Feasibility of and Rationale for the Collection of Orthopaedic Trauma Surgery Quality of Care Metrics

Abstract

Introduction: Reproducible metrics are needed to evaluate the delivery of orthopaedic trauma care, national care, norms, and outliers. The American College of Surgeons (ACS) is uniquely positioned to collect and evaluate the data needed to evaluate orthopaedic trauma care via the Committee on Trauma and the Trauma Quality Improvement Project.

Methods: We evaluated the first quality metrics the ACS has collected for orthopaedic trauma surgery to determine whether these metrics can be appropriately collected with accuracy and completeness. The metrics include the time to administration of the first dose of antibiotics for open fractures, the time to surgical irrigation and débridement of open tibial fractures, and the percentage of patients who undergo stabilization of femoral fractures at trauma centers nationwide. These metrics were analyzed to evaluate for variances in the delivery of orthopaedic care across the country.

Results: The data showed wide variances for all metrics, and many centers had incomplete ability to collect the orthopaedic trauma care metrics. There was a large variability in the results of the metrics collected among different trauma center levels, as well as among centers of a particular level.

Discussion: The ACS has successfully begun tracking orthopaedic trauma care performance measures, which will help inform reevaluation of the goals and continued work on data collection and improvement of patient care. Future areas of research may link these performance measures with patient outcomes, such as long-term tracking, to assess nonunion and function. This information can provide insight into center performance and its effect on patient outcomes.

Conclusions: The ACS was able to successfully collect and evaluate the data for three metrics used to assess the quality of orthopaedic trauma care. However, additional research is needed to determine whether these metrics are suitable for evaluating orthopaedic trauma care and cutoff values for each metric.

Assessing the quality of care delivered to patients with orthopaedic trauma is a vexing challenge. Determining the metrics that can and should be collected to assess the care provided at individual centers (and whether to compare care provided at different centers) remains an ongoing debate. Historically, few, if any, universally accepted guidelines have been available to help the clinician determine the appropriate intervention for
orthopaedic trauma. For example, in 1976, Gustilo and Anderson\textsuperscript{1} published guidelines on the use of antibiotics to prevent infection in the management of open fractures. These guidelines are still used today. However, trauma care and the availability of modern generations of antibiotics have evolved, and few studies have sought to validate or update the guidelines.\textsuperscript{2–4} Modern medicine is now focusing on quality assessment and improvement initiatives, and orthopaedic trauma is among the areas that will be evaluated. Orthopaedic trauma surgeons should participate in writing and implementing these initiatives to ensure that they are used appropriately to monitor fracture care.

### Trauma Quality Improvement Project and the Committee on Trauma

The American College of Surgeons (ACS) has outlined the resources that trauma centers across the United States must have in order to be verified by the ACS as a trauma center.\textsuperscript{5} The ASC Committee on Trauma (COT), which was initially known as the Committee on Fractures, was formed in 1922. It is charged with improving the care of patients with traumatic injuries via education, advocacy, standards of care, and the assessment of treatment outcomes.\textsuperscript{6}

The Trauma Quality Improvement Project (TQIP) is an ACS program that collects data from trauma centers across the country to create risk-adjusted benchmarks to provide feedback about a center’s performance.\textsuperscript{7} In addition to data collection, TQIP develops and publishes best practices guidelines. It recently published ACS TQIP Best Practices in the Management of Orthopaedic Trauma, which includes suggestions for managing nine aspects of orthopaedic trauma care as well as performance improvement (PI) indicators that could be used to monitor the delivery of care at institutions.\textsuperscript{8} These guidelines were developed by a multidisciplinary expert workgroup and were based on the best data available and expert opinion. The guidelines are cobranded by the ACS and the Orthopaedic Trauma Association.

### Methods

The Verification Review Committee (VRC), an ad hoc committee of the COT, performs verification and re-verification of ACS-verified trauma centers every 3 years. Data from all ACS-verified trauma centers that were verified or re-verified from July 2015 to December 2015 have been included in this study. Data from centers that were not verified or re-verified by the ACS in those 6 months were excluded. As of September 2016, 443 ACS-verified centers existed (ie, 112 level I, 167 level II, 79 level III, 48 level I pediatric, 4 level II pediatric, 33 combined adult and pediatric trauma centers). Non-ACS-verified centers were not part of this evaluation process as they do not have equivalent site tracking or standards.

In addition to ensuring that all the resources outlined in Resources for Optimal Care of the Injured Patient are in place, the COT began collecting three orthopaedic trauma surgery metrics in July 2016. These metrics include the time from emergency department (ED) arrival to administration of the first dose of intravenous antibiotics in patients with open fractures, the time from ED arrival to surgical irrigation and débridement of open tibial shaft fractures, and the percentage of patients with femoral shaft fractures alone who underwent surgical stabilization (eg, intramedullary nailing, external fixation, open reduction and internal fixation) within 24 hours of presentation to the ED. To our knowledge, this is the first time that orthopaedic trauma care metrics have been collected by a national organization. The metrics chosen were partially based on the ACS TQIP Best Practices in the Management of Orthopaedic Trauma and were vetted by the OTA members of the COT. These metrics were chosen in part because they are data points that centers could obtain from existing trauma registries. Trauma centers that have voluntarily enrolled in the ACS verification process must maintain a prospective, contemporaneously maintained registry as part of the process. However, some data were collected retrospectively because these metrics were new, and some registries may not have captured the data in real time.

We reviewed data on the three orthopaedic trauma care metrics...
from the first 115 trauma centers that underwent verification from July 2015 to December 2015, using the 2014 Resources for Optimal Care of the Injured Patient, including 30 level I centers (26%), 56 level II centers (49%), and 29 level III centers (25%). These include data from adult and pediatric trauma centers. Statistical analysis of the data included calculation of the mean and median values for each criterion, as well as standard deviations and variance. Further statistical analysis was not performed because this was a preliminary investigation of the early data collection.

Because no previous investigation has tracked orthopaedic trauma metrics, one goal of this study was to evaluate the initial data to determine the feasibility of collecting these metrics. Our study will provide meaningful information for future studies on whether these metrics are appropriate and will help to improve and refine future metrics. We hope to further define these metrics for inclusion in the TQIP database so that they can be used to establish national norms and outliers.

Results

Time to Administration of Antibiotics

The data for time to administration of the first dose of antibiotics in patients with open fractures was available from 90 of 115 centers (78%). The mean time to administration of antibiotics was 83 minutes (1.4 hours), and the median was 65 minutes (1.1 hours; range, 18 to 371 minutes [0.3 to 6.2 hours; SD, 70 minutes]). At level III centers, the mean time was 88 minutes (1.5 hours) with a median of 70 minutes (1.2 hours) with a range of 22 to 320 minutes (0.4 to 5.3 hours; SD, 61 minutes).

Time to Surgical Irrigation and Débridement of Open Tibial Fractures

Data on the timing of surgical irrigation and débridement of open tibial fractures was available from 98 of 115 centers (85%). The mean overall time to the operating room was 350 minutes (5.8 hours), and the median was 302 minutes (5 hours; range, 47 to 1,223 minutes [0.8 to 20 hours]). At all centers, the mean time to the operating room was less than the goal of 24 hours; however, there were large variances within centers (Figure 2). At level I centers, the mean time was 394 minutes (6.6 hours), with a median of 330 minutes (5.5 hours; range, 52 to 960 minutes [0.9 to 16 hours; SD, 240 minutes]). At level II centers, the mean time was 343 minutes (5.7 hours), with a median of 300 minutes (5 hours; range, 47 to 1,223 minutes [0.8 to 20.3 hours; SD, 206 minutes]). The mean time at level III centers was 314 minutes (5.2 hours), with a median of 249 minutes (4.2 hours) and a range of 60 to 631 minutes (1 to 10.5 hours; SD, 164 minutes).

Stabilization of Femoral Shaft Fractures

The metric for stabilization of femoral shaft fractures measured the percentage of fractures that were stabilized with an intramedullary nail, open reduction and internal fixation, or an external fixator within 24 hours of presentation to the ED. The data were available for 112 of the 115 centers (97%; Figure 3). The mean time was 83 minutes (1.4 hours), and the median was 58 minutes (0.9 hours; range, 18 to 371 minutes [0.3 to 6.2 hours; SD, 70 minutes]). At level III centers, the mean time was 88 minutes (1.5 hours) with a median of 70 minutes (1.2 hours) with a range of 22 to 320 minutes (0.4 to 5.3 hours; SD, 61 minutes).
The overall percentage for stabilization within 24 hours was 74%, with a median of 81% (range, zero to 100%; SD, 25%). The mean for level I centers was 78%, with a median of 89% (range, zero to 100%; SD, 24%). For level II centers, the mean was 76%, with a median of 81% (range, 12% to 100%; SD, 21%). The mean at level III centers was 65%, with a median of 67% (range, zero to 100%; SD, 30%).

We examined how many trauma centers stabilized ≥90% of their femoral shaft fractures within 24 hours. As discussed previously, there are no definitive criteria for this metric; however, we chose 90% as a cutoff because there will be some patients who cannot get to the operating room within 24 hours because of other medical issues. This goal was reached by 40%, 33%, and 30% of the level I, II, and III centers, respectively. When we decreased the parameter to ≥80%, 60%, 53%, and 41% of level I, II, and III trauma centers, respectively, reached this goal.

Of note, data from some centers was incomplete because this was the first time data had been collected on these metrics. Some ACS reviewers updated data manually at the time of the site visits. These manual entries were not included in our analysis.

**Discussion**

Reproducible metrics are essential to the evaluation of the delivery of care for orthopaedic trauma. These metrics allow evaluation of the quality of care nationally, development of norms and outliers, and comparison of care delivered by different trauma centers. The ACS is uniquely positioned to be able to collect and evaluate the data needed to assess the quality of orthopaedic trauma care via the COT and the TQIP. The COT is charged with the improvement of trauma care, and TQIP has a large national database that is used to create risk-adjusted benchmarks and develop best practices guidelines. Participating centers receive quarterly reports of their risk-adjusted outcomes. Thus, there are ongoing efforts to integrate the PI process with TQIP data and with the verification process at ACS-verified trauma centers. The use of the three metrics for orthopaedic trauma care described in this article can be used to establish guidelines for appropriate care of the patient with orthopaedic trauma that can be monitored with these metrics.

The orthopaedic members of the COT, VRC, and TQIP have been working closely to ensure that appropriate guidelines and metrics are vetted before being used for any verification process. The goal of this study was to determine whether these metrics could be collected. Further research and evaluation of each metric are needed to avoid enforcement of goals that do not
successfully improve the care of orthopaedic trauma patients.

The Best Practices Group of the TQIP recommended surgical irrigation and débridement of open tibial fractures within 24 hours of presentation, based on the best available evidence.8 These guidelines will be updated on the basis of new evidence as it becomes available. Some patients are unable to undergo surgery within 24 hours of presentation at the ED for a variety of reasons, such as ongoing resuscitative requirements or progressive neurologic deterioration. An institution not meeting the metric (ie, management of open fractures within 24 hours from initial presentation) is encouraged to implement a process in which outliers would be reviewed by the institution’s PI process. The institution determines whether the review is acceptable, then reports the finding to the TQIP. The TQIP-collected data would allow a given institution to be able to compare its statistics with those of other similar institutions. Real data will help the COT and TQIP change expectations and metrics based on these quality metric data, if needed.

A focus of this initial data collection period is to evaluate what the centers are doing and to further define appropriate goals for each of these metrics because the currently established goals may not ultimately be the appropriate standards. Orthopaedic surgeons agree that antibiotic administration within 1 hour of presentation to the ED is in the best interest of the patient with an open fracture.9,10 Until recently, the prevalent belief was that open fractures must be managed emergently with surgical irrigation and débridement. However, studies have shown that antibiotic administration and the quality of surgical débridement are more important than the timing of débridement and that the initial débridement should be performed within the initial 24 hours on an urgent basis, rather than on an emergent basis.11-14 Therefore, the hope is that débridement of open tibial fractures occurs within 24 hours from the time of presentation to the ED. A variety of studies exist with conflicting results on the timing of femoral shaft fracture fixation; however, in patients with isolated femoral fractures, fixation within 24 hours seems to be beneficial.15-19

The ACS was able to collect metrics to assess the quality of orthopaedic trauma surgery; however, the data collected thus far may not be entirely accurate because this was the first time these metrics were collected, and the institutions did not have much lead time to obtain the data. Despite these potential issues, we received data from most of the participating centers that seemed appropriate for what was expected on initial evaluation. Continued collection of these data will improve the assessment of these measures with regard to their suitability for evaluating the quality of orthopaedic care and will aid in identification of cutoff values for the metrics.

Time to antibiotic administration had a large variance in the data from trauma centers of different levels. This variance may indicate a lack of staff education on the importance of early antibiotic administration. Another reason could be that the metric for time to antibiotic administration from arrival at the ED does not account for transfers patients who may have received antibiotics before the transfer; to overcome this problem, it would be helpful for centers to include a range of times that antibiotics were given to help researchers determine whether these numbers are skewed. The maximum time to antibiotic administration was much higher at the level II and III trauma centers than at the level I centers, which may indicate a lack of resources at the level II and III centers.

Time to antibiotic administration clearly improved when a cutoff of 90 minutes instead of 60 minutes was used, and it may be helpful to consider this cutoff in future updates of the guidelines. The early involvement and education of ED personnel and the immediate availability of antibiotics through the ED pharmacy or local automated medication-dispensing systems is crucial for obtaining early antibiotics for open fractures (even before an orthopaedic consultation has even occurred).

There was a large variance in the timeframe for surgical irrigation and débridement of open tibial fractures. This variance was found among trauma centers of different levels and among centers of the same level. The reason for the large range of time to the operating room was unclear. The overall average time was <24 hours, but the standard deviations show that there must be many outliers skewing this data. We also do not have the number of patients treated at each institution. Potential future research could evaluate whether open fracture type correlates with decreased time to the operating room. In addition, database input of other factors that cause delay, such as inadequate operating room space or staff resources, could help to clarify the reasons for the variance, and this information may be used as a platform to increase orthopaedic resources in the future.

Universal stabilization of femoral shaft fractures within 24 hours was not achieved at a trauma center of any level. Specific information on factors related to patient safety and medical status and the availability of surgical staff and facility resources would help to clarify why some patients experienced a delay in fracture fixation. In addition, several centers reported a range of zero or 100% fixation within 24 hours. This range could indicate that certain centers are extremely successful.
(or unsuccessful) in getting patients with femoral shaft fractures to the operating room in a timely fashion, or it may indicate that the centers had a small number of patients included in this analysis, and therefore there were not enough data for an accurate investigation. The specific number of patients included at each center would facilitate further analysis of all of the performance metrics described here.

Conclusions

Our initial results show that the data for three metrics on orthopaedic surgery care (ie, time to administration of antibiotics, time to surgical irrigation and débridement, stabilization of femoral shaft fractures) can be collected successfully and evaluated by the ACS. Additional data collection is required before further analysis can be done to truly decide whether these metrics are suitable for assessing the quality of orthopaedic care and to determine the specific cutoff values for each metric. We found considerable variability not just between levels of trauma centers but also within a particular level. Future research in this area could attempt to link these performance measures to patient outcomes. Currently, only inpatient complications are tracked, but longer-term tracking would be needed to assess orthopaedic outcomes, such as nonunion and function. Additional data collection and analysis of the metrics for orthopaedic trauma care in future studies can provide insight into the performance of ACS-verified trauma centers and facilitate evaluation of how this performance affects patient outcomes.

References

References printed in bold type are those published within the past 5 years.


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