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Orthopaedic Injury Patterns Associated with Electric-Scooter Use

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Abstract

Aim

Urban use of electric scooters (e-scooter) continues to increase steadily in Ireland. This study analysed injuries from a six-month period at an urban trauma receiving hospital. Information derived from this will be shared with the Road Safety Authority to aid in safety and awareness planning.

Methods

Patient records were reviewed retrospectively with data stratified according to demographic and intervention variables. Contributory external and individual variables were also recorded.

Results

15 patients presenting with significant injuries (Abbreviated Injury Scale >2 in at least one body system) requiring surgical treatment were recorded. Injuries included extremity fractures and dislocations, chest, facial, and head injuries. Variable use of personal protective equipment (PPE) was noted. Most accidents occurred during daylight hours and dry weather and the majority of patients had little to no previous e-scooter experience. Many patients had pre-existing health conditions and at least one third were taking regular medications. A larger number of patients (81%) suffered an accident without any external cause and one fifth of patients were initially unconscious.

Conclusion

E-scooter-related accidents can result in severe injuries and steps should be taken to protect users. This may take the form of basic mandatory training and PPE use.

Introduction

According to the Road Safety Authority (RSA), an electric scooter or "e-scooter", is a small platform with two or more wheels that is propelled by an electric motor[1]. By law, these vehicles fall under Section 38 of the Road Traffic Act (1961) and are subject to use with the same specified conditions as mechanically propelled vehicles (MPV)[2]. A Garda statement on MPVs states that, "any users of such vehicles in a public place", as defined in the Road Traffic Act 1961, "must have insurance, road tax, and a driving licence"[3]. E-scooters do not currently meet the minimum required safety standards for vehicle registration, and therefore are not legally permitted on public roads, cycle lanes, pedestrianised streets, or footpaths[2]. For this reason, it is also not possible to tax or insure e-scooters[2]. Therefore, the use of electric scooters outside of one's own property is by law, prohibited[2]. The Department of Transport statement maintains that it is currently illegal to use an electric scooter on a public road[4]. Since the RSA statement on e-scooters issued in 2019[2], Sinn Féin TD Darren O'Rourke revealed Department of Justice figures that show an increase in e-scooter-related collisions from 3 in 2018 to 37 in 2020[5]. There were also 46 road traffic offences by e-scooterists and 91 seizures of e-scooters by Gardaí recorded by October 2020[5]. Amendment to legislation is currently under review at government level[6]. Minister for Transport Eamon Ryan has said he hopes to have the legislation in place in 2021[6]. The subject of much recent public debate[7], there are positive aspects to electric scooters also. For example, they are an economical and environmentally friendly alternative to cars and public transport. Use for work, recreation, running errands and social engagements has increased substantially in recent months[7,8]. A recent economic publication has reported a 700% increase in sales of these vehicles in Dublin during the second six months of 2020 relative to the first six months[8]. In spite of all this, e-scooters, like any vehicular mode of transport, are capable of travelling at speeds sufficient to result in accident and significant injury. No data on injury patterns associated with e-scooter use have been published in Ireland to date. The international literature is also very sparse.

It is the objective of this study to identify common, modifiable factors that may contribute to increased accident incidence or severity. This information will be shared with government agencies with responsibility for road safety to guide safety and awareness planning for all road users and pedestrians.

Methods

All patients involved in an accident with an e-scooter who presented to the emergency department (ED) of the Mater Misericordiae University Hospital (MMUH) were included in this retrospective cohort study. Ethical approval was obtained from the Research Ethics Committee at the Mater Misericordiae University Hospital. The hospital does not routinely collect data pertaining to e-scooter injuries for trauma audit. Incidents involving e-scooters do not have a diagnosis-related group (DRG) and are not routinely classified as road traffic accidents (RTA) or motor vehicle accidents (MVA). Therefore, data for this study was collated using the ED referral log.

A list of medical record numbers for all patients with injuries sustained from e-scooters between July 2020 and January 2021 in MMUH was obtained. A retrospective record review of physical and electronic patient records and radiologic imaging was then carried out. Data pertaining to patient demographics i.e. age and gender, and regarding time of accident, e.g. day of the week, daylight or darkness were recorded. The road type, weather condition, estimated speed, use of personal protective equipment, rider experience level, and reason for journey was also extracted. Patient co-morbidities and medication use, along with substance use was also established. The level of injury sustained, clinical care (i.e. conservative vs. surgical treatment), and outcome (i.e. outpatient vs. in-hospital care) were also noted.

Results

Over the six-month study period, a total of fifteen patients were identified as meeting the inclusion criteria. The mean age of patients was 40.4 years (range 23-65 years). No patient was younger than 18 years of age and 53% were female (n = 8). Fourteen patients (93%) self-presented to the emergency department and one patient was brought in by ambulance (6.6%). All patients were the established rider of the e-scooter.

Ten patients had an Abbreviated Injury Scale of 3 in at least one body system. The range of Injury Severity Scores (ISS) was between 4 and 11 among the fifteen patients (Figure 1).

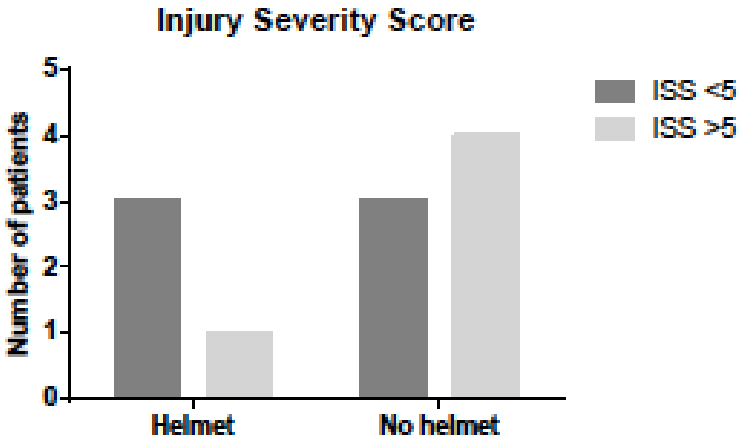

Figure 1: Graphical representation of the number of patients who had experienced an Injury Severity Score (ISS) greater than or less than 5, divided by those wearing a helmet or not.

Of the fifteen patients identified, four did not attend their routine outpatient follow up. This is accounted for in the statistical analysis. Due to restrictions imposed during the pandemic, or winter weather conditions limiting the use of the e-scooter as preferred choice of vehicle, the number of patients involved in e-scooter incidents was lowest during the months of November and December (n = 1 and 0 respectively). September had the highest number of accidents 26% (n = 4, Figure 2).

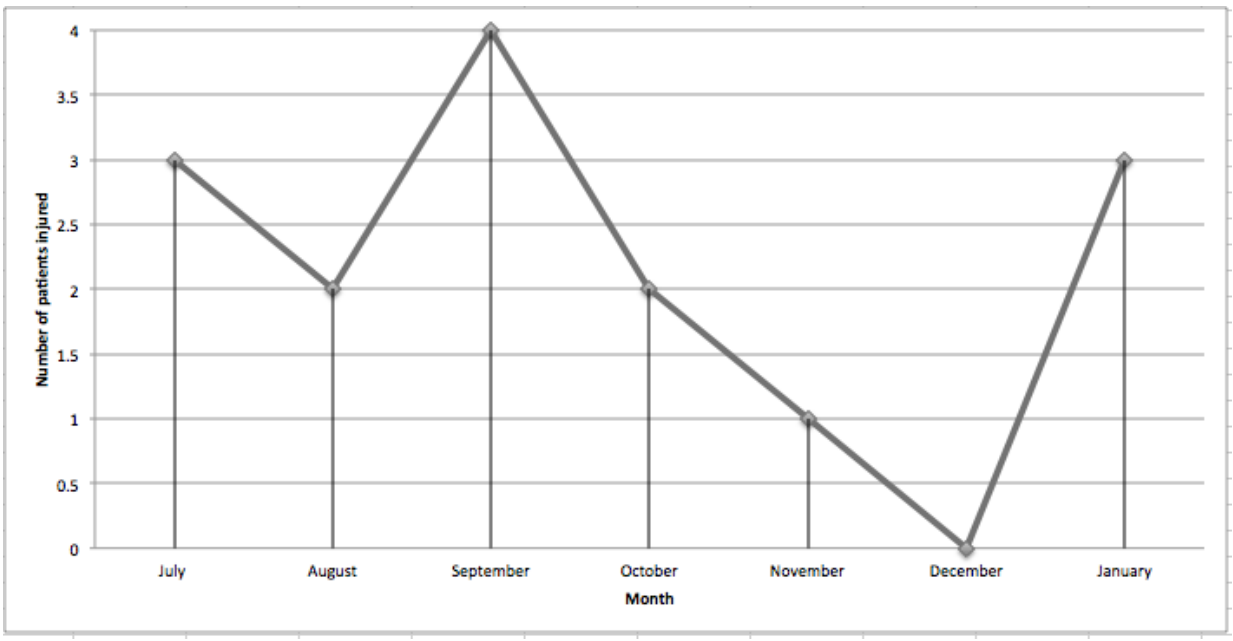

Figure 2: Graphical representation of the number of patients presenting over the course of this investigation.

Overall, twelve patients (80%) of hospital admissions occurred during working hours, on weekdays between Monday 6am and Friday 4pm. Fewer incidents occurred during weekend on-call time i.e. Friday 4pm and Monday 6 am (20%, n = 3). Most injuries were recorded on a Tuesday and Friday (n = 8, 53%). Throughout the week, 60% (n = 9) of the accidents were registered between 6am and 12pm, while 40% (n = 6) were seen between 6pm and 12am respectively.

Sixty-three percent of all accidents happened during the light hours and dry weather. Four incidents occurred during darkness and wet weather (36%). While all eleven patients stated they had lights present on the scooters (100%), no patient admittied to wearing light reflective or Hi Vis clothing. Only two patients stated they were carrying a load in the form of a backpack while on the scooter (18%). (Two patients, both lost to follow-up and thus excluded from the statistical analysis, indicated at presentation that they were carrying bags on the scooter handlebars at the time of the accident.) Two patients reported travelling to work when the accident occurred (18%). Two patients were on their way to pick up groceries, and seven patients were travelling for social engagements (63%). No relationship between make or model of scooter and rate of accident could be established as the vast majority of patients did not report what type of scooter they were driving (n = 7, 63%).

With regard to speed, e-scooters vary. Speeds have been noted to vary between 15-60km/hr on the flat. The slowest accident was reported to occur at approximately 10km/hr (n = 1, 9%, Figure 3). The fastest recorded incident occurred at approximately 60km/hr (n = 1, 9%). The majority of patients were recorded to have been travelling at 20km/hr (n = 5, 45%), and a further 36% of patients travelling at 30km/hr (n = 4).

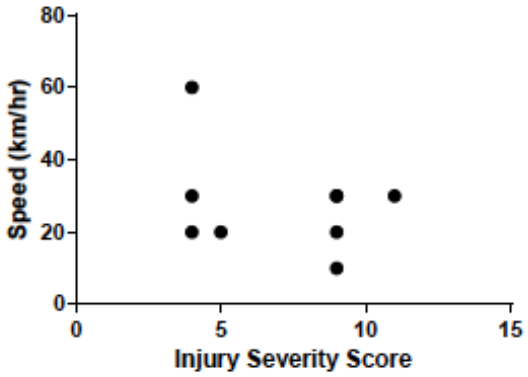

Figure 3: Graphical representation of Speed (km/hr) versus Injury Severity Score, with no significant correlation for comparison.

Two patients reportedly lost control of their scooter for undeclared reasons and collided with a street sign pole (18%), one crashed as a result of a car pulling out (9%), and one scooter was reported to malfunction where the handlebars broke (9%). The remainder of patients reported falling due to road conditions i.e. a defect in the road surface and being unable to activate the e-scooters brake system in time (n = 7, 63%).

Of the eleven scooterists, three of the injured individuals were first time users (27%), i.e. the accident occurred during their very first time using the e-scooter. One user had used the e-scooter once previously, and another two users only had experience riding the scooter 3 and 4 times. Five individuals had driving experience greater than one year.

Of the fifteen patients, nine (60%) stated that they suffered from a pre-existing health condition, and five (33%) were on prescribed medications at the time of the accident. In total, two patients (18%) were documented to have taken alcohol and recreational drugs shortly before the accident.

Shockingly, despite the relatively high speeds the majority of the riders were travelling at, only four patients were using a helmet while using their e-scooter (36%). Three patients (20%) were initially unconscious following the accident. Fortunately, endotracheal intubation or intensive care admission was not necessary in any of the patients.

Overall, every patient suffered from at least one serious injury (100%). A total of nine patients (60%) required surgical management for their injuries. The upper extremities were the main body region affected, with a total of nine injuries (60%). Four of these patients (26%) had to undergo surgical procedures for their upper extremity injury. The second most common injury location was to the lower limbs (n = 6, 40%), of which five (33%) required surgical fixation.

Overall, six patients (40%) were treated as outpatients. In total, nine (60%) of the patients required in-hospital treatment with a mean length of stay of 2.3 days (minimum 0 days, maximum 9 days). Of the fifteen patients, no patient required intensive medical care and no fatalities were registered. Table 1 provides an overview of the contributory factors considered for the accidents and injuries covered in this study.

Risk Factors	Incidence Rate				
Gender	**Male**	**Female**			
	7	8			
Age	**<18**	**18-35**	**36-49**	**50-65**	**>65**
	0	8	4	3	0
Daylight	**Good visibility**	**Dusk/Dawn**	**Dark**	**Unknown**	
	6	1	4	4	
Weather condition	**Wet**	**Dry**	**Unknown**		
	4	7	4		
Estimated Speed	**0-10 km/hr**	**10-20 km/hr**	**30-50 km/hr**	**>50 km/hr**	**Unknown**
	1	5	4	1	4
Helmet Use	**Yes**	**No**	**Unknown**		
	4	8	3		
Rider experience level	**Beginner**	**Less than 1 year**	**1-2 years**	**3+ years**	**Unknown**
	3	5	3	0	4
Use of lights	**Yes**	**No**	**Unknown**		
	11	0	4		
Reason for journey	**Commute to work**	**Running errands**	**Social Engagement**	**Unknown**	
	2	3	6	4	
Other contributing factors	**Carrying weighted objects**		**Under influence of substance**		
	2/15		2/15		

Table 1: Summary of the data obtained related to the potential contributory factors for the e-scooter accidents reviewed in this research.

Discussion

To the best of our knowledge, this is the first study of electric scooter-related injuries in Ireland. We carried out a systematic review of the databases PubMed/MEDLINE, and EMBASE up to February 2021. The combination of search terms were: (orthopaedic) AND (injury) AND (electric scooter OR e scooter). The reference lists of all studies were scanned for additional articles potentially not identified through the electronic search alone. Search was limited to literature from 2020 and 2021. A total number of eight studies were identified, one of which was a review article, and one which focused on facial injuries. Another was a retrospective review looking at data prior to 2019. These three articles were excluded. Four of the five identified articles were carried out in urban and suburban regions of California[10-13]. The other was based in Vienna, Austria[14]. These papers discussed a total of 1044 patients[10-14]. Four of the five papers focused on orthopaedic injuries[10, 12-14]. Siow et al. reported orthopaedic injury rates of 44% associated with e-scooter use[10]. This is near double that noted by Lavoie-Gagne et al. (29%)[13]. Interestingly, both of these papers came from the same city.

Ishmael et al. showed that thirty-two patients (43.8%) sustained upper-extremity injuries, and 42 patients (57.5%) sustained lower-extremity injuries[12]. This is expectedly higher than what Moftakhar et al. reported from Vienna, given the difference in population densities[14]. They reported rates of upper extremities of 36.6%[14]. Interestingly, only three of the five papers discussed helmet use[10, 11, 13]. All rates of helmet use was poor, with usage levels being reported as 2%, 3%, and 3.2% respectively[10, 11, 13]. Finally with respect to age, similar results were noted in comparison with our study (40.4 years). They ranged between an average of 34.4 years[14] to 40.19 years[13].

None of the papers reviewed discussed rider experience level in the context of accident aetiology. In 2019 the RSA commissioned Transport Research Laboratories (TRL) Ltd. to provide a report on electric personal mobility devices[2]. Among their comments were that *initial evidence suggests that experienced riders demonstrate better control than novice users*, and, *are better able to safely brake in response to both planned and unplanned events*. Rather than wait unnecessarily for numbers to increase, we feel it timely and imperative to broadcast the experience and observations from this research, as it can be expected that user and journey volumes will increase substantially in the summer months and as lockdown restrictions are scaled back. Further, legislation for these electric powered personal vehicles will be discussed at government level imminently as it is considered a matter of public health importance. Of the 15 patients treated in our centre, 4 were lost to follow-up and one declined to comment on experience level. Of the 10 patients followed up, 3 reported that the accident occurred during their very first e-scooter journey, and a further 3 patients stated it was on their second, third and fourth journeys respectively. In keeping with the TRL 2019 report, experience or more importantly lack thereof means less control and braking capacity, and in our experience, increases the likelihood of accident and potentially serious injury. By educating aspiring e-scooter users the risks of harmful events occurring can be mitigated.

There are a number of recognised limitations to our study. This is a single urban centre study which set out to only capture those patients requiring in-patient hospitalisation and surgical treatment. The data presented is also influenced by the Covid Pandemic such that overall traffic during the time frame was substantially reduced. Due to the relatively short investigation period, the present study provides observational data of the injury patterns. The study was deliberately published at this time point to coincide with government level discussion of proposed legislation. This study shall be continued prospectively.

Electric scooter-related accidents can result in severe injuries requiring hospitalisation, surgical treatment, and prolonged rehabilitation. It has been our observation that those presenting to hospital with injuries requiring surgical treatment have limited e-scooters experience. This, we believe, should inform a strategy to guide users during the initial periods of use of e-scooters.

Declaration of Conflicts of Interest:
The authors have no conflicts of Interest to declare.

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