Research Square

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Electric Bicycle Injuries at a Level 1 Major Trauma Centre in London - Patterns of Trauma Severity and Economic Burden: A Retrospective Cohort Study

Rachel J Patel

rachel.patel40@nhs.net

St George's University Hospitals NHS Foundation Trust

Oluwasemilore Adebayo

St George's University Hospitals NHS Foundation Trust

Katie Hutchinson

St George's University Hospitals NHS Foundation Trust

Febisayo Sidiku

St George's University Hospitals NHS Foundation Trust

Shamim Umarji

St George's University Hospitals NHS Foundation Trust

Research Article

Keywords: E-bike, Injury, injury pattern, helmet use, Injury severity score, Abbreviated injury scale

Posted Date: November 9th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11429183/v1

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Additional Declarations: No competing interests reported.

Abstract

Purpose:

With electric biking (E-biking) becoming an increasingly popular mode of recreation and transportation in England, its rapid growth has been linked to a significant rise in high-impact injuries. The purpose of this study was to identify the most common injuries, trauma severity and the financial impact of e-bikes on the National Health Service.

Methods:

Over a six-month period, sociodemographic data, injury characteristics, resource utilisation, interventions, and outcomes were reviewed. Injury severity was quantified using the Injury Severity Score (ISS). Statistical analyses were performed using non-parametric tests.

Results:

Fifty-one patients were included (median age 27 years, IQR 22–34; 72.5% male). Median ISS was 16 (IQR 9–20). Most injuries arose from e-bike vs environment (62.7%) or road traffic collisions (29.4%). Limb trauma predominated (84.3%), followed by head (47.1%) and facial injuries (33.3%). Higher ISS correlated with greater limb injury severity ($\rho = 0.34$, $p < 0.001$) and longer hospital stay ($\rho = 0.55$, $p = 0.001$). Helmet non-use was common (64.7%) but did not correlate with ISS ($p = 0.563$). Severe injuries required more imaging, multi-specialty input, and operative intervention. Total estimated costs exceeded £298,000 across the cohort; ward-based admissions represented the largest expenditure (£171,000), despite higher per-patient ICU costs (£35,000). E-bike collisions generated multi-regional, high-energy injuries with considerable surgical and financial burden.

Conclusion:

E-bike collisions in London cause substantial major trauma in young adults, with severe limb and head injuries and prolonged hospitalisation. These findings highlight the rising burden of micromobility trauma on the NHS and the need for targeted prevention and rider safety strategies.

Highlights

• One of the first London MTC studies of e-bike trauma and NHS costs.

• E-bike trauma frequently caused major injury in young adult male riders.

• Limb injuries predominated and limb AIS correlated significantly with ISS.

• Higher ISS was associated with longer hospital stay and greater resource use.

• Total estimated NHS costs exceeded £298,000 across 51 patients over six months.

1. Introduction

Electric assist bicycles (e-bikes) are increasingly popular throughout the United Kingdom (UK) due to their affordability, accessibility, and speed. They are transforming both commuting and leisure travel, exposing new groups of riders to unique patterns of injury risk. Lime®, the largest electric bicycle operator in London, has been central to the rapid growth of shared e-bike use in the city, facilitating over 12 million trips for more than 1.25 million riders between January 2019 and March 2023 [1].

In 2025, Lime® reported that nearly half of Londoners aged 18 to 34 used their e-bikes weekly, with total journeys increasing by 85 percent compared with the previous year [2]. In London, e-bike users are predominantly younger than the general population, with an average age of 35 years. Notably, approximately 800,000 of Lime's® four million lifetime users had never cycled in the city before, indicating that e-bikes are attracting new riders to cycling.

E-bikes are typically heavier and faster than conventional bicycles, and studies indicate that a portion of users ride under the influence of alcohol, potentially increasing both the risk and severity of injuries. In the United Kingdom, there is no legal requirement to wear a helmet when riding an e-bike, which leaves younger riders especially vulnerable to severe head injuries in the event of a collision [3]. As e-bike use grows, particularly due to the popularity of shared-scheme models in London, important questions arise regarding the scale and nature of the resulting strain on hospital resources.

E-bike injuries tend to result in higher rates of internal injuries and elevated Injury Severity Scores (ISS), with a significant portion of patients reaching an ISS of nine or above, indicating serious trauma [4–7]. Head injuries, limb fractures, and thoracic trauma are especially prevalent, particularly among older individuals and riders who were not wearing helmets.

The NHS faces substantial implications from e-bike injuries, including increased admissions, greater use of critical care resources, and more surgical interventions, all of which contribute to higher costs and additional indirect burdens, such as rehabilitation [6–8]. While precise UK data on e-bike trauma costs are unavailable, analyses of e-scooter injuries reveal average hospital charges over £1,000 per patient, not including extended rehabilitation. Importantly, most e-scooter injuries were minor [9]. By contrast, e-bike injuries are often more severe, with higher ISS and resource needs, suggesting a greater financial impact on the NHS. UK-specific data on electric bicycle injuries, integrating injury severity, hospital resource utilisation, and NHS costs, remain limited. Understanding the epidemiology, clinical severity, and economic impact of these injuries, particularly from shared schemes such as Lime®, is essential to inform public health policy and optimise resource allocation.

This study aims to characterise rider demographics and situational factors among patients with e-bike injuries, assess injury severity, quantify hospital resource utilisation, and identify demographic and behavioural predictors of severe injury, providing evidence to support the safer integration of e-bikes into the United Kingdom's transport system.

2. Methods

2.1 Study Design and Setting

A single-centre retrospective study was conducted at a London Major Trauma Centre (MTC) evaluating e-bike related injuries presented between April and September 2025. Electronic medical records of patients on the orthopaedic and trauma list were searched using the keywords "e-bike", "electric bike", "bike", "Lime®", "Forest®" and "electric bicycle". All flagged cases underwent manual review by two researchers to confirm eligibility. All data obtained were fully anonymized prior to analysis. No patient contact occurred, and consent was waived due to the retrospective design.

2.2 Inclusion and exclusion criteria

Inclusion criteria included riders presenting to hospital following e-bike injury. E-bike was defined as a bicycle equipped with pedal assistance and/or throttle capability, with a potential speed of at least 15mph. This definition included unmodified road-legal e-bikes and any modified or high-power variants, provided the mechanism of injury occurred during active riding. Cases involving pedestrians struck by an e-bike, or pillion passengers were excluded from the study.

2.3 Data Collection and Study Variables

Data collected included age, sex, mechanism of injury (MOI), mode of admission (MOA), injury region, ISS, AIS, loss of consciousness (LOC), helmet use, length of stay, ITU admission, and theatre time. MOI was categorised as e-bike RTC, e-bike versus environment, e-bike versus pedestrian, and other mechanisms. Major trauma was defined as ISS greater than 15 (Palmer et al., 2007). Estimated speed was recorded in 10 mph increments. Trauma alerts included Code Red (major haemorrhage protocol) and Code Black (suspected severe neurotrauma). MOA was recorded as self-presentation, ambulance (BIBA), or HEMS.

Primary outcomes were injury incidence and severity (ISS). Secondary outcomes included healthcare utilisation and cost analysis, imaging, admission duration, and operative time, calculated using NHS tariffs and unit costs [10].

Missing or undocumented data were coded as unknown and were not inferred.

2.4 Statistical Analysis

Analyses were performed in R Studio (v4.x). Data were assessed for completeness and normality; as distributions were non-normal, non-parametric tests were used. Continuous variables are presented as

median (IQR) and categorical variables as n (%).

Group comparisons across ISS categories (0–8, 9, 10–15, ≥ 16) used Kruskal–Wallis tests for continuous variables and Chi square tests for categorical variables. Spearman's rank correlation (ρ) assessed associations between ISS and continuous variables (age, length of stay, AIS scores) and binary outcomes (helmet use, loss of consciousness). Statistical significance was set at $p < 0.005$. Operative duration was defined primarily from anaesthetic start to anaesthetic finish; where these timestamps were unavailable, time entered theatre to time left theatre was used instead.

3. Results

3.1 Statistical Findings

Across the cohort of 51 patients, the median age was 27 years (IQR 22–34), with most participants aged 20–59 years (88.2%) and 72.5% male. The median ISS was 16 (IQR 9–20). The most common MOI was e-bike vs environment (62.7%) and limb injuries were most prevalent (84.3%). The median length of hospital stay was 2 days (IQR 1-4.5) (Table 1).

Table 1
Demographic characteristics of the cohort

Characteristics	Median (IQR) or Frequency (%)
Age, median (IQR)	27.0 (22.0–34.0)
20–59	45 (88.2%)
60–64	2 (3.9%)
65–69	2 (3.9%)
80–84	2 (3.9%)
Gender	
Male	37 (72.5%)
Female	14 (27.5%)
Mechanism of Injury	
e-bike vs person	2 (3.9%)
e-bike other	1 (2.0%)
e-bike vs car	1 (2.0%)
e-bike vs environment	32 (62.7%)
e-bike RTC	15 (29.4%)
Length of stay, median (IQR)	2 (1–4)
ISS, median (IQR)	16.0 (9.0–20.0)
Location of Injury (AIS > 0)	
Head	24 (47.1%)
Face	17 (33.3%)
Thorax	8 (15.7%)
Abdomen	4 (7.8%)
Spine	0 (0.0%)
Pelvis	0 (0.0%)
Limb	43 (84.3%)
Other	1 (2.0%)

When stratified by ISS group (0–8, 9, 10–15, ≥ 16) (Table 2), the median age ranged from 17 years (IQR 16–32) in the ISS 10–15 group to 30 years (IQR 24–44) in the ISS 9 group. Although older patients

tended to have higher ISS scores, this association did not reach statistical significance ($p = 0.219$, $\rho = 0.162$).

Table 2
Relationship between ISS and participant characteristics.

Age (Median; IQR)	**0–8 (N = 11)**	**9 (N = 3)**	**10–15 (N = 5)**	**≥ 16 (N = 32)**	**P-Value (Correlation Coefficient)**
Age (Median; IQR)	23 (20–27)	30 (24–44)	17 (16–32)	28 (23–36)	0.219 (0.162)
Gender					
Female	3 (27.3%)	1 (33.3%)	0 (0.0%)	10 (31.2%)	0.537
Male	8 (72.7%)	2 (66.7%)	5 (100.0%)	22 (68.8%)	0.537
Mechanism of Injury					
e-bike RTC	5 (45.5%)	0 (0.0%)	1 (20.0%)	9 (28.1%)	0.016
e-bike other	0 (0.0%)	1 (33.3%)	0 (0.0%)	0 (0.0%)	0.016
e-bike vs car	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (3.1%)	0.016
e-bike vs environment	5 (45.5%)	2 (66.7%)	3 (60.0%)	22 (68.8%)	0.016
e-bike vs person	1 (9.1%)	0 (0.0%)	1 (20.0%)	0 (0.0%)	0.016
Abbreviated Injury Scale (Median; IQR; Mean; SD)					
Head	1 (0–2); 0.91 (0.94)	0 (0–1); 0.67 (1.15)	3 (2–3); 2.20 (1.30)	0 (0–3); 1.12 (1.48)	0.308 (0.319)
Face	0 (0–2); 0.82 (0.98)	0 (0–0); 0.33 (0.58)	0 (0–2); 0.80 (1.10)	0 (0–2); 0.84 (1.44)	0.955 (0.274)
Thorax	0 (0–0); 0.00 (0.00)	0 (0–0); 0.00 (0.00)	0 (0–0); 0.60 (1.34)	0 (0–0); 0.69 (1.33)	0.317 (0.458)
Abdomen	0 (0–0); 0.00 (0.00)	0 (0–0); 0.00 (0.00)	0 (0–0); 0.00 (0.00)	0 (0–0); 0.44 (1.19)	0.471 (0.406)
Spine	0 (0–0); 0.00 (0.00)	0 (0–0); 0.00 (0.00)	0 (0–0); 0.00 (0.00)	0 (0–0); 0.00 (0.00)	0 (0)
Pelvis	0 (0–0); 0.00 (0.00)	0 (0–0); 0.00 (0.00)	0 (0–0); 0.00 (0.00)	0 (0–0); 0.00 (0.00)	0 (0)

Age (Median; IQR)	0–8 (N = 11)	9 (N = 3)	10–15 (N = 5)	≥ 16 (N = 32)	P-Value (Correlation Coefficient)
Limb	1 (0–1); 0.91 (0.70)	3 (2–3); 2.67 (0.58)	2 (1–2); 1.40 (0.89)	4 (3–4); 3.16 (1.42)	0.000 (0.338)

Gender distribution was similar across ISS groups, with males comprising 72.7%, 66.7%, 100.0% and 68.8% respectively (p = 0.537). Mechanism of injury differed significantly with ISS (p = 0.016), with higher ISS injuries more commonly resulting from e-bike versus environment collisions (68.8%) and e-bike RTCs (28.1%), while lower ISS groups included a greater proportion of e-bike versus person (9.1%) and other mechanisms (33.3% in ISS 9).

Abbreviated Injury scale (AIS) analysis showed a clear relationship between limb injury severity and overall ISS. Limb AIS increased significantly with ISS ($p < 0.001$, $\rho = 0.338$), rising from a median of 1 (IQR 0–1) in minor trauma to 4 (IQR 3–4) in major trauma. Head AIS increased with ISS but did not reach statistical significance ($p = 0.308$, $\rho = 0.319$), while facial, thoracic, abdominal and spinal injuries showed no significant associations. Pelvic injuries were absent across all groups.

Injury prevalence followed a similar pattern, with head (40.6%), facial (28.1%) and limb injuries (87.5%) most common in the ISS ≥ 16 group.

Median length of stay increased significantly with injury severity, from 1 day (IQR 0–1) in ISS 0–8 to 4 days (IQR 1–7) in ISS ≥ 16 ($p = 0.001$, $\rho = 0.552$). Helmet use remained low and showed no association with ISS ($p = 0.563$, $\rho = -0.008$), while loss of consciousness was also not correlated with injury severity ($p = 0.254$, $\rho = 0.237$).

3.2 Imaging Cost Analysis

Of the study cohort, 51 patients underwent a total of 279 imaging investigations. The total mapped imaging cost was £19,555, with a mean cost per patient of £383.43 (median £280.00, IQR £161.00 - £474.50). Per-patient costs were markedly variable, ranging from £56.00 to £2,122.00, reflecting the heterogeneity of injury patterns and associated diagnostic workup within the cohort (Table 3).

Table 3
Overall imaging cost summary.

Metric	Value
Patients with imaging recorded	51
Total imaging events	279
Total mapped imaging cost	£19,555
Mean mapped cost per patient	£383.43
Median mapped cost per patient	£280.00
IQR, per-patient cost	£161.00 to £474.50
Range, per-patient cost	£56.00 to £2,122.00

Note. Values represent tariff-based cost estimates derived from NHS 2025/26 HRG unbundled imaging prices, with plain radiography costed at £56 per examination based on NHS reference cost data [11]. *Previous workbook estimates (total cost £12,990, n = 263 events) differed due to (1) omission of 16 RF imaging events and (2) application of £31 per plain radiograph, which does not correspond to a published national tariff source.*

Plain radiography represented the largest single contributor to both imaging volume and expenditure, accounting for 185 investigations and £10,360 of the total mapped cost. CT trauma surveys accounted for 25 investigations and £2,625. Fluoroscopic imaging (RF imaging), approximated to the NHS contrast fluoroscopy tariff (HRG RD30Z), accounted for 16 investigations and £1,968. CT head examinations (n = 21) contributed £1,821 (Table 4).

Table 4
Highest-cost imaging categories.

Imaging category	Count	Unit cost applied (£)	Total cost (£)
Plain radiography (XR)	185	£56	£10,360
CT trauma survey	25	£105	£2,625
CT head	21	Age-adjusted	£1,821
RF imaging	16	£123	£1,968
CT cervical spine	4	Age-adjusted	£370
CT facial bones	4	£79	£316

Note. Plain radiography unit cost of £56 derived from NHS reference costs [11]. *Age-adjusted CT costs reflect NHS tariff variation by age group (HRGs RD20A/B/C: £79 adult, £133 paediatric). RF imaging mapped to HRG RD30Z (£123). CT trauma survey mapped to HRG RD27Z (£105). XR = plain radiography; CT = computed tomography; RF = fluoroscopy.*

With respect to mapping certainty, 217 imaging events (77.8%) were assigned costs via a direct tariff match, representing £13,448 (68.8%) of the total mapped cost. A further 46 events (16.5%) required assumption-based mapping to the nearest defensible NHS HRG unbundled imaging tariff, contributing £4,139 (21.2%) of total costs. Fluoroscopic imaging (n = 16, 5.7%) required explicit approximation, contributing £1,968 (10.1%) of total expenditure (Table 5). These proportions reflect the inherent limitations of applying a standardised tariff framework to a heterogeneous trauma imaging dataset and should be considered when interpreting the precision of cost estimates.

Table 5
Imaging cost contribution by mapping certainty category.

Mapping category	Imaging events, n (%)	Cost, £ (%)
Direct tariff match	217 (77.8%)	13,448 (68.8%)
Assumption-based mapping	46 (16.5%)	4,139 (21.2%)
Explicit approximation	16 (5.7%)	1,968 (10.1%)
Total	279 (100%)	19,555 (100%)

Note. Percentages calculated relative to total imaging events (n = 279) and total mapped cost (£19,555). Direct tariff match: NHS 2025/26 unbundled HRG price applied directly. Assumption-based: closest HRG applied with age adjustment or nearest-modality approximation. Explicit approximation: fluoroscopic imaging mapped to HRG RD30Z (contrast fluoroscopy < 20 min, £123). (Tariffs sourced from our centre's specific pricing tariffs)

Collectively, these data provide a tariff-based estimate of imaging resource utilisation within this cohort and support quantification of imaging burden at both individual patient and cohort level. All costs were derived from the NHS 2025/26 HRG unbundled imaging tariff, except for plain radiography, for which no HRG unbundled price exists; a unit cost of £56 per examination was applied, consistent with NHS reference cost data cited in NICE guidance [11]. All figures should be interpreted as tariff-based estimates and should not be taken as audited local provider costs.

3.3 Surgical costs and length of stay burden

46 (90.2%) of the 51 patients required hospital admission, and three required ICU admission. ICU utilisation totalled 22 bed-days, while ward-based care accounted for 292 bed-days, including ward stay following ICU step-down. Using institutional tariffs, estimated costs were £35,662 for ICU care and £171,112 for ward-based care, with a mean ward cost of £3,720 per patient and a mean ICU cost of £11,887 per ICU patient.

20 patients (39.2%) underwent operative intervention, with a cumulative operative duration of 59.9 hours and an estimated total operative cost of £71,880 (£3,594 per surgical patient). Overall, inpatient bed occupancy represented the greatest contributor to healthcare expenditure, with prolonged ward stay accounting for the majority of costs despite the higher per-patient cost of ICU admission.

4. Discussion

Our paper is one of the first London-based analyses of e-bike trauma, documenting the most common populations injured, the injuries sustained, and their financial consequences, which may support discussions on how we safely assimilate e-bike use into the city ecosystem.

Demographics

The majority of our injured riders were young men, which is not unexpected. Micromobility schemes are most frequently used by younger individuals. This, combined with their higher risk-taking tendencies, it is unsurprising that injuries are seen in this group globally [12–16]. Although, one Swiss paper did find that those who sustained injuries from e-bike rather than from conventional cycle use tended to be older, but this likely reflects their use for mobility assistance and recreation in this region [17, 18].

Injury type and severity

Extremity injury predominated, which is in keeping with prior studies reporting higher burdens of fracture and soft tissue injuries, particularly involving the lower limb [4, 12, 14]. Given that a reported third of orthopaedic injuries require operative intervention, this represents a significant orthopaedic workload [12]. Importantly, a large proportion of our patients met the criteria for major trauma (ISS greater than 15), with increasingly severe anatomical injuries correlating with greater multisystem trauma. The collisions can result in extensive and severe injuries, which contributes to clinical complexity. Compared to single system injury, the consequential physiological derangement or the potential requirement for damage control surgery that can be seen in polytrauma are both well recognised to be associated with worsened clinical outcomes [19].

Head injuries were also frequent, affecting nearly half of the cohort. Traumatic brain injury is a recognised consequence of e-bike trauma, with reported incidence ranging from 20 to 70 percent [12, 14, 17]. The increased mass and achievable speed of e-bikes likely contribute to higher energy impacts and increased risk of head injury [20].

Despite this, helmet use was infrequent. Although no statistically significant association was identified between helmet use and overall injury severity, this finding should be interpreted cautiously, given the limited sample size and a likely type II error. Helmets are well established to reduce the risk of severe brain injury, with evidence suggesting up to a 65 percent reduction in fatal head injury in cyclists. However, helmet uptake varies widely across settings, with reported rates ranging from 36 to 88.9 percent in bike share users [3], as low as 2.2 percent in some cohorts in China, and up to 73 percent in Switzerland [17, 21]. Given the differences in attitudes to helmet wearing, availability and accessibility between regions, a targeted approach would likely be beneficial for our setting.

Mechanisms

Mechanistically, nearly 70 percent of incidents in our cohort were e-bike versus environment collisions, suggesting that loss of control, falls, or impact with fixed objects are the predominant injury mechanisms. This contrasts with several international studies reporting higher proportions of collisions involving motor vehicles, typically around 30 to 50 percent in US and Israeli cohorts, while others describe falls from the device as the dominant mechanism [6, 8, 13, 14]. These differences likely reflect variation in urban infrastructure, traffic density, and rider experience. In London's dense urban environment, combined with rapid adoption among relatively inexperienced users, environmental collisions appear to predominate.

Healthcare burden

Patients with higher ISS scores required longer admissions, more advanced imaging, and operative management, and greater involvement from multiple specialties. This is consistent with existing literature describing e-bike trauma as frequently involving multisystem injury requiring coordinated multidisciplinary management and prolonged rehabilitation [7, 17].

Financial impact was considerable. In our cohort of 51 patients, estimated costs included nearly £20,000 for imaging, over £35,000 for ICU care, more than £171,000 for ward admissions, and approximately £71,880 for operative theatre time. These figures represent a substantial burden on NHS resources, particularly within the current financial climate. Importantly, these estimates likely underestimate the true cost, as they exclude implants, staffing, outpatient follow-up, rehabilitation, and ambulance services. With international studies demonstrating a continued rise in e-bike related trauma [7, 13, 14] this burden is likely to increase further within the UK.

Policy and prevention

Helmet use remains one of the most effective measures for reducing severe head injury [20, 22], while road safety education and infrastructure improvements, including segregated cycle lanes, are associated with lower cycling injury rates [21, 23, 24]. However, in the UK, e-bikes require no licence, formal training, or mandatory helmet use [25] a particular challenge for shared schemes where ad-hoc use limits safety preparation and enforcement.

Despite this, e-bikes and micromobility systems offer important benefits, including accessible, affordable, and environmentally sustainable urban transport with potential cardiovascular advantages [7, 9, 18, 22]. Balancing these benefits against a rising injury burden will require targeted regulation, education, and infrastructure measures. Further research should evaluate whether such interventions can reduce e-bike related trauma without compromising the utility of micromobility systems.

This study has several limitations. Its retrospective single centre design relies on the accuracy and completeness of routinely documented clinical data, introducing potential for missing information, underreporting, and misclassification. The list searched does not capture injuries that were not referred to orthopaedics or those that did not initiate a trauma call, thus skewing data toward more severe and

orthopaedic injuries. The relatively short study period and small sample size reduce statistical power and increase the risk of type II error, limiting the detection of smaller associations. Seasonal variation in e-bike use and injury incidence was not captured, which may affect generalisability of the findings across the year. In addition, cost estimates are likely conservative, as indirect and downstream costs including staffing, rehabilitation, implants, and prehospital care could not be fully incorporated, meaning the true economic burden is likely higher than reported.

5. Conclusion

E-bike trauma in London frequently results in major trauma among young male riders, characterised by severe limb and head injuries, operative intervention, and prolonged hospitalisation. Healthcare utilisation was substantial, with high imaging, surgical, ward, and intensive care demands generating costs approaching £300,000 across 51 patients.

These findings highlight the growing clinical and economic burden of e-bike related trauma on the NHS as micromobility use continues to rise in the UK. Targeted prevention strategies, including rider education, helmet promotion, infrastructure improvement, and proportionate regulatory reform, should be considered to reduce injury burden and support safer integration of e-bikes into urban transport systems.

Declarations

Funding:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability:

Data can be made available upon request.

Author Contribution

Conceptualization: R.P. and S.U.; Methodology: R.P. and O.A.; Formal analysis and investigation: R.P., O.A. and F.S.; Writing – original draft preparation: R.P., O.A., F.S. and K.H.; Writing – review and editing: R.P., K.H., O.A., F.S. and S.U.; Supervision: S.U. All authors reviewed and approved the final manuscript.

Data Availability

The data supporting the findings of this study were obtained from anonymised electronic patient records at a London Level 1 Major Trauma Centre. The dataset is not publicly available due to patient

confidentiality and institutional data governance requirements. Access to de-identified data may be considered upon reasonable request to the corresponding author, subject to institutional approval and applicable data protection requirements.

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