2024 TRAUMA INDEX

INSIGHTS AND BEST PRACTICES FOR TRAUMA SYSTEMS

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INSIGHTS AND BEST PRACTICES FOR TRAUMA CENTERS AND TRAUMA SYSTEMS

The 2024 ESO Trauma Index is the fourth annual ESO Trauma Index. It is one of the three annual indices – along with the EMS Index and Fire Service Index – that ESO releases to share trends and benchmarking metrics.

The ESO Trauma Index is a quantitative set of metrics for hospitals and trauma systems to reference when comparing their work to other organizations across the nation. This Index offers insights and best practices for trauma centers and trauma systems quality improvement programs.

We believe that the combination of accurate data collection and meaningful measures can propel hospitals and trauma systems toward better patient outcomes, efficiency, and evidence-based practices.

975,433
PATIENT RECORDS

576
HOSPITALS

DATA SOURCE

The dataset for the 2024 ESO Trauma Index is real-world, de-identified data, compiled and aggregated from hospital admissions between January 1 and December 31, 2023. This ESO Trauma Index includes 975,433 patient records from 576 participating hospitals that use ESO services and agreed to have their de-identified data used for research purposes. The ESO Trauma Index is created from the ESO Data Collaborative, the world's largest de-identified trauma registry dataset available at no cost.

HOW TO USE THE ESO TRAUMA INDEX

Trauma centers of all levels and sizes, along with emergency departments and state trauma systems, can use the 2024 ESO Trauma Index to identify which areas of their practices are nationally aligned and where there are opportunities for improvement. We hope that trauma centers, emergency departments, and state trauma systems use this report to spark curiosity, start conversations, compare processes, refine tactics, improve efficiency, and allocate resources toward the ultimate purpose of our work – improving community health and safety.

> ***"The Trauma Index is life and breath to me because it gives me what I didn't have before: real data from across the country of like facilities — data that I can truly compare myself to."***
>
> **– Roberta Berry**
> Trauma Nurse and Program Manager, Gila Regional Medical Center, Silver City, New Mexico

The 2024 ESO Trauma Index can help your health system answer questions such as:

- **How many of our trauma patients need a blood transfusion? What percent received whole blood versus packed red blood cells (PRBC)?**
- **How soon are trauma patients with open long bone fractures receiving antibiotics?**
- **How often do we surgically repair hip fractures in older adults within 24 hours?**
- **What percentage of penetrating trauma victims have a systolic blood pressure (SBP) less than 90 mmHg or a shock index (SI) greater than one? What is the relationship between these vital signs and mortality?**
- **How often do we experience key hospital events? Is that number going up or down?**
- **How frequently are trauma patients reporting interpersonal violence?**
- **What are the top three most common mechanisms of injury? Where do firearms rank?**
- **Is my organization aligned with others nationally when it comes to patient care measures?**
- **How can my trauma center focus on making meaningful impact on each measure?**

LIMITATIONS

The 2024 ESO Trauma Index follows the 2023 American College of Surgeons National Trauma Data Standards. The data is raw, containing no risk adjustment or other manipulations. This document is not a scientific analysis nor is it peer-reviewed; it is intended to be informational and directional. The data are not comprehensive, and there are no universal rules designed around the measures.

The 2024 ESO Trauma Index Report follows the 2023 American College of Surgeons National Trauma Data Standards.

2024 KEY METRICS

The 2024 ESO Trauma Index includes nine measures. First, it investigates using whole blood and blood component therapy, namely, packed red blood cells (PRBC). The second metric considers injury severity scores (ISS), and how scores and mortality vary by trauma center level.

The Trauma Index also examines the time to antibiotic administration for patients with longbone fractures, and the time to surgery for older adult patients with hip fractures. Penetrating trauma data explores SBP and SI related to mortality. The occurrence of hospital events, formerly known as hospital complications, captures the most common events across trauma center levels. This year's Trauma Index includes two new measures as well.

WHAT'S NEW

For the first time, the ESO Trauma Index looked at metrics for time to transfer patients, and mechanisms of injury for patients in trauma centers. We considered the relationship between the time to transfer from both emergency department vs. inpatient location, and we also explored whether patient ISS or Trauma Center Level designation related to patient outcomes.

In the second new measure, we examined the most common types of injuries trauma centers treat, how they vary by age, and how trauma centers can follow recommendations and new best practices.

TOGETHER, THE NINE MEASURES ARE:

WHOLE BLOOD USE

BLOOD COMPONENT THERAPY – PRBC

ANTIBIOTICS AND OPEN LONG BONE FRACTURE

TIME TO SURGICAL REPAIR FOR OLDER ADULTS WITH HIP FRACTURES

PENETRATING TRAUMA

HOSPITAL EVENTS

ISS AND MORTALITY

NEW!
MECHANISM OF INJURY

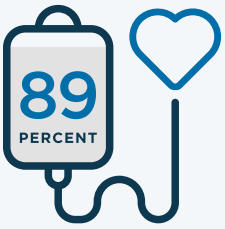
NEW!
TIME TO TRANSFER

KEY FINDINGS

Whole Blood Usage: Among the almost 70,000 trauma patients who received a blood transfusion, 5% received whole blood only. For patients who met the EBTNS score of greater than five and received whole blood, 98% received whole blood within four hours, the goal.

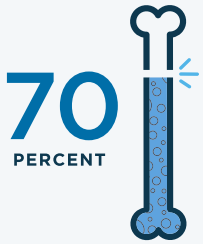
98%

WITHIN 4 HOURS



Blood Component Therapy: Among all patients who received a blood transfusion, about 89% received PRBC. The median time to transfusion for all patients who received PRBC was 12 hours, significantly longer than patients with EBTNS greater than five who received PRBC in 27 minutes.

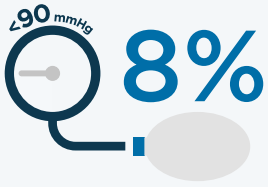
Antibiotics and Open Long Bone Fracture: 70% of patients with an open long bone fracture received antibiotics within 60 minutes of arrival at the trauma center. This is up slightly from 67% last year.



Time to Surgical Repair for Hip Fractures: 94% of patients 65 years and older requiring surgery for a hip fracture moved to the operating room (OR) within 24 hours. Nearly 100% moved within 48 hours, which is the same percentage as the previous ESO Trauma Indices.

94% WITHIN 24 HOURS

Penetrating Trauma: 8% of patients with penetrating traumas had an SBP of less than 90 mmHg, and 13% had SI greater than one. A lower SBP and higher SI were associated with increased mortality.



Injury Severity Score (ISS): Almost 50% of all patients with trauma-related injuries received treatment at a Level I trauma center, and 95% of these patients survived, based on crude mortality. As expected, those patients with the most severe injuries – with ISS scores greater than or equal to one – experienced the highest mortality..

INVOLVED HOSPITAL EVENTS

Hospital Events: Matching trends from similar years, about 8% of hospital encounters involved a hospital event. The five most reported events remained consistent.

Mechanism of Injury: The most common mechanisms of injury in the data are falls, motor vehicle crash (MVC), and struck by/against, collectively accounting for 74% of all trauma injuries. Pediatric patients are 115 times more likely to report experiencing interpersonal violence than older adults.

Time to Transfer: From the time written orders were received, the median transfer time from the emergency department to a higher-level facility was 78 minutes, while the transfers from an inpatient location took much longer at 141 minutes.

"It's hard to know how well you're doing for your patients if you're just looking at your own data. Comparing results to national benchmarks can help paint a clearer picture."

– **Antonio R. Fernandez, PHD, NRP**
Principal Research Scientist, ESO

TRAUMA INDEX

WHOLE BLOOD AND BLOOD COMPONENT USE

KEY FINDINGS

Almost 70,000 trauma patients received a blood transfusion. 5% received whole blood only, 87% received PRBC, and 8% received both whole blood and PRBC.

The median time to PRBC transfusion for patients with EBTNS greater than five was 27 minutes. However, among all patients who received PRBC, the time to transfusion notably increased to 12 hours.

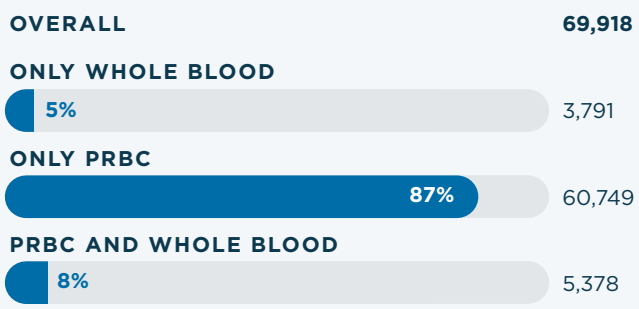
75% of patients who met the EBTNS definition did not receive a transfusion, the same percentage as the 2023 ESO Trauma Index.

The EBTNS is a tool to rapidly assess and predict the likelihood that a patient will need a blood transfusion. It involves scoring several patient components such as blood pressure, age, type of injury, etc. Scores greater than five indicate a significant risk of requiring early blood transfusion.[1] Using EBTNS in trauma care standardizes timely blood product administration and reduces delays in care.

We know that more patients receive blood or blood products than those with an EBTNS score greater than five. In this 2024 ESO Trauma Index, for the first time, we looked at all patients who received blood/blood products – regardless of EBTNS. Nearly 70,000 trauma patients received blood or blood products; this is about 7,000 more patients receiving transfusions than only those with EBTNS greater than five.

Chart 1

Type of Blood Administered among ALL Patients who Received Transfusion

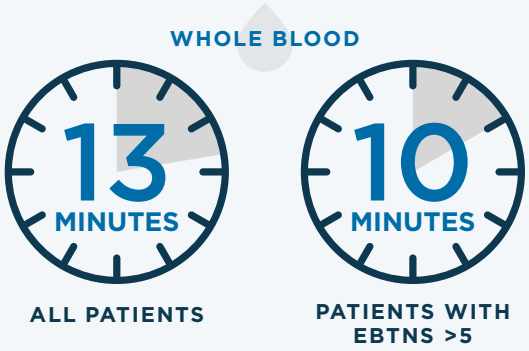


Whole Blood Use

The median time to whole blood delivery among ALL patients who received whole blood was 13 minutes. The median time among those with EBTNS greater than five and received whole blood was 10 minutes. A difference of only three minutes likely reflects the strict protocols for using whole blood.

Chart 2

Median Time to Whole Blood Transfusion



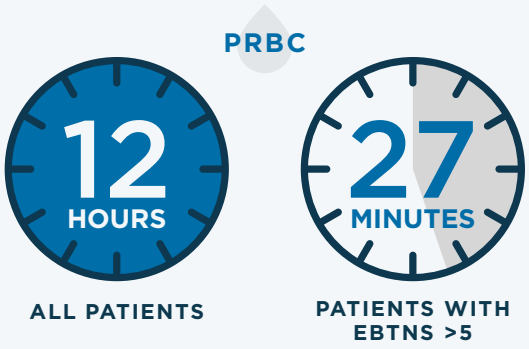
Additionally, among those who received whole blood with EBTNS greater than five, 98% received whole blood within four hours. That's good news, as timely blood transfusions have been shown to decrease mortality in severely injured trauma patients impacted by hemorrhage.[2]

PRBC Use

More trauma transfusions involve PRBC than whole blood, making the trends significant. The median time to PRBC transfusion for patients with EBTNS greater than five was 27 minutes. However, among all patients who received PRBC, the time to transfusion notably increased to 12 hours.

Chart 3

Median Time to PRBC Transfusion

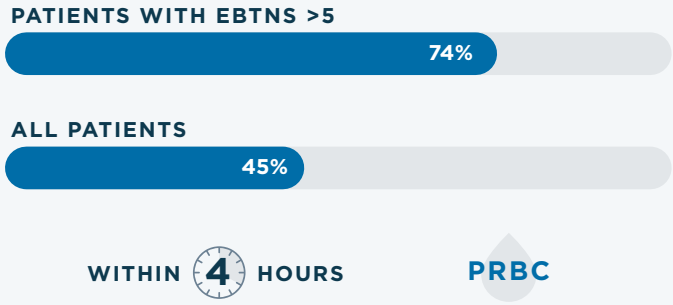


This large time range of 27 minutes to 12 hours includes patients who required additional interventions, such as damage control surgery or managing other traumatic injuries, which can delay PRBC administration beyond the initial four-hour window. The delay may account for the time required for blood type matching and crossmatching in patients who did not meet the criteria for uncrossmatched transfusions, which extends the time to crossmatched transfusion.

While 98% of patients with EBTNS greater than five received whole blood transfusion within four hours, the percentage is much lower for PRBC. Among patients with EBTNS greater than five who received PRBC, 74% received PRBC within four hours. However, among ALL patients who received PRBC, only 45% received PRBC transfusions within four hours, highlighting an area for improvement.

Chart 4

Percent of Patients Receiving PRBC Within 4 Hours



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WHOLE BLOOD AND BLOOD COMPONENT BACKGROUND

Hemorrhage is the most common cause of death within the first hour of arrival to a trauma center.[3] Approximately 30% of trauma-related deaths in the U.S. and 40% worldwide are due to bleeding or the consequences of uncontrolled hemorrhage, making it the most common cause of preventable death in trauma, according to ACS and the Joint Trauma Systems (JTS).[4,5]

The most common transfusion options for trauma patients facing massive blood loss are whole blood, blood components (PRBC), or both. In patients experiencing hemorrhagic shock, whole blood transfusion is associated with both improved survival and decreased overall blood use compared to PRBC.[6]

PRBC in Trauma Care

Using PRBC in trauma care is standard practice[7] for addressing acute blood loss and the associated risk of hemorrhagic shock. Administering PRBC helps replace lost volume, stabilizes blood pressure, and mitigates the risk of hypovolemic shock, which can be life-threatening if not managed promptly. Timely administration of PRBC, including prehospital[8] care during a massive transfusion protocol (MTP), has been shown to reduce mortality rates in severely injured trauma patients.[9]

Whole Blood in Prehospital Settings

Research supports using whole blood in prehospital settings. Emergency medical services (EMS) administering whole blood to critically ill and injured patients is practical, feasible, and associated with a low risk of adverse events and transfusion reactions.[10] A study showed trauma patients who received prehospital whole blood transfusion had a greater improvement in SI and a reduction in early mortality.[11] The timing to first whole blood transfusion increases trauma patients' survival following severe hemorrhage when given as an adjunct to MTP.[12] Further research is needed.

Whole Blood Challenges

Despite its effectiveness, whole blood remains expensive and challenging to manage due to its short shelf life, screening and testing requirements, temperature-controlled transportation and storage needs, compatibility issues, and more. These challenges need to be addressed to ensure timely and safe administration in trauma situations where whole blood is necessary. While the early administration of whole blood is crucial, its availability and ability to administer it quickly can vary depending on the healthcare setting.

Blood Component Challenges

While PRBC transfusions are beneficial, they are not without risks. Potential complications include transfusion reactions, infection, and immune modulation. Additionally, some trauma providers express concern about over-reliance on PRBC leading to issues like hypervolemia or impaired clotting when not balanced with other components like plasma and platelets.[13,14] Studies show that over half of trauma patients are hypocalcemic prior to receiving any blood products on arrival to emergency and trauma centers.[15,16] Hypocalcemia contributes to coagulopathy, which may lead to ongoing blood loss and potential death.[17]

WHOLE BLOOD AND BLOOD COMPONENT RECOMMENDATIONS

1. Monitor treatment outcomes for patients in hemorrhagic shock and administer timely transfusions of whole blood or PRBC.
2. Use whole blood to help improve outcomes for patients experiencing severe hemorrhage and shock.
3. Consider implementing changes that facilitate clinicians' use of whole blood for patients with life-threatening hemorrhages.
4. Closely monitor the availability of blood products during massive transfusions to identify key areas for improvement.
5. For performance monitoring and improvement, use data from all patients who receive blood product transfusion within three hours of injury.[18]
6. Monitor for hypocalcemia, a key component of the "diamond of death" in trauma care. Hypocalcemia during massive transfusion is linked to coagulopathy and cardiovascular instability, thus proactively managing calcium levels through monitoring supplementation is recommended to improve patient outcomes.[19]
7. Use MTPs for patients with severe hemorrhage.
8. Administer tranexamic acid (TXA) early, preferably within three hours of injury, can help reduce mortality in patients with significant bleeding.
9. Implement point-of-care coagulation testing using rapid coagulation tests such as thromboelastography (TEG) or rotational thromboelastometry (ROTEM). Use results to guide blood transfusion therapy based on the patient's specific coagulation profile, while tracking data with trauma registry.
10. Balance resuscitation strategy, often in a 1:1:1 ratio of PRBC with fresh frozen plasma (FFP) and platelets.
11. Review the time to administration of all transfusion recipients and consider it an area for improvement.
12. Consider mechanisms to provide rapid access to blood products, for non-critical, yet time-sensitive situations to decrease the probability of patient deterioration.

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ANTIBIOTICS AND OPEN LONG BONE FRACTURES

KEY FINDINGS

70% of patients with an open long bone fracture received antibiotics within 60 minutes of arrival at the trauma center. This is up from 63% in the 2021 ESO Trauma Index.

This is the third consecutive year that pediatric patients are less likely to receive antibiotics than adults.

We examined two metrics: the number of patients with an open long bone fracture who receive antibiotics, and the amount of time it takes for a patient with an open long bone fracture to receive antibiotics once they arrive at the trauma center.

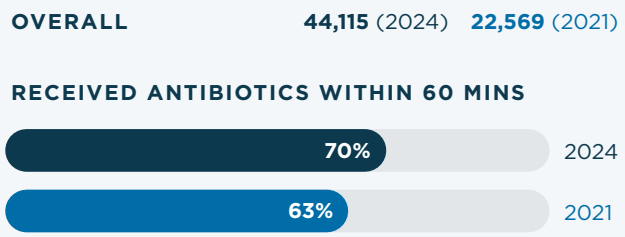
About 44,000 patients were diagnosed with an open long bone fracture and 88% received antibiotics. Of the patients suffering from an open long bone fracture, 70% received antibiotics within 60 minutes of arrival at the hospital. The median time to antibiotics was 23 minutes.

Compared to the 2021 ESO Trauma Index, the first ESO Trauma Index, we see progress. While nearly doubling the number of patients with open long bone fractures in three years, the percentage who receive antibiotics within 60 minutes of arrival increased from 63% to 70%.

For the data in Chart 5, we included "negative times" for administration of antibiotics prior to hospital arrival. Negative times and missing data potentially indicate EMS administered antibiotics while traveling to the hospital.

Chart 5

Open Long Bone Fractures and Antibiotics*



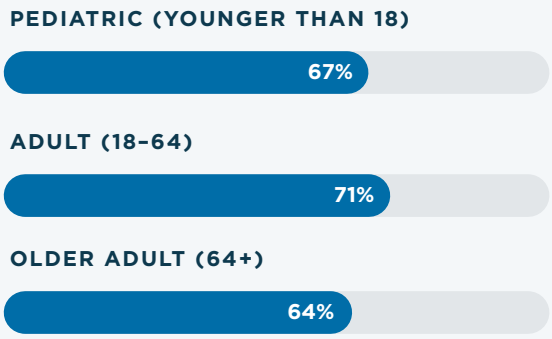
** Including negative times*

To provide the most valuable data, we calculated the time to antibiotic administration both including and excluding the negative times. Removing the negative times, the median time to antibiotics was eight minutes longer at 31 minutes. Also, 7% fewer patients received antibiotics within 60 minutes, down to 63%.

We also considered age groupings, specifically pediatric (1–18) and older adults (65+). Data show a disparity in antibiotic delivery. Similar to previous years, pediatric patients received antibiotics less frequently than adults. Pediatric patients received antibiotics within 60 minutes 67% of the time, the older adult population 64% of the time, and adults 71% of the time.

Chart 6

Antibiotic Administration by Age Group – Including Negative Data

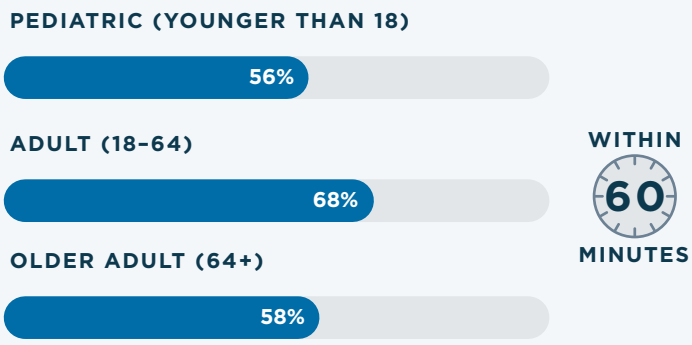


** Including negative data*

In comparison, by excluding the negative data, the percentage of patients receiving antibiotics within 60 minutes decreases in every age group.

Chart 7

Antibiotic Administration by Age Group – Excluding Negative Data



** Excluding negative data*

BACKGROUND ON ANTIBIOTICS AND OPEN LONG BONE FRACTURE

Open long bone fractures are complex injuries within the trauma system. Targeted antibiotic treatment reduces the risk of infection when soft tissue and bone are exposed to the environment with to these types of fractures.[20] Administering antibiotics early has been found to significantly decrease infection, and antibiotics should be given within 60 minutes of the patient's arrival at the trauma center.[21]

Implementing an open fracture working group and protocols surrounding antibiotic prophylaxis can significantly reduce the time it takes to administer them. Since time is of the essence in treating these types of fractures, it's important to also investigate the prehospital implementation of antibiotics.

EMS personnel can administer antibiotic prophylaxis for patients without complication.[22] It is likely that further training would lead to even higher rates of successful prehospital antibiotic administration for open fractures, and potentially raise the percent of pediatric patients who receive antibiotics within 60 minutes.

ANTIBIOTICS AND OPEN LONG-BONE RECOMMENDATIONS

1. **Give antibiotics within 60 minutes of trauma center arrival.**
2. **Implement an open fracture working group and protocols surrounding antibiotic prophylaxis.**
3. **Encourage training prehospital personnel to provide antibiotics for patients with open fractures before arrival at trauma centers, decreasing both the time to antibiotics and infection rates.**

TRAUMA INDEX

HIP FRACTURES

KEY FINDINGS

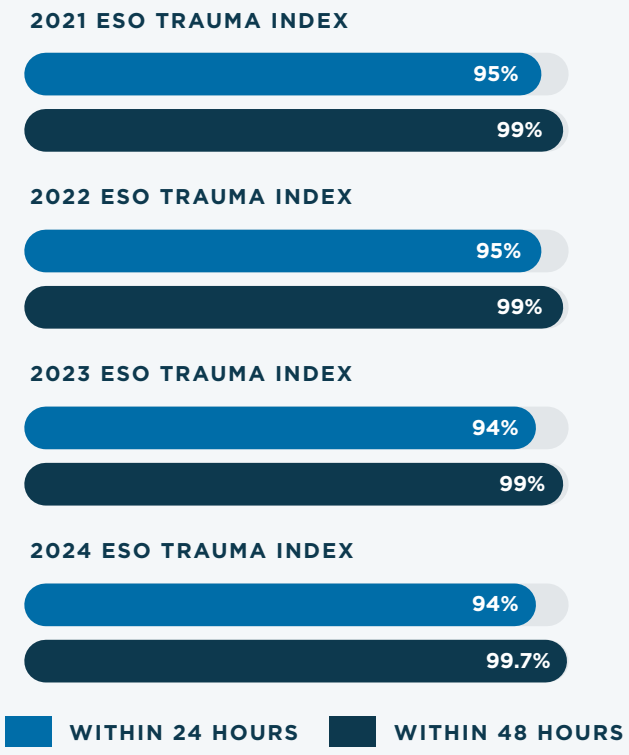
94% of patients 65 years and older who required surgery for a hip fracture moved from the trauma center to the OR within 24 hours. Nearly 100% moved within 48 hours (99.7%).

ESO will likely retire this metric since it is ingrained in clinical practice.

Guidelines from the American Academy of Orthopaedic Surgeons (AAOS) and British Orthopaedic Association (BOA) recommend that surgery for hip fractures should ideally occur within 24 to 48 hours after admission. Year-over-year, at least 94% of trauma systems moved older adult patients requiring hip fracture surgery to the OR within 24 hours, and nearly 100% moved within 48 hours.

Chart 8

2021–2024 ESO Trauma Indices: Older Patients with Hip Fractures Moving to the OR with 24 and 48 hours



In the 2024 ESO Trauma Index, nearly 100% moved to the OR within 48 hours (99.7%). Given the consistent high marks on this metric, ESO will likely retire it. Keep up the excellent work.

HIP FRACTURE BACKGROUND

Hip fractures among elderly patients are associated with an in-hospital mortality rate of 7–14%, plus a profound temporary – and sometimes permanent – decline in independence and quality of life.[23] Time to surgery is crucial for hip fractures because it significantly impacts patient outcomes. Surgical delays for hip fractures (more than 24[24] hours) associated with a significant increase in the risk of death and pressure sores,[25] deep vein thrombosis (DVT, pressure ulcers, pneumonia, and urinary tract infections.[26]

Also, prompt surgery helps control severe pain more effectively, improving patient comfort and reducing the need for prolonged high-dose pain medication. Related, early surgery facilitates quicker mobilization and rehabilitation, which is essential for preserving muscle strength and function.[27] This can reduce the length of hospital stay and the risk of post-operative complications.

Generally, timely surgery has been associated with better functional outcomes, leading to higher rates of recovery and return to pre-fracture levels of independence.[28] It is promising that nearly 100% of older patients moved to surgery within 48 hours.

HIP FRACTURE RECOMMENDATIONS

1. Repair hip fractures in geriatric patients within 48 hours to reduce mortality and improve patient outcomes. Earlier is better.[29]

2. Triage and diagnose rapidly, including a thorough clinical examination and prompt imaging such as X-rays or, if needed, CT scans to confirm the fracture.

3. Prioritize pain management for patient comfort and cooperation. This can involve the use of opioids or regional anesthesia like a femoral nerve block.

4. Repeat imaging if findings are unclear. Clear documentation of the imaging findings and any associated issues is vital for surgical planning.

5. Enhance care and improve outcomes with a multidisciplinary approach, especially for elderly patients with multiple health issues. Coordinating with specialists such as geriatricians or internists can help the patient's recovery.

6. Initiate anticoagulation therapy, if indicated, to reduce the risk of DVT.

7. If appropriate resources are available at the admitting hospital, it is not necessary to transfer isolated hip fractures to a designated trauma center.[30]

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PENETRATING TRAUMA

KEY FINDINGS

There was a statistically significant difference in mortality when comparing patient SBP and SI.

Patients with penetrating trauma and SBP greater than 90mmHg survived 96% of the time, compared to those with SBP less than 90mmHg, who survived 45% of the time.

Patients with penetrating trauma and a SI greater than one lived 84% of the time, compared to patients with a SI less than one, who lived 96% of the time.

Penetrating trauma in the 2024 ESO Trauma Index includes an examination of patterns in SI and SBP. These two measures serve as crucial tools for clinicians to triage and prioritize patients based on the severity of their injuries.

Nearly 80% of traumas were among adults 18–64, 15% were among children under the age of 18, and 6% were among adults aged 65 years and above. Overall trauma numbers and trends were similar to the 2023 ESO Trauma Index.

Penetrating Trauma and Shock Index

Of the roughly 76,000 penetrating traumas (with SBP and HR documented), 13% had an SI greater than one. There was a significant difference in mortality when comparing penetrating trauma victims with a SI less than one to those with SI greater than one. Among those with SI less than one, 96% lived and 4% died. Among those with SI greater than one, 84% lived and 16% died.

Chart 9

Penetrating Trauma by Age Group

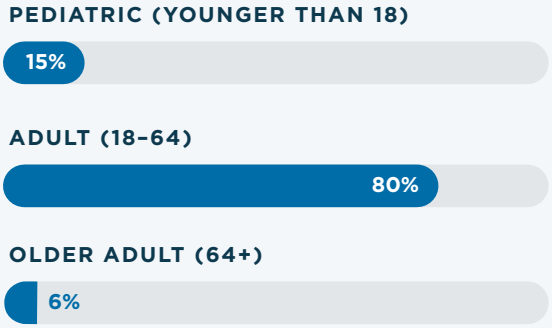
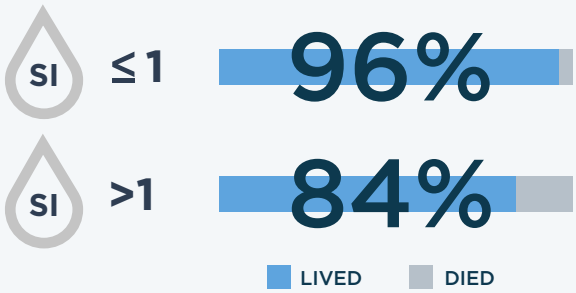


Chart 10

Shock Index and Mortality



Penetrating Trauma and Systolic Blood Pressure

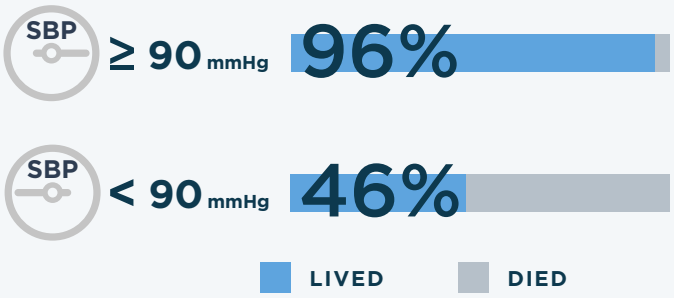
A SBP less than 90mmHg often indicates hemorrhagic shock, a condition where severe blood loss leads to inadequate tissue perfusion and oxygenation. Patients in shock are at a greater risk of death.

> ***The American College of Surgeons Trauma Quality Improvement Program considers a systolic blood pressure of < 90mmHg in an adult trauma patient to be hemorrhagic shock and at greater risk of morality.[31]***

Among patients with a SBP greater than or equal to 90mmHg, 96% lived while 4% died. Whereas, among those with a SBP of less than 90mmHg, only 46% lived.

Chart 11

SBP and Mortality



Note: Blood pressure includes adult data only; pediatric blood pressures excluded as nominal impact.

Interestingly, this is the second year the data results suggest that SBP may be a greater predictor of mortality than SI for adults. Specifically, an adult with SBP less than 90mmHg may mean they are at a greater risk of dying than a SI of five or greater.

Penetrating Trauma Background

A patient's SI is heart rate divided by SBP, and it is a measure of patient acuity. Higher SI values are associated with increased injury severity, greater need for blood transfusions, and higher likelihood of death.[32]

Over the past few decades, two penetrating trauma trends emerged nationally. First, multiple studies showed an increase in penetrating trauma mortality rates nationally.[33,34] Second, areas with limited access to trauma centers experience worse patient outcomes.[35,36,37] This is particularly true in rural areas or underserved urban neighborhoods in part because of the time it takes to reach a healthcare facility, and time can be crucial in determining patient outcomes.

Penetrating trauma remains a persistent challenge within trauma care, and it places significant stress on the trauma system, both in terms of resource-intensive and social impact. Characterized by a foreign object entering the body and breaking the skin, penetrating trauma includes injuries such as stabbing and gunshot wounds. Because of the higher mortality seen with penetrating trauma, EMS personnel must quickly identify injuries and rapidly deliver the patient to the closest appropriate trauma center.[38]

SBP is a critical factor in the initial assessment of the severity and outcomes of penetrating trauma cases. The National Trauma Triage Protocol published by the American College of Surgeons' Committee on Trauma (ACS-COT) in collaboration with (CDC) uses SBP as one of the essential criteria when identifying if an injured patient should be taken to a trauma center.

PENETRATING TRAUMA RECOMMENDATIONS

1. Quickly and efficiently triage to assess the extent of penetrating injuries and immediately stabilize. This includes controlling bleeding, ensuring adequate airway and breathing, and stabilizing vital signs, including blood pressure.

2. Control hemorrhage by stopping or rapidly controlling bleeding, both externally with tourniquets and pressure dressings and internally with surgical interventions.

3. Implement damage control resuscitation (DCR) using DCR principles, which focus on minimizing crystalloid use, administering blood products early, and controlling coagulopathy.

4. Provide access to Advanced Trauma Life Support® (ATLS®) training and education to ensure standardized and effective care, using the American College of Surgeons and ATLS systematic approach to assess and treat penetrating trauma patients.

5. Practice timely and skilled surgical interventions for penetrating injuries that require prompt surgical care.

6. Provide rapid access to blood products, including an emergency release, without a complete cross-matching process in critical time-sensitive situations.

7. Provide access to blood for timely transfusions and fluid replacement, particularly in the early stages of treatment.

8. Have a MTP with predefined ratios of blood products for the management of blood loss in penetrating traumas.

9. Improve access to public health and injury prevention efforts.

10. Monitor response times. Significant variations in EMS response times impact access to immediate lifesaving care for penetrating trauma patients.

11. Improve EMS access to and administration of prehospital blood for penetrating trauma.

12. Train and educate teams treating penetrating trauma patients, emphasizing the importance of SI in trauma care and enhancing the ability of healthcare professionals to assess and respond based on patients' needs quickly.

13. Collect key clinical data beyond the first 30 minutes, such as vitals, SBP, and heart rate.

14. Trauma registry professionals need to ensure that clinical practice guidelines and key performance indicators are achieved for trauma patients, especially penetrating trauma patients.

TRAUMA INDEX

HOSPITAL EVENTS

KEY FINDINGS

8% of patient records document at least one hospital event

The 2024 ESO Trauma Index data for hospital events show similar trends to the previous three years' indices.

Hospital events, such as infections, falls, medication errors, or surgical complications, can lead to longer hospital stays, increased morbidity, and even mortality. The 2024 ESO Trauma Index shows 8% of patient records document at least one hospital event. This is a similar percentage as previous ESO Trauma Indices.

The ACS maintains a list of hospital complications to track. The top five most common hospital events include: unplanned admission to the intensive care unit (ICU), delirium, unplanned intubations, unplanned visit to the OR, and cardiac arrest with cardiopulmonary resuscitation (CPR).

Chart 12

Top Five Reported Hospital Events

"We are providing hospital event data so that trauma centers can make informed decisions and evaluate how many complications they have against the Data Collaborative from ESO. It's information to start a conversation."

– Garrett D. Hall (they/them/their), MS, BSN, RN, CSTR, CAISS
Senior Director of Hospital and Registry Programs, ESO

HOSPITAL EVENT BACKGROUND AND INSIGHTS

Reducing hospital events – such as infections, falls, medication errors, or surgical complications – directly contributes to better patient health and recovery, and it minimizes the risk of long-term consequences. Hospital events also cost the U.S. healthcare system $20 billion each year.[39]

The Institute of Medicine recommends a culture of open communication around hospital events and near-misses, adding, "Errors can be prevented by designing systems that make it hard for people to do the wrong thing and easy for people to do the right thing."[40]

Additionally, tracking hospital events is vital for quality improvement initiatives. By monitoring and analyzing incidents, healthcare facilities can identify

patterns, root causes, and areas for intervention. A data-driven approach allows hospital trauma centers to implement targeted strategies to improve protocols, staff training, and patient care practices, fostering continuous improvement.

For instance, hospital-acquired conditions (HAC) contribute substantially to healthcare costs. But positive progress can be made. A national study by the Agency for Healthcare Research and Quality (AHRQ) estimated that between 2014 and 2017, a 13% decline in HAC prevented approximately 20,500 deaths and saved $7.7 billion in healthcare costs.[41]

Reducing hospital events helps lower expenses associated with readmissions and extended stays, optimize resource allocation, and reduce overall costs. Plus, addressing events can enhance hospital reputation and compliance with regulatory standards.[42]

HOSPITAL EVENTS RECOMMENDATIONS

1. **Create processes for identifying hospital events concurrently.**
2. **Analyze data to determine the best practices for incorporating early warning signs that allow care teams to anticipate and prevent hospital events before they occur.**
3. **Prioritize validating prospective data and accurately benchmarking hospital events.**
4. **Establish a non-punitive event review process to identify areas for improvement.**
5. **Implement projects to improve performance and address systematic issues.**
6. **Take advantage of the ESO hospital events reporting. It's a powerful tool for Level IV and non-designated trauma centers that have limited access to resources such as TQIP for benchmarking hospital events.[43]**
7. **Examine the root cause of hospital events and then design and implement strategies to help reduce the frequency of hospital events.**
8. **Collaborate to improve trauma data quality.**

TRAUMA INDEX

INJURY SEVERITY SCORE (ISS)

KEY FINDINGS

- Level I trauma centers receive the majority of severely injured patients, which is the goal.
- Mortality may be higher at lower-level trauma centers, even with equal ISS.[44]
- Directing patients with the most severe traumatic injuries to Level I trauma centers optimizes patient outcomes.

Susan P. Baker, MPH, developed ISS to determine the severity of a traumatic injury, with increasing scores indicating greater severity.[45] In addition to assessing trauma severity, the ISS also is associated with mortality, and hospitalization time after trauma.

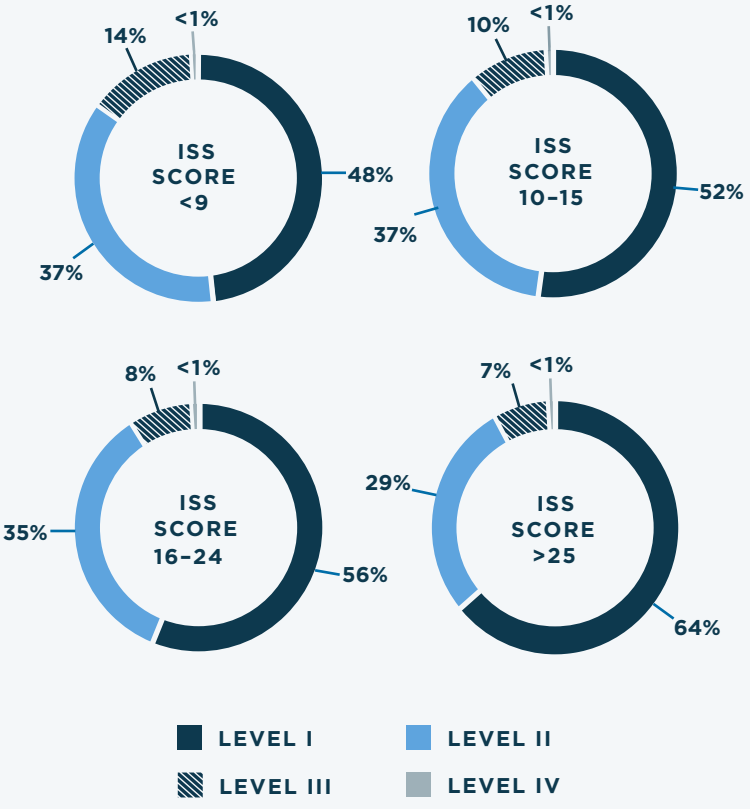
ISS values range from one to 75.[46] An ISS of 25 or higher indicates a severe traumatic injury with a significant risk of mortality, requiring treatment at the highest available trauma center. Studies collectively advocate for directing patients with a high ISS to Level I trauma centers to optimize patient outcomes. ISS has shown a direct correlation with accurate prehospital trauma triage and transport to facilities equipped to manage the most severe injuries.[47]

ISS and Distribution to Trauma Center Level

Among patients who had an ISS score less than nine – meaning not the highest acuity – about half went to Level I trauma center and 36% went to a Level II trauma center. For those with an ISS between 16 and 24, about 56% went to a Level I, and 35% went to a Level II.

Chart 13

Distribution of Patients by ISS Score and Trauma Center Level



The trend continues, with 64% of patients with an ISS of 25 or higher going to a Level I trauma center. This means that a higher percentage of the most severely injured patients went to a Level I trauma center, and that's what we want to see. That's where the patients should be.

However, Level I trauma centers receive nearly half of all trauma patients, not just the most acute. It raises a question about the best distribution of trauma patients by trauma center level. However, there are multiple reasons Level I trauma centers seeing patients at all levels of ISS.

For one, prehospital trauma triage protocols recommend that patients with lower ISS may also be transported to Level I trauma centers based on proximity, availability, or unclear injury severity at time of triage. Also, regional trauma systems are designed to funnel patients to the appropriate level of care, and these ESO data indicate that regional systems work.

Keep in mind that as part of trauma systems, prehospital providers are instructed not to bypass Level I trauma centers to avoid delays in patient care. Proximity, logistics, and avoiding secondary transfers are all addressed by having trauma transport protocols that aim to reduce the need for secondary transfers. This ensures patients are taken to the facility that best meets the injury.

REASONS LEVEL I TRAUMA CENTERS TREAT ALL ACUITY LEVELS:

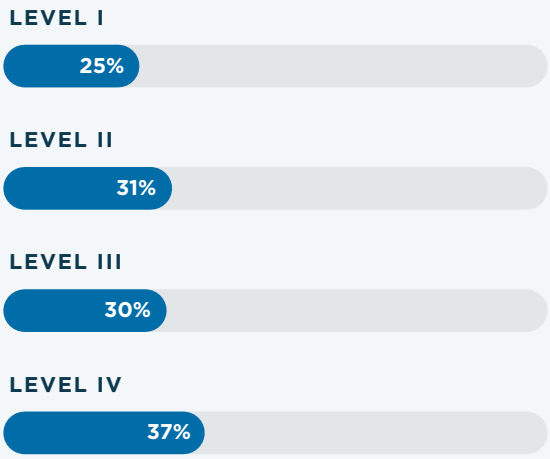
- ***Proximity***
- ***Availability***
- ***Unclear injury severity***
- ***Regional funneling***
- ***Logistics***
- ***Avoiding secondary transfers***
- ***Bypass protocols***

Level I trauma centers receive all ISS levels primarily due to trauma bypass protocols which prioritize getting patients to the highest level of care quickly and efficiently. While this ensures optimal care for severely injured patients, it may also result in over-triage, meaning less severely injured patients are treated at higher-level centers. We recommend the best practice of monitoring both over-and-under triage.[48]

We also examined the relationship between high ISS scores, mortality, and trauma center levels. Among patients with ISS greater than 25, arguably the highest acuity, there is an increase in patient mortality as the trauma center level decreases. Level I trauma centers experience 25% mortality; Level II, 31%; Level III, 30%; and Level IV, 37%.

Chart 14

Mortality by Trauma Center Level Among Patients with ISS >25



While this may appear as though patients are more likely to die in a level IV center, that is an oversimplification. Lower-level trauma centers may stabilize patients before attempting transfers to higher level centers. Also, patients may arrive at lower-level trauma centers with nonsurvivable injuries, and ISS score is only determined post-mortem.

"Although our ESO analysis is not risk-adjusted, our numbers mirror the risk-adjusted work from the New England Journal of Medicine's publication of A National Evaluation of the Effect of Trauma-Center Care on Mortality."[49]

– Garrett D. Hall (they/them/their), MS, BSN, RN, CSTR, CAISS
Senior Director of Hospital and Registry Programs, ESO

RECOMMENDATIONS FOR INJURY SEVERITY SCORE

1. The best way to improve trauma score accuracy is for trauma registrars to develop their AIS coding skills.[50]
2. Use ISS data as part of overall hospital quality improvement programs to assess care effectiveness and outcomes.
3. Determine the ISS as soon as possible following a trauma assessment to aid in early decision-making process for treatment and resource allocation.
4. Refresh trauma center providers on the differences and best uses for AIS, ISS, and NISS scoring.
5. Remind your medical professionals about ISS limitations, such as its inability to account for multiple severe injuries within the same body region. Understanding these limitations can guide appropriate supplementary assessments and interventions.
6. Hospitals should incorporate ISS into their trauma protocols for better prioritization and management.
7. Monitor over-and-under triage to align the severity of patient injury with the most appropriate trauma center level.

TRAUMA INDEX

MECHANISM OF INJURY

KEY FINDINGS

The top three reasons for trauma injury were the same across all ages: falls, then motor vehicle crash (MVC), and struck by/against.

Interpersonal violence disproportionally affects pediatric patients. 3% of children under 18 who visited the emergency department reported interpersonal violence, while less than 1% of adults or older adults who visited reported interpersonal violence.

Firearms rank as the fourth leading cause of injury for all ages, according to the 2024 ESO Trauma Index. In 2023, firearms were the fifth leading cause of injury for children and adolescents under 18 years, fourth for adults, and tenth for older adults aged 65 and above.

This is the first ESO Trauma Index to include mechanism of injury as a metric. In the U.S., injury is the most common reason for using 9-1-1 EMS,[51] with EMS playing a critical role in the early evaluation and care of injured patients.

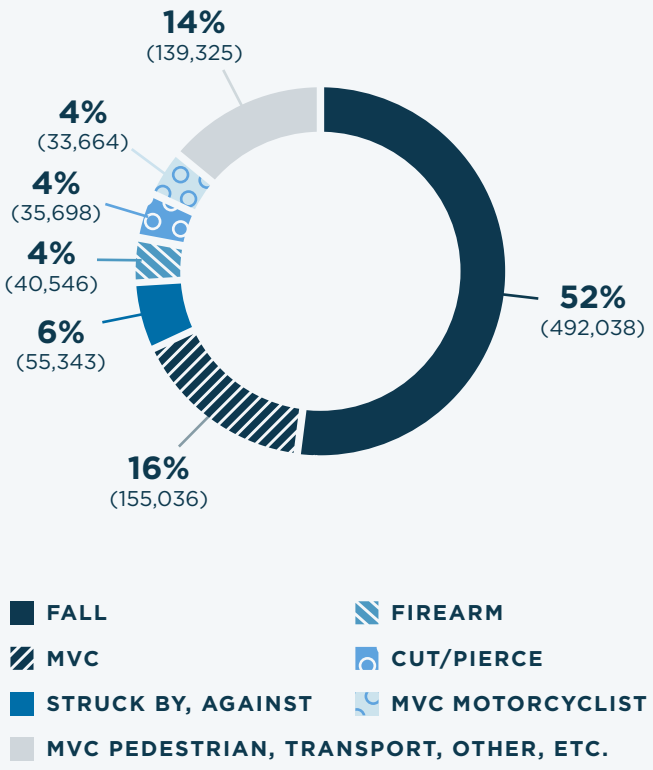
According to the CDC, unintentional injuries, including trauma, are the third leading cause of death in the U.S. Notably, among individuals aged one to 44, unintentional injuries are the leading cause of death, surpassing other causes such as heart disease and cancer, based on CDC WISQARS data. These statistics underscore the significant impact of traumatic injuries on community health and safety across various ages.[52]

In the ESO Data Collaborative, the top five mechanisms of injury appearing at trauma centers include fall, MVC, struck by/against, firearm, then cut or pierce. We broke data out by age into pediatric (<18), adult (18–64), and older adult (65+), to look for di° erences.

The top three reasons for trauma injury were the same across each age group: falls, then MVC, and third, struck by/against.

Chart 15

Overall Mechanisms of Injury – All Ages



After the top three mechanisms, differences occurred based on age group. All age groups experienced trauma injury from firearms, MVC pedestrian, and pedal cyclist among the top 10 mechanisms of injury.

Chart 16

10 Most Common Trauma Types Ranked by Age

	PEDIATRIC (<18)	ADULT (18–64)	OLDER ADULT (65+)
FALL	1	1	1
MVC	2	2	2
STRUCK BY/AGAINST	3	3	3
TRANSPORT, OTHER	4	8	9
FIREARM	5	4	10
NATURAL/ENVIRONMENTAL, BITES AND STINGS	6	-	-
INTERPERSONAL VIOLENCE	7	-	-
PEDAL CYCLIST, OTHER	8	10	5
CUT/PIERCE	9	6	8
MVC PEDESTRIAN	10	7	4
MVC MOTORCYCLIST	-	5	6
MVC OTHER	-	9	7

** MVC Other refers to transport-related incidents which do not fit into standard ICD10CM external cause of morbidity code categories such as drivers, passengers, or pedestrians. These encompass a variety of situations. They are part of Chapter 20 of the ICD10CM external causes and can be reviewed in detail within ICD10CM.*

ESO data show firearms as the number four cause of injury for all ages, the number five cause of injury for pediatrics, the number four for adults, and tenth in the older adult population. More than 40,000 people experienced traumatic injury from firearms.

FIREARM INJURIES BACKGROUND

Firearms are the leading cause death for children and adolescents aged one to 19 years, and many more youth sustain firearm injures and survive.[53] Youth exposed to gun violence are more likely to become victims of gun violence themselves.[54] In 2019, firearm injuries and fatalities cost an estimated $410 billion in medical costs, work loss, quality of life lost, and total value of life loss.[55]

Reflecting on recent national trends, firearm injuries in the U.S. show a complex pattern since the onset of the COVID-19 pandemic. Initially, there was a significant increase in both fatal and nonfatal firearm injuries; firearm purchases also increased with an estimated 7.5 million new firearm owners.[56] From 2019 to 2020, firearm homicides and nonfatal firearm injury–related trauma and emergency center visits increased by approximately 35 to 37%, respectively.[57]

Subsequent data published by the CDC indicated a decrease in firearm injury-related hospital visit rates during 2021-2023.[58] Even with a small decline, overall firearm injury rates remain elevated compared to pre-COVID-19 numbers.

FIREARMS RECOMMENDATIONS

1. **Address trauma early by screening and providing access to mental health services during hospital visits may help prevent future involvement in gun violence.[59]**
2. **Participate in CDC's National Syndromic Surveillance Program at state, local, and territorial health departments.**
3. **Consider screening for firearms in patients' homes, particularly pediatric patients. Provide free firearm safety kits that include a cable-style gun lock.[60]**
4. **Improve access to public health and injury prevention efforts. Communities with fewer resources often have limited public health programs focused on violence prevention and education, which are crucial for reducing the incidence of firearm injuries.[61]**
5. **Ensure that your trauma center uses updated prevention, interventions, and trauma-informed care protocols.**

INTERPERSONAL VIOLENCE BACKGROUND

In this 2024 ESO Trauma Index, for the first time, we explored interpersonal violence as a mechanism of injury, which aligns with the ACS and CDC. It refers to any type of intentional harm inflicted by one person on another, encompassing physical, sexual, and psychological aggression. Interpersonal violence is considered a significant mechanism of injury within the broader category of violence prevention efforts that include intimate partner violence, child abuse, elder abuse, and sexual assault.

In the U.S., 36% of women and 34% of men report sexual violence, physical violence, and/or stalking by an intimate partner during their lifetime.[62] Interpersonal violence disproportionally a° ects pediatric patients, with one in four children witnessing, hearing, or in proximity to caregiver interpersonal violence.[63] Children exposed to interpersonal violence are more likely to develop adverse health, behavioral, psychological, and social disorders later in life.[64]

Data in the ESO Data Collaborative show pediatric patients are 115 times more likely to report experiencing interpersonal violence than older adults. About 3% of those under 18 who visited a trauma center reported interpersonal violence, compared to less than 1% for adults and older adults.

Pediatric patients are 115 times more likely to present with interpersonal violence than older adults.

ACS established specific requirement for trauma centers to screen patients for interpersonal violence, abuse, and mental health disorders.[65] These guidelines aim to ensure comprehensive care for trauma patients by identifying and addressing psychological and social factors that can often impact patient outcomes and recovery.

The *ACS TQP Best Practice Guidelines for Child Abuse, Elder Abuse, and Intimate Partner Violence* serve as a resource for trauma center professionals to identify, evaluate, manage, document, and report patients who are victims of abuse and interpersonal violence.[66]

INTERPERSONAL VIOLENCE RECOMMENDATIONS

1. **Implement standardized protocols for screening all patients for interpersonal violence, including intimate partner violence, child abuse, and elder abuse.**
2. **Train in using validated screening tools to assess signs of abuse in trauma patients, such as behavioral indicators, inconsistent injury explanations, or patterns of repeated injuries.**
3. **Conduct screening in a private and supportive environment to ensure disclosure without fear of reprisal.**
4. **Educate staff on trauma-informed care to ensure interactions with patients are compassionate and avoid re-traumatization.**
5. **Provide ongoing education for trauma center staff on recognizing and responding to interpersonal violence, emphasizing mandatory reporting requirements and cultural sensitivity.**
6. **Integrate abuse recognition into the trauma center's performance improvement and patient safety initiatives to enhance outcomes for trauma patients experiencing interpersonal violence.**
7. **Use a formal danger assessment tool as a follow-up to a positive screen.**
8. **Consider admitting patients to the hospital who are in danger of violent harm and who have no other options.**
9. **Provide resources and referrals to local legal, financial, and safety resources. Label the resources as women's health issues, social services, or with other general terms; do not language such as "domestic violence" or "intimate partner violence" on takeaway materials.[67]**

TRAUMA INDEX

TIME TO TRANSFER

KEY FINDINGS

The median transfer time from the emergency department to a higher-level facility was 78 minutes.

The median time to transfer from an inpatient location was almost double the duration, at 141 minutes.

This is the first ESO Trauma Index to explore time to transfer.

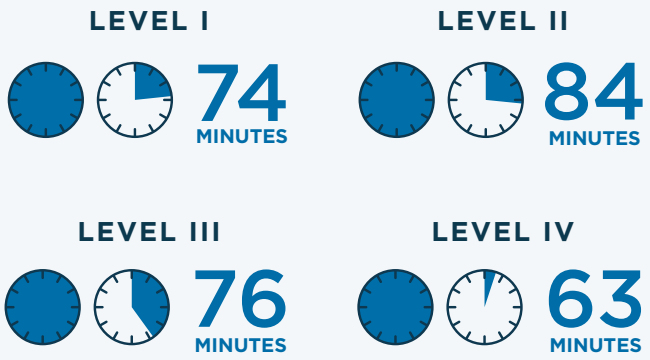
Time to transfer is defined by the National Trauma Data Bank (NTDB) as the minutes between when an order is written for a patient to be transferred and when the patient leaves. Most states have specific clinical practice guidelines for time to transfer, often 60 minutes. The gold standard, according to ESO's Garrett Hall, is, "The faster out the door, the better."

Emergency Department Time to Transfer

The median transfer time from the emergency department to a higher-level facility was 78 minutes, ranging from 63–84 minutes. Time to transfer varies by trauma center level, but not dramatically.

Chart 17

Time to Transfer from the Emergency Department by Trauma Center Level



Inpatient Location Time to Transfer

In comparison to emergency department transfers, the median inpatient transfer time was 141 minutes. Time ranged from 132–147 minutes, which is nearly 2.5 hours.

For a Level II trauma center, the median inpatient time to transfer was 153 minutes. For a Level III trauma center, the inpatient time to transfer was 145 minutes, and it was 147 minutes for Level IV trauma center. There is not a clear trend of inpatient time to transfer increasing or decreasing as trauma center level changes.

Chart 18

Inpatient Location Time to Transfer by Trauma Center Level

TIME TO TRANSFER BACKGROUND

Research shows that delays in transferring critically injured trauma patients to a higher-level trauma center significantly increase the risk of adverse outcomes and events, including higher mortality rates.[68] Ensuring timely transfer is particularly critical for injuries such as traumatic brain injures (TBI), complex orthopedic injuries, and hemodynamic instability – all which require advanced trauma surgical intervention and critical care capabilities.[69]

The findings also highlight a need to review how transfer times are recorded using the NTDB definition. Many systems use the time a discharge order is written as the official discharge time, rather than when the patient physically leaves the facility. This practice may underestimate actual delays, raising questions about the accuracy of current data and emphasizing the need for consistent reporting to guide process improvements.

The ACS *Resources for the Optimal Care of the Injured Patient* emphasizes that trauma patient requiring transfer to a higher level of care should be transferred when their needs exceed the capabilities of the current facility.[70] The decision to transfer must be made quickly. ACS does not set a strict time frame; rather, it highlights the importance of minimizing delays with three focus areas:

1. **Early identification for transfer needs.**
2. **Established transfer agreements and established protocols.**
3. **Prompt communication between referring and receiving facilities.[71]**

TIME TO TRANSFER RECOMMENDATIONS

1. **Quickly identify trauma patients whose injuries exceed the capabilities of your center. This should occur within 30 minutes of their arrival.**
2. **Establish criteria to determine injured patients' transfer eligibility, including the need for specialized surgical services such as neurosurgery, orthopedic surgery, or hand surgery; hemodynamic instability; complex multisystem trauma; pediatric trauma; or burn-specific injuries requiring specialized trauma centers.**
3. **Create and implement predefined agreements with higher-level trauma centers to streamline the transfer process.**
4. **Ensure direct physician-to-physician communication when transferring trauma patients out.**
5. **Designate a transfer coordinator to assist with logistics and reduce delays.**
6. **Focus on stabilizing the patient to the extent possible without unnecessarily delaying transfer for imaging or other services.**
7. **Establish a Decision-to-Transfer Time and monitor it as part of your trauma performance improvement program (PIP).**
8. **Hold trauma operations meetings that include regular reviews of transfer times, and provide feedback on cases and specific identified delays.**
9. **Ensure compliance with state and regional trauma system guidelines, which may have specific requirements for inter-facility transfers.**

"Trauma centers can look at their data as they compare to the nation, and if they're leaders in the field, they can share their best practices. If there's room for improvement based on their analysis and comparison to what's in the trauma registry nationally, then they can look for different strategies and interventions to improve care."

– **Antonio R. Fernandez, PHD, NRP**
Principal Research Scientist, ESO

CASE STUDY

A three-year transfer quality improvement project at Oregon Health and Science University achieved the following:

- **Dropped the number of transfers that arrived with incomplete (or missing) medical records from greater than 17% to just over 1%**
- **Decreased arrival-to-procedure time for patients being transferred for a procedure from 51 hours to 35 hours**
- **Dropped unnecessary transfers from 15% to 3%**
- **Increased case mix index by one-third, corresponding to about a 60% jump in reimbursement**[72]

SUMMARY OF TRENDS

WE SEE SOLID PERFORMANCE ACROSS SEVERAL METRICS.

The 2024 ESO Trauma Index provides insights into progress. For instance:

National, comprehensive quality and process improvement efforts in trauma centers are gaining recognition for reducing trauma mortality and injury mortality – what you're doing is noticed and working.[73]

Trauma centers within the ESO data collaborative are successfully moving older adults with hip fractures to the OR within 48 hours more than 99% of the time.

Comparing data across the four years of data from the ESO Trauma Indices, only about 8% of patients experience a hospital event. This is steady and hasn't increased.

One percent more patients requiring a blood transfusion received whole blood in this 2024 ESO Trauma Index compared to the 2023 ESO Trauma Index. Plus, 98% of those patients received whole blood within four hours, the goal.

However, there's room for improvement as well.

- Trauma center **time to transfer was 78 minutes**, but the median ED time to transfer was nearly double, at 141 minutes. This could be an opportunity for collaboration on a performance improvement project to reduce the time to transfer.
- **Monitoring the availability and use of whole blood products during major trauma** may identify key areas for improvement within the transfusion process, which can help lead to better outcomes for trauma patients.
- Measure against the benchmark for the administration of antibiotics for patients with an open long bone fracture. We only see **antibiotics administered within 60 minutes of arriving at the trauma center 67% of the time**.
- Patients meeting the EBTNS definition successfully receive PRBC within a **median time of 27 minutes**; this interval increases to 12 hours for others. Further evaluation is needed to fully explore the reasons for this difference.
- **75% of patients** who met the EBTNS definition did not receive any transfusion, which is worrying.
- Among the new metrics, pediatric and adolescent patients are particularly vulnerable to violence, with **3% of those under 18 reporting interpersonal violence**, compared to less than 1% for adults and older adults. Consistent screening is a start to the whole-person care model recommended by ACS. ESO will report this metric in future ESO Trauma Indices.
- Also, new in this report, many **firearm injuries** appear in trauma centers and pediatric ICUs, and **rank among the top five most common causes for pediatric trauma visits**. There is an opportunity to practice increased screening, enhanced trauma-informed care, and collaborate with other hospital departments. ESO will report this metric in future ESO Trauma Indices.

IMPROVING YOUR TRAUMA SERVICES IS FEASIBLE AND DESIRABLE.

Review the annual ESO Trauma Index recommendations, target metrics within your trauma system with the highest remaining preventable mortality, and prioritize a culture of performance improvement. Together, you can continue making a difference in patients' lives.

ABOUT ESO

ESO (ESO Solutions, Inc.) is dedicated to improving community health and safety through the power of data. Since its founding in 2004, the company continues to pioneer innovative, user-friendly software to meet the changing needs of today's EMS agencies, fire departments, hospitals, and state EMS offices. ESO currently serves thousands of customers throughout North America with a broad software portfolio, including the industry-leading **ESO Electronic Health Record (EHR)**, the next generation ePCR; **ESO Health Data Exchange (HDE)**, the first-of-its-kind healthcare interoperability platform; **ESO Fire RMS**, the modern fire Record Management System; **ESO Patient Registry** (trauma, burn and stroke registry software); and **ESO State Repository**. ESO is headquartered in Austin, Texas. For more information, visit **www.eso.com**.

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