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# Understanding an inclusive trauma system through characterization of admissions at level IV centers

Hayden L. Smith, Ph.D.[a,b], H. Clay Dean V, M.D.[a], Richard A. Sidwell, M.D., F.A.C.S.[a,*]

[a]*Iowa Methodist Medical Center, General Surgery Residency Program, 1415 Woodland Avenue, Suite 140, Des Moines, IA 50309-1453, USA;* [b]*Department of Internal Medicine, Carver College of Medicine, University of Iowa, Iowa City, IA, USA*

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**Abstract**

**BACKGROUND:** Level IV trauma centers are an integral part of inclusive trauma systems, although sparse data exists for these facilities.

**METHODS:** An observational study was conducted using a Midwestern state's inpatient data files to characterize level IV center patients. Injury and severity levels, injury mechanism and/or intent, and distances to nearest tertiary centers were determined.

**RESULTS:** During the study year, 3,346 injured patients were admitted at level IV centers. The median distance to nearest tertiary center was 43 miles. Median patient age was 81 years, and primary injury mechanism was falls. Overall, 22% of patients had an isolated hip fracture. Of moderately injured patients, 64% had an isolated hip fracture, 8% nonisolated hip fractures, and 9% rib fractures without hip fracture. Overall, 30% of patients had a high severity of injury.

**CONCLUSIONS:** A large number of patients were admitted to level IV trauma centers. Patients admitted tended to be elderly and have orthopedic fall injuries. Study results provide important implications for provider education, prevention efforts, need for orthopedic surgical capabilities, and necessity of capturing these data in registries.



An inclusive trauma system uses all facilities to care for patients with varying severity of injury. The goal of the system is to match patient needs with available resources. Published data have shown trauma systems can improve patient outcomes and reduce mortality by up to 15%.[1–5]

Level IV trauma centers are an integral part of an inclusive trauma system. In general, these centers are expected to perform initial assessment and stabilization of patients, with many patients requiring transfer to tertiary centers. However, patients can be admitted to level IV trauma centers for definitive care. A frequent limitation

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* Corresponding author. Tel.: +1-515-241-4076; fax: +1-515-241-8040.

E-mail address: Richard.Sidwell@unitypoint.org

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in published research is the inability to characterize patients who are admitted and received care at level IV centers.[2,6–18] Issues arise due to the completeness and consistency of available level IV data in traditional trauma registries (eg, state trauma registries and National Trauma Data Bank). If level IV center data have been published, it has been combined with level III trauma center data[19–21] or has focused on data for patients transferred from level III or IV centers to tertiary centers.[2–4,7,9,10,17,18,22] Without overall data on admitted patients at level IV trauma centers, it is not possible to understand a trauma system as a whole or evaluate its complete effectiveness. The purpose of this study was to characterize injured patients admitted at level IV trauma centers in a mature inclusive trauma system.

## Methods

An observational study was conducted using retrospective 2011 inpatient hospital data from the state of Iowa in the United States. The study state had an inclusive trauma system, which had been fully functional since 2001. Institutional Review Board approval was granted for the study. Inclusion criterion required an inpatient admission at a hospital classified as a level IV trauma center. Excluded patients were: elective admissions or newborns; patients with same calendar day transfer to another facility; and patients with no trauma International Classification Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code as defined by the National Trauma Data Bank.[23] Hip fracture, rib fracture, and traumatic brain injury (TBI) status were based on ICD-9-CM code ranges: 820.00-820.99, 807.00-807.09, and 800.00-804.99 as well as 850-854.19, respectively.

Abbreviated Injury Severity (AIS) scores and Injury Severity Scores (ISS) were generated for patients using ICD-9-CM lexicon via the ICDPIC 3.0 package within STATA 13.0 (StataCorp, College Station, TX, USA). Diagnosis codes for burns were not converted into AIS scores nor were codes for 958.xx (ie, Certain Early Complications of Trauma). Probability of patient mortality was also determined using the Trauma Mortality Prediction Model within the ICDPIC 3.0 package.[24] Injury mechanism and intent were determined for patients using ICD-9-CM External Cause of Injury codes (E-codes) based on the Centers for Disease Control and Prevention classification matrix.[25] E-codes were the only data element in the data set with missingness, with approximately 35% absent. Missingness was examined using multiple logistic regression with E-codes (missing or observed) classified as the binary dependent variable. Model results provided information toward data *missing at random* ($(P(Y_{missing}, Y_{observed}) \not\perp \mathbf{X})$, $\mathbf{X}$ = vector of covariates) and multiple imputation based on fully conditional specification of arbitrary missing

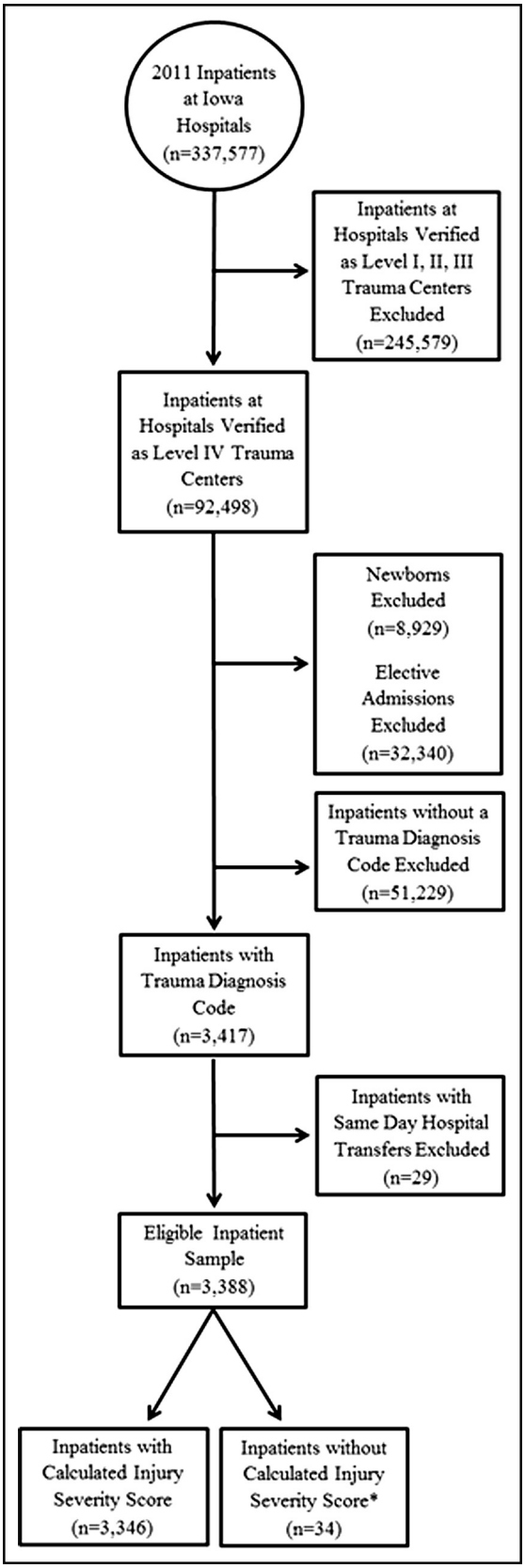


**Figure 1** Flow diagram of 2011 Iowa inpatients admitted at level IV trauma centers ($n$ = 3,346). *Patients with only a burn or early complications of trauma diagnosis.