SPECIAL ARTICLE

Methodology and Analytic Rationale for the American College of Surgeons Trauma Quality Improvement Program

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Trauma systems and trauma centers have been shown to improve outcomes among seriously injured adults[1-8] and children.[9-13] Previous research also suggests that there is variability in care between trauma centers.[14-17] Differences in patient selection (selection bias), case mix, data quality, geography, and other factors inherent to different injured populations likely contribute in part to this variability. However, variability in the processes and quality of care at different trauma centers can also contribute to outcomes variations among hospitals.

In 2006, the American College of Surgeons (ACS) Committee on Trauma launched the Trauma Quality Improvement Program (TQIP) to study the variability in outcomes between trauma centers and to use this information to improve the quality of trauma care in the United States and Canada.[18] The Trauma Quality Improvement Program expands on a foundation of quality improvement programs already conducted by the ACS, including the NSQIP,[19,20] performance improvement/patient safety, and trauma center verification. The primary goal of TQIP is to improve the quality of trauma care through outcomes-based, risk-adjusted benchmarking of trauma centers and feedback reports.[15,18]

The Trauma Quality Improvement Program measures quality through comparative estimates and reporting of mortality, complications, and resource use, after accounting for differences in case mix and important confounders. The Trauma Quality Improvement Program also seeks to understand reasons for variability in trauma care, to learn from high-performing hospitals, and to provide constructive feedback to participating trauma centers that will maximize health outcomes among trauma patients. Although NSQIP has served as an example for TQIP with several similarities, trauma patients and trauma care are distinct from nontrauma surgical patients and their care.[21] These differences require a unique approach to risk-adjusted benchmarking and measurement of quality in trauma. Although previous publications have detailed the inception, vision, and feasibility of TQIP,[15,18] the methodology used for risk adjustment and benchmarking have not been reported.

The objective of this article is to detail the methodology, data processing, data quality, statistical analysis, and analytic rationale for TQIP. A group of experts in trauma research methodology and statistical analysis (the TQIP Analytics Project Team) was tasked with developing the TQIP methodology, which forms the basis for this article. In presenting the methodological framework and statistical rationale behind TQIP, our goal is to provide transparency about the process of risk-adjusted benchmarking of participating trauma centers.

Study design and setting

The Trauma Quality Improvement Program uses a retrospective cohort of trauma patients meeting specific inclusion criteria and cared for in designated and ACS-verified Level I and II hospitals across the United States and Canada. Trauma center participation in TQIP is voluntary, entails the use of existing trauma registry data conforming to specific standards, and requires an annual

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Abbreviations and Acronyms

ACS = American College of Surgeons
ED = emergency department
IQR = interquartile range
ISS = Injury Severity Score
LOS = length of stay
O/E = observed to expected
TQIP = Trauma Quality Improvement Program

fee to offset the costs of the program. In this publication, we use information from the most recent TQIP database available for analysis (patients admitted in 2010). Currently, there are 143 participating trauma centers (90 Level I hospitals and 53 Level II hospitals), with the number increasing over time. Participating centers represent a variety of regions, hospital types, and geographic locations (Table 1).

Patient population and inclusion criteria

The Trauma Quality Improvement Program uses a broad, heterogeneous group of seriously injured patients, with focused assessment of several distinct subset populations (Table 2). The aggregate TQIP sample includes adults (age 16 years or older) with at least 1 valid trauma ICD-9-CM diagnosis code (800 to 959.9, excluding diagnosis codes for late effects, superficial injuries, and foreign bodies); blunt or penetrating mechanisms of injury; Abbreviated Injury Scale (AIS) score ≥3 (Injury Severity Score [ISS] ≥9); and non-missing values for emergency department (ED) and hospital discharge dispositions (Table 2). A pre-existing advanced directive to withhold life-sustaining care is an exclusion criterion. Due to variability among hospitals in classifying patients as "dead on arrival," TQIP mortality analyses are performed both including and excluding patients with an ED discharge disposition of "died." The Trauma Quality Improvement Program reports also exclude elderly patients (65 years or older) with an isolated hip fracture[22]; however, these patients are included in elder-specific reports.

Table 1. Hospital Characteristics for Participating Trauma Quality Improvement Program Hospitals (n = 131)

Hospital characteristics	n	%
Trauma Level		
I	85	65
II	46	35
Bed size, n		
<200	6	5
201–400	36	27
401–600	41	31
>600	48	37
Teaching type		
University	65	50
Community teaching	54	41
Community nonteaching	12	9
Hospital type		
For profit	9	7
Nonprofit	122	93
Region		
Northeast	17	13
Midwest	44	34
South	40	31
West	30	23

Based on the number of participating centers with data available at the time of this report.

The Trauma Quality Improvement Program specifies several different cohorts to address different aspects of trauma care. These groups include blunt multisystem injury (AIS ≥ 3 in at least 2 body regions); penetrating truncal injury (AIS ≥ 3 in the neck, chest or abdomen); shock (systolic blood pressure [SBP] <90 mmHg); isolated traumatic brain injury; and elderly. These cohorts were selected to focus performance and treatment efforts, target distinct types of trauma patients with different needs and management strategies, highlight injury populations with varying representation and experience among centers, and to increase comparability among hospitals. These groups also allow better evaluation of different aspects of multidisciplinary care coordination, timing and strategies of resuscitation, processes of care, expected outcomes, and resource use.

For admissions occurring in 2010, TQIP includes 96,537 trauma patients, 19,586 blunt multisystem injury patients, and 6,440 penetrating injury patients. When assessed on a hospital level, the annual median patient sample size and interquartile range (IQR) are 662 (IQR 409 to 887) total TQIP patients per hospital; 109 (IQR 64 to 194) blunt multisystem patients per hospital; and 35 (IQR 16 to 66) penetrating injury patients per hospital. There is no minimum sample size requirement for a trauma center to participate in TQIP.

Outcomes measures

Primary outcomes include mortality (on arrival, in the ED, and in-hospital), complications and resource use.[23,24] Although in-hospital mortality is influenced by many factors, it is a well-recognized outcome in trauma care, reliably captured in trauma registries and useful for TQIP. For complications, TQIP has focused on addressing potentially preventable events that cause disability, additional resource use, and deviations from the expected clinical course after