Determining the Time of Injury for Trauma Research and Systems Improvement

Edwige Sewavi[1], Dale A. Barnhart[1], Lani Finck[1], Mengli Xiao[2], Julia Dixon[1], Hendrick Lategan[3], George Oosthuizen[3] Nee-Kofi Mould-Millman[1]

University of Colorado Anschutz Medical Campus

1University of Colorado, School of Medicine, Anschutz Medical Campus, Aurora, CO
2Colorado School of Public Health, Anschutz Medical Campus, Aurora, CO
3Stellenbosch University, Faculty of Medicine and Health Sciences, Cape Town, South Africa

Background

- Trauma causes 5.8M+ deaths annually, with LMICs carrying the greatest burden[1].
- In South Africa, trauma was the second leading cause of death in 2020–2021 (89.9 per 100,000)[2]. Young men are most affected.
  - Leading causes: homicide (36.2%), often firearm-related, and road traffic collisions[3].
- Delays in trauma care (e.g., hospital arrival, blood product access, diagnostics, and surgery) worsen outcomes. Thus, determining injury time is critical[4-6].
- The EpiC study (Western Cape, launched 2020) investigates trauma care timelines and outcomes[7].
- This prospective quantitative study aims to compare the validity of three approaches for estimating injury times: patient-reported, initial encounter with the health system, and research staff extrapolated times .

Methods

- Interview period: July 24 – August 1, 2023 at Tygerberg Hospital, Western Cape, South Africa.
- Participants were adult trauma patients (≥18 years) with blunt or penetrating trauma, admitted or transferred from EpiC sites.
- Data collection was based on patients' self-reported injury times (exact or time range).
- While EpiC staff independently inferred injury times via protocolized medical record review and pre-specified time windows.

Analysis:

- We estimated validity coefficients (VC) between three proxy injury times: Patient-reported injury times (P), EpiC research staff injury time (R), and time of initial encounter with the healthcare system (E)) and true (unknown) injury time using the method of triads.
- Pearson correlation coefficients were calculated among all three injury times (rRP, rPE, rER). We then calculated the coefficient of validity (VC) for each proxy injury time and the unobserved true injury time (T)

Results

Table 1: Demographic distribution of the study population

Characteristics	Total (N=66)
Age (years)	
Median (IQR)	31.0 (25.9, 38.9)
Patient's Sex, n (%)	
Male	55 (83.3%)
Female	11 (16.7%)
Injury Force Type, n (%)	
Blunt	32 (48.5%)
Penetrating	30 (45.5%)
Blunt + Penetrating	4 (6.1%)
Dominant Mechanism of Injury, n (%)	
Firearm	19 (28.8%)
Struck/hit	11 (16.7%)
Stabbing or cut	14 (21.2%)
Vehicular Injury	18 (27.3%)
Fall	3 (4.5%)
Other	1 (1.5%)
New Injury Severity Score (NISS)	
Median (IQR)	17.0 (9.0, 27.0)
Initial Glasgow Coma score (GCS) Category, n (%)	
15	53 (80.3%)
3 to 14	13 (19.7%)
Maximum Abbreviated Injury Score (AIS) Severity	
Median (IQR)	3.0 (2.0, 3.0)
Maximum Head AIS Head Severity	N = 19
Median (IQR)	3.0 (1.0, 3.0)
Research Staff Injury time type, n (%)	
Specific time abstracted	45 (68.2%)
Time window abstracted, midpoint used	21 (31.8%)
Patient-reported injury time type, n (%)	
Specific time reported	41 (62.1%)
Time window reported, midpoint used	25 (37.9%)
Difference between patient-reported injury time and initial encounter with the healthcare system (hours)	
Median (IQR)	1.0 (0.5, 2.5)
Difference between research staff injury time and initial encounter with the healthcare system (hours)	
Median (IQR)	0.6 (0.5, 2.0)

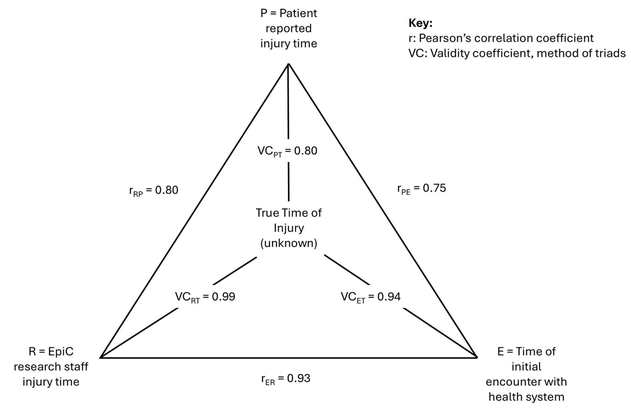

Figure 1.
Method of triads: EpiC research staff injury time (R) vs. patient-reported injury times (P) vs. time of initial encounter with the healthcare system (E)

Table 2: Validity Coefficients Between Three Proxy Measurements of Injury Time and True Injury Time Calculated Using The Method of Triads (N=66)

	Research staff injury time vs. true injury time VC_{RT} (95% CI)	Time of initial encounter with the healthcare system vs. True injury time VC_{ET} (95% CI)	Patient-reported time vs True injury time VC_{PT} (95% CI)
Full sample (N = 66)	0.99 (0.96, 1.05)	0.94 (0.85, 0.99)	0.80 (0.63, 0.95)
Maximum Abbreviated Injury Score (AIS) Severity Score			
1-2 (N = 22)	0.97 (0.87, 1.09)	0.88 (0.68, 1.00)	0.84 (0.64, 1.01)
3-5 (N = 44)	0.98 (0.92, 1.02)	0.99 (0.97, 1.00)	0.77 (0.44, 0.98)
Any head injury			
No head injury (N = 47)	1.01 (0.96, 1.08)	0.92 (0.81, 0.99)	0.82 (0.62, 0.98)
Any head injury (N = 19)	0.97 (0.85, 1.02)	0.99 (0.97, 1.03)	0.78 (0.35, 0.98)
Initial GCS			
15 (N = 53)	1.00 (0.93, 1.12)	0.91 (0.75, 1.00)	0.72 (0.45, 0.93)
<15 (N =13)	1.00 (1.00, 1.01)	0.99 (0.97, 1.00)	0.97 (0.95, 0.99)

Conclusions

- All three proxy injury times were highly correlated with true injury time with the strongest correlation observed for research staff injury time.
- Patient-reported injury times was more weakly correlated with time of injury than other proxy injury times. These findings held even when taking into consideration clinical factors that may impact patient's ability to self-report and or affect clinical documentation. Such as, trauma due to pain, stress, intoxication, or altered mental status.
- Our findings suggest that using a standardized, step-wise approach to determining injury time from the clinical record can yield valid estimates of injury time.
- Accurate injury timing supports better trauma care and health system performance monitoring.

Implications

- Standardized injury time imputation by trained medical professionals improves data quality at tertiary care facilities in a resource-limited healthcare environment where medical records lack detail.
- Chart-based injury time estimation may be more reliable than patient recall in trauma settings.
- Reliable injury time data is essential for the following:
  - Improving medical provider decision - making and patient care
  - Informing quality improvement and policy decisions

References

Paun S, Beuran M, Negoi I, Runcanu A, Gaspar B. Trauma epidemiology: Where are we today? Chirurgia-Bucharest. 2011;106(4):439-43. PubMed PMID: WOS:000294112000003.
Council SAMR. 3rd Injury Mortality Survey: A National Study of Injury Mortality Levels and Causes in South Africa, 2020/2021. 2021.
Matzopoulos R, Prinsloo M, Pillay-van Wyk V, Gwebushe N, Mathews S, Martin LJ, et al. Injury-related mortality in South Africa: a retrospective descriptive study of postmortem investigations. Bull World Health Organ. 2015;93(5):303-13. Epub 20150313. doi: 10.2471/BLT.14.145771. PubMed PMID: 26229201; PubMed Central PMCID: PMC4431514.
Acosta JA, Yang JC, Winchell RJ, Simons RK, Fortlage DA, Hollingsworth-Fridlund P, et al. Lethal injuries and time to death in a level I trauma center. J Am Coll Surg. 1998;186(5):528-33. doi: 10.1016/s1072-7515(98)00082-9. PubMed PMID: 9583692.
Mould-Millman NK, Wogu AF, Fosdick BK, Dixon JM, Beaty BL, Bhaumik S, et al. Association of freeze-dried plasma with 24-h mortality among trauma patients at risk for hemorrhage. Transfusion. 2024;64 Suppl 2:S155-S66. Epub 20240319. doi: 10.1111/trf.17792. PubMed PMID: 38501905.
Mould-Millman NK, Baldwan NK, Beaty B, Suresh K, Dixon JM, Patel C, et al. Prolonged casualty care: Extrapolating civilian data to the military context. J Trauma Acute Care Surg. 2022;93(2S Suppl 1):S78-S85. Epub 20220521. doi: 10.1097/TA.0000000000003675. PubMed PMID: 35546736; PubMed Central PMCID: PMC9323658.
Suresh K, Dixon JM, Patel C, Beaty B, Del Junco DJ, de Vries S, et al. The epidemiology and outcomes of prolonged trauma care (EpiC) study: methodology of a prospective multicenter observational study in the Western Cape of South Africa. Scand J Trauma Resusc Emerg Med. 2022;30(1):55. Epub 20221017. doi: 10.1186/s13049-022-01041-1. PubMed PMID: 36253865; PubMed Central PMCID: PMC9574798.