NATIONAL QUALITY FORUM

Trauma Outcomes

DRAFT REPORT FOR COMMENT

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Contents

Executive Summary

A Framework for Measurement

In 2018, the National Quality Forum (NQF) convened a multistakeholder expert Committee to develop a conceptual framework for measuring population-based trauma outcomes and to identify priorities for future measure development. The conceptual framework is intended to facilitate systematic identification and prioritization of measure gaps and to help guide efforts to fill those gaps through measure development and endorsement.

With guidance from the Committee, NQF staff conducted an environmental scan to identify measures related to population-based trauma outcomes and to inform development of the measurement framework. The environmental scan served as the starting point for a series of Committee deliberations outlining the existing state of quality measurement within trauma care, and projecting a path forward to optimize quality outcomes. Over the course of several months, the Committee convened through multiple in-person and web-based meetings, resulting in the consensus-based measurement framework outlined in this report. The framework comprises four domains and 15 subdomains and is summarized in Table 1 below. The Committee also identified measure concepts to address gaps within the framework. Those gaps were grouped into prioritized measurement areas to guide future measure development.

Table 1. Population-Based Trauma Quality Framework

Domain	Subdomain
Access to trauma services	System capacity Availability of services Timeliness of services Resource matching
Trauma clinical care	Acute care Post-acute care Longitudinal care
Cost and resource use	Individual Trauma center System Societal
Prevention of trauma	Engineering Education Legislation Enforcement

Cross-Cutting Themes and Recommendations

Shared Accountability and Attribution

An increasing national focus on population health and the alignment of policies around a comprehensive national quality strategy have contributed to a movement toward shared accountability in healthcare performance measurement. Trauma care is no exception, being well suited to shared accountability approaches. Given the distribution of responsibility across various care settings and the importance of

system-wide planning and coordination to ensure the optimal use of resources and capabilities, the Committee emphasized consideration of measurement at regional levels. Measures that assess the quality and efficiency of care at the regional level may incentivize greater integration of trauma systems and collaboration across sectors. The Committee cautioned that extant data limitations challenge efforts to advance attribution science and to develop and implement broad performance measures reflecting shared accountability. The Committee emphasized further measure development in measures that assess population-level outcomes for regional trauma systems.

Attribution refers to the methodology used to assign patients and their quality outcomes to providers, clinicians, or other accountable entities. The Committee recommended advancing models of attribution that promote improved planning and coordination within regional trauma networks in order to promote shared accountability across relevant stakeholders and accelerate quality improvement in trauma care. The Committee highlighted the potential for these measures to drive coordination and planning in terms of locating trauma centers, deployments of air and ground emergency medical services, and appropriate triage of trauma victims. The Committee cautioned that some measure concepts, particularly those having to do with response time for emergency medical services, should be designed to cross state lines to share accountability broadly. As an example, the Committee advocated evaluating under- or overtriage at the regional level.

Data Sources

In their assessment of measures currently in use within the marketplace, the Committee noted that performance measures to assess trauma outcomes use data sources which can be categorized by their operant level of analysis. These categories include population-level data sets; event-based data sets and registries; and patient-level data sets. Population-level datasets contain large amounts of representative data, often at the national level. Most notably, vital health statistics datasets can be mapped to sociodemographic factors to inform geospatial analyses of trauma. While data provided by population-level datasets are often the least specific to trauma outcomes, these data are broadly and consistently available. Access to registries and patient data contained in proprietary systems such as electronic health records (EHR) may be more specific, but also present some access challenges for quality measurement.

The Committee noted that sufficiently robust datasets are a necessary precursor to developing standardized measures of trauma care quality, as well as identifying effective approaches to risk adjusting those performance measures. The Committee emphasized the importance of combining patient-level data from EHRs with novel sources of data on trauma outcomes such as medical examiner data assets, data from death registries, data from nontrauma centers, and social security data. Data limitations pose a significant challenge to population-level measurement of outcomes; the ability to aggregate data across the prehospital, hospital, and post-hospital settings and link those data to individual patients to track quality over episodes of care remains limited.

Social Determinants of Health, Risk Adjustment, and Equity as a Cross-Cutting Domain

Throughout the deliberations, the Committee reiterated the central place of Equity within the fundamental components of an effective framework through which to analyze trauma outcomes. Performance measure concepts to assess clinician performance should prioritize areas of trauma care that may be most vulnerable to inequity.

A fundamental component of developing and implementing performance measures is an accompanying approach to risk adjustment. Risk adjustments are modifications made to the reported healthcare performance measure result to account for intrinsic patient factors that could influence the clinical outcomes being evaluated. Once developed, quality measure results should be appropriately risk adjusted by race, gender, socioeconomic status, geographic location, and other indicators of social inequities.

The Committee noted a distinction between measures used internally for quality improvement where risk adjustment may not be needed, and measures used externally for benchmarking or other comparative purposes, including assessing population-based trauma outcomes. The Committee advanced several important factors for measure developers to consider when creating an approach to risk adjustment for trauma outcome measures.

The Committee noted that although there is no one way to approach risk adjustment, the approach (or approaches) used should be valid and tailored to what is being risk adjusted, and which entity will be using the measure (e.g., trauma centers or states). The Committee cautioned that risk adjustment approaches should be narrowly tailored to the measures under consideration.

Project Background and Objectives

Intentional and nonintentional injuries resulting in trauma are the third leading cause of death in the United States.[1] Traumatic injuries result in 39 million emergency visits and 12.3 million hospital admissions every year, and trauma is associated with $670 billion in medical expenses in 2013.[2,3] Despite the significant impact of trauma injury on public health, relatively few performance measures have been implemented to improve quality in trauma care. While major progress has been made in trauma care—including improvements in rapid transfer to appropriate care, hemorrhage management, patient stabilization, and resuscitation—performance of trauma systems requires increased attention.[1] Performance measures allow for assessment of trauma care and increased focus on improvement efforts with respect to quality of care. Performance measures may also help in addressing key outcomes within trauma care, such as quality of life, mental health status, rehabilitation, and loss of life.

This work was accomplished over the course of 12 months through one in-person meeting and seven web meetings with the Committee. This report describes the conceptual measurement framework for population-based trauma outcomes and the subsequent systematic identification and prioritization of measure gaps. The Committee hopes that this project will add to the existing body of knowledge around trauma measurement and associated challenges, and spur action in areas of measurement that need additional research and development.

Framework for Trauma Outcomes and Prioritized Measure Concepts and Gaps

Current efforts at measurement in trauma tend to focus on specific parts of the trauma continuum, particularly through gauging individual hospital performance on various metrics. However, there is growing recognition of the importance of population-level measurement of trauma, which can provide a more comprehensive view of system-wide performance, allow for a tailored approach through consideration of risk factors, and a enable a fuller assessment of whether outcomes for injured patients are improving.

Purpose and Limitation of Measure Concepts

NQF distinguishes between a measure and a measure concept. A **measure** is defined as a fully developed metric that includes detailed specifications and may have undergone scientific testing. A fully developed measure identifies what should happen (what is being measured), who should be measured (population), where measurement should happen (setting), when it should happen (time), and how it should occur. A **measure concept** is an idea for a measure that includes a description of the measure, ideally including planned target and population. With this report, the Committee intends to provide guidance to the field on the measurement of trauma outcomes. With this in mind, the Committee has proposed measure concepts and measurement areas for further exploration and development (see Appendix C).The Committee is not recommending specific measures for immediate implementation and use. Note that some measure concepts are rooted in current work, and others are more forward-thinking ideas with little or no existing research.

NQF has a long history of evaluating population-level measures through the NQF measure endorsement process. Population-level measures encapsulate a broad range of quality metrics, spanning virtually every measure type and therapeutic area. Trauma outcome measures are needed within this space in order to shift the focus of quality improvement from the facility to the system level. The Committee identified several concepts for measure development, as well as ideas for potential research. Appendix C includes a comprehensive list of concepts identified by the Committee following the environmental scan. Tables 2 through 5 below summarize concepts thought to be of greatest import for trauma care.

Building on a review of the landscape of trauma measurement, including an environmental scan of existing trauma quality measures, the NQF Trauma Outcomes Committee developed a framework for measurement of trauma quality at a population level. The framework provides a conceptual model for emphasizing the evaluation of trauma care within a population or geographical region, rather than within an individual facility or single part of the system. The purpose of this framework is to guide the conceptualization and development of population-level trauma quality measures through the identification of gaps in measures and measure concepts.

The draft framework (see Table 1) consists of four primary domains, which reflect the major categories that Committee members felt should be addressed through population-level trauma quality measurement. These domains are further divided into subdomains identifying the key components to measure within each of the broader domains.

Table 1. Population-Based Trauma Quality Framework

Domain	Subdomain
Access to trauma services	Capacity of services Availability of services Timeliness of services Resource matching
Trauma clinical care	Acute care Post-acute care Longitudinal care
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Access to Trauma Care

The Committee agreed that access to trauma care is a critical dimension of quality at a population level. Committee members recognized the challenges in defining access, noting that access has been defined in numerous ways, and can be conceptualized across a number of important dimensions. For the

purposes of this report, we define access broadly as *the ability of populations to obtain needed healthcare services in a timely manner*.

This may include whether a geographic region has the infrastructure and capacity to serve the trauma needs of its population; the extent to which specific services or specialists are available; the extent to which patients receive timely access to care; and the extent to which resources are deployed appropriately.

During their discussion on measure concepts for the access to trauma care domain, the Committee provided numerous examples of how access can be measured (see Table 2 below). In order to measure access to trauma centers and specialty services, the Committee proposed metrics for assessing the number of trauma centers per million population, or access to specialty services per million population. These concepts are similar to archived Healthy People 2020 indicators (IVP-8.1: Increase access to trauma care in the United States; and IVP-8.2: Increase the proportion of the land mass of the continental United States with access to trauma care).[4] The access domain also includes concepts related to the availability of emergency medical services (EMS), the levels of trauma care available, and depth of subspecialty providers. With respect to patients and medical providers, access also includes access to assistive medical devices for patients and access to medical technology.

With regard to EMS services, the Committee called out concepts such as timeliness of dispatch and transport, mode of transport, and the impact of geography on access. Committee members pointed out that in addition to rural areas where residents do not have timely access to trauma centers, traffic congestion in large cities can also cause delays in getting the patient to trauma centers. The Committee acknowledged that geography cannot be changed but believed that metrics could be developed to overcome the challenges of geography. For example, availability of trauma services could be measured in ways that resemble practices used by fire departments. Fire response areas are broken out by urban, suburban, and rural regions, allowing fire departments to better understand travel times and road systems between stations and geographic areas. Availability of services could also be measured by proportion of EMS dispatch times that fall within a particular range, availability of air transport, and discovery times and dispatch times in rural areas. Additional concepts centered on delays in transfers to the appropriate trauma center and a measure of compliance to the CDC field triage criteria for trauma.[5]

The Committee emphasized the importance of access to rehabilitation services. As survivability of traumatic injuries increases, so does the importance of measuring patients' access to rehabilitative care. In addition, the Committee believed there is a need to understand the rate at which patients discharged from a trauma center are transferred to an appropriate rehabilitation facility. Future measure development should also consider the role that medical insurance plays in patient access to rehabilitation services and patient outcomes.

While the importance of access to trauma centers in the interest of improved outcomes was a key topic in the framework, the Committee also discussed the need for balancing concepts by ensuring that the use of one measure does not negatively influence the outcomes of another. Committee members provided several examples of potential unintended consequences that some measures could produce. For example, providing over-access to trauma services could have downstream impacts for timely access

to operating rooms, hospital beds, critical procedures, etc. Issues of high capacity and overtriage—or diversion of trauma patients to levels of care that are higher than their needs require—could cause appropriateness of care issues if patients with minimal trauma are cared for by higher level trauma centers. In addition to decreased efficiency in the trauma system, overtriage drives up overall costs. The Committee acknowledged the difficulty in measuring overtriage across regions due to geographic considerations, weather, and other factors.

Table 2. Access to Trauma Care – Concepts

	Description	Subdomain
1	The proportion of population who meet CDC field triage guidelines but did not go to a trauma center	Resource Matching
2	The proportion of population who meet CDC field trauma triage step 1 (physiologic) or step 2 (anatomic) criteria who are transported to the highest level of care in the trauma system	Resource Matching
3	Percent of patients greater than 55 who meet CDC field trauma triage criteria who are primarily transported to a trauma center	Resource Matching
4	Trauma centers per million population	Availability of Services
5	Specialty providers within a given radius of patients based on urbanicity or rurality	Availability of Services
6	Percent of population in a region within one hour of a level 1 trauma center (by ground and/or air)	Availability of Services
7	Percent of population in a region within a 10-minute EMS on scene response time	Timeliness of Services
8	Transport to the appropriate trauma center (for adults and pediatric patients)	Timeliness of Services
9	Inter-hospital transfer rate to level I/II trauma center among seriously injured patients (e.g., ISS >= 16, head AIS >= 3) in a region (under triage)	Resource Matching
10	Proportion of trauma patients in a region that are discharged from a trauma center within 24 hours and proportion of trauma patients in a region that were not seen in the OR/ICU within 24 hours (overtriage)	Resource Matching
11	The proportion of trauma patients who needed rehabilitation services that were transferred to an appropriate site for rehabilitation	Availability of Services

Cost and Resource Use of Trauma Care

Recognizing the public's significant interest in reducing healthcare costs and making care more affordable to employers, government, families, and individuals, the Committee agreed that cost and resource use should be considered a primary domain of measurement with regard to trauma care.

The Committee considered concepts addressing the costs of trauma care at the individual, center, system, and societal level (Table 3). Concepts prioritized by the Committee include adjusted cost of care with aggregated severity, costs to a hospital in sustaining a trauma program, the total cost of injury care over the population, or the cost of injury care per capita, and the cost of disease-specific utilization of services. Another way of assessing the cost of trauma care could be addressed by understanding the mortality and morbidity of specific types of trauma in a population and assessing associated expenses. A

measure of trauma readmissions was also proposed which would measure both the cost and quality of trauma care. NQF endorses several all-cause admissions and readmissions measures; however, none is specific for traumatic injuries.

Concepts for this domain stretched beyond financial costs to provide lifesaving care, and into concepts such as the costs of informal caregiving for those with the most severe injuries, lost productivity and wages, and loss of potential future income. The Committee also believed it was important to consider how lack of insurance and medical debt might affect those suffering traumatic injuries and the cost of trauma care paid for by state or federal governments for underinsured and uninsured patients. The Committee also discussed the cost of care provided when the expectation of survival is low for patients with severe trauma.

When all the actors in the trauma system from first responders to surgeons succeed in saving a life or preventing lifelong physical disability, the Committee stated that the averted costs of dependency and disability could also be measured. The Committee acknowledged that some of these concepts would be difficult to measure at the population level but felt they were important to consider in the measurement framework.

It is widely recognized that the cost of care is more expensive in a trauma center than in a nontrauma center. A recent study measured cost-effectiveness of trauma care using cost per life saved, cost per life-year gained, and cost per quality-adjusted life-year gained from 69 hospitals (18 trauma centers) in 14 states. Researchers found that the cost per life-year saved at a trauma center was $36,319 or $790,931 per life.[6] The Committee also mentioned the cost effectiveness of modes of transport for trauma patients. A recent study determined that a 1.6 percent difference in survivorship between patients transferred by ground (90 percent) and air (91.6 percent) is needed for helicopter transport to be considered cost effective.[7] In order to demonstrate the need for and support for regionalized trauma care systems, the Committee noted that measure concepts in this domain should be paired with outcomes in order to determine the cost effectiveness of care.

Table 3. Cost and Resource Use of Trauma Care – Concepts

#	Description	Subdomain
1	Cost per year of lives saved	Societal
2	Cost and how many lives were saved (stratified based on severity of trauma)	Individual
3	Cost of care per trauma patient for care at a rehabilitation center at local/regional/state level	System
4	Total societal (healthcare, lost wages, etc.) costs per trauma patient at a local, regional, or state level	Societal
5	Work days missed following trauma care due to physical health or mental health issues	Individual
7	Averted costs of dependency and disability	Societal
8	Trauma readmission stratified by type of trauma	System
9	Individual cost of care per trauma patient (by region)	Individual
10	Cost effectiveness of transport (air vs ground)	System

Trauma Clinical Care

This domain comprises what is typically conceived as quality of trauma care, focusing on the extent to which safe, effective, and high-quality clinical treatment is delivered to patients within a given population.

The Committee recognized that the existing conceptualization of the trauma care continuum (from pre-hospital care, to in-hospital care, to post-hospital care) is well-established and remains useful for identifying points of accountability and improvement, and should be represented in the framework somehow.

However, while this model traditionally separates pre-hospital from in-hospital treatment, the Committee wanted to emphasize the importance of achieving greater integration of pre-hospital and hospital care, and therefore combined the pre-hospital and in-hospital phases of treatment into a single subdomain (acute care). Committee members noted that this could encourage evaluation of comprehensive care, rather than care within the traditional silos. The Committee acknowledged that there may be some outcomes or other measures that are more driven by or attributable to one phase of care or another, but they suggested that the overall system ultimately owns the outcomes, and measurement should reflect that.

In addition to measures addressing the quality of acute and post-acute (e.g., rehabilitation) care, this domain is intended to capture longitudinal outcomes of care, such as functional outcomes, return to normal activities, and the like. The longitudinal care subdomain is also intended to include measures assessing care coordination and transitions of care.

Some concepts considered by the Committee were built on existing measures such as population-based mortality and morbidity rates by injury and overall injury rates. These concepts are similar to two retired Healthy People 2020 indicators that looked at the rate of fatal trauma brain injury and spinal cord injury per 100,000 population.[4]

The Committee's approach to measuring long-term outcomes of traumatic injuries focused on whether patients were able to return to their previous level of function and access to rehabilitation services. Committee members then prioritized concepts around rate of patients who return to their previous level of function and—even more specifically based on injury severity—how soon they were able to return to their previous function. The Committee stated that these measures would ideally use standardized time intervals starting at the time of presentation (or time of injury).

The Committee emphasized the importance of care coordination, and suggested that measuring the quality of care transitions would be useful in this domain. One NQF-endorsed measure (NQF 0291) touches on care coordination and feedback by measuring whether required information was shared with the receiving facility within 60 minutes. The Committee also cited Care Coordination Atlas measures, which measure patients' perceived continuity of care across multiple providers and quantify problems of continuity for patients with multiple long-term conditions.[8]

Again, the Committee acknowledged that while not all of these may be feasible at the population level, they would still be important to capture as processes that are linked to patient outcomes. The

Committee also emphasized the importance of collecting data from trauma and nontrauma centers since some trauma patients are seen at nontrauma centers.

Table 4. Trauma Clinical Care – Concepts

#	Description	Subdomain
1	Rate of patients by severity of injury returning to previous level of function within a time period (e.g., 6 months, 1 year)	Longitudinal
2	Population-based mortality rate from injury	Acute
3	Injury rates by specific injury (e.g., spinal cord, traumatic brain injury)	Acute
4	Length of stay at post-acute care facility	Post-Acute
5	Case fatality rate	Acute
6	Percent of patients receiving one year follow-up for functional status	Post-Acute
7	Percent of trauma patients with a need for rehabilitation after discharge from a trauma center who are transferred to an appropriate rehabilitation facility	Post-Acute
8	Percent of trauma patients whose condition improved after EMS care	Acute
9	Injury-based mortality (regional)	Acute
10	Out-of-hospital deaths/deaths in the field	Acute

Prevention of Trauma

The Committee recognized the importance of efforts to prevent traumatic events from happening in the first place, and agreed that prevention merited its own domain of measurement. Table 5 summarizes the concepts that the Committee identified. The Committee considered various options for prevention-related subdomains, including categorizing prevention measures by type of trauma (e.g., intentional, unintentional, other), or by type of preventive effort (e.g., educational, legislative, regulatory, etc.). Committee members wanted to build on existing injury prevention frameworks, and in the interest of identifying population-based concepts, considered outcomes that could be linked back to a variety of subdomains. The Committee did not want to not reproduce efforts by the CDC Injury Prevention Center or resources such as the Haddon Matrix[9,10], but felt strongly that this measurement domain should be in place when considering overall trauma outcomes.

Concepts at the population level included injury hospital admission rates, unintentional and intentional injury rates, legislation for the use of bicycle helmets and safety seats, and concepts around injury, disability, and death by firearm. The Committee noted that measuring injury hospitalization rates by county could be beneficial in that it could begin the conversation as to why these rates might be higher in one county than in another. Such efforts could then allow for the evaluation of what injury prevention programs are happening, how they are performing, and so on.

The previously mentioned concepts are also similar to current indicators reported by the District of Columbia. For example, DC Health Matters reports several indicators at the city level, by ward, ZIP code, census tract, and at the hospital level.[11] One indirect measure of community-based prevention focuses on age-adjusted death rates due to unintentional injuries, and includes motor vehicle collisions, poisoning, and falls as the major injury categories. This metric is also in line with the Healthy People 2020's goal to reduce deaths caused by unintentional injuries. DC Health Matters also includes a metric focusing on teens injured with a weapon at school. These are just two examples of concepts noted by

the Committee that are in practice and could be modified for measuring the outcomes of high-quality trauma care.

The Committee also proposed concepts targeting motor vehicle crash related deaths by miles traveled, also similar to a Healthy People 2020 indicator.[4] The Committee then noted that even design of highways to reduce traffic accidents can be seen as an environmental response to reduce motor vehicle accidents and thus could help reduce traumatic injuries.

In addition to population-based measures, the Committee stated that processes closely linked to outcomes are important to consider. Just as tissue Plasminogen activator (TPA) is critical for ischemic stroke, the Committee believed that processes of care such as hemorrhage control and use of tourniquets are especially important to trauma outcomes. Such processes could also be built out to population-based measures. For example, alcohol screening and brief intervention performed at the clinical level could be rolled up into a community-wide measure of the prevalence of alcohol consumption in a county or region. This measure could then be combined with other data to make predictions around motor vehicle crashes and alcohol consumption.

Table 5. Prevention of Trauma – Concepts

#	Description
1	Injury hospital admissions rates for population reflect prevention
2	Population-level unintentional injury rate
3	Population-level intentional injury rate
4	Death by firearm
5	Accidental firearm injury in children
6	Disability by firearm injury
7	Head injury by firearm
8	Highway design
9	Hemorrhage control
10	Use of tourniquets

Measurement Gaps

In general, the Committee noted the absence of population-based trauma outcomes as described in the environmental scan report. Specifically, the Committee called out the importance of developing patient-reported outcome (PRO) measures for trauma care as more patients are surviving traumatic injuries. The Committee acknowledged the many measurement tools identified in the environmental scan (e.g., Short Form 36) but felt that uniform use of PRO tools could provide valuable information for trauma outcomes research.

The Committee also emphasized the importance of measures that are sensitive to specific subpopulations such as pediatric and geriatric patients, in particular, around triage. Consideration must also be given for measures that address the difference in care and availability of services for patients in rural areas. Many of the concepts included could be specified to focus on particular age groups and the care delivered in rural environments.

Cross-Cutting Themes and Recommendations

Shared Accountability and Attribution

The movement toward shared accountability in healthcare is reflected in the emergence of new care models such as accountable care organizations, integrated delivery networks, and patient-centered medical homes. Shared accountability is the notion that a wide range of stakeholders may contribute to patient outcomes, and that performance measures should encourage integration and coordination across settings and providers to ensure that high-value, patient-centered care is being delivered across the continuum of care. Performance measurement in healthcare has generally focused on the performance of distinct accountable units such as individual clinicians, practices, or larger facilities to hold providers responsible for adhering to best practices and achieving positive outcomes for patients who are in their direct care at any point in the care episode.

Trauma care is well suited to shared accountability approaches, given the distribution of responsibility across various groups and the importance of system-wide planning and coordination to ensure the optimal use of resources and capabilities.[1] Stakeholders are increasingly recognizing that "regionalization"—establishing organized networks to deliver care to populations within defined geographical areas—is likely to be critical for quality improvement in emergency and trauma care.[12,13] Measures that assess the quality and efficiency of care at the regional level may incentivize greater integration of trauma systems and collaboration across sectors. The Committee emphasized that although patient populations are not homogenous, important findings from the implementation of performance measures can lead to meaningful improvements in patient outcomes. However, the Committee cautioned that extant data limitations challenge efforts to advance attribution science and to develop and implement broad performance measures reflecting shared accountability.

The measures identified in the environmental scan largely focus on individual aspects of the trauma care continuum (e.g., EMS agencies, hospitals/trauma centers, etc.). Several measures and concepts can be applied at the state level, and may serve as potential examples of measuring system capacity at a population level, but these measures do not allow for evaluation, comparison, and benchmarking between regional trauma networks. The scan did not identify any measures that assess population-level outcomes for regional trauma systems. Consequently, the Committee emphasized further measure development in these areas.

However, the scan did identify two measures that may serve as a model for eventual adaptation of other measures for use in evaluating regional trauma systems. Community viral load (CVL) is an example of a population-based measure aimed at understanding the quality of care in a defined community. To calculate CVL, viral loads of all HIV-infected persons are aggregated and then used in the monitoring of HIV treatment and its impact on HIV transmission.[14] Low CVL may indicate good uptake of HIV treatment and can provide estimates on HIV incidence. CVL serves as a model metric for measuring population-based outcomes, although it has its limitations, including selection and measurement of viral load, among others.[14] In addition, efforts by the Resuscitation Outcomes Consortium (ROC) have been successful in studying regional variations in survival of out-of-hospital cardiac arrests (OOHCA) across EMS systems.[15] The ROC effort used the Epistry Cardiac Arrest registry to study all out-of-hospital

cardiac arrests from 11 sites in the U.S. and Canada and found significant variation in the incidence of OOHCA and associated outcomes. While both CVL and the research conducted by ROC have limitations, both of these approaches can serve as examples of how to approach measurement and improvement of population-based trauma outcomes.

Moreover, there is currently no standard way of defining regional trauma networks and attributing patients to those networks for measurement purposes.[16,17] Attribution refers to the methodology used to assign patients and their quality outcomes to providers, clinicians, or other accountable entities.[18] Glickman and colleagues suggest potential approaches to defining emergency care networks for measurement purposes, including the use of geographical boundaries, market-based health referral regions, or government-defined hospital service areas.[16] Carr and colleagues also propose a method for "clustering" hospitals together based on patient use patterns, and suggest that these groupings could serve to define and attribute geographical populations for measurement of emergency care, including trauma.[19] In addition, other initiatives focused on regional coordination of emergency care, such as the federal Hospital Preparedness Program (HPP)—which supports the development of regional healthcare coalitions to improve preparedness for public health emergencies—could provide examples of how regional trauma systems could be defined for measurement purposes.[20] The Health Preparedness Program assesses participating healthcare coalitions on structural and process measures focused on system readiness and adequacy of planning, and some of these measures could potentially be modified or adapted to assess regional trauma system readiness.[21]

The Committee recommended advancing models of attribution that promote improved planning and coordination within regional trauma networks in order to promote shared accountability across relevant stakeholders and accelerate quality improvement in trauma care. The Committee highlighted the potential for these measures to drive coordination and planning in terms of locating trauma centers, deployments of air and ground emergency medical services, and appropriate triage of trauma victims.

The Committee cautioned that some measure concepts, particularly those having to do with response time for emergency medical services, should be designed to cross state lines to share accountability broadly. As an example, the Committee advocated evaluating under- or overtriage at the regional level.

Data Sources

In their assessment of measures currently in use within the marketplace, the Committee noted that performance metrics to assess trauma outcomes use data sources which can be categorized by their operant level of analysis. These categories include population-level data sets; event-based data sets and registries; and patient-level data sets.

Population-level datasets contain large amounts of representative data, often at the national level. Most notably, vital and health statistics datasets can be mapped to sociodemographic factors to inform geospatial analyses of trauma. While data provided by population-level datasets are often the least specific to trauma outcomes, they are broadly and consistently available. Additionally, population-level datasets are typically slow to be updated. One example of such a dataset, repeatedly cited by the Committee, is the Fatality Analysis Reporting System (FARS). A product of the National Highway Traffic

Safety Administration, FARS is a nationwide census intended to supply both Congress and researchers public yearly data on fatal injuries suffered in motor vehicle traffic accidents. However, as is inherent in the database design, data available are not generalizable to other accident types or nonfatal trauma.

The Committee noted that sufficiently robust datasets are a necessary precursor to developing standardized measures of trauma care quality, as well as identifying effective approaches to risk adjusting those performance measures. The Committee emphasized the importance of combining patient-level data from EHRs with novel sources of data on trauma outcomes such as medical examiner data assets, data from death registries, data from nontrauma centers, and social security data. Data limitations pose a significant challenge to population-level measurement of outcomes; the ability to aggregate data across the prehospital, hospital, and post-hospital settings and link those data to individual patients to track quality over episodes of care remains limited.

Event-based datasets move towards a finer level of detail that is specific to trauma. Two examples are the National Trauma Data Bank (NTDB), an aggregation of trauma registry data and the National Emergency Medicine Services Information System (NEMSIS), which collects data from state EMS systems using a standard data element model. The data are stored by event, without patient identifiable information, so it is not possible to differentiate between a single patient with multiple events or multiple patients with a single event. Despite the specificity of the data, it is subject to bias as not all institutions submit all cases. Moreover, the Committee noted that important information about disparities is not generally captured to a sufficient degree of specificity in these data resources. The Committee reiterated that sufficiently robust datasets are a necessary precursor to developing effective approaches to risk adjusting performance measures.

At the most granular level, patient-level data are available in the forms of EHR data, claims data, and even paper records. These data are commonly used to evaluate outcomes and calculate quality measures. Patient-level data provide the greatest opportunity for meaningful improvement. On the other hand, patient-level data are not interoperable, and lack standardization across EHR vendors or even within the same EHR vendor. The Committee emphasized the importance of combining these sources with novel sources of data on trauma outcomes, including medical examiner data and data from death registries.

Social Determinants of Health, Risk Adjustment, and Equity as a Cross-Cutting Domain

In the course of deliberations, the Committee reiterated the central place of Equity within the fundamental components of an effective framework through which to analyze trauma outcomes. Performance measure concepts to assess clinician performance should prioritize areas of trauma care that may be most vulnerable to inequity. Within quality measurement, this inequity is addressed through risk adjustment of the measurement outcome. The Committee advanced several important factors for measure developers to consider when creating an approach to risk adjustment for trauma outcome measures.

Risk adjustments are modifications made to the reported healthcare performance measure result to account for intrinsic patient factors that could influence the clinical outcomes being evaluated. It is

accepted practice to adjust for differences in patient severity of illness before the episode of care begins in order to account for a reasonable increase in expected poorer outcomes in less healthy patients, for reasons that have no bearing on the clinician or facility's performance. Although adjustment for socioeconomic status and other patient characteristics such as race, ethnicity, and gender is more controversial, empirical relationships suggesting disparities in care have been demonstrated.

The Committee noted a distinction between measures used internally for quality improvement, where risk adjustment may not be needed, and measures used externally for benchmarking or other comparative purposes, including assessing population-based trauma outcomes where "detailed knowledge of factors that affect the outcome of interest, (such as patient age, injury severity, and co-morbid status)" are important components of a valid performance measure.[22] Existing trauma outcome measures use race, comorbidities, and transfer status, in addition to a variety of clinical factors such as blood pressure, pulse, or the presence of a spinal injury. However, a review of 286 publications using data from the NTDB indicated that as many as 43 percent did not follow these best practices in evaluating trauma outcomes.[23]

The Committee advanced several important factors for measure developers to consider when creating an approach to risk adjustment for trauma outcome measures:

- Social factors (e.g., ZIP code)
- Physical factors (e.g., type of injury and severity of injury)
- Mental health factors (e.g., pre-existing mental illness)
- Access to care (i.e., rurality and timeliness)
- Hospital interventions
- Surgical interventions
- Level of the trauma center
- Patient insurance status

The Committee noted that although there is no one way to approach risk adjustment, the approach (or approaches) used should be valid and tailored based on what is being risk adjusted, and which entity will be using the measure (e.g., trauma centers or states). The Committee stated that system-wide risk adjustment would not be an acceptable approach, since it could hide important long-term patient health status outcomes (e.g., access to rehabilitation services) or other information deemed important by personnel involved in trauma care. Committee members also noted that mortality should not be an overall outcome for trauma measurement since some specialties (e.g., neurology) may differ on what is the best outcome for trauma patients.

Conclusion

The ultimate goal of trauma care is to ensure that patients receive the right care at the right time. This means patients are treated quickly at the appropriate facility based on their injuries. Research has shown that when trauma care systems work together and coordinate with other facilities, population-based outcomes have improved.[24]

With this in mind, the Committee designed a measurement framework that can be used to address the measurement and improvement of population-based trauma outcomes. The final measurement framework takes into account patients' access to care from timeliness of EMS response to rehabilitation, outcomes for patients as they are treated across the trauma care continuum, financial and nonfinancial costs of this care, and prevention efforts to reduce traumatic events. Equity and quality of care are both intrinsic to the Committee's framework—trauma patients of all ages and backgrounds, whether they live in large cities or rural towns, deserve high-quality trauma care.

The Committee developed a comprehensive measurement framework for measuring trauma outcomes and identifying measures and measurement gaps for this area. Although some of the concepts address processes of care, and others could be difficult to implement, they provide a starting point for the measurement developer community, researchers, clinicians, and EMS providers to come together to capture trauma outcomes.

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Appendix A: Committee Members, NQF Staff, and Federal Liaisons

Committee Members

Carol Immermann, BSN, RN
Nursing Manager, Trauma, Critical Care and General Surgery, Mayo Clinic
Rochester, MN

Avery Nathens, MD, MPH, PhD, FACS
Medical Director, ACS Trauma Quality Programs, American College of Surgeons
Chicago, IL

Robert Bass, MD, FACEP
Director Emeritus, Maryland Institute for EMS Systems
Annapolis, MD

Derek Bergsten, Paramedic, CFO, CEMSO, CTO
Chief, Rockford Fire Department
Rockford, IL

Bryan Collier, DO
Section Chief of Acute Care Surgery; Medical Director of Trauma and Surgical Critical Care, Carilion Clinic
Roanoke, VA

Joseph Cuschieri, MD
Professor of Surgery, Harborview Medical Center, University of Washington
Seattle, WA

James Eubanks, MD, FACS
Chief, Division of Pediatric Surgery, Le Bonheur Children's Hospital
Memphis, TN

Alexander Garza, MD, MPH
Chief Quality Officer, SSM Health
St. Louis, MO

Michael Gonzalez, MD, FACEP, FAAEM
Associate Medical Director, Emergency Medical Services, Houston Fire Department
Houston, TX

Adil Haider, MD, MPH, FACS
Kessler Director, Center for Surgery and Public Health at Brigham and Women's Hospital, Harvard Medical School
Boston, MA

Kurt Hoppe, MD
Consultant, Mayo Clinic
Rochester, MN

Elliott Haut, MD, PhD, FACS
Associate Professor of Surgery, Anesthesiology & Critical Care Medicine, and Emergency Medicine, Johns Hopkins University School of Medicine
Baltimore, MD

Gregory Hawryluk, MD, PhD, FRCSC
Assistant Professor of Neurosurgery, University of Utah
Salt Lake City, UT

David Livingston, MD
Wesley J. Howe Professor, Chief of Trauma and Surgical Critical Care, Rutgers New Jersey Medical School
Newark, NJ

Barry Markman, MD, MBA, FACS
Senior Medical Director Medicaid, Aetna
Las Vegas, NV

Linda Melillo, MA, MS, CPHRM, CPXP
Olanta, PA

Anna Miller, MD, FACS
Associate Professor, Washington University Orthopaedics
St. Louis, MO

Sage Myers, MD, MSCE
Assistant Professor of Pediatrics, Children's Hospital of Pennsylvania
Philadelphia, PA

Craig Newgard, MD, MPH
Professor of Emergency Medicine, Oregon Health & Science University
Portland, OR

Jack Sava, MD
Regional Vice Chair for Education; Regional Chief, Trauma/Burns; Program Director, General Surgery, MedStar Washington Hospital Center
Washington, DC

Andrew Schrag, MBA, MA, LPCS
Regional Director of Community Operations, Partners Behavioral Health Management
Hickory, NC

David Seidenwurm, MD, FACR
Quality & Safety Director, Sutter Health Group
Sacramento, CA

Theresa Snavely, MSN, RN
Manager of Performance Improvement, Pennsylvania Trauma Systems Foundation
Camp Hill, PA

Peter Thomas, JD
Principal, Powers Law Firm
Washington, DC

Garth Utter, MD, MSc
Professor, University of California, Davis School of Medicine
Sacramento, CA

NQF Staff

Elisa Munthali, MPH
Senior Vice President, Quality Measurement

John Bernot, MD
Vice President, Quality Measurement Initiatives

Andrew Lyzenga, MPP
Senior Director

Samuel Stolpe, PharmD, MPH
Senior Director

Christy Skipper, MS, PMP
Senior Project Manager

Jean-Luc Tilly
Senior Manager, Data Analytics

Vaishnavi Kosuri, MPH
Project Analyst

Federal Liaisons

Nina Heggs
Centers for Medicare and Medicaid Services

Brendan Carr, MD, MA, MS
HHS Office of the Assistant Secretary for Preparedness and Response

Appendix B: Environmental Scan Report

Introduction

Traumatic injuries (both non-intentional and intentional) are the third leading cause of death in the United States, and in the aggregate, these injuries cause more premature death than any other illness or disability.[1] Traumatic injuries are a major public health concern accounting for 39 million emergency department visits and 12.3 million hospital admissions annually, and they were among the highest condition-related expenditure among adults ages 18-64 in 2012 and were also associated with approximately $670 billion in medical expenses and lost productivity in 2013.[2,3] Further, studies have found that trauma disproportionately affects the young and estimated that 20 percent of trauma deaths were survivable.[4] In addition to loss of life, rehabilitation, quality of life, and mental health status are also key outcomes of interest in trauma care.

The 2016 report by a committee of the National Academies of Medicine (NAM), *A National Trauma Care System: Integrating Military and Civilian Trauma Systems to Achieve Zero Preventable Deaths After Injury*, offered 10 recommendations to help achieve high-quality trauma care on a national level.[1] Two recommendations that are relevant to this work called for a "designated locus of responsibility and authority" to be held accountable for developing a national approach to improve care for trauma patients. The committee also called for governmental, private, and academic partners to work together to collect and share data across the trauma continuum of care to help identify measures that assess the quality of trauma care.

Despite the magnitude and expense of traumatic injuries, few performance measures address the quality of trauma care. While gains have been made in trauma care including better patient stabilization, rapid transfer to appropriate care, resuscitation, and management of hemorrhage, how trauma systems perform as a whole is understudied.[1] Performance measures provide an opportunity to assess key aspects of care for specific conditions or settings of care and identify levers and areas where focused attention can promote improvement in the quality of care. The 2016 NAM Committee noted the absence of standard, national metrics for trauma care, and called for further development of measures in this area.

Measurement related to trauma care presents unique challenges, including risk adjustment and attributing performance across the trauma care continuum, including prehospital care (e.g., emergency medical services and coordination of patient transport) and post-acute care (e.g., rehabilitation). Accountability for trauma care is challenging since leadership can be assigned to states, counties, and cities with minimal federal oversight.[1] Responsibility for patient care and patient outcomes is distributed among multiple stakeholders, including regional and community entities. Measures that promote shared accountability, such as population-level measures, may help to drive greater integration of care and system-wide improvement.

Project Purpose, Scope, and Approach

The National Quality Forum (NQF), with funding from the Department of Health and Human Services (HHS), convened a multistakeholder Trauma Outcomes Committee (Appendix A) to provide input and

guidance on the identification of developed measures and concepts addressing population-based trauma outcomes. Results of the scan will be used to produce a measurement framework to help identify areas for measure development and gaps in trauma care. This measurement framework will help to conceptualize measurement strategies related to the quality of trauma care and to address related issues, such as level of analysis, attribution, and risk adjustment. NQF will also issue a final report summarizing the results of the final environmental scan, the measurement framework, the multistakeholder committee's discussion on population-based measurement of trauma care and strategies for future quality measurement efforts related to trauma care.

This work will be accomplished over the course of 12 months through one in-person meeting, and up to seven web meetings with the Committee. Key informant interviews may also be used to obtain additional expert insight not otherwise identified in publicly available sources. This project will add to the existing body of knowledge around trauma measurement and associated challenges, and spur action in areas of measurement that need additional research and development.

Environmental Scan Strategy

With parameters established in consultation with the HHS Government Task Lead (GTL), the Contracting Office Representative (COR), and the Committee, NQF staff completed an environmental scan of measures and measure concepts to address population-based trauma outcomes. Upon completion of the environmental scan, NQF staff gathered the information and used it to identify measurement gaps. The Committee used the analysis to: (1) provide input and direction on the development of a conceptual framework for analyzing measures to improve the quality of trauma care and (2) identify measurement gaps.

NQF used the search terms outlined in the subsection below and the search parameters (Appendix C). Note that search words were combined with terms like "measure," "measurement," "survey," "scale," etc. to help identify relevant measures. Information sources were identified through various resources such as PubMed, as well as grey literature and web searches through Google Scholar to identify reports, white papers, and other documentation related to trauma care and traumatic injuries.

NQF staff initially reviewed abstracts and articles that were relevant to the operational definition and research questions, synthesized the sources, and compiled a list of measure concepts related to trauma care (Appendix B).

For the environmental scan, NQF staff identified 90 measures from the NQF Quality Positioning System, the Centers for Medicare & Medicaid Services Measures Inventory, HEDIS, the National Trauma Databank, and several other measure inventories. Out of the 90 identified measures, 49 measures were included in the scan. Measures were excluded due to duplication, irrelevance to trauma outcomes, or listing of traumatic injuries as exclusions in the measure specifications. With input from the Committee and NQF members, 238 measure concepts were identified.

Purpose and Limitations of Measure Concepts

NQF distinguishes between a measure and a measure concept. A **measure** is defined as a fully developed metric that includes detailed specifications and may have undergone scientific testing. A fully developed measure identifies what should happen (what is being measured), who should be measured (population), where measurement should happen (setting), when it should happen (time), and how it should occur. It is important to note that the Committee is not recommending specific measures for immediate implementation and use. A **measure concept** is an idea for a measure that includes a description of the measure, ideally including planned target and population. Note that some measure concepts are rooted in current work, and others are more forward-thinking ideas with little or no existing research.

Characteristics of Good Measures

To receive NQF endorsement, measures must meet four criteria: important to measure and report, scientific acceptability, usability and use, and feasibility. As measures related to trauma outcomes are developed, these criteria may guide measure developers as they work to specify and test measures. The first criterion, **important to measure and report**, aims to keep measurement focused on high-priority areas with strong evidence that measurement can have a positive impact on healthcare quality. The **scientific acceptability** criterion assesses whether the measure, when implemented, will produce consistent (reliable) and credible (valid) results about the quality of care. Measures are also assessed for whether they are **usable and relevant**—that is whether the intended users of the measure can understand the measure results and use them in a meaningful way. Finally, the **feasibility** criterion assesses whether data needed for the measure are readily available and retrievable without undue burden.

Findings: Measures, Concepts, Tools

As previously mentioned, the NAM report called on government, private, and academic agencies to work together to collect and share data to develop measures that address the continuum of trauma care. Measures should include structure, processes, outcomes, access and patient experiences from the point of injury, the emergency department, in-patient care, through rehabilitation. A thorough review of more than 300 measures and concepts identified in the scan resulted in the final list included in Appendix B. Measures and concepts were removed from the inventory if they were not specifically focused on trauma (e.g., general fall prevention measures or care coordination measures) and if the measure specifications included trauma as an exclusion.

Measures

The environmental scan included 49 measures, including seven NQF-endorsed measures. Measures were found in the Centers for Medicare & Medicaid Services measure inventory and in registries maintained by the American College of Surgeons and the American College of Emergency Physicians and several others. Of the 49 measures identified, 25 are process measures, 12 are outcome measures, nine are structural measures, and three are efficiency measures. Measures focused on the timeliness of transport to trauma centers, timeliness of intervention for hemorrhage and venous thromboembolism prophylaxis, pain assessment for the injured patient, utilization of emergency department resources,

and information sharing between hospitals. Eight patient safety indicators were also included at the request of the Committee. While certain process measures are key to assess critical processes like transfer of a patient to a trauma center in a timely manner, this assessment does not guarantee that the patient received high-quality care. More outcome measures are needed to assess the quality of trauma care.

Table 1 and Table 2 detail measures by data source and level of analysis, respectively. As expected, most of the measures identified are computed via registry, followed by electronic health record and electronic health data, and paper records. Multiple data sources marked "other" included survey data, hospital licensure and regulation data, and management data. With regard to level of analysis, most measures were specified at the facility level, followed by states and EMS organizations in a state or region. Level of analysis was unknown or unavailable for five measures.

Table 1. Measures by Data Source

Data source	# of measures
Registry	14
Claims	12
Electronic health record/ electronic health data	7
Paper records	6
Other	11

Table 2. Measures by Level of Analysis

Level of analysis	# of measures
Facility	22
State	9
EMS system	4
Clinician: group/practice	10
Unknown	5

Measures were also categorized using the conceptual model used by Stelfox et al. where measures were segmented into one of four categories: prehospital, hospital, posthospital, and secondary prevention (Table 3).[5] Note that the structural measures identified were not included in this table. Similar to findings by Stelfox et al., a majority of the measures identified in this project were for processes and outcomes occurring in the hospital setting.[5] Topic areas included in the hospital category included efficiency, resource utilization, and appropriate use or avoidance of use.

Three measures addressed patient preferences such as palliative care and advance care plans. Five previously endorsed NQF measures described the timing of information shared from the transferring hospital to another healthcare facility. Two mortality measures, one imaging measure, one timeliness measure, and one nonoperative management measure were also included in the inventory. The prehospital measures focused on pain assessment (two measures), pain management (one) and patients transported to trauma centers (one). The sole injury prevention measure addressed alcohol screening in the emergency room.

Table 3. Measures by Where Measurement Occurs

Where measurement/intervention occurs	# of measures
Prehospital	4
Hospital	35
Posthospital	0
Secondary prevention	1

Measure Concepts

More than 200 concepts were identified in the scan. Most concepts contained a proposed topic or title, but many lacked detailed descriptions and detailed information on target populations, how to construct and calculate the measure, and other pertinent information. Concepts were pulled from various sources including from the Eastern Association for the Surgery of Trauma (EAST), the American College of Surgeons Trauma Quality Improvement Program (ACS TQIP), and the literature. Of the 238 concepts identified, 39 were duplicative of other concepts, or there was a fully developed measure based on the concept. From the ACS TQIP guidelines, 56 concepts were identified and 46 were based on EAST guidelines. Note that some guidelines encompassed several protocols that could be developed into individual concepts, but they are not listed in the inventory. Twelve concepts were pulled from the Victorian State Trauma System, and 11 concepts were based on indicators outlined in HHS Health Resources and Services Administration (HRSA) Model Trauma System Planning and Evaluation handbook.[6] Although some guidelines documented varying levels of evidence, they may still provide a path forward to measure and improve trauma outcomes.

Six additional concepts were gathered using data elements collected in the National Trauma Data Bank, five from deliberations at the Hartford Consensus meetings, five from the American Association of Blood Banks (AABB), and two from the Tactical Combat Casualty Care (TCCC) guidelines. The Hartford Consensus meetings were held after the mass shooting at Sandy Hook Elementary School to develop strategies to increase survivability following these events.[7] Some of the metrics to evaluate the effectiveness of their strategy, THREAT (threat suppression; hemorrhage control; rapid extrication to safety; assessment by medical providers; transport to definitive care), were included in this scan as applicable. Patient blood management standards from the AABB were included since they can help guide the transfusion decision making process, decrease blood loss, and reduce the waste of blood products.[8] The TCCC prehospital guidelines used in the military were also consulted and included as applicable.[9]

Concepts addressed indicators that could evaluate the status of trauma systems and specific populations, such as geriatric and pediatric patients, and for specific injuries or conditions including orthopedic trauma, traumatic brain injury, massive transfusion, and hepatic injuries among others. Similar to the findings of a mixed methods study for trauma indicators, the majority of concepts found focused on specific injuries or populations which limits the broad application of the concepts for population-based trauma outcomes.[10] General palliative care concepts and those that addressed specific injuries (e.g., spinal cord injury) and special populations (e.g., pediatric) were also included.

In the literature, 19 concepts (four were removed as they were duplicative of other concepts) were identified in Gruen et al. addressing elements across the trauma care continuum including dispatch criteria, prehospital deaths, triage and transfer, activation of trauma protocols, screening for alcohol and drug use for alcohol or drug related injuries, access to rehabilitation facilities, and return to work.[11] Newer concepts were also discussed including trauma team efficacy,[12] missed injuries,[13] and compliance with specific protocols including trauma team activation,[14] hemorrhage control and anticoagulation, and compliance to trauma alerts.[15] Concepts identified from the international community included hospital survival rates and probability of survival,[16] and destination compliance, discharge status, and major trauma ICU mechanical ventilation hours.[17]

As stated previously, most of the measure concepts had varying levels of evidence or had no evidence base, and the scan did not identify any measures or concepts that assess population-level outcomes for regional trauma systems. Further research is needed to determine the concepts that should be further developed.

Instruments, Scales, and Tools

Although this work specified that performance measures and concepts should be included, the Committee also identified 61 instruments, tools, or scales that measured other outcomes important for trauma survivors including quality of life, disability, and mental health. Several tools measured quality of life (e.g., SF-12, SF-36, and trauma-specific quality of life (T-QoL), patient-reported outcomes (e.g., Beck's Depression Inventory, Spinal Cord Independence Measure), and longer-term outcomes (e.g., Glasgow Outcome Scale – Extended, European Quality of Life 5D). Scales for populations (e.g., pediatric), and clinical areas (e.g., musculoskeletal) and for patients with ongoing rehabilitation needs were also included (e.g., Rehabilitation Complexity Scale). Although NQF does not consider these individual instruments and scales to be standalone measures, measures could be developed from them. For instance, NQF 0712 *Depression Utilization of the PHQ-9 Tool*, is an example of a measure developed based on a validated instrument.

Findings: Risk Adjustment

Risk Adjustment in Measures

Of the measures identified in the environmental scan, five included a risk adjustment model:

- ACSTrauma2 Mortality Rate Following Blunt Traumatic Injury to the Chest and/or Abdomen
- ACSTrauma3 Mortality Rate Following Penetrating Traumatic Injury to the Chest and/or Abdomen
- ACSTrauma4 Splenic Salvage Rate
- PSI 14 Postoperative Wound Dehiscence

For the ACS trauma measures, the risk adjustment includes race, comorbidities, and transfer status, in addition to a variety of clinical factors such as blood pressure, pulse, or the presence of a spinal injury. PSI 14 and one other untested measure concept of cost of treating intracranial hemorrhage or cerebral infarction, included a risk adjustment methodology with unspecified parameters.

The National Surgical Quality Improvement Program and Trauma Quality Improvement Program use a risk adjustment methodology to identify differences between hospitals, generally based on outcome measures of mortality, complications, and cost. Recent publications have suggested applying a similar framework to the assessment of emergency general surgery patients.[18]

Gruen et al.[11] identified a risk-adjusted mortality measure for head injuries as a potential measure concept, while highlighting that such a measure does not yet exist. Gruen et al. also draws a distinction between measures used internally for quality improvement, where risk adjustment may not be needed, and measures used externally for benchmarking or other comparative purposes, including assessing population-based trauma outcomes where "detailed knowledge of factors that affect the outcome of interest, (such as patient age, injury severity, and co-morbid status)" are important components of a valid performance measure.[11]

Covariates Used and Discussion

In some aspects of trauma care, such as hip fracture mortality assessment, efforts such as Jiang et al.[19] to create a risk adjustment model were successful, identifying factors such as age, gender, and some co-morbidities as strong components of a model of mortality. Other published approaches to risk adjustment for mortality follow a similar approach,[18,20,21] including a seminal effort based on the National Trauma Data Bank Registry.[22] After reviewing 106 possible covariates, the researchers found that just six covariates—age, hypotension, pulse, the total Glasgow Coma Scale (tGCS), Injury Severity Score, and need for ventilator use—were sufficient to develop a multivariate model with strong predictive power of mortality. However, a review of 286 publications using data from the NTDB indicated that as many as 43 percent did not follow these best practices in evaluating trauma outcomes.[23]

Gruen et al.[11] and other works critiquing extant risk adjustment approaches concentrate on risk adjustment based on clinical factors, but do not address risk adjustment on the basis of sociodemographic status. Other critiques of existing risk adjustment models are based on the use of the GCS motor component (mGCS) at admission; Gomez et al.[24] note that while it is extensively used as a covariate for risk adjustment models used in external benchmarking programs,[25] it does not reflect the effect of possible confounders, and they suggest the highest mGCS score as a supplemental covariate. Their research shows incorporating this new factor results in stronger model performance. Others have suggested increasing the statistical sophistication of the modeling approaching to address volume concerns and the discriminatory power of models.[26]

Other criticism has been directed at the Injury Severity Score (ISS) and the trauma and injury severity score (TRISS), reproaching the score for insufficient predictive power of mortality. Alternatives have been proposed, including the Trauma Risk Adjustment Model (TRAM)[27] and the TMPM (Trauma Mortality Prediction Model).[28] The TRAM includes adjustments such as inclusion of body region and counting the number of comorbidities. The TMPM relies on an empirical analysis of the severity of injuries classified in the Abbreviated Injury Scale (AIS), rather than expert opinion.

Findings: Shared Accountability and Attribution

Measurement in healthcare has traditionally focused on the performance of individual facilities or practices, seeking to hold providers responsible for adhering to best practices and achieving positive outcomes for patients who are in their direct care. However, with the emergence of accountable care organizations and an increasing focus on population health, there has been a movement toward shared accountability in measurement. Shared accountability is the notion that a wide range of stakeholders may contribute to patient outcomes, and that performance measures should encourage integration and coordination across settings and providers to ensure that high-value, patient-centered care is being delivered across the continuum of care.

Trauma care is well suited to shared accountability approaches, given the distribution of responsibility across various groups and the importance of system-wide planning and coordination to ensure the optimal use of resources and capabilities.[1] Stakeholders are increasingly recognizing that "regionalization"—establishing organized networks to deliver care to populations within defined geographical areas—is likely to be critical for quality improvement in emergency and trauma care.[29,30] Measures that assess the quality and efficiency of care at the regional level may incentivize greater integration of trauma systems and collaboration across sectors.

Community viral load (CVL) is an example of a population-based measure aimed at understanding the quality of care in a defined community. To calculate CVL, viral loads of all HIV-infected persons are aggregated and then used in the monitoring of HIV treatment and its impact on HIV transmission.[31] Low CVL may indicate good uptake of HIV treatment and can provide estimates on HIV incidence. CVL serves a model metric for measuring population-based outcomes, although it has its limitations, including selection and measurement of viral load, among others.[31] In addition, efforts by the Resuscitation Outcomes Consortium (ROC) have been successful in studying regional variations in survival of out-of-hospital cardiac arrests (OOHCA) across EMS systems.[32] The ROC effort used the Epistry Cardiac Arrest registry to study all out-of-hospital cardiac arrests from 11 sites in the U.S. and Canada and found significant variation in the incidence of OOHCA and associated outcomes. While both CVL and the research conducted by ROC have limitations, both of these approaches can serve as examples of how to approach measurement and improvement of population-based trauma outcomes.

The measures identified in the environmental scan are focused largely on individual aspects of the trauma care continuum (e.g., EMS agencies, hospitals/trauma centers, etc.). Several measures and concepts can be applied at the state level, and may serve as potential examples of measuring system capacity at a population level, but these measures do not allow for evaluation, comparison, and benchmarking between regional trauma networks. The scan did not identify any measures that assess population-level outcomes for regional trauma systems.

Data limitations pose a significant challenge to population-level measurement of outcomes; the ability to aggregate data across the prehospital, hospital, and posthospital settings and link those data to individual patients to track quality over episodes of care remains extremely limited.[33]

Moreover, there is currently no standard way of defining regional trauma networks and attributing patients to those networks for measurement purposes.[33,34] Attribution refers to the methodology used to assign patients and their quality outcomes to providers, clinicians, or other accountable entities.[35] Glickman and colleagues suggest potential approaches to defining emergency care networks for measurement purposes, including the use of geographical boundaries, market-based health referral regions, or government-defined hospital service areas.[34] Carr and colleagues also propose a method for "clustering" hospitals together based on patient use patterns, and suggest that these groupings could serve to define and attribute geographical populations for measurement of emergency care, including trauma.[36] In addition, other initiatives focused on regional coordination of emergency care, such as the federal Hospital Preparedness Program (HPP)—which supports the development of regional healthcare coalitions to improve preparedness for public health emergencies—could provide examples of how regional trauma systems could be defined for measurement purposes.[37] The Health Preparedness Program assesses participating healthcare coalitions on structural and process measures focused on system readiness and adequacy of planning, some of which could potentially be modified or adapted to assess regional trauma system readiness.[38]

Advancing models of attribution that promote improved planning and coordination within regional trauma networks could help promote shared accountability across relevant stakeholders and accelerate quality improvement in trauma care.

Findings: Data Sources

As noted in the above section, "Findings: Measures, Concepts, Tools," current measures use a variety of different data sources to measure trauma outcomes. These variations create a foundation to evaluate outcomes by a variety of different, yet complementary, methods. Loosely speaking, the datasets can be grouped into population-level data sets, event-based sets/registries, and patient-level/patient-identifiable data sets. Each of these different data sources has inherent strengths.

At the broadest level, population -level datasets contain large amounts of representative data, often at the national level. Most notably, vital and health statistics datasets can be used for items such as geospatial analysis and sociodemographic factors. The data provided by population-level datasets are often the least specific to trauma outcomes, but are broadly and consistently available. Additionally, population-level datasets often lag and are slow to be updated.

Event-based datasets move towards a finer level of detail that are specific to trauma. Two examples of these are the National Trauma Data Bank (NTDB) and the National Emergency Medicine Services Information System (NEMSIS). Both datasets contain information specific to trauma. Additionally, these datasets collate data from many institutions across the country. The data are stored at the level of the event. Patient identifiable information is not included, and it is not possible to differentiate between a single patient with multiple events as opposed to multiple patients with a single event. Despite the specificity of the data, it is subject to bias as not all institutions submit all cases.

At the most granular level, patient-level data is available in the forms of electronic health record (EHR) data, claims data, and even paper records. These data are commonly used to evaluate outcomes and

calculate quality measures. Patient-level data provide the greatest opportunity for meaningful improvement. On the other hand, patient-level data are not interoperable, and lack standardization across EHR vendors or even within the same EHR vendor.

In summary, while the environmental scan highlighted different data sources that have been used to evaluate trauma outcomes, it is important to consider the utility of different sources when assessing the universe of potential data.

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[Scan] Appendix B: Measure and Measure Concept Inventory

Measures

Measure Title	Measure Description	Measure Type	Developer
PSI 3 Pressure Ulcer Rate	Stage III or IV pressure ulcers or unstageable (secondary diagnosis) per 1,000 discharges among surgical or medical patients ages 18 years and older.	Outcome	Agency for Healthcare Research and Quality
PSI 5 Retained Surgical Item or Unretrieved Device Fragment Count	The number of hospital discharges with a retained surgical item or unretrieved device fragment (secondary diagnosis) among surgical and medical patients ages 18 years and older or obstetric patients.	Outcome	Agency for Healthcare Research and Quality
PSI 6 Iatrogenic Pneumothorax Rate	Iatrogenic pneumothorax cases (secondary diagnosis) per 1,000 surgical and medical discharges for patients ages 18 years and older.	Outcome	Agency for Healthcare Research and Quality
PSI 7 Central Venous Catheter-Related Blood Stream Infection Rate	Central venous catheter-related bloodstream infections (secondary diagnosis) per 1,000 medical and surgical discharges for patients ages 18 years and older or obstetric cases.	Outcome	Agency for Healthcare Research and Quality
PSI 9 Perioperative Hemorrhage or Hematoma Rate	Perioperative hemorrhage or hematoma cases involving a procedure to treat the hemorrhage or hematoma, following surgery per 1,000 surgical discharges for patients ages 18 years and older.	Outcome	Agency for Healthcare Research and Quality
PSI 14 Postoperative Wound Dehiscence Rate	Postoperative reclosures of the abdominal wall per 1,000 abdominopelvic surgery discharged for patients aged 17 and older.	Outcome	Agency for Healthcare Research and Quality
PSI 15 Accidental Puncture or Laceration Rate	Accidental punctures or lacerations (secondary diagnosis) per 1,000 discharges for patients ages 18 years and older who have undergone an abdominopelvic procedure; in which a second abdominopelvic procedure follows one or more days after an index abdominopelvic procedure.	Outcome	Agency for Healthcare Research and Quality
PSI 16 Transfusion Reaction Count	The number of medical and surgical discharges with a secondary diagnosis of transfusion reaction for patients ages 18 years and older or obstetric patients.	Outcome	Agency for Healthcare Research and Quality
ACEP 19 Emergency Medicine: Emergency Department Utilization of CT for Minor Blunt Head Trauma for Patients Aged 18 Years and Older	Percentage of emergency department visits for patients aged 18 years and older who presented within 24 hours of a minor blunt head trauma with a Glasgow Coma Scale (GCS) score of 15 and who had a head CT for trauma ordered by an emergency care provider who have an indication for a head CT.	Efficiency	American College of Emergency Physicians
ACEP 20 Emergency Medicine: Emergency Department Utilization of CT for Minor Blunt Head Trauma for Patients Aged 2 Through 17 Years	Percentage of emergency department visits for patients aged 2 through 17 years who presented within 24 hours of a minor blunt head trauma with a Glasgow Coma Scale (GCS) score of 15 and who had a head CT for trauma ordered by an emergency care provider who are classified as low risk according to the Pediatric Emergency Care Applied Research Network (PECARN) prediction rules for traumatic brain injury	Efficiency	American College of Emergency Physicians
ACEP22 Appropriate Emergency Department Utilization of CT for Pulmonary Embolism	Percentage of emergency department visits during which patients aged 18 years and older had a CT pulmonary angiogram (CTPA) ordered by an emergency care provider, regardless of discharge disposition, with either moderate or high pre-test clinical probability for pulmonary embolism OR positive result or elevated D-dimer level	Process	American College of Emergency Physicians
Imaging in adult ED patients with minor head injury	Percent of adult patients who presented within 24 hours of a non-penetrating head injury with a Glasgow coma score (GCS) of 15 and underwent head CT for trauma in the ED who have a documented indication consistent with guidelines prior to imaging	Process	American College of Emergency Physicians
Avoidance of inappropriate use of head CT in ED patients with minor head injury	Percentage of emergency department patients with minor head injury who received inappropriate imaging study (not clinically indicated)	Efficiency	American College of Emergency Physicians
Imaging in pediatric ED patients aged 2 through 17 years with minor head injury	Percent of pediatric patients who presented within 24 hours of a non- penetrating head injury with a Glasgow coma score (GCS) of 14 or 15 and underwent head CT for trauma in the ED who have a documented indication consistent with guidelines (PECARN) prior to imaging	Process	American College of Emergency Physicians
ACSTrauma1 Trauma Initial Assessment Composite	Percentage of blunt multisystem trauma patients having the following components documented upon presentation of the emergency department (ED) within 30 minutes of arrivals: 1. Glasgow Coma Scale score (GCS) 2. Temperature	Process	American College of Surgeons
ACSTrauma2 Mortalilty Rate Following Blunt Traumatic Injury to the Chest and/or Abdomen	In-hospital mortality rate for patients with severe blunt injury to the abdomen and/or chest (abbreviated injury score AIS >3)	Outcome	American College of Surgeons
ACSTrauma3 Mortality Rate Following Penetrating Traumatic Injury to the Chest and/or Abdomen	In-hospital mortality rate for patients with severe penetrating injury to the abdomen and/or chest (abbreviated injury score AIS >3)	Outcome	American College of Surgeons
ACSTrauma4 Splenic Salvage Rate	Percentage of patients with a spleen injury (spleen AIS >2 and <5) that do not undergo a splenectomy	Outcome	American College of Surgeons
ACSTrauma5 Optimal Timing of Surgical or Procedural Intervention for Hemorrhage in Trauma	Percentage of patients presenting with traumatic hemorrhagic shock who undergo an operative or procedural intervention for hemorrhage control within 4 hours	Process	American College of Surgeons
ACSTrauma6 Optimal Ratio of Blood Product Transfusion	Percentage of patients presenting with traumatic hemorrhagic shock who receive plasma and packed red blood cells (pRBC's) in a ratio or equal to 1 unit of plasma for every 2 units of pRBCs over the first four hours after arrival to the emergency department	Process	American College of Surgeons

Measure Title	Measure Description	Measure Type	Developer
ACSTrauma7 Timely Initiation of VTE Prophylaxis in Trauma Patients	Percentage of seriously injured patients with pharmacologic venous thromboembolism (VTE) prophylaxis initiated within 48 hours of admission.	Process	American College of Surgeons
NQF 0495 Median time from ED arrival to ED departure for admitted ED patients	Median time from emergency department arrival to time of departure from the emergency room for patients admitted to the facility from the emergency department	Process	Centers for Medicare & Medicaid Services
NQF 0496 Median time from ED arrival to ED departure for discharged ED patients	Median time from emergency department arrival to time of departure from the emergency room for patients discharged from the emergency department.	Process	Centers for Medicare & Medicaid Services
NQF 0497 Admit decision time to ED departure time for admitted patients	Median time from admit decision time to time of departure from the emergency department for emergency department patients admitted to inpatient status	Process	Centers for Medicare & Medicaid Services
NQF 0662 Median Time to Pain Management for Long Bone Fracture (no longer endorsed)	Median time from emergency department arrival to time of initial oral, nasal or parenteral pain medication administration for emergency department patients with a principal diagnosis of long bone fracture (LBF)	Process	Centers for Medicare & Medicaid Services
EMSC 01 Submission of NEMSIS compliant data	The degree to which EMS agencies submit NEMSIS compliant version 3.x or higher data to the state EMS office	Structure	Emergency Medical Services for Children
EMSC 02 Pediatric Emergency Care Coordinator	The percentage of EMS agencies in the state or territory that have a designated individual who coordinates pediatric emergency care.	Structure	Emergency Medical Services for Children
EMSC 03 Use of Pediatric Specific Equipment	The percentage of EMS agencies in the state or territory that have a process that requires EMS providers to physically demonstrate the correct use of pediatric specific equipment	Structure	Emergency Medical Services for Children
EMSC 04 Hospital Recognition for Pediatric Medical Emergencies	The percent of hospitals with an Emergency Department (ED) recognized through a statewide, territorial, or regional standardized program that are able to stabilize and/or manage pediatric medical emergencies	Structure	Emergency Medical Services for Children
EMSC 05 Hospital Recognition for Pediatric Trauma	The percent of hospitals with an Emergency Department (ED) recognized through a statewide, territorial, or regional standardized system that are able to stabilize and/or manage pediatric trauma	Structure	Emergency Medical Services for Children
EMSC 06 Interfacility Transfer Guidelines	The percent of hospitals with an Emergency Department (ED) in the state or territory that have written interfacility transfer guidelines that cover pediatric patients and that include 8 components of transfer.	Structure	Emergency Medical Services for Children
EMSC 07 Interfacility Transfer Agreements	The percent of hospitals with an Emergency Department (ED) in the state or territory that have written interfacility transfer agreements that cover pediatric patients	Structure	Emergency Medical Services for Children
EMSC 08 Permanence of EMSC	The degree to which the state or territory has established permanence of EMSC in the state or territory EMS system	Structure	Emergency Medical Services for Children
EMSC 09 Integration of EMSC Priorities into Statutes or Regulations	The degree to which the state or territory has established permanence of EMSC in the state or territory EMS system by integrating EMSC priorities into statutes or regulations	Structure	Emergency Medical Services for Children
Trauma 01 Pain assessment of injured patients	Recognizing that pain is undertreated in injured patients, it is important to assess whether a patient is experiencing pain	Process	EMS Compass Measures
Trauma 02 Pain re-assessment of injured patients	Recognizing that pain is undertreated in injured patients, it is important to assess whether a patient is experiencing pain	Process	EMS Compass Measures
Trauma 03 Effectiveness of pain management for injured patients	Of injured patients, how many had less pain	Outcome	EMS Compass Measures
Trauma 04 Trauma patients transported to trauma center	Trauma patients transported to trauma center	Process	EMS Compass Measures
Alcohol Screening and Brief Intervention (ASBI) in the ER	Percentage of patients aged 15 to 34 seen in the ER for injury who were screened for hazardous alcohol use AND provided a brief intervention within 7 days of the ER visit if screened positive.	Process	Indian Health Service
NQF 0326 Advance Care Plan	Percentage of patients aged 65 years and older who have an advance care plan or surrogate decision maker documented in the medical record or documentation in the medical record that an advance care plan was discussed but the patient did not wish or was not able to name a surrogate decision maker or provide an advance care plan.	Process	National Committee for Quality Assurance
NQF 1626 Patients admitted to ICU who have care preferences documented	Percentage of vulnerable adults admitted to ICU who survive at least 48 hours who have their care preferences documented within 48 hours OR documentation as to why this was not done.	Process	RAND Corporation
NQF 1641 Hospice and Palliative Care – Treatment preferences	Percentage of patients with chart documentation of preferences for life sustaining treatments.	Process	UNC Chapel Hill
NQF 0291 Emergency transfer communication	Percentage of patients transferred to another healthcare facility whose medical record documentation indicated that REQUIRED information was communicated to the receiving facility prior to departure (SUBSECTION 1) OR WITHIN 60 MINUTES OF TRANSFER (SUBSECTION 2-7)	Process	University of Minnesota Rural Health Research Center
NQF 0292 Vital Signs (no longer endorsed)	Percentage of patients transferred to another HEALTHCARE FACILITY whose medical record documentation indicated that the entire vital signs record was communicated to the receiving FACILITY within 60 minutes of departure	Process	University of Minnesota Rural Health Research Center
NQF 0293 Medication Information	Percentage of patients transferred to another HEALTHCARE FACILITY whose medical record documentation indicated that medication information was communicated to the receiving FACILITY within 60 minutes of departure	Process	University of Minnesota Rural Health Research Center
NQF 0294 Patient Information	Percentage of patients transferred to another HEALTHCARE FACILITY whose medical record documentation indicated that patient information was communicated to the receiving FACILITY within 60 minutes of departure	Process	University of Minnesota Rural Health Research Center

Measure Title	Measure Description	Measure Type	Developer
NQF 0295 Physician Information	Percentage of patients transferred to another HEALTHCARE FACILITY whose medical record documentation indicated that physician information was communicated to the receiving FACILITY within 60 minutes of departure	Process	University of Minnesota Rural Health Research Center
NQF 0296 Nursing Information (no longer endorsed)	Percentage of patients transferred to another HEALTHCARE FACILITY whose medical record documentation indicated that nursing information was communicated to the receiving FACILITY within 60 minutes of departure	Process	University of Minnesota Rural Health Research Center
NQF 0297 Procedures and Tests (no longer endorsed)	Percentage of patients transferred to another healthcare facility whose medical record documentation indicated that procedure and test information was communicated to the receiving FACILITY within 60 minutes of departure	Process	University of Minnesota Rural Health Research Center

Measure Concepts

Title	Description	Type	Source
n/a	Guidelines for blood recovery and reinfusion in surgery and trauma	Structure	American Association of Blood Banks
n/a	Standards for a Patient Blood Management Program (example: There is a process for managing the blood needs of unidentified patients and resolving their identification)	Structure	American Association of Blood Banks
n/a	Standards for a Patient Blood Management Program (example: Adverse events and incidents related to transfusions)	Structure	American Association of Blood Banks
n/a	AABB Standard 5.15.1 Use of low titer O whole blood in patients with life-threatening hemorrhage	Structure	American Association of Blood Banks
n/a	Rapid decision making for anemia/coagulation management	Structure	American Association of Blood Banks
Patient not transferred from a nondesignated facility to a trauma hospital	n/a	Process	American College of Emergency Physicians
Patient transferred from a nondesignated facility to another non designated facility	n/a	Process	American College of Emergency Physicians
Patients transferred between trauma hospitals	n/a	Process	American College of Emergency Physicians
Patients transferred from a nondesignated facility to a trauma hospital	n/a	Process	American College of Emergency Physicians
90-day readmission rates	n/a	Outcome	American College of Surgeons Trauma Quality Improvement Program (ACS TQIP) Geriatric Guidelines
Benzodiazepine use	n/a	Process	ACS TQIP Geriatric Guidelines
Bowel Regimen	n/a	Process	ACS TQIP Geriatric Guidelines
Code Status	n/a	Process	ACS TQIP Geriatric Guidelines
Delirium Diagnosis	n/a	Process	ACS TQIP Geriatric Guidelines
Delirium Screening	n/a	Process	ACS TQIP Geriatric Guidelines
Discharge medications	n/a	Process	ACS TQIP Geriatric Guidelines
Discharge to higher level of care	n/a	Process	ACS TQIP Geriatric Guidelines
Goals of care discussion	n/a	Process	ACS TQIP Geriatric Guidelines
ICU Stay	n/a	Outcome	ACS TQIP Geriatric Guidelines
Initial living situation	n/a	Process	ACS TQIP Geriatric Guidelines
Initial Medication	n/a	Process	ACS TQIP Geriatric Guidelines
Length of stay	n/a	Outcome	ACS TQIP Geriatric Guidelines
Mobilization	n/a	Process	ACS TQIP Geriatric Guidelines
Triage and transfer of orthopaedic injuries	n/a	Process	ACS TQIP Management of Orthopaedic Trauma
Management and treatment of open fractures	n/a	Process	ACS TQIP Management of Orthopaedic Trauma
Damage control orthopaedic surgery	n/a	Process	ACS TQIP Management of Orthopaedic Trauma
Management and treatment for mangled extremities	n/a	Process	ACS TQIP Management of Orthopaedic Trauma
Treatment for compartment syndrome	n/a	Process	ACS TQIP Management of Orthopaedic Trauma
Management of pelvic fractures with associated hemorrhage	n/a	Process	ACS TQIP Management of Orthopaedic Trauma
Rehabilitation of the multisystem trauma patient	n/a	Outcome	ACS TQIP Management of Orthopaedic Trauma
Management of Hip Fractures in the Elderly	n/a	Process	ACS TQIP Management of Orthopaedic Trauma/American American Academy of Orthopaedic Surgeons
Management of pediatric supracondylar humerus fractures	n/a	Process	ACS TQIP Management of Orthopaedic Trauma/American American Academy of Orthopaedic Surgeons
Use of Glasgow Coma Scale with reporting of all three components (eye, verbal and motor response)	n/a	Outcome	ACS TQIP Management of Traumatic Brain Injury (TBI) Guidelines
Proper filed triage and transport for patients with suspected TBI	n/a	Process	ACS TQIP Management of TBI Guidelines
Goals of treatment (all TBI patients)	n/a	Process	ACS TQIP Management of TBI Guidelines

Title	Description	Type	Source
Goals of treatment (ICU patients)	n/a	Process	ACS TQIP Management of TBI Guidelines
Intracranial pressure monitoring	n/a	Process	ACS TQIP Management of TBI Guidelines
Three-tiered management of intracranial hypertension	n/a	Process	ACS TQIP Management of TBI Guidelines
Advanced neuromonitoring in TBI	n/a	Process	ACS TQIP Management of TBI Guidelines
Surgical management of TBI	n/a	Process	ACS TQIP Management of TBI Guidelines
Nutritional support for TBI	n/a	Process	ACS TQIP Management of TBI Guidelines
Tracheostomy for TBI	n/a	Process	ACS TQIP Management of TBI Guidelines
Timing of secondary procedures	n/a	Process	ACS TQIP Management of TBI Guidelines
Timing of pharmacologic VTE prophylaxis in TBI	n/a	Process	ACS TQIP Management of TBI Guidelines
Management of pediatric patients with TBI	n/a	Process	ACS TQIP Management of TBI Guidelines
Management of elderly patients with TBI	n/a	Process	ACS TQIP Management of TBI Guidelines
Prognostic decision making and withdrawal of medical support for severe TBI patients	n/a	Process	ACS TQIP Management of TBI Guidelines
GOS-E at 6 months for TBI patients	n/a	Outcome	ACS TQIP Management of TBI Guidelines
Development of a Massive Transfusion Protocol (MTP)	n/a	Structure	ACS TQIP Massive Transfusion (MT) in Trauma Guidelines
Criteria to trigger the activation of MTP	n/a	Structure	ACS TQIP MT in Trauma Guidelines
Blood product resuscitation	n/a	Process	ACS TQIP MT in Trauma Guidelines
Massive transfusion in the Intensive Care Unit (ICU)	n/a	Process	ACS TQIP MT in Trauma Guidelines
24:7 On-site transfusion service	n/a	Process	ACS TQIP MT in Trauma Guidelines
Transfusion endpoints	n/a	Process	ACS TQIP MT in Trauma Guidelines
Therapeutic adjuncts in massive transfusion	n/a	Process	ACS TQIP MT in Trauma Guidelines
Use of antifibrinolytics to treat blood loss and receipt of transfusion	n/a	Process	ACS TQIP MT in Trauma Guidelines
Interdisciplinary palliative care team	n/a	Structure	ACS TQIP Palliative Care
Palliative care assessment	n/a	Process	ACS TQIP Palliative Care
Goals of care conversation	n/a	Process	ACS TQIP Palliative Care
End of life care	n/a	Process	ACS TQIP Palliative Care
Frailty screen for geriatric patients	n/a	Process	ACS TQIP Palliative Care
Palliative care for pediatric patients	n/a	Process	ACS TQIP Palliative Care
Palliative care for spinal cord injury	n/a	Process	ACS TQIP Palliative Care
Palliative care for traumatic brain injury	n/a	Process	ACS TQIP Palliative Care
Documentation of palliative care activities	n/a	Process	ACS TQIP Palliative Care
Assessment and administration of fluid status	n/a	Process	Eastern Association for the Surgery of Trauma (EAST) Guidelines
Surgical management of pancreatic necrosis	n/a	Process	EAST Guidelines
Prophylaxis against VTE in pediatric trauma	n/a	Process	EAST Guidelines
Operative fixation of rib fractures after blunt trauma	n/a	Process	EAST Guidelines
Damage control resuscitation for severe traumatic hemorrhage	n/a	Process	EAST Guidelines
Surgical management of adult pancreatic injuries	n/a	Process	EAST Guidelines
Pain management for blunt thoracic trauma	n/a	Process	EAST Guidelines
Prevention of fall-related injuries in the elderly	n/a	Process	EAST Guidelines
Surgery or stenting for colonic obstruction	n/a	Process	EAST Guidelines
Management of penetrating extraperitoneal rectal injuries	n/a	Process	EAST Guidelines
Patient selection for emergency department thoracotomy	n/a	Process	EAST Guidelines
Presumptive antibiotics for tube thoracostomy in trauma	n/a	Process	EAST Guidelines
Cervical collar removal	n/a	Process	EAST Guidelines
Identification of cervical spine injuries following trauma	n/a	Process	EAST Guidelines
Cervical spine injury in blunt trauma	n/a	Process	EAST Guidelines
Evaluation and management of blunt traumatic aortic injury (BTAI)	n/a	Process	EAST Guidelines

Title	Description	Type	Source
Optimal timing of femur fracture stabilization in polytrauma patients	n/a	Process	EAST Guidelines
Timing and type of surgical treatment in Clostridium difficile-associated disease	n/a	Process	EAST Guidelines
Evaluation and management of small-bowel obstruction	n/a	Process	EAST Guidelines
Management of pulmonary contusion and flail chest	n/a	Process	EAST Guidelines
Emergency tracheal intubation immediately following traumatic injury	n/a	Process	EAST Guidelines
Screening for thoracolumbar spinal injuries in blunt trauma using MDCT scans with axial collimation	n/a	Process	EAST Guidelines
Prophylactic antibiotic use in penetrating abdominal trauma	n/a	Process	EAST Guidelines
Evaluation and management of penetrating lower extremity arterial trauma	n/a	Process	EAST Guidelines
Nonoperative management of blunt hepatic injury	n/a	Process	EAST Guidelines
Preperitoneal packing for pelvic fracture hemorrhage	n/a	Process	EAST Guidelines
Hemothorax Management	n/a	Process	EAST Guidelines
Prophylactic Antibiotic use in open fractures	n/a	Process	EAST Guidelines
Selective nonoperative management of penetrating abdominal trauma	n/a	Process	EAST Guidelines
Management of the open abdomen in trauma and emergency general surgery	n/a	Process	EAST Guidelines
Open abdomen management	n/a	Process	EAST Guidelines
Diagnosis and Management of injury in pregnant patients	n/a	Process	EAST Guidelines
Red blood cell transfusion in adult trauma and critical care	n/a	Process	EAST Guidelines
Timing of tracheostomy	n/a	Process	EAST Guidelines
Prehospital fluid resuscitation in the injured patient	n/a	Process	EAST Guidelines
Operative versus selective nonoperative management of penetrating zone II neck trauma	n/a	Process	EAST Guidelines
Nutritional support for trauma patients	n/a	Process	EAST Guidelines
Prevention of VTE in trauma patients	n/a	Process	EAST Guidelines
Treatment of traumatic brain injury with beta blockers	n/a	Process	EAST Guidelines
Evaluation and management of geriatric trauma	n/a	Process	EAST Guidelines
Renal trauma	n/a	Process	EAST Guidelines
REBOA use in hemorrhage control	n/a	Process	EAST Guidelines
Duodenal Trauma	n/a	Process	EAST Guidelines
Penetrating colon injury	n/a	Process	EAST Guidelines
Blunt cerebrovascular injury	n/a	Process	EAST Guidelines
Management of pediatric renal trauma	n/a	Process	EAST/Pediatric Trauma Society
Time to computed tomography for severe polytrauma patients	Time to computed tomography (CT) for severe polytrauma patients presenting to a level 1 trauma center (surrogate for trauma team efficacy)	Process	Easton R, Sisak K, Balogh Z. Time to computed tomography scanning for major trauma patients: the Australian reality. *ANZ J Surg*. 2012; 82:644-647
Use of Trauma Associated Severe Hemorrhage Score (TASH)	n/a	Process	Emergency Nurses Association (ENA) Guideline
Use of Assessment of Blood Consumption (ABC)	n/a	Process	Emergency Nurses Association (ENA) Guideline
All deaths	n/a	Outcome	Florida Department of Health Trauma Center Standards
n/a	Any trauma patient readmitted to ICU, or an unplanned admission to the ICU from a medical/surgical unit	Outcome	Florida Department of Health Trauma Center Standards
n/a	Any trauma patient with an unplanned readmittance to the hospital within thirty days of discharge	Outcome	Florida Department of Health Trauma Center Standards
n/a	Percentage of all traumatic C1, 2, and/or C3 spinal cord injury patients permanently dependent on mechanical ventilator support who were admitted or transferred to the ICU during the quarter or who remained in the ICU from the previous quarter; who received the diaphragm pacer surgery and were discharged to a less restrictive facility, home or home-health.	Outcome	Florida Department of Health Trauma Center Standards
Appropriate activation of massive transfusion protocol	n/a	Process	Gruen RL, Gabbe BJ, Stelfox HT et al. 2011. Indicators of the quality of trauma care and the performance of trauma systems. *Br J Surg* 2012;99(suppl1):97-104
Deaths due to haemorrhagic shock	n/a	Outcome	Gruen et al. (2011)
Dispatch criteria	n/a	Structure	Gruen et al. (2011)

Title	Description	Type	Source
Injury prevention activities	n/a	Structure	Gruen et al. (2011)
Long-term outcomes	n/a	Outcome	Gruen et al. (2011)
Prehospital deaths	n/a	Outcome	Gruen et al. (2011)
Prehospital triage	n/a	Structure	Gruen et al. (2011)
Proportion of patients returning with new alcohol-or drug-related injuries	n/a	Outcome	Gruen et al. (2011)
Rehabilitation facility in community	n/a	Structure	Gruen et al. (2011)
Return to work, adjusted for severity	n/a	Outcome	Gruen et al. (2011)
Risk adjusted mortality for head injury	n/a	Outcome	Gruen et al. (2011)
Standardized rehabilitation protocols	n/a	Structure	Gruen et al. (2011)
Time to rehabilitation consultations	n/a	Process	Gruen et al. (2011)
Total prehospital time with component parts	n/a	Process	Gruen et al. (2011)
Training	n/a	Structure	Gruen et al. (2011)
Admission to intensive care unit	n/a	Process	Sasser SM, Hunt RC, Faul M et al. Guidelines for field triage of injured patients: recommendations of the National Expert Panel on Field Triage, 2011. *Morbidity and Mortality Weekly Report (MMWR)*. https://www.cdc.gov/mmwr/preview/mmwrhtml/rr6101a1.htm. Published January 13, 2012. Last accessed September 2018.
Interventional radiology procedure	n/a	Process	Sasser SM, Hunt RC, Faul M et al. Guidelines for field triage of injured patients: recommendations of the National Expert Panel on Field Triage, 2011. *Morbidity and Mortality Weekly Report (MMWR)*. https://www.cdc.gov/mmwr/preview/mmwrhtml/rr6101a1.htm. Published January 13, 2012. Last accessed September 2018.
Major nonorthopedic surgery within 24 hours	n/a	Process	Sasser SM, Hunt RC, Faul M et al. Guidelines for field triage of injured patients: recommendations of the National Expert Panel on Field Triage, 2011. *Morbidity and Mortality Weekly Report (MMWR)*. https://www.cdc.gov/mmwr/preview/mmwrhtml/rr6101a1.htm. Published January 13, 2012. Last accessed September 2018.
Complications	n/a	Outcome	Holena, Daniel. "Developing an EGS PIPS Process: what to collect? What to measure?" American College of Surgeons Quality and Safety Conference. July 22 2018, Orlando FL. Conference presentation
Re-operations	n/a	Outcome	Holena, Daniel. "Developing an EGS PIPS Process: what to collect? What to measure?" American College of Surgeons Quality and Safety Conference. July 22 2018, Orlando FL. Conference presentation
Use of higher ratios of plasma to red blood cells in massive transfusions	n/a	Process	Jenkins, Donald. "Trauma Induced Coagulopathy: What is it? What can be done about it? What is the future?" 5th Annual Major John P. Pryor MD FACS Memorial Lecture. October 25, 2013. Conference presentation.
Use of thawed or liquid plasma for treating coagulopathy	n/a	Process	Jenkins, Donald. "Trauma Induced Coagulopathy: What is it? What can be done about it? What is the future?" 5th Annual Major John P. Pryor MD FACS Memorial Lecture. October 25, 2013. Conference presentation.

Title	Description	Type	Source
Pre-hospital plasma transfusion	Any adult injured trauma patient with >2 of the following plus evidence of active hemorrhage or traumatic brain injury: Single reading of systolic blood pressure <90 mm Hg; single reading of heart rate >120; penetrating mechanism (i.e., stabbing, gunshot); positive Focused Assessment with Ultrasound in Trauma (FAST); point of care lactate >5.0 mg/dL; point of care INR >1.5; warfarin use	Process	Jenkins, Donald. "Trauma Induced Coagulopathy: What is it? What can be done about it? What is the future?" 5th Annual Major John P. Pryor MD FACS Memorial Lecture. October 25, 2013. Conference presentation.
Pre-hospital hemorrhage control with hemostatic agents	n/a	Process	Bulletin of the American College of Surgeons. See something, Do Something: Improving Survival. 2015; 100(15). https://www.facs.org/~/media/files/publications/bulletin/hartford%20consensus%20compendium.ashx. Accessed September 2018.
Pre-hospital hemorrhage control with tourniquets	n/a	Process	Bulletin of the American College of Surgeons. See something, Do Something: Improving Survival. 2015; 100(15). https://www.facs.org/~/media/files/publications/bulletin/hartford%20consensus%20compendium.ashx. Accessed September 2018.
Compliance with high-risk geriatric protocols	Triages patients based on injury patterns and comborbid conditions for occult hypotension	Process	Bradburn EH, Gross B, Jammula S et al. Improved outcomes in elderly trauma patients with the implementation of two innovative geriatric-specific protocols – Final report. *J Trauma Acute Care Surg.* 2018; 84(2):301-307.
Compliance with the anticoagulation and trauma (ACT) alert	Streamlines the care of geriatric trauma patients on anticoagulants	Process	Bradburn EH, Gross B, Jammula S et al. Improved outcomes in elderly trauma patients with the implementation of two innovative geriatric-specific protocols – Final report. *J Trauma Acute Care Surg.* 2018; 84(2):301-307.
Compliance with ACS-COT minimum criterial for full trauma team activation	n/a	Process	Tignanelli CJ, Vander Kolk WE, Mikhail JN et al. Noncompliance with American College of Surgeons Committee on Trauma recommended criteria for full trauma team activation is associated with undertriage deaths. *J Trauma Acute Care Surg.* 2018;(84)2:287-294
Disability for patients who survive a traumatic brain injury	n/a	Outcome	Washington State Department of Health
Mortality of TBI by Year	n/a	Outcome	Washington State Department of Health
Accessibility of field hemorrhage control equipment for law enforcement, EMS/fire/rescue and the general public	n/a	Access	Hartford Consensus
Documentation of the use of hemorrhage control equipment by law enforcement, EMS/fire/rescue and the general public	n/a	Process	Hartford Consensus
Timeliness and appropriateness of initial hemorrhage control	n/a	Process	Hartford Consensus
Timeliness and effectiveness of rapid extrication	n/a	Process	Hartford Consensus
Readiness of definitive care facilities for control of internal hemorrhage	n/a	Structure	Hartford Consensus
Pediatric patients needing highest-level trauma team activation	Includes: airway management; thoracostomy procedure; receipt of blood; criteria for termination of resuscitation; had surgery; interventional radiology; emergency c-section; received vasopressors; received burr hole; confirmed spinal cord injury; died of injury in the ED		Joint Committee on Surgical Training
HRSA # 325.132(3)(c)(ii)(A) 306.2 injury prevention activities and programs	The RTN is active within the region in the monitoring and evaluation of regional	Structure	Health Resources and Services Administration (HRSA)
HRSA #325.132 (3)(c)(ii)(E)302.6	The region has adopted mandatory regional pre-hospital triage protocols to ensure that trauma patients are transported to an appropriate trauma center based on their injuries.	Structure	HRSA

Title	Description	Type	Source
HRSA #325.132(3)(c)(ii)(C)302.10	There are established procedures for EMS and trauma system communications for major EMS events or multiple jurisdiction incidents that are effectively coordinated with the overall regional response plans	Structure	HRSA
HRSA #325.132(3)(c)(ii)(C)302.9	There is a procedure for communications among medical facilities when arranging for inter-facility transfers including contingences for radio or telephone system failure	Structure	HRSA
HRSA #325.132(3)(c)(ii)(D)302.1	There is well-defined regional trauma system medical oversight integrating the needs of the trauma system with the medical oversight of the overall EMS system.	Structure	HRSA
HRSA #325.132(3)(c)(ii)(F)303.2	The regional trauma network…should develop procedures to insure that trauma patients are transported to an appropriate facility that is prepared to provide care.	Structure	HRSA
HRSA #325.132(3)(c)(ii)(H)303.4	When injured patients arrive at a medical facility that cannot provide the appropriate level of definitive care, there is an organized and regularly monitored system to ensure that the patients are expeditiously transferred to the appropriate, system-defined trauma facility	Structure	HRSA
HRSA #325.132(3)(c)(ii)(J)310.10	As new protocols and treatment approaches are instituted within the regional trauma system, structured processes are in plan to inform or educate all personnel of those changes in a timely manner	Structure	HRSA
HRSA #325.132(3)(c)(ii)(J)310.346	The regional trauma network establishes and ensures that appropriate levels of EMS, nursing and physician trauma training courses are provided on a regular basis	Structure	HRSA
HRSA#325.132(3)(c)(i)(F)308.1	The regional work plan addresses the integration and participation of rehabilitation services within the continuum of care for trauma patients	Structure	HRSA
HRSA#325.132(3)(c)(ii)(G)303.4	There is a regional trauma bypass protocol that provides EMS guidance for bypassing a trauma care facility for another more appropriate trauma care facility	Structure	HRSA
Preventable mortality		Outcome	Military Trauma Care Learning Health System Manual
Total Presumed Ground and Transport Time	The total presumed ground and transport time intervals for the air crews should not exceed that of the time that would been required by ground crews to get the patient to the trauma center	Process	Myers JB, Slovis CM, Eckstein M et al. Evidence-based performance measures for emergency medical services systems: a model for expanded EMS benchmarking. *Prehosp Emerg Care*. 2008;12(2):141-41
Transport Time	Transporting paramedics should limit on-scene time to less than 10 minutes or document reasons for the exception (e.g., entrapment, scene safety, etc)	Process	Myers JB, Slovis CM, Eckstein M et al. Evidence-based performance measures for emergency medical services systems: a model for expanded EMS benchmarking. *Prehosp Emerg Care*. 2008;12(2):141-41
Use of TXA in adult trauma patients with severe hemorrhagic shock (SBP <75 mm Hg) with known predictors of fibrinolysis, or with known fibrinolysis by TEG (LY30 >3%)	n/a	Process	Napolitano LM, Cohen MJ, Cotton BA et al. Tranexamic acid in trauma: How should we use it? *J Trauma Acute Care Surg.* 2013;74(6):1575-1586
Highest GCS Motor	Highest motor GCS within 24 hours of ED/Hospital arrival	Outcome	National Trauma Data Bank
Hospital Complications	Any medical complications that occurred during the patient's stay at your hospital (31 complications)	Outcome	National Trauma Data Bank
Hospital Discharge Disposition	The disposition of the patient when discharged from the hospital. (Field values include Discharged/transferred: to a short-term general hospital for inpatient care/intermediate care facility/organized home health service, hospice, court/law enforcement, inpatient rehab or designated unit, long term care hospital, psychiatric hospital or psychiatric distinct part unit of a hospital, another type of institution not defined elsewhere, to home or self-care, to skilled nursing facility; Left against medical advice or discontinued care; deceased/expired	Outcome	National Trauma Data Bank
Initial ED/Hospital Pupillary Response	Physiological response of the pupil size within 30 minutes or less of ED/hospital arrival	Process	National Trauma Data Bank
Total ICU Length of Stay	The cumulative amount of time spent in the ICU. Each partial or full day should be measured as one calendar day.	Outcome	National Trauma Data Bank
Total Ventilator Days	The cumulative amount of time spent on the ventilator. Each partial or full day should be measured as one calendar day.	Outcome	National Trauma Data Bank
Patient arrival to trauma team leader response time to bedside	The time between when a patient arrives at an LTH and the arrival of the Trauma Team Leader to the patient's bedside.	Process	*Regional Trauma Network Development – A guide for Ontario Hospitals*. https://www.criticalcareontario.ca/EN/Toolkits/Regional%20Trauma%20Network%20Development%20Guide.pdf. Accessed September 2018.

Title	Description	Type	Source
Referring hospital time-to-transfer	The time between when a patient arrives at a referring hospital and when the patient departs that hospital to be transferred to a LTH.	Process	*Regional Trauma Network Development – A guide for Ontario Hospitals*. https://www.criticalcareontario.ca/EN/Toolkits/Regional%20Trauma%20Network%20Development%20Guide.pdf. Accessed September 2018.
Avoidance of large volume IV fluid crystalloid in pre-hospital resuscitation (#13, p. 13)	n/a	Process	Kotwal RS, Butler Fk, Edgar EP et al. Saving lives on the battlefield - a joint trauma system review of pre-hospital trauma care in combined joint operating area - Afghanistan (CJOA-A) executive summary. *J Spec Oper Med*. 2013;13(1):77-85
Prevention of hypothermia	n/a	Process	Kotwal RS, Butler Fk, Edgar EP et al. Saving lives on the battlefield - a joint trauma system review of pre-hospital trauma care in combined joint operating area - Afghanistan (CJOA-A) executive summary. *J Spec Oper Med*. 2013;13(1):77-85
Infection rates after trauma	n/a	Outcome	Kotwal RS, Butler Fk, Edgar EP et al. Saving lives on the battlefield - a joint trauma system review of pre-hospital trauma care in combined joint operating area - Afghanistan (CJOA-A) executive summary. *J Spec Oper Med*. 2013;13(1):77-85
Cardiovascular reserve index of the arterial pulse as a sign of impending shock	n/a	Process	Kotwal RS, Butler Fk, Edgar EP et al. Saving lives on the battlefield - a joint trauma system review of pre-hospital trauma care in combined joint operating area - Afghanistan (CJOA-A) executive summary. *J Spec Oper Med*. 2013;13(1):77-85
Preventable death review	n/a	Outcome	Kotwal RS, Butler Fk, Edgar EP et al. Saving lives on the battlefield - a joint trauma system review of pre-hospital trauma care in combined joint operating area - Afghanistan (CJOA-A) executive summary. *J Spec Oper Med*. 2013;13(1):77-85
Missed Injury	Patients readmitted or treatment changed	Outcome	Beattie E, Mackway-Jones K. A Delphi study to identify performance indicators for emergency medicine. *Emerg Med J* 2004;21:47–50
Pain management	Pain management with ketamine, fentanyl lozenges	Process	Tactical Combat Casualty Care (TCCC) Guidelines
Tranexamic Acid (TXA) administration	If a casualty is anticipated to need significant blood transfusion (for example: presents with hemorrhagic shock, one or more major amputations, penetrating torso trauma, or evidence of severe bleeding), administer 1 gram of TXA as soon as possible but not later than 3 hours after injury; begin second infusion of 1 gm TXA after Hextend or other fluid treatment)	Process	TCCC Guidelines
Probability of Survival/TRISS	Retrospective measure of patients with same profile on TARN database. Use components of ISS, Age, Gender, GCS, Pre-exisiting medical conditions	Outcome	Trauma Audit and Research Network (TARN)
ED admit to discharge	Referring hospital ED triage time less than 2 hours	Process	Utah State Trauma System
Inter-hospital transfer time	Measured from time of arrival at referral hospital to time of arrival at definitive care	Process	Victorian State Trauma System
Inter-hospital transfer times with and without retrieval activation	Measured from time of arrival at referral hospital to time of arrival at definitive care	Process	Victorian State Trauma System
In-transit deaths	n/a	Outcome	Victorian State Trauma System
Major trauma ICU mechanical ventilation hours for major trauma patients with an ICU admission	n/a	Outcome	Victorian State Trauma System
Median ambulance response time	Measured from time of ambulance call to arrival at scene	Process	Victorian State Trauma System
Median pre-hospital scene time	Measured from ambulance arrival at scene to depart location time	Process	Victorian State Trauma System
Median pre-hospital time	Measured from ambulance arrival to primary hospital arrival	Process	Victorian State Trauma System
Median time to activation of ARV/PIPER for metropolitan transfers	Measured from time of arrival at a health service to retrieval activation	Process	Victorian State Trauma System

Title	Description	Type	Source
Median time to activation of ARV/PIPER for regional transfers	Measured from time of arrival at a health service to retrieval activation	Process	Victorian State Trauma System
Proportion of ICU admissions at the health service for definitive care	n/a	Process	Victorian State Trauma System
Proportion of MTS trauma team activation for Ambulance Victoria or AAV signal one trauma cases	n/a	Process	Victorian State Trauma System
Total time to an appropriate health service	Measured from time of injury to first presentation)	Process	Victorian State Trauma System

Instruments, Scales, and Tools

Title	Description
Abbreviated Injury Score >3	
American Spinal Injury Association Impairment Scale	The ASIA scale is based on the Frankel scale, and is a clinician-administered scale used to classify the severity of injury in individuals with SCI. It identifies sensory and motor levels indicative of the highest spinal level demonstrating "unimpaired" function. Preservation of function in the sarcal segments is a key for determining the AIS grade.
Awareness questionnaire	
Beck's Anxiety Inventory	
Beck's Depression Inventory	
Brief Approach/Avoidance Coping Questionnaire	
Centre for Epidemiologic Studies Depression Scale (CES-D)	
Clinician administered PTSD Scale (CAPS)	
Cribari Grid	Measures undertriage and overtriage rates within a trauma system. Undertriage = patients with an ISS >15 for which a major or modified was not activated, and overtriage = patients with an ISS <16 for which a major was activated.
Davidson Trauma Scale	17-item measure with each item corresponding to DSM-IV symptoms of PTSD.
Dissociative Experience Scale (DES)	
EQ-5D	EQ-5D is a standardized instrument as a measure of health related quality of life that can be used in a wide range of health conditions and treatments. The Eq-5D consists of a descriptive system and the EQ VAS. The descriptive system comprises five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. The EQ VAS records the patient's self-rated health on a vertical visual analogue scale. This can be used as a quantitative measure of health outcome that reflects the patient's own judgement. The scores on these five dimensions can be presented as a health profile or can be converted to a single summary index number (utility) reflecting preferability compared to other health profiles.
Extended Glasgow Outcome Scale	The GOS is a global scale for functional outcome that rates patient status into one of five categories: dead, vegetative state, severe disability, moderate disability or good recovery. The extended GOS provides more detailed categorization into eight categories by subdividing the categoies of severe disability, moderate disability and good recovery into a lower and upper category.
Family Experiences of in-hospital Care Questionnaire for family members of patients with severe Traumatic Brain Injury (FECQ-TBI)	The FECQ-TBI assesses important aspects of in-hospital care in the acute and rehabilitation phases, as seen from a family perspective.
Functional Activities Questionnaire (FAQ)	
Functional Capacity Index	
Functional Independence Measure	The FIM is an 18-item, 7-level functional assessment designed to evaluate the amount of assistance required by a person with a disability to perform basical life activities safely and effectively. The FIM assessments are used clinically to monitor the outcomes of rehabilitative care as required by the Joint Commission on the Accreditation of Health Care Organizations (JCAHO) and the Commission on the Accreditation of Rehabilitative Facilities (CARF). According to VHA Directive 2000-16, medical centers are mandated to measure and track rehabilitation outcomes on all new stroke, lower-extremity amputees, and traumatic brain injury (TBI) patients using the FIM.The FIM assessments are used clinically to monitor the outcomes of rehabilitative care as required by the Joint Commission on the Accreditation of Health Care Organizations (JCAHO) and the Commission on the Accreditation of Rehabilitative Facilities (CARF). According to VHA Directive 2000-16, medical centers are mandated to measure and track rehabilitation outcomes on all new stroke, lower-extremity amputees, and traumatic brain injury (TBI) patients using the FIM.
General Health Questionnaire (GHQ)	
Glasgow Outcome Scale	
Gronigen Activity Restriction Score (GARS)	
Hannover Score for Polytrauma Outcome (HASPOC)	
Health Utilities Index	
Hospital Anxiety and Depression Scale (HADS)	
Identifying Seniors At Risk (ISAR)	Identify patients for likelihood of functional decline or poor long term outcomes
Impact of Events Scale-Revised (IES-R)	
Informant Questionnaire of Cognitive Decline in the Elderly Short Form	
Injury Severity Score	An anatomical score that measures the overall severity of injured patients
Injury Severity Score >15	
Karasek's 31-item Job Content Questionnaire	
Katz Index of Independence in Activities of Daily Living	

Title	Description
Kings Outcome Scale for Childhood Head Injury (KOSCHI)	The KOSCHI provides a practical scale for paediatric head injury which will enable clinicians to describe rate and extent of recovery, and evaluate the effects of service and research interventions.
Modified Functional Independence Measure	
Modified Physiological Triage Tool-24 (MPTT-24)	A triage tool to predict the need for life saving interventions
Multidimensional Health Locus of Control	
Musculoskeletal Function Assessment (MFA)	
Pediatric Quality of Life Inventory	Evaluates the reported quality of life in children within a healthcare setting as per the child's self-report or the parent/caregiver's observations.
Polytrauma Outcome (POLO) chart	Assesses health related QoL, measuring many trauma related apsects of QoL and includes other tools (GOS, EUROQOL, SF-36 and the trauma outcome profile).
Post Traumatic Symptom Scale (PTSS-10)	
Post-Traumatic Stress Disorder Checklist (PCL)	
Quality of Wellbeing Scale	
Quality Rounds Checklist	Checklist to identify compliance with 16 evidence based preventative measures for various ICU complications
RCS-E - Rehabilitation Complexity Scale Extended	The Rehabilitation Complexity Scale Extended (RCS-E) provides a simple overall measure of Care, Nursing, Therapy, Medical and Equipment needs, and is designed to offer crude banding of complexity
Short Form Health 12	
Short Form Health 36	
Sickness Impact Profile	
Social support Questionnaire (Fragebogen zur Sozialen Unterstutzung: F-Sozu-22)	
Social Support Questionnaire (SSQ)	
Spinal Cord Independence Measure	The SCIM captures the ability of a person with spinal cord injury to complete activities of daily living. It assesses independence in 19 key areas including self care (6), respiration and sphincter management (4) and mobility (9 items)
State-Trait Anxiety Inventory (STAI)	
Symptom Checklist 90-Revised (SCL 90R)	
Syndrom-Kurtz Test (SKT)	
T-QoL	A five component, 43-item questionnaire with domains unique to trauma populations
Trauma and Injury Severity Score (TRISS)	
Trauma Early Monitoring Prediction Tool (TEMPT)	A score that can be used for the early identification of those at risk of doing poorly following minor injury.
Trauma Outcomes Profile (TOP)	
World Health Organizasation Disability Assessment Schedule II (WHODAS II)	
World Health Organizational Quality of Life Instrument	A general questionnaire for assessment of quality of life (QOL) in both healthy populations and in various diseases subgroups.
Quality of Trauma Care Patient-Reported Experience Measure (QTAC-PREM) - Short Form	
HCAHPS Survey	
(EDPEC Discharge to Community) Emergency Room Patient Survey	Trial version of ED Patient Experience of Care Survey. Intended as an add-on to HCAHPS

[Scan] Appendix C: Environmental Scan Strategy

Purpose

This document details the National Quality Forum (NQF) team's approach to conducting the environmental scan of measures for the Trauma Outcomes project.

Research Questions:

The environmental scan will be guided by these research questions. These questions will help to focus the NQF team's research efforts and ensure the information sources collected are relevant to the project objectives.

- What are measures currently in use that can assess trauma care outcomes?
- What are measure concepts that can assess trauma care outcomes?
- What are the measurement gaps in trauma care? What measure concepts can be translated into performance measures to fill existing measurement gaps?
- What frameworks exist related to trauma care?
- What are the key considerations related to shared accountability, attribution, and risk adjustment in developing a trauma outcomes framework?
- Add question on frameworks if possible.

Scope

The environmental scan will begin with a broad search and gradually decrease in scope as certain settings, types of measures, or concepts are prioritized. The Committee and key informants will provide input on the inclusion of measures and concepts into the environmental scan report. NQF will only collect measures for which there is enough information to understand how the measure should be used (e.g., what is being measured, where does measurement occur, etc.). Therefore, NQF will only collect measures that have the required data elements included in Table C1. The scan will not include measures or concepts related to psychological trauma (e.g., abuse) or secondary trauma.

Table C1. Data Elements Captured in the Environmental Scan

Data Element	Description
Title	Name of measure
Description	Measure description
Numerator	Numerator statement*
Denominator	Denominator statement*
Measure Type	Measure type based on NQF taxonomy
Level of Analysis	Entity accountable for improving performance (e.g. state, individual provider, agency, consumer)
Setting	The setting where data are collected (outpatient, inpatient, community, etc.)
Accountability	The extent to which the measure or concept facilitates or discourages accountability

Data Element	Description
Attribution	The extent to which the current attribution approach could enhance delivery system reform
Risk adjustment	Approach to risk adjustment for outcome measures*
Data Source	Data source for measure information (i.e., inventory, database, repository)

*Only collected for performance measures.

Sources

The NQF team will conduct the search in a clear and transparent manner. Key informants will be used to identify seminal work, relevant ongoing efforts, as well as measures under development. Sources will be gathered over the life of the project. The search will be an iterative process with constant opportunities for feedback from the project team and the Committee. The environmental scan will include, but not be limited to a review of the peer-reviewed literature and grey literature and:

- NQF's portfolio of endorsed measures;
- Centers for Medicare & Medicaid Services (CMS) Measures Inventory, including measures under development;
- Merit-based Incentive Payment System (MIPS) and Advanced Alternative Payment Models (APM) measures
- Accountable Care Organization (ACO) and Patient Centered Medical Home (PCMH) Primary Care Measures
- Healthcare Effectiveness Data and Information Set (HEDIS)
- Agency for Healthcare Research and Quality (AHRQ) National Quality Measures Clearinghouse and National Guidelines Clearinghouse;
- General and targeted outreach to the NQF membership and the broader public;
- Recommendations from the Trauma Outcomes Committee.

The following publications will also be reviewed:

- CMS Measures Management System Blueprint, including but not limited to Chapter 1: Measure Conceptualization
- A National Trauma Care System: Integrating Military and Civilian Trauma Systems to Achieve Zero Preventable Deaths After Injury
- Resources for Optimal Care of the Injured Patient

Example Sources:

- Databases: Google Scholar, PubMed/Medline (Medicine), Academic Search (multidisciplinary), LexisNexis (News), JSTOR (multidisciplinary), and Web of Science (multidisciplinary)
- Measure Repositories: AHRQ National Quality Measures Clearinghouse (NQMC) and AHRQ National Guidelines Clearinghouse (NGC)
- Grey Literature (i.e., academic or policy literature that is not commercially published):

- Government publications (e.g., Congressional reports, federal or state agency reports, rules and regulations, etc.)
- Reports or publications from foundations, associations, or nonprofit groups (e.g., Commonwealth Fund, Kaiser Family Foundation, AcademyHealth, medical/healthcare associations or specialty societies, etc.)
- Conference papers or proceedings, abstracts

Search Parameters

The NQF team will use the parameters defined in Table C2. The NQF team will refine the search parameters when appropriate as additional information is gathered.

Table C2. Search Parameters

Included	Excluded
• Developed or published after 2000 OR originally published prior to 2000 and still current • Measures that include specifications that meet the operational definitions of trauma • Instruments, scales, survey tools, and surveys	• Published before 2000 and not current • Not available in English • Does not include data from the required data elements (Table C1)

Search Terms:

The NQF team will use specific "terms" or "strings" to search for information sources. As additional information is gathered, NQF will revisit and refine the list of terms as appropriate. Databases are searched using combinations and variations of the example search terms below. NQF will also use relevant MeSH terms. For the environmental scan of measures, these terms may be combined with terms like "measure," "survey," "scale", "quality," etc.

Terms:

- Trauma (-tic)
- Injury (-ies)
- Traumatic injuries
- Intentional injury (-ies)
- Unintentional injury (-ies)
- Advanced trauma
- Polytrauma
- Pediatric trauma
- Geriatric trauma
- Rural trauma
- Shock trauma
- Trauma mortality

- Neurotrauma
- Prehospital
- Critical care
- Emergency care
- Undertriage
- Overtriage
- Burn
- Fracture
- Spinal cord injury
- Traumatic brain injury
- Life support

Operational Definitions

- *Trauma*: severe blunt, blast, or penetrating injury primarily caused by automobile crashes, gunshots, knife wounds, falls, battery, or burns
- *Traumatic injury*: refers to physical injuries of sudden onset and severity which require immediate medical attention
- *Performance measure:* an assessment tool that aggregates data to assess the structure, processes, and outcomes of care within and between entities (typically specifies a numerator (what/how/when), denominator (who/where/when), and exclusions (not)).
- *Measure concept:* a description of existing or potential assessment tool or instrument that includes planned target and population
- *Instrument:* an assessment tool such as a survey, scale, questions, etc.

Appendix C: Concepts for the Conceptual Measurement Framework

Please note that this appendix lists all of the concepts, including process, outcome, and structural measures, identified by the Committee following the environmental scan report. The list was not de-duplicated in order to demonstrate recurring themes for measurement of trauma outcomes.

Domains	Concepts
Access to Trauma Services • Capacity of services • Availability of services • Timeliness of services • Resource matching	1. Time to trauma center 2. Appropriateness of arrival location (i.e., the patient goes to a level III center when they really should have gone to a level I) 3. Diversion or capacity of a facility and its subsequent consequences 4. Percent of patients with ISS 15 or greater with bystander care prior to EMS arrival 5. Percent of patients with ISS 15 or greater with an EMS responder on scene within 10 minutes of injury 6. Percent of population within a 10-minute EMS on scene response time 7. Percent of patients with ISS 15 or greater who arrive at a level 1 trauma center within 1 hour of injury 8. Percent of patients who meet CDC field trauma triage step 1 (physiologic) or step 2 (anatomic) criteria who are primarily transported to the highest level of care in the trauma system 9. Percent of patients who meet CDC field trauma triage criteria who are primarily transported to a trauma center. 10. Percent of patients greater than 55 who meet CDC field trauma triage criteria who are primarily transported to a trauma center 11. Percent of population who are within 1 hour of a level 1 trauma center by ground or air 12. Percent of patients with closed head injury who are evaluated and treated by a neurosurgeon within 1 hour of injury 13. Percent of patients with uncontrolled abdominal bleeding who are in the OR within 30 minutes of arrival at the hospital 14. Proximity to home within 30-minute, 60-minute driving time (GIS-based assessment from centroid of home zip code to nearest trauma hospital by level); could be split by state, county, other population-level geospatial measurement blocks. This could be a measure of access by driving private vehicle 15. EMS response interval in minutes (by 90th percentile, 90th percentile), split by similar geospatial measurement blocks. This could be a measure of access to 911 emergency services 16. Interhospital transfer rate to level I/II trauma center among seriously injured patients (e.g., ISS >= 16, head AIS >= 3) across geospatial blocks. This could be a measure of access to specialized trauma care among those in need who present to nonmajor trauma centers 17. Death in the field after injury by 911 EMS (population-adjusted count or percent of all 911 injury calls). This could be a measure of delay in access to emergency services (either delayed notification of 911 “discovery time” or delay in 911 response “response interval”) 18. Hospital capability 19. Level of care of this unit (Basic life support or advanced life lupport)

Domains	Concepts
	20. On scene odometer reading 21. Patient destination odometer reading 22. Unit left scene date/time 23. Destination patient transfer of care date/time 24. Reason for choosing destination 25. Cause of injury 26. Adherence to field triage criteria for transport to a trauma center as defined by the CDC and Prevention and the ACS-Committee on Trauma 27. Adherence to field triage criteria for transport to a trauma center as defined by the CDC and Prevention and the ACS-Committee on Trauma for vehicular, pedestrian, or other injury risk factor 28. Percent of trauma patients diverted (reason for choosing destination) 29. Percent of trauma patients transported to a level 1 trauma center (hospital capability) 30. 90th percentile trauma patient transport time (unit left scene date/time/destination patient transfer of care date/time) 31. Average mileage to hospital for trauma transport (on scene odometer reading/patient destination odometer reading) 32. Use of geomapping to ensure there are enough providers within a 30-mile radius of urban consumers, or 45 to 60 miles for rural consumers depending on type of service. Similar approach could be used for access to care 33. Trauma centers per million population 34. Specialty providers per capita 35. Patients that met CDC field triage criteria that didn't go to a level 1 center 36. Proportion of dispatch times that fall within a certain range 37. A measure that adults and pediatric patients were transported to the appropriate trauma center based on injury
Trauma Clinical Care • Acute care • Post-acute care • Longitudinal care o Continuity of care/care coordination *NOTE: All subdomains contain patient-level and population-level measures and measure concepts	1. Rate of work resumption among the trauma injured 2. Case fatality rate 3. Population based mortality rate 4. ACS verification processes for trauma centers (e.g., fixation of femur fractures within 24 hours) 5. Number of days patients get therapy in the hospital 6. Percent of patients with access to rehab facility 7. Number of patients receiving one year follow-up for functional status, return to work 8. Percent of trauma patients with uncontrolled extremity bleeding who have a tourniquet applied prior to hospital arrival 9. Percent of trauma patients transported by EMS who have an SaO2 of greater than 95% on arrival at the hospital 10. Percent of trauma patients transported by EMS who were diagnosed with spinal injuries and who were immobilized prior to arrival at the hospital 11. Percent of trauma patients who are intubated in the field that have positive confirmation of correct endotracheal tube placement on arrival at the hospital

Domains	Concepts
	12. Percent of trauma patients with an ISS of 15 or greater who have an EMS scene time of 10 minutes or less prior to transport 13. Percent of trauma patients transported by EMS who have a patient care report completed and submitted to the hospital prior to EMS going back in service 14. Percent of patients who are undertriaged to a local hospital who are subsequently transported to a trauma center 15. TRISS adjusted trauma outcomes for EMS services, trauma centers, hospitals, regions and states 16. Mortality rate for trauma patients with ISS 15 or greater for EMS services, trauma centers, regions, and states 17. Percent of trauma patients with a need for rehabilitation after discharge from a trauma center who are transferred to an appropriate rehabilitation facility. 18. Outcome measures (e.g., survival, functional outcome, return to work) across population-level geospatial blocks (i.e., including all hospitals in a region) for all admitted/observation status patients with ICD10 code for injury. These measures would ideally use standardized time intervals starting at the time of presentation (or time of injury) = 30-day, 60-day, 90-day, 1-year. 19. DVT prophylaxis among admitted patients 20. Follow-up clinic visit within 2 weeks of discharge, rehabilitation services 21. Initial patient acuity 22. Final patient acuity 23. Percent of trauma patients whose condition improved after EMS care (initial patient acuity vs. final patient acuity) 24. Number or percent of trauma patients (CDC trauma criteria) 25. Percent of trauma patients receiving ALS care vs. percent of trauma patients receiving BLS care (level of care of this unit) 26. Care Coordination Measures Atlas Measure 67 Brief 5 A's Patient Survey 27. Care Coordination Measures Atlas Measure 68 Patient Perceived Continuity of Care from Multiple Providers 28. Care Coordination Measures Atlas Measure 69 Relational and Management Continuity Survey in Patients with Multiple Long-Term Conditions 29. Return to work in a year (longitudinal/long-term outcomes) 30. Patient-eported outcome measures (e.g., using existing measurement tools) 31. Previous level of function/return to previous normal activity 32. Independent living 33. Community reintegration 34. Quality of life 35. Level of functioning 36. Measure of delay in care (>2 hours at a lower level trauma center prior to transfer to a level 1 center)

Domains	Concepts
Cost and Resource Use of Trauma Care • **Individual** • Trauma center • System • Societal	1. Cost per year of lives saved 2. Number of lives saved 3. Mortality and morbidity by specific types of trauma and associated costs 4. Cost of trauma care paid for by state/federal government for underinsured and uninsured patients 5. Cost of care per trauma patient for care and transport by EMS at a local, regional, or state level 6. Cost of care per trauma patient for care at the trauma center at a local, regional, or state level 7. Cost of care per trauma patient for care at a rehabilitation center at a local, regional, or state level 8. Total cost of care per trauma patient from injury to discharge at a local, regional, or state level 9. Total societal (healthcare, lost wages, etc.) costs per trauma patient at a local, regional, or state level 10. Standby costs (to meet standards of care and rules) for EMS and trauma centers at a local, regional, or state level 11. Days missed due to physical health or mental health issues. This could be measured with cost to society using median income, for example 12. Disease-specific utilization of services/procedures 13. Aggregate severity adjusted costs 14. Cost/effort for patients who die (all causes) 15. Length of stay by magnitude of trauma 16. LOS by diagnosis 17. Cost of care provided when the chance of survival is low 18. Averted cost of dependency and disability

Domains	Concepts
Prevention of Trauma • Engineering • Enforcement • Legislation • Education	1. Number of patients that receive alcohol screening and brief intervention 2. Injury hospital admission rates at the population level 3. Hospitalization rates for major injury 4. Death from firearms 5. Rate of injuries from firearms 6. Accidental firearm injury in children 7. Intentional injury rate 8. Number of states with helmet laws 9. Number of states with seatbelt laws 10. Rate of unintentional, intentional, and all injuries at the local, regional, and state level 11. Death rate for unintentional, intentional, and all injuries at the local, regional, and state level 12. Both these rates for selected high-impact injuries such as from motor vehicles, guns, falls, drownings, etc. 13. Testing of vehicles for crash worthiness. (unintentional/motor vehicle/engineering) 14. Seat belt compliance for the general public and in motor vehicle injuries and deaths. (unintentional/motor vehicle/enforcement) 15. Surveys of state or local laws regarding seat belt use, care seats, helmets, etc. (unintentional/motor vehicle/legislation) 16. The use of PSAs for drug use and drunk driving (unintentional/motor vehicle/education) 17. The use of educational moments in EDs after injuries. (unintentional/motor vehicle/education) 18. Percent breakdown of injury type (cause of injury, i.e., assault, burns, falls, firearms, etc.) 19. Compare rates of injuries/suicides/MVA per 1,000 of states with differing legislation/laws/educational programs to identify effectiveness of policies