed.

RESULTS There were 36 cases, all of whom were electric scooter users. The median age was 34 (range 17–70) years and 66.7% were male. There was a 2.3-fold increase in the number of cases from 2015 to 2016. In 11 (30.6%) of cases, another road user was implicated. Two cases involved the use of protective equipment. 14 (38.9%) cases were conveyed by Emergency Medical Services. In the ED, 4 (11.1%), 17 (47.2%) and 15 (41.7%) cases were triaged as P1 (emergent), P2 (urgent) and P3 (ambulatory), respectively. Investigations were performed in the ED for 31 (86.1%) cases. External injuries were most common (72.2%), followed by extremity injuries (33.3%), with median Abbreviated Injury Scale scores of 1 and 2, respectively. Overall, the median Injury Severity Score was 1. Nine patients were admitted to the hospital with three requiring surgery. The median length of stay was 2 (range 1–6) days.

CONCLUSION The incidence of electric scooter-related injuries appears to be on the rise and may potentially incur significant morbidity and healthcare costs. Further efforts at safety education and enforcement should be made to prevent accidents and minimise the impact of these injuries.

Keywords: accident, epidemiology, wounds and injuries

INTRODUCTION

Electric scooters (e-scooters), including kick scooters and electric hoverboards, are personal mobility devices (PMDs) that have been adopted as a commute mode. As they provide convenience at a highly affordable price, PMDs are swiftly gaining popularity in Singapore. The Active Mobility Advisory Panel, commissioned by the Singapore Government in July 2015, recommended criteria of use (Box 1) as well as a code of conduct to improve the safety of riders and avoid conflicts with other commuters.⁽¹⁾ Despite these recommendations, accidents involving PMDs continue to occur amid growing public concern, culminating in the passing of the Active Mobility Bill in January 2017. This bill established a penalty framework comprising fines and jail terms for reckless riding behaviour, illegal device modifications and the sale of devices that fail to comply with specifications found in the bill.⁽²⁾ In the first quarter of 2018, further revisions were proposed, which included the mandatory purchase of third-party insurance, helmet use and official registration of all e-scooters.⁽³⁾ Tougher penalties and a Safe Riding Programme were also advocated for reckless riders.⁽⁴⁾

There have been numerous media reports of e-scooter-related accidents involving both pedestrians and other road vehicles that resulted in injuries and death, reflecting an increased incidence of e-scooter-related injuries with time.⁽⁵⁻¹⁰⁾ The Singapore Civil Defence Force (SCDF), the main provider of pre-hospital Emergency Medical Services (EMS) in Singapore, has reported a nearly three-fold increase in e-scooter-related ambulance calls

from 16 cases in January 2017 to 52 cases in September 2017.⁽¹¹⁾

To address the gap in the existing literature regarding this growing problem, our study aimed to characterise the spectrum and severity of e-scooter-related injuries presenting to an emergency department (ED), as well as to examine the consequent burden on health resource utilisation.

METHODS

This study was conducted at the ED of Singapore General Hospital, which sees about 135,000 patients a year. A retrospective review of case records was performed for all injuries sustained by e-scooter users who presented to the ED from 2015 to 2016. Parameters collected include demographics, mode of arrival to the ED, triage category, mechanism of injury, injuries sustained, investigations performed and the clinical course of the patient within the ED and hospital. The study was

Box 1. Criteria for use of personal mobility devices:

Device:

- Registered with Land Transport Authority
- Maximum unladen weight of 20 kg
- Maximum device speed of 25 km/h
- Maximum width of 700 mm
- Adoption of UL2272 standard (from 1 January 2021)

Operation:

- Speed limit of 25 km/h on shared paths
- Speed limit of 10 km/h on footpaths
- Not allowed on roads

¹Department of Emergency Medicine, Sengkang General Hospital, ²Department of Emergency Medicine, Singapore General Hospital, Singapore

Correspondence: Dr Pek Jen Heng, Consultant, Department of Emergency Medicine, Sengkang General Hospital, 110 Sengkang East Way, Singapore 544886. pek.jen.heng@singhealth.com.sg

approved by the SingHealth Centralised Institutional Review Board (CRIB Reference Number 2017/2016). Statistical analysis was performed using SPSS version 16 (SPSS Inc, Chicago, IL, USA). Categorical data was presented as frequency and percentages, while continuous data was presented as median (range).

RESULTS

A total of 36 e-scooter users presented to the ED during the study period. Their median age was 34 (range 17–70) years and 24 (66.7%) patients were male. There was a 2.3-fold increase in the incidence of e-scooter-related cases, from 11 in 2015 to 25 in 2016. 14 (38.9%) of the injuries were caused by the riders themselves, and 11 (30.6%) involved another party. Only 2 (5.6%) riders used a helmet as protective gear (Table I).

External injuries involving soft tissues, such as contusions, abrasions and lacerations, were the most common ($n = 26$, 72.2%), followed by extremity injuries involving fractures or dislocations ($n = 12$, 33.3%). The median Abbreviated Injury Scale (AIS) score was 1 for all body regions affected, except for extremities, which had a median AIS score of 2 (Table II). Among all the patients, the median Injury Severity Score was 1 (range 1–5). There were no deaths associated with e-scooter injuries in this series.

14 (38.9%) cases were conveyed by EMS provided by the SCDF, while the remaining patients went to the ED via their own transport. Within the ED, 4 (11.1%) cases were triaged as emergent (P1), 17 (47.2%) cases as urgent (P2) and 15 (41.7%) as ambulatory (P3). 1 (2.8%) case required the attention of a multidisciplinary trauma team. None of the patients required blood transfusions following initial assessment in the ED. Investigations were performed in 31 (86.1%) cases, of which radiography ($n = 26$) was the most common, followed by computed tomography ($n = 5$) and blood tests ($n = 3$). In some cases, more than one type of investigation was performed.

One quarter of the patients was subsequently admitted to the hospital (four to the ED observation unit and five to the inpatient wards). None of the patients required admission to a high dependency or intensive care unit. The median length of stay was 2 (range 1–6) days. 3 (8.3%) patients underwent an operation for their injuries (Table III).

DISCUSSION

The increased e-scooter-related ED attendance in our study reflects the rise in e-scooter-related injuries in recent years. This is a growing public concern, and the trend is likely to persist considering the popularity of e-scooters. An Israeli study reported a similar observation of a six-fold increase in hospitalisation from 2013 to 2015 arising from the use of electric bicycles and motorised scooters.⁽¹²⁾ To address this issue in Singapore, the Active Mobility Advisory Panel examined a series of measures to promote safe e-scooter usage and recommended license registration to increase user responsibility and facilitate law enforcement against errant riders. Challenges remain, however, in increasing public awareness of these measures and ensuring compliance with recommendations on safe e-scooter usage.

Table I. Patient characteristics (n = 36).

Variable	No. (%)
Age* (yr)	34 (17–70)
Male gender	24 (66.7)
Ethnicity	
Chinese	23 (63.9)
Malay	4 (11.1)
Indian	4 (11.1)
Others	5 (13.9)
No. of cases per year	
2015	11 (30.6)
2016	25 (69.4)
Cause of injury	
Rider (e.g. loss of balance/control)	14 (38.9)
Collision with vehicle (e.g. car)	10 (27.8)
Collision with object (e.g. lamppost, kerb)	6 (16.7)
Road condition (e.g. slope, uneven surface)	4 (11.1)
Collision with person	1 (2.8)
Device (e.g. brake failure)	1 (2.8)
Another road user involved	11 (30.6)
Vehicle driver	10 (27.8)
Pedestrian	1 (2.8)
Personal protective equipment used	
Helmet	2 (5.6)

*Data presented as median (range).

Table II. Body region injured and severity of injury (n = 36).

Body region	No. (%)	Median AIS score (range)
External	26 (72.2)	1 (NA)
Extremity	12 (33.3)	2 (1–2)
Face	4 (11.1)	1 (1–2)
Chest	2 (5.6)	1.5 (1–2)

14 patients sustained injuries to > 1 body region. AIS: Abbreviated Injury Scale; NA: not applicable

While e-scooters provide a highly affordable and convenient mode of commute, they are not without risks, as injuries and even death may occur. Similar to an Australian study, we found that most local e-scooter-related accidents occurred due to the rider, without involvement of another party.⁽¹³⁾ The most common injuries were minor soft tissue injuries and bony injuries involving the upper and lower extremities. Correspondingly, the mortality rate of e-scooter-related injuries is low.^(11,13–16) This observation could be attributed to the device and operation criteria, which specify limits for the weight, size and speed of e-scooters, thereby reducing the risk of serious injuries when accidents occur. Further, the hazards of e-scooters extend beyond accidents related to usage. E-scooters operate on chargeable batteries, which have been reported to result in explosions and burns during charging, accounting for 40 fire incidents in 2017.⁽¹⁷⁾ Knowledge of common e-scooter-related injuries would allow healthcare providers to anticipate potential injuries when managing these patients.

It would also be important to test for any correlation between rider behaviour and circumstances of e-scooter-related injuries, to

Table III. Details of patients requiring operations.

Circumstances of injury	Injuries sustained	Operation
Skidded and hit lamppost, flung 5 m	Open fracture of middle phalanx of left middle finger	Excision and debridement of the open fracture with Kirschner wire fixation
Hit by a taxi	Closed fracture of right lateral tibial plateau	Open reduction internal fixation of right tibial plateau fracture
Braked and flew forward	Left orbital floor and nasal fracture	Repair of left orbital floor fracture and open septorhinoplasty

provide insight into and justify new recommendations or revisions to existing guidelines on improving safety for all road users. We found that helmets, which were not recommended when riding e-scooters during our study period, were worn by only 5.6% of the injured riders in our study. This was a worrying trend, considering that head injuries represented the third most common type of e-scooter-related injuries (Table II). The implementation of a universal helmet law among motorcycle riders has been shown to confer protection against head injuries.^(18,19) Hence, the proposal by the Active Mobility Advisory Panel to mandate the use of helmets when riding e-scooters may aid in the reduction of the incidence and severity of head injuries in e-scooter-related accidents. Similarly, wrist guards, which were shown to reduce fracture severity among roller skaters,⁽²⁰⁾ may warrant a review as compulsory protective equipment for e-scooter riders given the higher incidence of soft tissue and bony injuries to the upper extremities. Lastly, considering the potential injuries to self and others that can arise from irresponsible e-scooter usage, the imposition of an age limit for e-scooter use, not unlike that for other motor vehicles, is an additional measure that policymakers ought to explore.⁽²¹⁾

The burden on healthcare resources incurred by e-scooter-related accidents was largely limited to the ED, as most patients were fit for discharge based on the nature and severity of their e-scooter-related injuries. Within the ED, the utilisation of high-level resources such as intubation, chest tube insertion, pericardiocentesis and cardiopulmonary resuscitation was uncommon. Similarly, inpatient healthcare resources such as hospital beds, operating theatres and intensive care beyond the ED were infrequently utilised.

We recognise several inherent limitations to our study. It likely underestimated the incidence and healthcare costs incurred by e-scooter-related accidents, as it did not include e-scooter users who presented to other institutions or primary care providers. Likewise, injuries sustained by other road users who may have been injured in e-scooter-related accidents were also not captured. Owing to the retrospective nature of our study, we were limited by varying documentation practices and were unable to perform a more detailed analysis of the various factors that may affect the incidence and severity of e-scooter-related injuries. For instance, we were unable to determine whether these accidents occurred on roads, cycling paths or footpaths.

Nonetheless, to the best of our knowledge, this first look at the spectrum and severity of e-scooter-related injuries and utilisation of health resources provides a glimpse into the potential scale of the problem. A future national prospective

study involving all primary care units and hospitals would be useful to seek further clarity on this issue. The recent move by the National Trauma Registry to specify e-scooters and other types of PMDs in data collection is a positive step towards accurate information gathering for surveillance and analysis of e-scooter-related injuries. To develop preventive and mitigating measures, we can utilise tools such as the Haddon Matrix, which aids in the examination of e-scooter-related accidents according to pre-event, event and post-event phases, as well as possible human, vehicle and environment factors within each phase.⁽²²⁾ Information sharing and collaboration with the Ministry of Transport, Land Transport Authority and Traffic Police is also important to help shape guidelines and legislation to improve safety for all road users.

In conclusion, with e-scooter-related injuries on the rise, there is potential for significant morbidity and even mortality. To tackle the problem effectively, we need to take a systematic approach focused on surveillance and injury prevention through public education and law enforcement.

REFERENCES

- Active Mobility Advisory Panel, Land Transport Authority, Singapore. Recommendations on rules and code of conduct for cycling and the use of personal mobility devices. Available at: [https://www.lta.gov.sg/data/apps/news/press/2016/20160317_AMAPPanelReport\(final\).pdf](https://www.lta.gov.sg/data/apps/news/press/2016/20160317_AMAPPanelReport(final).pdf). Accessed July 9, 2018.
- Land Transport Authority, Singapore. Factsheet: active mobility bill. Available at: <https://www.lta.gov.sg/apps/news/page.aspx?c=2&id=2e0d9c1a-55ab-4647-9b08-4cd4ff6d44cb>. Accessed July 9, 2018.
- Land Transport Authority, Singapore. Factsheet: mandatory registration of electric scooters. Available at: <https://www.lta.gov.sg/apps/news/page.aspx?c=2&id=be68c021-09cc-48ff-92ed-c1e6088dbf7c>. Accessed July 9, 2018.
- Land Transport Authority, Singapore. Factsheet: stricter enforcement and education to deter errant use of PMDs. Available at: <https://www.lta.gov.sg/apps/news/page.aspx?c=2&id=dfbdee2d-450e-4abf-8b80-6c3af44cf06d>. Accessed July 9, 2018.
- Lam L. E-scooter rider, 16, taken to hospital after accident with car in Woodlands. *The Straits Times* 2017 Nov 31. Available at: <https://www.straitstimes.com/singapore/e-scooter-rider-16-taken-to-hospital-after-accident-with-car-in-woodlands>. Accessed July 9, 2018.
- Lam L. E-scooter rider taken to hospital after collision with car in Yishun. *The Straits Times* 2017 Dec 16. Available at: <https://www.straitstimes.com/singapore/e-scooter-rider-taken-to-hospital-after-collision-with-car-in-yishun>. Accessed July 9, 2018.
- Man arrested for knocking down woman with e-scooter at Chinatown MRT station. *Channel NewsAsia* 2018 Jan 27. Available at: <https://www.channelnewsasia.com/news/singapore/man-arrested-for-knocking-down-woman-with-e-scooter-at-chinatown-9901902>. Accessed July 9, 2018.
- Lam L. Woman suffers head injuries after allegedly being hit by e-scooter. *The New Paper* 2018 Mar 12. Available at: <http://www.np.sg/news/singapore/woman-suffers-head-injuries-after-allegedly-being-hit-e-scooter>. Accessed July 9, 2018.
- Koh F, Lam L. E-scooter rider dies in hospital after accident with double-decker bus in Kaki Bukit. *The Straits Times* 2017 Nov 30. Available at: <https://www.straitstimes.com/singapore/e-scooter-rider-seriously-injured-after-accident-with-double-decker-bus-in-kaki-bukit>. Accessed July 9, 2018.
- 52-year-old man dies after e-scooter accident at Bedok Reservoir. *TODAY* 2017 Nov 30. Available at: <https://www.todayonline.com/singapore/52-year>

- old-man-dies-after-e-scooter-accident-bedok-reservoir. Accessed July 9, 2018.
11. Lim A, Ng M, Shanker S, et al. Electric scooter injuries: a study of descriptive records by Singapore Emergency Medical Services. Singapore Trauma and Acute Care Conference 2018; 20-21 April 2018, Raffles City Convention Centre, Singapore. p. 38.
 12. Siman-Tov M, Radomislensky I; Israel Trauma Group, Peleg K. The casualties from electric bike and motorized scooter road accidents. *Traffic Inj Prev* 2017; 18:318-23.
 13. Cassell E, Clapperton A. Consumer product-related injury (2): injury related to the use of motorised mobility scooters. *Hazard* 2006; 62. Victorian Injury Surveillance Unit, Monash University Accident Research Centre. Available at: https://www.monash.edu/_data/assets/pdf_file/0005/218435/haz62.pdf. Accessed July 9, 2018.
 14. Goh S, Teo LT, Cheng J, et al. Electronic scooters and bikes – are they convenience at the expense of danger? Singapore Trauma and Acute Care Conference 2018; 20-21 April 2018, Raffles City Convention Centre, Singapore. p. 54.
 15. Cha SKC, Liu M, Patel S, et al. Injury patterns associated with personal mobility devices and electric bicycles: an analysis from an acute general hospital in Singapore. Singapore Trauma and Acute Care Conference 2018; 20-21 April 2018, Raffles City Convention Centre, Singapore. p. 58.
 16. Hwang KY, Nordin N, Pearce CJ, et al. The advent of the electronic scooter (e-scooter) and its impact on injury patterns. Singapore Trauma and Acute Care Conference 2018; 20-21 April 2018, Raffles City Convention Centre, Singapore. p. 61.
 17. Teoh H. SCDF received 40 cases of e-scooter fires in 2017, cautions against overnight charging. Yahoo! News 2018 Feb 9. Available at: <https://sg.news.yahoo.com/scdf-received-40-cases-e-scooter-fires-2017-cautions-overnight-charging-073308147.html>. Accessed July 9, 2018.
 18. La Torre G, Van Beeck E, Bertazzoni G, Ricciardi W. Head injury resulting from scooter accidents in Rome: differences before and after implementing a universal helmet law. *Eur J Public Health* 2007; 17:607-11.
 19. Sarkar S, Peek C, Kraus JF. Fatal injuries in motorcycle riders according to helmet use. *J Trauma* 1995; 38:242-5.
 20. Lewis ML, West OC, Standeven J, Jarvis HE. Do wrist guards protect against fractures? *Ann Emerg Med* 1997; 29:766-9.
 21. Lim TZ, Lim ST, Loo MAL, et al. The bane of electric scooters: a review of clinical outcomes. Singapore Trauma and Acute Care Conference 2018; 20-21 April 2018, Raffles City Convention Centre, Singapore. p. 66.
 22. Haddon W Jr. The changing approach to the epidemiology, prevention, and amelioration of trauma: the transition to approaches etiologically rather than descriptively based. *Am J Public Health Nations Health* 1968; 58:1431-8.