

Gotta Scoot: The Financial Burden of E-Scooter Related Orthopaedic Injuries at a Level 1 Trauma Center

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Objectives: To determine the cost of electric scooter (e-scooter)-related orthopaedic injuries and the subsequent hospital and community financial burden.

Design: Retrospective economic review

Setting: Level 1 trauma center

Participants: Patients presenting to the emergency department of an urban level 1 trauma center from January 2017 through August 2020 with e-scooter-related orthopaedic injuries.

Results: 82 patients (58 [70.1%] male; mean age 34.1) presented to the ED requiring orthopedic consultation for injuries caused by e-scooter use during the study period. 64% were employed and only 33% had private insurance. 21% were on the county-funded or discounted coverage through the county hospital system as qualified county residents. 2.4% were covered by Medicaid and the remaining 44% were uninsured. Admission was required in 30% of patients and surgery in 35%. The aggregate cost of hospital interventions, including surgery, added up to a total cost of \$2,329,325.39 or an average of \$28,406.41 per patient.

Conclusion: E-scooter-related orthopedic injuries are common and often require procedural and surgical intervention. The cost per patient is high, as is the total financial burden. Additionally, at our county-funded institution, most of these injuries occur in patients with either no insurance or county funded care leading to a significant displacement of cost-burden to the local tax-payer.

Keywords: electric scooter, e-scooter, orthopaedics, cost, tax-payer burden

Level of Evidence: Level IV

INTRODUCTION

Electric scooters were first introduced as part of a ride-sharing network to the public in 2017 in San Francisco as an environmentally sustainable answer to improved transportation. The purpose was to offer convenient and accessible short-distance ride-assisted options.¹ The electric scooter (e-scooter) market quickly spread to other large metropolitan cities in the United States and by 2020

the US electric scooter market was valued at 1.3 Billion USD.² This booming new industry, however, has not been without its own cost.

Hospitals in areas where e-scooters were adopted saw an influx of patients, treating an estimated 115 injured patients for every million e-scooter trips.³⁻⁵ Hitting speeds upwards of 20 miles per hour, e-scooters are capable of producing high-energy trauma requiring admission in 8.9-16% of cases.⁶⁻¹⁰ Studies vary, however, consistently report facial injuries and extremity fractures among the most common associated injuries, with orthopaedics being the most commonly required physician consult.^{8,11-14} Rates of admission are higher in orthopaedic patients (23-45%) likely as a result of operative needs, with injuries requiring surgery in 30-45% of reported admission cases.^{3,15-19} In a study of 75 operative injuries, 12.3% were open fractures, necessitating urgent surgery.⁶ The need for immediate surgery has been associated with increased cost of care.¹⁰

While e-scooter travel may be a fiscally responsible option for the rider, the costs to the hospital with such an increased patient burden are not negligible. The 200% increase in presentation and 300% increase in admission rates have driven hospital systems to evaluate the associated financial burden from this mechanism of injury.^{4,10,20-22} Our trauma center is unique in that it is a county

hospital, funded by county residents through property taxes so as to provide safety net care and funding for those with no other insurance payor. Due to this structure, a component of treatment costs is absorbed by the community as a whole.

The purpose of this study was to assess the financial burden of orthopaedic injuries sustained from e-scooter use at an American level one trauma center.

METHODS

This study was reviewed and approved by the university institutional review board. Emergency department encounters with an orthopaedic consultation at a single county hospital with level 1 trauma center designation were retrospectively reviewed from January 2017 to August 2020. An electronic medical record query was performed of physician note documentation looking for keywords such as “scooter”, “e-scooter”, and “electric scooter”, as well as brand names such as “Bird”, “Lime” and “Uber”. Identified emergency room encounters were reviewed by a member of the research team to confirm the mechanism of injury was consistent with what has been identified as an e-scooter (as may be differentiated from a scooter without a motor or a seated mobility scooter). Any mechanism other than an e-scooter or lack of orthopaedic consultation placed at the time of emergency department evaluation resulted in exclusion from the study.

Target outcomes were then extracted from the medical record to include patient demographics, employment, and insurance status, details of injury

presentation and injury characteristics, details of evaluation and interventions, and cost of treatment. Costs analyzed represent that billed to the patient by the hospital system, rather than collections returned. All applicable itemized costs for interventions and services were tabulated for each individual patient. It should be noted that the initial general evaluation was included in its entirety, including imaging and admission costs but specialty care, such as procedural intervention, surgical cost, and outpatient follow up was only reviewed for orthopaedic care.

RESULTS

Patient Demographics

In the study time period, we identified 82 patients treated for orthopaedic injuries related to an e-scooter. The majority were male (71%) and either white or Hispanic, with an average age of 34.1 years and an average BMI of 27.1 (Table 1).

Table 1. Patient demographic characteristics

Demographic Characteristics	N=82
Gender, % (n)	
Male	70.7% (58)
Female	29.3 % (24)
Ethnicity/Race, % (n)	
White	40.2% (33)
Hispanic	30.5% (25)
Black	25.6% (21)
Asian	2.4% (2)
Other	1.2% (1)
Age, mean \pm SD	34.1 \pm 11.5
BMI, mean \pm SD	27.1 \pm 5.5

Financial Background

Residents of the county where the hospital is located comprised 78% of the study population. 64% were employed and only 33% had private insurance. 21% were on the county-funded or discounted coverage through the county hospital

system as qualified county residents. 2.4% were covered by Medicaid and the remaining 44% were uninsured (Table 2). Notably, 9 out of 36 of these uninsured also resided outside of the county, representing 11% of the overall study population with no source of funding.

Table 2. Patient financial characteristics

Financial Characteristics	N=82
County of Resident, % (n)	
Hospital County	78% (64)
Other	22% (18)
Employment, % (n)	
Yes	64.7% (53)
No	31.7% (26)
Student	3.7% (3)
Insurance Status, % (n)	
Private	32.9% (27)
County	20.7% (17)
Medicaid	2.4% (2)
None	43.9% (36)

Injury Presentation/Characteristics

The majority of patients self-presented to the emergency department (76.8%), with only 23.2% requiring emergency medical service (EMS) transport. 15% subsequently warranted a trauma activation upon arrival. Only one patient was a pedestrian in the accident, all others were riders. 9.8% had documented alcohol use and 2.4% documented methamphetamines use at the time of presentation, although in 35% involvement of substances was unknown or undocumented.

The upper extremities were disproportionately affected, representing 64% of injuries (Figure 1). The most common orthopaedic-related injury seen was radial head/neck fracture,

followed by ankle fracture, distal radius fracture, tibial plateau fracture, and finger fracture/dislocation (Table 3). 11% were additionally treated for concomitant non-orthopaedic injuries.

Figure 1. Distribution of e-scooter related injuries by anatomic location

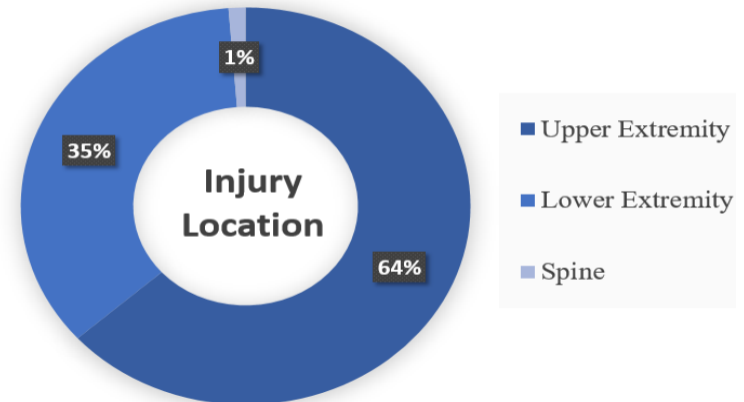


Table 3. Orthopaedic injury patterns resulting from e-scooter mechanism

Injury Pattern	Frequency
Radial head/neck fracture	14
Ankle/pilon fracture	9
Distal radius fracture	7
Finger fracture or dislocation	7
Tibial plateau fracture	7
Metacarpal fracture	4
Clavicle fracture	3
Carpal fracture	3
Shoulder dislocation	2
Olecranon fracture	2
Both bone forearm fracture	2
Ligamentous knee injury	2
Fibular head fracture	2
Lisfranc injury	2
Metatarsal fracture	2
Infection	2
Acromioclavicular Separation	1
Glenoid fracture	1
Proximal humerus fracture	1
Humerus shaft fracture	1
Elbow dislocation	1
Ulnar shaft fracture	1
Intertrochanteric femur fracture	1
Distal femur fracture	1
Patella fracture	1
Tarsal fracture	1
Toe fracture	1
Vertebral compression fracture	1
Other	3

Evaluation, Treatment, and Disposition

All patients had plain radiographs obtained in the emergency department (ED). A CT scan was additionally performed in 39% of patients. Per inclusion criteria, all patients had an orthopaedic surgery consultation in the ED. Over half (57.3%) required an orthopaedic procedure in the ED, and 55% of this subset utilized fluoroscopy (Table 4).

Table 4. Evaluation, Treatment, and Disposition from Emergency Department at Initial E-Scooter Injury

Diagnostic Imaging	
X-ray, % (n)	100% (82)
CT, % (n)	39.0% (32)
MRI, % (n)	2.4% (2)
Fluoroscopy, % (n)	31.7% (26)
Emergency Department Interventions	
Ortho Consult, % (n)	100% (82)
Ortho Procedure, % (n)	57.3% (47)
Ortho Surgery, % (n)	35.3% (29)
Non-Ortho Surgical Consult, % (n)	6.1% (5)
Non-Ortho Procedure, % (n)	9.8% (8)
Non-Ortho Surgery, % (n)	1.2% (1)
Disposition	
Admission, % (n)	29.6% (21)
Callback for Outpatient Surgery, % (n)	12.2% (10)
Clinic, % (n)	51.2% (42)
Follow up with Outside Provider, % (n)	7.3% (6)
No Ortho Follow Up, % (n)	3.7% (3)
Outpatient Follow Up	
Clinic visits, mean \pm SD	1.6 \pm 2.2
Radiographs, % (n)	48.8% (40)
Advanced Imaging, % (n)	8.5% (7)

Non-orthopaedic procedures were performed in the ED in 9.8% of patients, most commonly laceration repair. Additional surgical

consultation was warranted in 5 patients, 1 of whom was taken to the operating room for facial fractures.

Twenty-one patients required an inpatient admission from the emergency department. Ten were discharged to return for outpatient orthopaedic surgery. Forty-two were discharged to follow up in the clinic, six with plans to be seen at an outside hospital, and three required no outpatient orthopaedic follow-up.

In the outpatient setting, the average number of follow-up clinic visits was 1.6. Radiographs were obtained in the clinic 48.8% of the time and 7 patients required outpatient advanced imaging (CT or MRI).

Surgical Intervention

Twenty-nine patients (35.3%) required orthopaedic surgical intervention, 19 performed inpatient, and 10 performed outpatient. The average surgery time was 119 minutes. Fluoroscopy was utilized in 79% of cases and 41% of patients received a peripheral nerve block. Complication and reoperation rates were 17.2% and 13.8% respectively (Table 5).

Table 5. Operative Details for E-Scooter-Related Orthopaedic Surgical Intervention

Orthopaedic Surgical Intervention	N=29
Inpatient, % (n)	65.5% (19)
Outpatient, % (n)	34.5% (10)
ASA, mean \pm SD	1.7 \pm 0.5
Operative Time, mean \pm SD	118.9 \pm 50.8
Perioperative Peripheral Nerve Block, % (n)	41.4% (12)
Intraoperative Fluoroscopy, % (n)	79.3% (23)
Complications, % (n)	17.2% (5)
Reoperations, % (n)	13.8% (4)

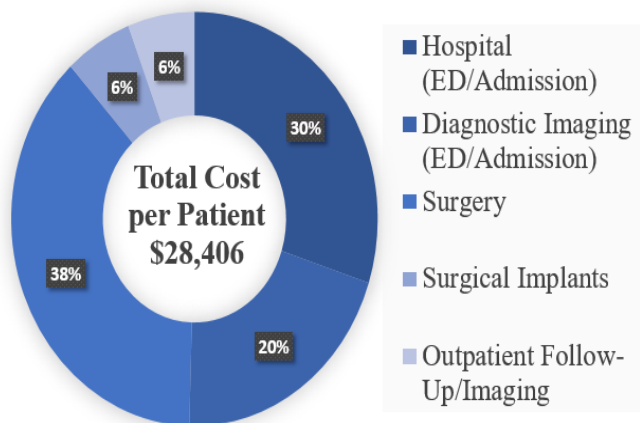
Cost of Orthopaedic Care

Averaging \$8,500 for ER evaluation and hospitalization, \$5800 for initial imaging, \$10,700 for surgery, \$1700 for implants, and \$1700 for outpatient follow-up, the care of a patient with an orthopaedic e-scooter injury totals \$28,406 per person (Table 6). Over the study period, this resulted in a total cost of \$2,329,325.39. When factoring in the 21% of the study population that has county-funded insurance and the 44% that were uninsured, \$1,514,061.50 of this total cost (65%) represents the local county tax-payer burden (Figure 2).

Table 6. Average Healthcare Costs per Patient with an Orthopaedic E-Scooter-Related Injury

Category	Cost (USD)
Hospital (ED/Admission)	\$8,544.86
Diagnostic Imaging (ED/Admission)	\$5,825.87
Surgery	\$10,749.54
Surgical Implants	\$1,688.80
Outpatient Follow-up/Imaging	\$1,677.09
Total Cost per Patient, mean ± SD	\$28,406.41 ± 35,740

Figure 2. Average Cost Per Patient and Total Cost Financial Burden of Orthopaedic E-Scooter Injuries



DISCUSSION

With the rise in the popularity of e-scooters, there has been an associated rise in injuries requiring emergency room evaluation. In 2018, there were an estimated 19 e-scooter injuries per 100,000 people in the United States.⁴ Fractures and other orthopaedic injuries are prevalent with an e-scooter mechanism, representing 32-43% of all injuries.^{2,11-14} It is reasonable that such an influx of injuries may place a strain on a hospital system and carry with it substantial added cost. Our study reports an average cost of \$28,406 USD per patient with orthopaedic e-scooter-related injuries, totaling over 2.3 million dollars in hospital system costs during the study period.

In this study, eighty-two patients were treated in the emergency department for injuries requiring orthopaedic surgery consultation. Upper extremity injuries predominated, comprising 64% of presenting injuries, with radial head and neck fractures being the single most common. Injury patterns seen in our study are consistent with that previously reported in the literature.^{15,16,19,23} Admission rate of 30% and operative rate of 35% in our patients is also in keeping with the 23-45% and 30-45% rates respectively reported in previous orthopaedic-specific e-scooter cohorts.^{3,15-19}

This rise in e-scooter popularity and resultant injury has been a worldwide phenomenon. In Singapore, the median cost of treatment for e-scooter-related orthopaedic injuries was \$5,620 USD.²⁴ In New Zealand, a cost analysis of those orthopaedic patients specifically requiring surgery found an average cost of \$15,676 NZD

(approximately \$9,470 USD) per patient. The breakdown of the total cost was 45% operating room cost, 39% inpatient admission, 11% orthopaedic implants, and 5% outpatient clinic.²⁵ Operating room costs similarly represented the greatest contributor to cost in our American hospital (37%). While the direct comparison in cost is difficult across international medical structures with inherently different infrastructure, it does reflect that other systems are experiencing and analyzing the increased cost burden being incurred by these injuries.

In the United States, the average total billing for all-inclusive injuries resulting from an e-scooter mechanism has been reported as \$95,710. Only 29% of these, however, were orthopaedic injuries, and the cost was significantly increased by non-orthopaedic factors including intracranial bleeding and traumatic brain injury.²² A single American study recently published hospital costs for patients with orthopaedic-only e-scooter injuries, 61% requiring surgery, to average \$9,781.15.¹⁹ This is similar to our study, in which individual hospital costs (ED evaluation and inpatient admission) averaged \$8,545, but with the significant additional expenses of \$10,750 for surgery, \$1688 for orthopaedic implants, \$5825 for imaging, and \$1677 for outpatient follow up.

The care of a patient with an orthopedic e-scooter injury thus averages approximately \$28,000, totaling over \$2.3 million dollars in health care costs for orthopaedic injuries alone as a result of e-scooters during this study period of approximately 3.5 years. The study site is a county-funded

hospital, which has unique financial implications. The hospital offers county-funded insurance coverage to those county residents who qualify due to financial hardship. In our population, 64% were employed and only 33% had private insurance. Twenty-one percent had already been established with the county insurance plan and 44% were uninsured at the time of presentation. As a result, 65% of the cost is left to the hospital system, representing over \$1.5 million dollars in county taxpayer burden.

There are several limitations of this study. It is a single-center, retrospective study and therefore limited by the accuracy of health record documentation. The generalizability of our results may also be limited. Costs were calculated to include all orthopaedic care, as well as the initial multidisciplinary workup in the ED. While this introduces a component of non-orthopaedic cost, we think it is representative of the complete care of an orthopaedic patient at the initial time of injury. Any procedural or surgical interventions performed by another team were excluded from the calculated cost. Additionally, the study period was limited to 2017-2020 by local current events, as e-scooters were banned in the hospital's city jurisdiction in September 2020, but with a possible return planned for late 2022.

CONCLUSION

As a result of safety concerns, several cities have similarly banned the use of mass rental e-scooters in portions of or all of their jurisdictions. Given the magnitude of associated health system costs demonstrated within this study, the financial burden

to the city or taxpayers may be of additional consideration when regulating this burgeoning form of transportation.

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