

**TIME-TO-KNIFE: IMPACT OF A NOVEL 30 MINUTE BENCHMARK
TIME FOR ARRIVAL TO INCISION FOR TRAUMA PATIENTS AT
RISK OF EXSANGUINATION REQUIRING
EMERGENT TRUNCAL OPERATION**

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Introduction: Time dependent quality benchmarks are a common tool both to improve patient outcomes and in trauma center verification. Hemorrhage is the leading cause of preventable death after injury and causes death within hours. Hemorrhage control operations via laparotomy or thoracotomy are commonly required to salvage patients with exsanguinating hemorrhage. However, no time dependent quality benchmarks exist regarding time to incision for truncal hemorrhage control operations. We established a time-to-knife benchmark of 30 minutes for hypotensive patients at risk of massive truncal hemorrhage (FAST+, massive hemothorax, or penetrating chest/abdominal injury). We sought to compare outcomes between pre- and post-implementation periods with the hypothesis that a time-to-knife benchmark may decrease hemorrhage mortality.

Methods: Single center retrospective cohort study from 01/2015-02/2026 of patients requiring emergent thoracotomy or laparotomy (PRE: 01/2015-04/2025; TTK: 04/2025-02/2026). Patients with hypotension (systolic blood pressure (SBP) ≤ 90 mmHg) any time prehospital or upon ED arrival were eligible for inclusion. Time-to-knife calculated from arrival to incision if prehospital hypotension or from time of first hypotension for those patients with ED hypotension only. Hemorrhage mortality independently confirmed by two trauma surgeons. Primary outcome was hemorrhage mortality with secondary outcomes of 6- and 24-hour mortality.

Results: 115 patients were included (TTK=14; PRE=101). There were no differences in average age (45 vs 41 years; $p=0.58$), gender (100% vs 78%; $p=0.11$), or penetrating injury (36% vs 49%; $p=0.54$) between TTK and PRE. Almost all patients underwent laparotomy (100% vs 95%; $p=0.88$). Average time-to-knife was significantly lower in TTK compared to PRE (28 vs 56 minutes; $p=0.003$) with significantly more (79% vs 32%; $p=0.002$) with incision within 30 minutes. Hemorrhage (0% vs 28%; $p=0.053$), 6-hour (7% vs 26%; $p=0.23$), and 24-hour (7% vs 30%; $p=0.14$) mortality rates were less in the TTK compared to PRE, although not statistically significant.

Conclusion: Initiation of a time-to-knife benchmark of 30 minutes for hypotensive patients requiring emergent truncal operation was associated with significantly lower times to incision. Rates of hemorrhage mortality and 6- and 24-hour mortality were lower, but not statistically significant.

FINANCIAL HARDSHIP: GUN INJURIES EXPENSIVE TOLL ON AN URBAN LEVEL 1 TRAUMA CENTER

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Introduction: Firearm injury causes devastating physical and psychological effects, but the economic burden of firearm-related injury is poorly understood. Previous studies have reported hospital charges and costs to individual patients, but the cost to the health system remains unknown. This study describes the financial burden of firearm injury on a health system, evaluating hospital costs and reimbursement to inform future policy.

Methods: From July 1, 2020-December 31, 2024, patients presenting with firearm-related injuries to an urban, level 1 trauma center were identified. All post-discharge follow-ups up to 1 year after injury were assessed. Demographic and clinical characteristics were reviewed for all encounters. Hospital-level costs were compared including hospital contribution margin (net revenue-direct costs) and operating income (net revenue-total cost).

Results: There were 4,656 firearm-injured patients, with the majority discharged home from the ED (n=2,146, n=46.1%). Median age was 28 (IQR 22-37) with 82% Black and 71% with Medicaid as primary insurance. The cost of initial hospital care for victims of firearm injury was \$147 million with the majority of index costs (92%) resulting from inpatient care (\$135 million). Median contribution margin was -\$257 per patient (IQR -\$1,290 to \$12,135) and median operating income was -\$1,628 (IQR -\$3,653 to \$4,532). In the one year after injury, 57% of patients (n=2,647) had an encounter within the health system with a median of 7 encounters per patient (IQR 3-12). Total cost of post-discharge hospital care was \$29 million, including 8,506 outpatient visits (83.4%), 521 inpatient readmission (5.1%) with a median LOS of 5 days (IQR 3-9 days). Median operating income for follow up care 1-year post-injury was -\$123 (IQR -\$304 to \$12).

Conclusion: Firearm injury is an expensive disease, costing a single hospital system \$176 million in care costs over a 5-year period. Understanding these costs is essential for trauma systems and policy makers. Investments in primary, secondary and tertiary prevention efforts offer opportunities for substantial cost savings at the health system level.

CHARACTERIZING TRAUMA CENTER PROLIFERATION ACROSS THE UNITED STATES

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Introduction: The number of trauma centers in the U.S. continues to increase, with potential implications for trauma care access and building a more unified trauma care system. This study provides an update on trauma center categorization and proliferation over the past 20+ years.

Methods: The number and level of adult trauma centers as of January 2026 were identified via two certification pathways: 1) ACS verified centers (per the ACS website), and 2) state-designated centers (per state government websites and additional verified resources). Certification is not mutually exclusive and varies by state, though state-designation as level I-III is roughly aligned with ACS criteria. Data collected in 2026 were compared to data published in a previous study (MacKenzie et al., 2003 *JAMA*).

Results: As of 2026, there are 554 ACS verified trauma centers, an increase of 201% since 2003. There are 2,100 state-designated trauma centers, an increase of 95% since 2003. Across certifications, the largest growth occurred among lower-level centers (levels III-V), a total increase of 139% since 2003. Forty-seven states and DC participate in ACS certification and the number of states with formal trauma systems using ACS-based designation criteria increased by 26% from 35 in 2003 to 44 in 2026.

Conclusion: Since 2003, U.S. trauma center growth has been substantial, with notable expansion of lower-level trauma centers. The introduction of more entry points into the trauma system may lead to better outcomes in rural communities. These findings are alongside increased state participation in both certification pathways. While more widespread use of the ACS-based designation criteria is encouraging, further standardization is needed to minimize discrepancies between the two certification pathways and to create a unified trauma system.

Level of Center	ACS Verified Trauma Centers 2003*	ACS Verified Trauma Centers 2026	State-Designated Trauma Centers 2003*	State-Designated Trauma Centers 2026
Level I	89	204	149	242
Level II	80	203	234	314
Level III	15	147	244	501
Level IV and V†	0	0	450	1043
Total	184	554	1077	2100

ACS, American College of Surgeons. *Estimates are from MacKenzie, Hoyt, Sacra, et al. (2003). National Inventory of Hospital Trauma Centers. *JAMA*, 289(12):1515-1522. †ACS verification not performed for Level IV/V trauma centers.

DOES UPDATING THE ABBREVIATED INJURY SCALE (AIS) IMPROVE MORTALITY PREDICTION? A COMPARATIVE ANALYSIS OF AIS 2005 AND AIS 2015 USING TQIP DATA

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Introduction: The Abbreviated Injury Scale (AIS) is widely used to quantify anatomical injury severity in trauma patients. However, limited data exist comparing the performance of AIS 2005 and AIS 2015 in predicting mortality. This study aimed to compare mortality prediction using AIS 2005, converted AIS 2015, and native AIS 2015.

Methods: Data from the Trauma Quality Improvement Program (TQIP) database between 2021 and 2024 were analyzed. Using the official TQIP mapping algorithm, three datasets were constructed: AIS 2005, converted AIS 2015 (mapped from AIS 2005), and native AIS 2015. Injury Severity Score (ISS) distributions and mortality prediction using the Trauma and Injury Severity Score (TRISS) model were compared across AIS versions. Receiver operating characteristic (ROC) curve analysis with bootstrap resampling was performed to evaluate predictive performance.

Results: A total of 4,276,273 patients were included in the analysis; 3,821,817 (89.4%) were coded using AIS 2005 and 454,456 (10.6%) using AIS 2015. After conversion from AIS 2005 to AIS 2015, injury severity classification changed in 457,343 cases, with 138,404 showing increased ISS and 318,939 showing decreased ISS. In TRISS-based mortality prediction, the area under the curve (AUC) was significantly higher for native AIS 2015 than for AIS 2005 (0.892 vs. 0.876; $p < 0.001$) in bootstrap analysis, whereas converted AIS 2015 demonstrated performance similar to AIS 2005.

Conclusions: Converted AIS 2015 derived from AIS 2005 demonstrated mortality prediction performance comparable to AIS 2005. In contrast, native AIS 2015 provided superior mortality discrimination using the TRISS model. These findings suggest that direct AIS 2015 coding should be preferentially adopted in trauma registries and clinical research.

REAL WORLD PREDICTORS OF REQUESTING AIR MEDICAL
TRANSPORT BY EMS

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Introduction: We recently developed and validated a consensus definition of air medical transport (AMT) need after trauma (Table); however, the real-world drivers of AMT use remain unclear. Our objective was to compare predictors of AMT use with the consensus definition.

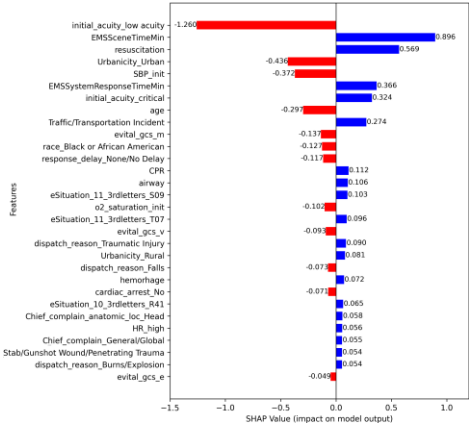
Methods: Injured adults transported by ground or air in 2024 NEMSIS dataset were included. Data for air patient was derived from ground EMS that requested AMT. Extreme gradient boosting modeling determined predictors of AMT use. Feature importance was quantified by SHAP values for contribution to predicting transport type.

Results: 3,173,439 patients were included with 0.25% AMT. Feature importance (Figure) identified several factors that align with the consensus definition including GCS, SBP, resuscitation needs, and time savings.

However, acuity perception, age, and mechanism are not in the definition.

Conclusions: Data-driven analysis of AMT utilization factors highlight a gap between our validated consensus definition and real-world practice, identifying targets for education, implementation, and potential refinements of the definition. Future work will identify implementation barriers.

Specialized care or 30-min time savings by AMT for:		Operational/System Criteria:	
• SBP<90 • GCSm<6 • GCS<13 if age>65 • Chest injury + resp distress • Arrest with ROS • +FAST • Need for surgery		• Terrain accessible only by AMT • # of patients exceed ground capabilities • Benefit from more distant specialized center	
• Penetrating torso injury • Unstable pelvic fracture • Crush/mangled extremity • Amputation • Bleeding req tourniquet • Spinal cord injury • Multisystem trauma		• Need for center with OB/PCI/Stroke services • Time savings for trauma + STEM/LVO • Ground capabilities cannot transport to trauma center	



CALCULATING TRAUMA UNDERTRIAGE RATES: SCHRODINGER'S CAT REVISITED

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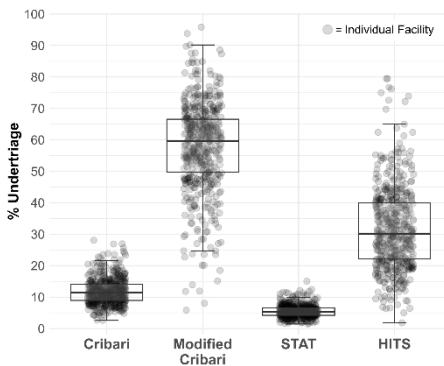
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Introduction: Undertriage (UT) is central to trauma center quality improvement, yet UT definitions vary and no data-driven consensus target exists for inter-facility benchmarking. We compared facility-level UT rates across four methods and assessed the impact on facility benchmarking.

Methods: This retrospective study included patients aged 18-89 from Level I & II trauma centers in ACS TQP Files (2021-2023). Facility-level UT was calculated using Cribari Matrix Method, modified Cribari Matrix Method, Standardized Triage Assessment Tool (STAT) and the High-Intensity Time-Sensitive (HITS) intervention-based definition representing trauma team actions. Paired facility-level UT rates were compared across methods (Wilcoxon signed-rank). To estimate benchmarking impact, we calculated within-facility rank change (higher rank = higher UT) relative to Cribari.

Results: 2,718,519 patients and 514 facilities were included. Median facility-level UT significantly differed by method: Cribari 11% [IQR 9-14], Modified Cribari 60% [50-67], STAT 9% [7-11], and HITS 30% [22-40] (Fig, all $p < 0.001$). At individual hospitals, the median range of UT values was 54% [45-62]. The median absolute facility rank change between the Cribari method and other tools was 129 [53.5-240] for Modified Cribari, 20 [3-38] for STAT, and 141.5 [60.3-251.8] for HITS.

Conclusion: These UT data highlight a concerning level of variation and uncertainty in the calculation and interpretation of a key trauma center performance metric. Until a UT definition is standardized and data-driven UT target goals established, cross-center benchmarking using UT should be interpreted cautiously and may be better suited for within-center trending.



DISTANCE AND BLOOD MATTER: GEOSPATIAL ANALYSIS OF PREHOSPITAL BLOOD AVAILABILITY AND TRAUMA CENTER ACCESS FOR FATAL MOTOR VEHICLE CRASHES IN THE UNITED STATES

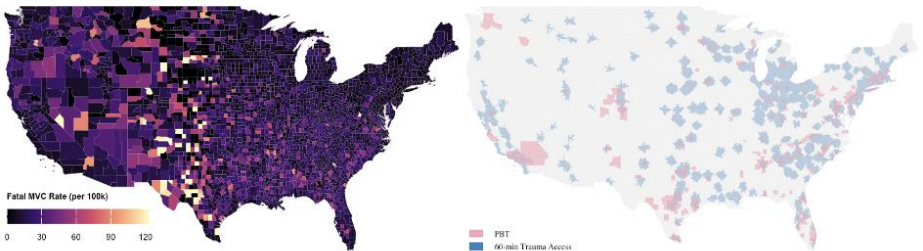
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Introduction: Early hemorrhage control through prehospital blood transfusion (PBT) and timely definitive trauma care are central to modern trauma systems, yet national access to these capabilities remains poorly defined. Fatal motor vehicle crashes (MVCs) may serve as a population-level marker of severe injury burden. We hypothesized that county-level PBT availability and proximity to trauma centers would be associated with lower fatal MVC incidence.

Methods: National geospatial analysis of MVC fatalities from the 2023 NHTSA Fatality Analysis Reporting System was performed. County-level fatal MVCs were spatially linked to EMS agencies providing PBT and 60-minute driving time catchment areas surrounding continental ACS-verified trauma centers (TCs). Negative binomial regression, offset by county population, was used to evaluate associations between PBT availability, TC proximity, rurality, and fatal MVC incidence.

Results: Among 37,355 MVC fatalities, 10,378 (27.8%) occurred in counties with PBT access and 25,397 (68%) occurred within 60-minute proximity of a TC. Urban counties were more likely than rural counties to have PBT capability (OR 7.3; 95% CI 6.68-7.95) and 60-minute TC access (OR 13.1; 95% CI 12.36-13.85). In population-adjusted models controlling for rurality, both PBT capability (IRR 0.87; 95% CI 0.81-0.94) and 60-minute TC proximity (IRR 0.79; 95% CI 0.74-0.84) were independently associated with lower fatal MVC incidence.

Conclusion: County-level access to PBT and timely TC proximity were independently associated with lower population-adjusted fatal MVC incidence. These resources remain disproportionately concentrated in urban regions, underscoring geographic disparities in trauma system capability and highlighting opportunities to enhance early life-saving resuscitative care.



BRIEF INTERVENTIONS ALONE ARE NOT ENOUGH FOR TRAUMA PATIENTS WITH HIGH-RISK SUBSTANCE USE

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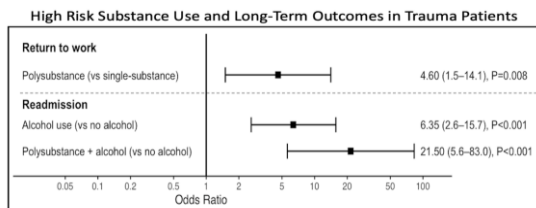
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Introduction: Substance use, particularly alcohol use, is highly prevalent among trauma patients and associated with recurrent injury and worse in-hospital outcomes. ACS Level I trauma centers are required to implement Screening, Brief Intervention, and Referral to Treatment (SBIRT). We evaluated the association between substance use, SBIRT consults, and long-term patient-reported outcomes after trauma.

Methods: Retrospective cohort study linking SBIRT data, electronic health record data, and long-term outcomes from the Functional Outcomes and Recovery After Traumatic Injury (FORTE) registry. Adult trauma patients with moderate or severe trauma (Injury Severity Score ≥ 9) admitted to a Level I trauma center (2016-2022) were included. Multivariable regression assessed associations between substance use, SBIRT consult, and long-term health related quality of life, mental health, and return to work, adjusting for demographic, clinical, and injury-related characteristics.

Results: Among 1,334 trauma patients with long-term follow-up, 89.7% were tested for substance use, 32.6% tested positive, and 44.9% of those patients received an SBIRT consult. Polysubstance use was associated with higher odds of not returning to work (OR 4.6 [1.5–14.1], $p=0.008$). Alcohol use was associated with increased odds of readmission (OR 6.35 [2.6–15.7], $p<0.001$), which was markedly higher among patients with alcohol-involved polysubstance use (OR 21.5 [5.6–83.0], $p<0.001$) [Figure]. PTSD at 6 months was more prevalent among alcohol users (14.9% vs 8.9%, $p<0.001$) and highest among alcohol-involved polysubstance users (23.9% vs 8.9%, $p<0.001$). SBIRT was not associated with improved mental health or functional outcomes (all $p>0.5$).

Conclusion: Polysubstance use and alcohol-involved polysubstance use are associated with significantly worse long-term outcomes after trauma. SBIRT delivered as a single bedside intervention was not associated with improved recovery.



EARLY RESULTS OF A POST-TRAUMATIC STRESS DISORDER SCREENING PROGRAM AT A LEVEL 1 TRAUMA CENTER

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Introduction: In March 2022, The American College of Surgeons Committee on Trauma (ACS-COT) released the seventh edition of Resources for Optimal Care of the Injured Patient, which required screening and referral for mental health after trauma. Post-traumatic stress disorder (PTSD) is thought to be prevalent among trauma patients and thus warrants screening. The ACS-COT did not specify the way to screen, and thus we employed an automated screening tool. We sought to evaluate the feasibility of an automated screening and referral system designed to align with the ACS-COT guidelines at a level 1 trauma center.

Methods: A retrospective review of trauma patients screened from November 2024 - December 2025 was performed. All trauma patients were screened for PTSD via SMS texting or voice call after discharge. Using the Primary Care PTSD Screen for DSM-5, PTSD was defined as > 4 issues for males and > 3 or more issues for females. Our primary outcome was overall successful contact rate; secondary outcomes included screening completion rate, PTSD screening results, and referral outcomes.

Results: There were 1,010 patients screened; 586 patients were enrolled from the emergency department, 288 from inpatient services, 135 from the observation unit, and 3 from overnight recovery. There were 393 (67%) patients who answered at least one clinical screening question and 280 (48%) patients who completed all screening questions. Of those, 96 patients (43.3%) screened positive for PTSD. Outreach was primarily conducted via voice call (82.5%) with the remaining 17.7% via SMS. Successful referral was achieved in 38.9% of contacted patients: 24 patients were referred to the in-house Trauma Psych Program, 22 patients to community mental health workers, 41 patients were provided community resources, and 28 patients declined services.

Conclusion: Implementation of a technology-forward screening and referral program for PTSD in trauma patients is feasible with a substantial number of patients screening positive for PTSD. In line with Resources for Optimal Care of the Injured Patient (ACS-COT March 2022), mental health screening and referral are important and required parts of whole patient trauma care. Future efforts should include identifying the most effective modes of communication for patient engagement, qualitatively assessing barriers to completion of surveys, and optimizing ways for referral to mental health services.