

Trauma Outcomes & Performance Improvement Course



Course Manual 2020 Edition

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Revised 052215
Revised 071017
Revised 050120

Society of Trauma Nurses
446 East High Street, Suite 10
Lexington, KY 40507
www.traumanurses.org



Sponsored by the Society of Trauma Nurses

MEMBERSHIP BENEFITS

Are you new to trauma nursing or have you been practicing for years?
Either way, the Society of Trauma Nurses (STN) is the association for you.

STN is a professional non-profit organization whose mission is to ensure optimal trauma care to all people locally, regionally, nationally and globally through initiatives focused on trauma nurses related to prevention, education and collaboration with other healthcare disciplines. The Society of Trauma Nurses' advocates for the highest level of quality trauma care across the continuum. We accomplish this through an environment that fosters visionary leadership, mentoring, innovation and interdisciplinary collaboration in the delivery of trauma care.

The leadership and staff of STN invite you to join our organization so you can start taking advantage of the various benefits we offer, including:

- The Journal of Trauma Nursing (JTN) – JTN now offers 6 issues per year both in print and online versions. Upon joining you will have immediate access to JTN online as well as a JTN iPad application. (International members receive an online-only subscription)
- STN Online Community – Over 500 members subscribe to the STN Online Community which provides the daily opportunity to collaborate with trauma nurses from around the globe.
- Resource Library – STN members have submitted over 300 templates, policies, forms, etc. which are available for download and use by all STN members.
- Discounted STN Annual Conference registration
- Leadership Positions – All STN members are eligible to volunteer for various positions within the organization, including the board of directors, committee chairs and members, task forces, and more.
- Trauma Awareness Month – Every year STN partners with related trauma organizations to develop and provide resources for Trauma Awareness Month. Past years have included falls and distracted driving materials to educate both the nursing staff and general public.

STN's commitment to education is evident through its diversity and multitude of courses and resources available to trauma professionals. The leadership, volunteers and staff of the organization update content and develop new programming which will continue to support and educate the trauma professional.

- Trauma Outcomes & Performance Improvement Course (TOPIC) – The STN TOPIC course is taught to all members of the trauma system team who participate in the ongoing assessment of trauma care.
- Advanced Trauma Care for Nurses (ATCN) – ATCN is a great way to ensure nurses are trained and ready to provide trauma care. It is now offered in a two-day format for new students and a one-day refresher course for students who just need to update.
- Electronic Library of Trauma Lectures (eLibrary) – The eLibrary features 18 PowerPoint presentations written and edited by STN members. This series of lectures spans the continuum of care and is designed to be presented to a group of trauma professionals or as a self-guided educational activity.
- Optimal Trauma Center Organization & Management Course – Are you preparing for a site visit? The Optimal course was developed in collaboration with the American College of Surgeons Committee on Trauma and is focused on providing the education required to prepare trauma professionals for their site visit.

- Leadership Institute – The Leadership Institute is designed to equip trauma leaders with the tools needed to effectively lead. This web-based course occurs over a 12 week time period covering key elements associated with trauma program leadership effectiveness.
- Online Education – STN offers regularly scheduled webinars to help meet the educational needs of trauma nurses from the bedside to the boardroom.

We look forward to welcoming you to the Society of Trauma Nurses and providing you with resources and expertise to enhance your career. Thank you to those of you who are loyal members – because of you, STN has grown and is able to offer all of the benefits listed. We hope to continue to be your choice organization. Visit www.traumanurses.org for up-to-date information.

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☐ Associate Member – **not** licensed to practice as a Registered Nurse; non-voting membership

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On occasion, STN rents its membership list, excluding e-mail addresses, to vendors that offer products, services or employment opportunities that STN believes would be of interest to its members. If you do not wish your name to be included on these lists, please check here. ☐ Please exclude me.

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- ☐ \$125 (USA) ☐ \$75 (all other countries—US dollars)
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Total Payment: \$ _____

PAYMENT METHOD

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Check # _____

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MEMBERSHIP SURVEY

Please specify one option that best describes your primary role:

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☐ Clinical Nurse
☐ Clinical Nurse Specialist / Hospital Educator
☐ ICU / ED / OR Nurse
☐ Injury Prevention Coordinator
☐ Research Nurse Trauma
☐ Coordinator Trauma
☐ Program Manager Trauma
☐ Registrar

SPECIAL INTEREST GROUPS

Please indicate any Special Interest Group(s) in which you are interested:

- ☐ Advanced Practice Nursing
☐ Injury Prevention
☐ Legislative
☐ Rural Trauma

SUGGESTIONS

Please provide suggestions for programs or activities for STN to consider.

Referred by

U.S. Members, please note: A portion of membership dues may be tax deductible as an ordinary and necessary business expense. Dues are not deductible as a charitable contribution for federal income tax purposes. Approximately \$30 of annual membership dues is applied to a one-year subscription to the Journal of Trauma Nursing. Consult your tax advisor. STN is a 501(c)(3) organization; FEIN #52-1780525.

THE STN MEMBERSHIP YEAR IS BASED UPON JOIN DATE Invoices are issued to the address on file with STN. Be sure to advise STN of any changes to keep your record current.



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STATEMENT ON ACCREDITATION

Society of Trauma Nurses is accredited as a provider of nursing continuing professional development by the American Nurses Credentialing Center's Commission on Accreditation.

To successfully complete this course, you must be present for the entire session and submit an evaluation of the presentation.



ACKNOWLEDGMENT

Quality in healthcare requires a commitment to teamwork, transparency, and tenacity to improve patient outcomes. It is mindful of processes and resource utilization. This manual is dedicated to trauma leaders, regardless of role, who want to be involved in the care, management, and improvement in outcomes for injured patients regardless of where they are across the globe. The reason we work so hard and tirelessly is to eliminate preventable deaths and disabilities by providing optimal, harm-free care.

This course, which is now utilized by thousands of trauma teams across the globe, started with a small group of forward-thinking nurses and has bloomed into the cornerstone in trauma quality. A special thanks to all the authors, past and present, for your commitment, determination, and resilience to this work. In addition, our collaboration with the American College of Surgeons Committee on Trauma is especially valued.

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Agenda & Objectives

24 slides	Introduction, Objectives & Case Scenario
32 slides	MODULE 1: Trauma Performance Improvement Patient Safety (PIPS) Culture of Safety Model & Conceptual Plan <i>Objective: Discuss culture of safety, its application to performance improvement (PI) through development of a PI plan and how that interfaces into highly reliable organizations.</i>
28 slides	MODULE 2: Event Identification & Levels of Review <i>Objective: Describe the levels of review process from event identification through resolution and selection of level of harm of the event.</i>
45 slides	MODULE 3: Audit Filters, Core Measures, and Clinical Practice Guideline Variance <i>Objective: Apply the use of audit filters, core measures and use of practice management guidelines to minimize variances in care.</i>
43 slides	MODULE 4: Committee Structure <i>Objective: Identify and understand committee structure options and ways of integration into facility quality improvement through multidisciplinary review processes.</i>
34 slides	MODULE 5: Data Management Supporting the Trauma PIPS Process <i>Objective: Review effectiveness of data collection, reliability and validation processes.</i>
40 slides	MODULE 6: Trauma PIPS Reports <i>Objective: Identify ways to present trauma data to various committees, departments, administration, state meetings, etc. to convey the message in the most effective manner.</i>
22 slides	MODULE 7: Classification System for Trauma PI Events <i>Objective: Discuss event identification and guidelines that influence care, types of opportunities for improvement and contributing factors of an event.</i>
28 slides	MODULE 8: Action Plan/Prevention: Development and Implementation <i>Objective: Apply the principles of event identification and patient safety to develop an effective corrective action plan, and discuss options on how to present, track, trend, and do ongoing professional practice evaluations.</i>
32 slides	MODULE 9: Event Resolution/Loop Closure <i>Objective: Provide options and methods to achieve event resolution and demonstrate resolution using measurable outcomes.</i>
8 slides	CASE SCENARIOS <i>Objective: Active learning evaluation of case scenarios with presentation, actions, and expected outcome for resolution. Summative use of all aspects of earlier lectures and discussions.</i>

INTRODUCTION

COURSE OBJECTIVES

**TRAUMA
OUTCOMES &
PERFORMANCE
IMPROVEMENT
COURSE**



SOCIETY OF TRAUMA NURSES



Virtual Course

- Cameras must be used
- Verify your name is correct on the screen

Trauma Outcomes Performance and Improvement Course

- TOPIC offers practical applications for all levels of trauma centers, from entry level to mature trauma programs
- A self paced, modular, and interactive content is combined with breakout sessions with application of materials to case studies
- The course is customized to meet the needs of multidisciplinary providers with varying levels of trauma performance improvement and patient safety experience
- Operational definitions, sample tools, and case studies are incorporated to facilitate learning

3



Successful Completion

- To successfully complete this course, all participants must attend the entire event
- Attendance must be verified by signature on the sign-in sheets
- If virtual, attendees must attend all day

4



Continuing Education

- Upon completion of the course you will receive an email with a link to the on-line evaluation
- Once completed you will be directed to the STN website with directions on how to download the CE certificate
- Evaluation should be completed within 30 days

5



Continuing Nurse Education

Society of Trauma Nurses is accredited as a provider of nursing continuing professional development by the American Nurses Credentialing Center's Commission on Accreditation.

This event has been awarded
8.25 contact hours.

6



Continuing Medical Education

- This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the University of Kentucky College of Medicine, and Society of Trauma Nurses. The University of Kentucky College of Medicine is accredited by the ACCME to provide continuing medical education for physicians.
- The University of Kentucky College of Medicine designates this live activity for a maximum of 7.5 AMA PRA Category 1 Credit(s)™. Physicians should only claim credit commensurate with the extent of their participation in the activity.
- The University of Kentucky College of Medicine presents this activity for educational purposes only. Participants are expected to utilize their own expertise and judgment while engaged in the practice of medicine. The content of the presentations is provided solely by presenters who have been selected for presentations because of recognized expertise in their field

Financial Disclosure

Faculty/Presenters/Authors/Content
Reviewers/Planners disclose no conflict of interest
relative to this educational activity

Course Objectives

- Discuss culture of safety, its application to performance improvement through development of a PI plan, and how that interfaces into highly reliable organizations
- Describe the levels of review process from event identification through resolution and selection of level of harm of the event
- Apply the use of audit filters, core measures, and use of practice management guidelines to minimize variances in care
- Identify and explain committee structure options and ways of integration into facility quality improvement through multidisciplinary review processes
- Review effectiveness of data collection, reliability, and validation processes

Course Objectives (continued)

- Identify ways to present trauma data to various committees, departments, administration, state meetings, etc. to convey the message in the most effective manner
- Discuss event classifications, influencing factors, and guidelines related to identifying opportunities for improvement
- Apply the principles of event identification and patient safety to develop an effective corrective action plan
- Discuss options on how to present, track, trend, and do ongoing professional practice evaluation (OPPE)
- Choose options and methods to achieve event resolution and demonstrate resolution using measurable outcomes as they apply to the hospital, health system, or region
- Critique trauma cases using the principles of performance improvement

Course Format

- Each module is tied into the overall goal to improve knowledge and practice of performance improvement (PI)
- Case scenarios will provide an opportunity to apply the knowledge

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Introductions

- What is your role?
- What is the level trauma center you are affiliated with?
- How many years of experience do you have in your current role?
- Have you taken TOPIC before?

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Why Is Performance Improvement Important?

- Increase patient safety
- Monitor performance
- Improve services
- Savvy consumers
- Maximize reimbursement



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PI is Hard!

- Dynamic
- Challenging
- Time consuming
- Requires commitment and dedication
- Requires staff resources
- Detail oriented
- Requires data validation
- **Most Common Reason for Unsuccessful Review**

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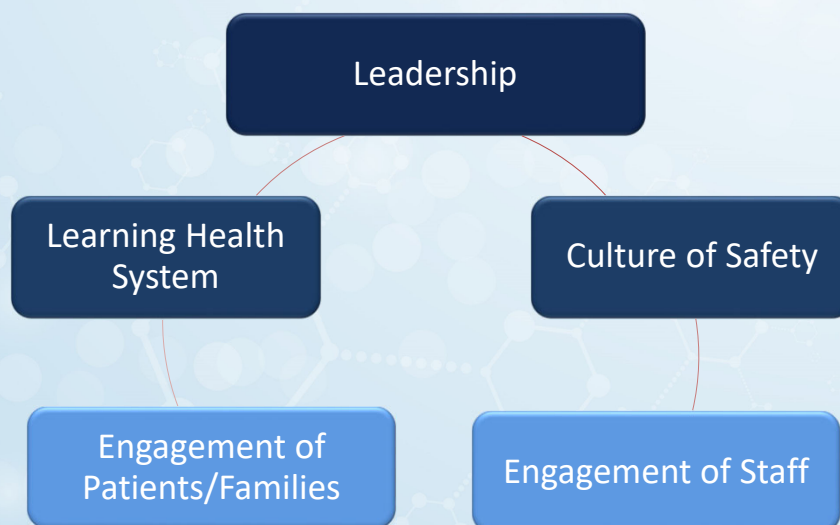
**Module 1: Trauma
Performance Improvement
Patient Safety (PIPS)
Culture of Safety Model &
Conceptual Plan**



Module 1: Trauma Performance Improvement Patient Safety (PIPS) Culture of Safety Model & Conceptual Plan

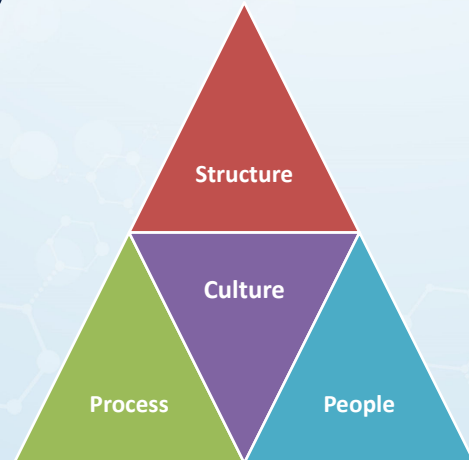
TRAUMA OUTCOMES & PERFORMANCE IMPROVEMENT COURSE

Highly Reliable Organizations



Culture of Safety in the Workplace: Leadership

- How your organization is managed—its systems, processes, structures, people, hierarchy, controls, and goals
- The degree to which managers empower employees to make decisions, support and interact with them, and act consistently



3



What Impacts Culture of Safety in the Workplace: Leadership Embracing Generational Differences

Generation	% Global Population	Years	Key Technology	Digital Proficiency	Deepest Fear	Communication Style	How they get around
Silent	5%	1914-1945	Care	Pre Digital	World in 2016	Letter	55 Ford thunderbird
Baby Boomers	15%	1946-1963	TV	Digital Immigrants	No longer center of attention	Telephone	SUV
Generation X	20%	1964-1980	PC	Early Digital Adopters	What about me generation	Email/SMS	Bicycle/Car
Generation Y /Millennials	27%	1981-2001	Smart Phone	Digital Natives	Paying off student debt	Instant messaging	Uber/Lyft
Generation Z	32%	2002- ?	AR/VR	Digital Inmates	Low batteries	Emoji's	Mom's Prius

4



What Impacts Culture of Safety in the Workplace: **Communication and Teamwork**

- Is the lifeline of a well functioning team
- Facilitated by leadership
- Engagement of staff
- Promotes information sharing
- Decreases communication-related error
- Enhances effective communication



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Essential Teamwork in Trauma PIPS

- Incorporate the all-inclusive program or unit within the trauma center and system (e.g., continuum of care)
- Inspire involvement, engagement, and mindfulness
- Engage all team members
- Implement point-of-care (bedside) PI
- Evaluate
 - timeliness of care
 - appropriateness of care
 - patient care outcome
 - system performance and integration



6



11 Essential Principles for Effective PIPS

1. Appropriate team
2. Clearly defined goals
3. Clearly defined process
4. Clearly defined parameters
5. Structured communication, common language, and shared understanding
6. Power/Authority
7. Champions
8. Shared norms and accountability
9. Skilled facilitation
10. Understanding of systems theory
11. Self-evaluation



See the TOPIC Manual Appendix for more information

Berg et al. Trauma Performance Improvement and Patient Safety Committee: Fostering an Effective Team. *Journal of Trauma Nursing*. 18(4):213-220, October/December 2011.



Teamwork in Trauma PIPS

- Empowers the team to correct events in real-time
- Enables transparent discussions
- Fosters competent and accountable providers
- Classifies events which focus on opportunities for improvement

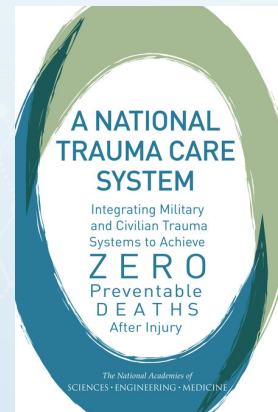


Teamwork is the essence of trauma center development and maturation and essential in hospitals of all sizes.



Characteristics of a Trauma Care Learning Health System

- Science, informatics, incentives, and culture aligned for continuous improvement
- Innovation with best practices seamlessly embedded in the delivery process
- New knowledge (change) captured as an integral by-product of the delivery experience

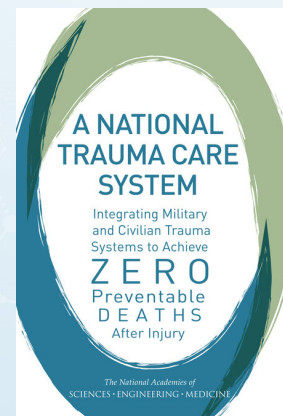


National Academies of Science-Engineering-Medicine



Characteristics of a Trauma Care Learning Health System

- Path for navigating
 - Complexing healthcare system
 - Rising value
 - Emerging technology, industry, and policy
- Promotes and values evidence based best care and optimal outcomes
- Constant change as evidence is produced



National Academies of Science-Engineering-Medicine



Trauma Performance Improvement and Patient Safety (PIPS)

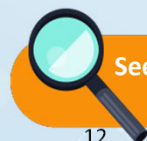
- Dynamic (individualized to your institution) yet prescriptive (must have required components)
- A multidisciplinary team that examines trauma related patient care and operations from a system perspective
- Collaborative and trust oriented
- Integrated into the hospital PIPS system
- Benchmarked (internal over time, external, risk adjusted)
- Facilitated by Trauma Medical Director and the Trauma Program Manager

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Components of a Trauma Center PIPS Plan

- Philosophy/Mission/Vision
- Authority/Scope
- Indicators/Audit Filters
- Event Identification
- Data Management/Benchmarking
- Committee Structure
- Team Members
- Roles/Responsibilities
- Levels of Review
- Peer Determinations
- Corrective Action Plans and Implementation
- Event Resolution and Re-evaluation
- Confidentiality
- Integration into Hospital PIPS process
- Mentoring/Coaching



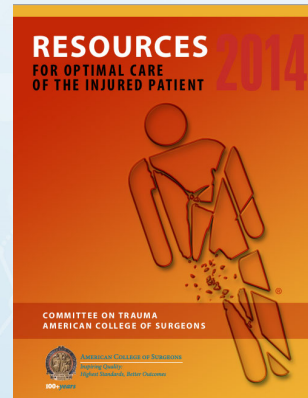
See the TOPIC Manual Appendix
for more information

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Considerations in Developing a Trauma PIPS Plan

- Principles are universal
- Foster a learning environment
- Ensure patient-centered care
- Culture of high reliability
- Evidence based practice
- Non punitive analysis of errors
- Teamwork and transparency



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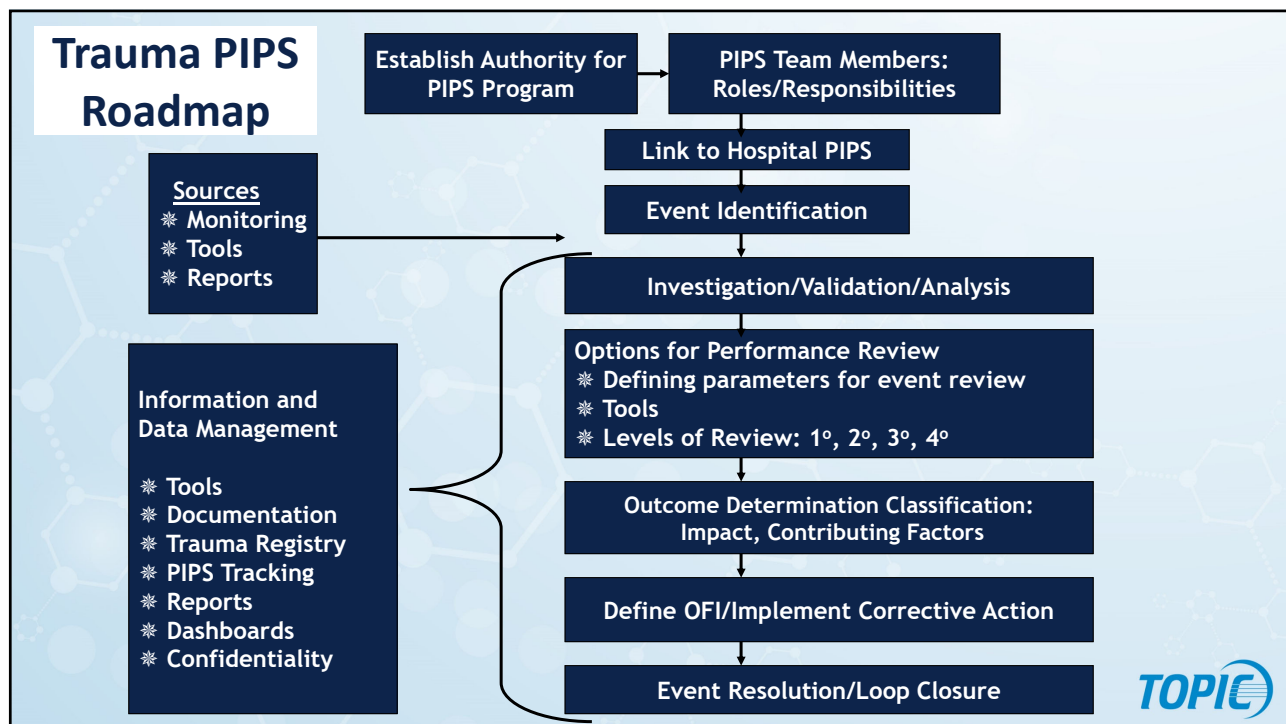


Foundation for Trauma PIPS Plan

- Provides an educational tool for new staff (distribute annually)
- Assures continuity and expectations of all members
- Links to Hospital Quality Department PIPS plan
- Links to State/Region PIPS Plan
- Consistent adherence to the Trauma PIPS plan will support site survey preparations
- Provides a **roadmap** for implementing a Trauma PIPS program

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Do you have a written PIPS trauma plan?

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Adopt a Culture of Safety Language

Blame

Eliminates hierarchy and certain language that places blame

- “error”
- “wrong”
- “preventable”
- “cause”
- “unanticipated”



Safety

Identifies strategies to reduce the risk of

- “near misses “
- “adverse events”
- “event”
- “concern”
- “opportunity for improvement”

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Culture of Safety: Inherent Risks

System Risks

- Technologically complex
- Constantly changing technology, clinical practice, medication, and equipment
- Competing priorities
- Variable individual competence
- Every patient is different

Human Error

- Involves human issues
 - Fatigue
 - Knowledge
 - Skill
 - Reliance on personal **perfections**
- Humans are not perfect

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Culture of Safety: Promotion

- The patient ALWAYS comes first
- Identify safe practices and optimal principles in trauma care
- Focus on opportunities for improvement
- Staff communication motivated by safety
- Empower all members of the team to communicate freely
- Hierarchy never outranks safety
- All levels of staff are appropriately assertive when needed
- Elicit staff's opinions; "how can we improve"?



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Culture of Safety: Promotion

- Tools and technology which promote teamwork and safety
 - Open discussion of “events” with definitions at fingertips
 - Understanding and analysis of trauma registry data
 - Standard order sets
 - Easy access to policies/CPGs (apps/Sharepoint)
- Concurrent PIPS during patient rounds
 - Engage entire team
 - Checklists



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AUDIENCE POLL

How Mature is your trauma PIPS program?

- Unmindful (no awareness)
- Reactive (defensive, react to events)
- Systematic (system in place to manage)
- Proactive (offensive, anticipate events)
- Generative (wired for safety and improvement)

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CLASS DISCUSSION

Class Discussion

How do you integrate Trauma PIPS with your Hospital Quality Department?

25



Variables in Your Trauma PIPS Process Development

Other considerations

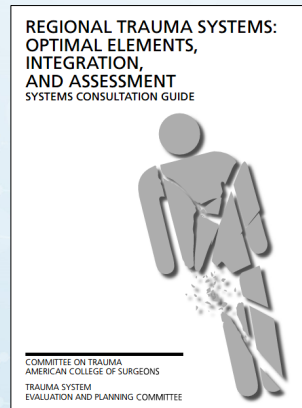
- Annual trauma volume
- Hospital bed capacity
- Trauma center verification/designation/accreditation level
- Academic/Community/Rural
- Environmental/Geographic Changes (coastal, mountains, earthquakes)

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Integration: Essential Trauma System Elements (ETSE)

- Trauma System Components
- Statutory Authority
- Multidisciplinary Advisory Group
- Trauma System Plan
- Designation based on Need
- Funding
- Data Collection
- Confidentiality and Discoverability
- **System-wide Performance Improvement**
- Disaster Preparedness
- Military Integration



The National Academy of Sciences, Engineering, and Medicine 2016. *A National Trauma Care System Integrating Military and Civilian Trauma Systems to Achieve Zero Preventable Deaths After Injury*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/23511>.

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Integration: Components of a Trauma System

Trauma System Assessment

- Injury Epidemiology
- Tool for System Assessment

Trauma System Policy Development

- Statutory Authority and Administrative Rules
- System Leadership
- Coalition Building and Community Support
- Lead Agency
- Trauma System Plan
- System Integration
- Financing

Trauma System Assurance

- Prevention and Outreach
- Emergency Medical Services
- Definitive Care Facilities
- System Coordination and Patient Flow
- Rehabilitation
- Disaster Preparedness
- System-wide Evaluation and Quality Assurance
- Trauma Management Information Systems
- Research

American College of Surgeons, Committee on Trauma, Trauma Systems Evaluation and Planning Committee. (2008). *Regional trauma systems: optimal elements, integration, and assessment; systems consultation guide*. Chicago, IL: American College of Surgeons.



Goal: Improving Processes and Patient Outcomes



Summary

- A continuous learning system, combined with coaching and mentoring, is necessary to drive optimal trauma patient care
- Trauma PIPS covers a broad scope of performance improvement processes and must be defined by your program in the Trauma PIPS Plan
- Culture of safety principles are transitioning from blame to opportunities for improvement
- Components of PI Plan are constant & prescriptive in all trauma program levels, but how you implement them may vary

Module 2: Event Identification and Levels of Review



Module 2: Event Identification and Levels of Review

TRAUMA OUTCOMES & PERFORMANCE IMPROVEMENT COURSE

Lewin's Change Theory



Event Identification



TOPIC

Sources of Event Identification

Internal

- Medical Record
- Staff Referral
- Daily Rounds
- PI Conferences/ Meetings
- Risk/ Quality
- Patient Feedback
- Registry Reports/ TQIP

External

- EMS
- Referral Center
- Transfer In/ Out
- Transfer/ Communications Center
- Survey Reports
- Autopsies

TOPIC

Where Did the Event Occur?

Hospital

- Resuscitation
- Radiology
- Blood Bank/ Lab
- OR/ PACU
- ICU
- Step-Down
- General Care

Non-Hospital

- Pre-Hospital
- Transferring Facility
- Rehab
- Outpatient
- Patient/ Family
- Home
- Other

5



When Did the Event Occur and Who was Involved?

Time

- Date
- Day (holiday/ weekend)
- Shift
- Shift Change
- Mass Casualty Event

Staff Involved

- Physicians/ Providers
- Nurses
- Therapists
- Others

6



Concurrent vs. Retrospective Review Event Identification

Concurrent

- Affects care at the point of service
- Data is retrieved immediately to impact positive change
- More efficient and timely feedback is provided

Retrospective

- Allows for evaluation of the full scope of the issue
- Delay to providing feedback
- Potentially negative outcomes/ events can occur despite best efforts

****Programs should strive for concurrent review processes****



7

Concurrent Review in Action

A 65-year-old female is admitted with a non-operative pelvic fracture. On post trauma day 6 she develops a DVT.

Concurrent

Post trauma day 2, a Trauma Nurse Coordinator rounding on the patient notes that the patient was not on VTE prophylaxis and asks the rounding team to evaluate. The patient is then placed on appropriate prophylaxis.

Retrospective

28 days after admission this case is reviewed by a Trauma Nurse Coordinator who notes that the patient was not placed on VTE prophylaxis until post trauma day 4.

8



Elements of PIPS Management

- Process and tools for tracking identified events
 - Strongly recommend electronic tracking
 - Standardized reporting formats
 - Ability to interface with Hospital Quality, Medical Staff, etc.
- Tracking and documentation to confirm loop closure (event resolution)

9



How are you tracking events?

- Electronic (using registry)
- Spreadsheet
- Paper form
- Paper form then registry
- Other

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Validation of Performance Improvement Events



12



Levels of Review



13



Levels of Review



****Event resolution (loop closure) can occur at any level****

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Primary Level of Review

Finding the events

- Concurrent event identification
- Verification and validation of actual event
- Immediate resolution and feedback
- Events may be closed or trended at this level
- Determination if it needs further review
- Establish electronic PIPS tracking system to show event addressed/action/closure

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Who Is Involved with Primary Review at Your Facility?



Secondary Level of Review

Triaging events

- Review by TMD and/or TPM
- Review electronic medical record
- Confirmation of all involved
- Development of timeline
- Review any additional information
- Event may be closed at this level
- Feedback
- May require referral

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How is Secondary Review Done at Your Facility?



Tertiary Level of Review

Structured review by formal committee

- Trauma Multidisciplinary Peer Review Committee
- Trauma Operational Process Performance Committee

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Components of Structured Tertiary Review

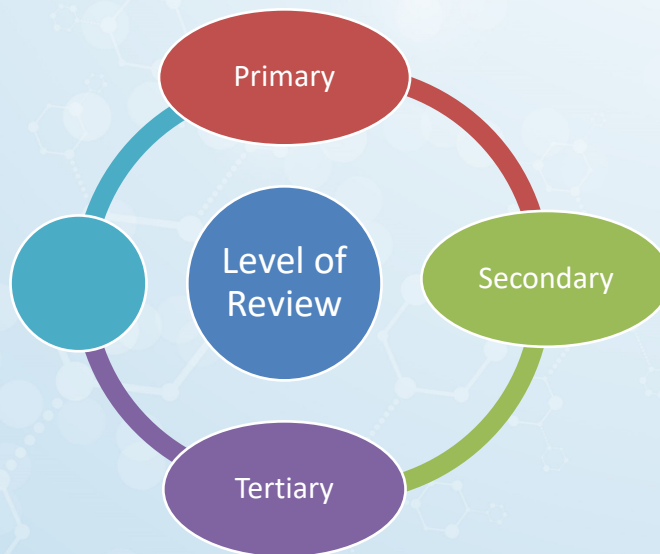
- Efficacy, efficiency, and safety of care
- Provide focused education
- Provide peer review
- System vs. Provider cause
- Team performance
- Contributing factors
- Identify opportunities for improvement
- Corrective recommendations/actions
- Close loop and document to Trauma PIPS



20



How Do You Determine Which Cases Require Tertiary Review?



Which Cases are Forwarded to a PIPS Meeting?

- Select events
- Select based on clinical significance
- All indicators
- All complications
- All deaths
- Unexpected outcomes
- Systems issues
- Sentinel events
- CPG non-compliance
- Policy/protocol non-compliance
- Special populations:
 - Include in PI plan which select cases are reviewed at committee
 - If no fallouts, consider collated outcomes reports

Quaternary Level of Review

- Trauma system case review
(with other system trauma centers)
- Additional options:
 - External peer review
 - Subject matter expert



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Key Questions in Case Evaluation

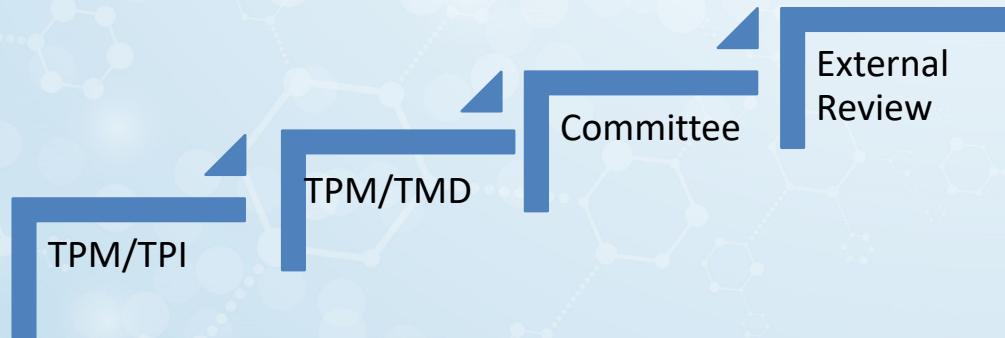
- What was the outcome?
- Were standards of care followed?
- Was supervision adequate?
- What were the pre-existing conditions?
- Were trauma practice management guidelines and protocols followed?
- What were the circumstances surrounding the event?
- Who was involved and what safety goals were related?
- Were system failures present?
- Were there knowledge and skill variations?
- Were there associated performance or behavioral events?

24



Aligning Levels of Review

Pre-assigning levels of review in the Performance Improvement Plan can streamline processes significantly



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Alignment of Events

Define the “event” and “level of review” in the Performance Improvement Plan

Example: Acute Kidney Injury

- Verify/ Validate event meets definition and collect data using specific questions to aid review
- Review at appropriate level based upon PI plan, e.g, if patient harm then should be 3rd level review



Alignment of events streamlines PI processes



Summary

- Multiple ways exist to identify PIPS events.
- Concurrent monitoring is recommended.
- Tracking system tools are required for event analysis.
- Systematic classification for PIPS events will aid in process improvement.
- Pre-identifying and assigning levels of review to specific events (i.e. death, complication) can streamline the review process.

Module 3: Audit Filters, Core Measures, and Clinical Practice Guideline Variance



Module 3: Audit Filters, Core Measures, and Clinical Practice Guideline Variance

TRAUMA OUTCOMES & PERFORMANCE IMPROVEMENT COURSE

A close-up photograph of a medical professional wearing blue scrubs, a blue surgical cap, and a white surgical mask. They are also wearing blue gloves and are adjusting their clear safety goggles. The background is a plain, light-colored wall.

AUDIENCE POLL

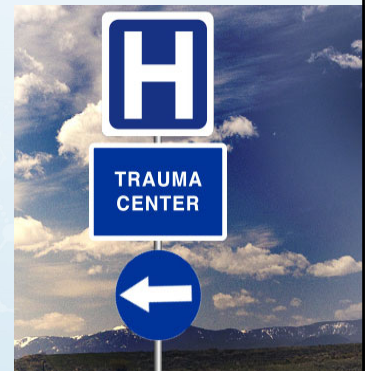
Are you a “good” trauma center?

3



Are You a “Good” Trauma Center?

- “A trauma center should provide safe, efficient, and effective care to the injured patient”
- How is this Measured?



American College of Surgeons Committee On Trauma. *Resources for Optimal Care of the Injured Patient*, 2014 (6th edition). Chicago: American College of Surgeons, 2014.



Adverse/Sentinel Events

- **National Quality Forum Definition of Adverse Event**

An event that results in unintended harm to the patient by an act of commission or omission rather than by the underlying disease or condition of the patient. A sentinel event is a Patient Safety Event that reaches a patient and results in any of the following: Death, permanent harm or severe temporary harm and intervention is required to sustain life

- **The Joint Commission (TJC) Sentinel Event Definition**

An unexpected occurrence involving death, serious physical or psychological injury, or risk thereof

Adverse Event Terms

- Unintended consequence
- Unplanned clinical occurrence
- Therapeutic misadventure
- Peri-therapeutic event
- Hospital-acquired complication
- Medical mishap
- Unexpected occurrence
- Untoward incident
- Iatrogenic complication/injury

Audit Filters/Core Measures

- **Audit Filters** assist with monitoring the process of care relative to standards of care
- **Core Measures** are based on data/scientific evidence about processes and treatments that are known to get the best results for a condition or illness

7



Audit Filters

- Tools that assist with monitoring the process of care relative to standards of care
- Triggering an audit filter does not imply “bad” care
- Audit filters prompt a review (red flag)
- Not all events rise to a need for deep review
- Surveillance of care is a netting system



8



Audit Filters

- Need to be clearly defined
- Definitions based on accepted standards of care/practice
- Should be valuable and relevant
- Incorporated into the trauma PIPS written plan and reviewed at least **annually**



9

TOPIC

Audit Filters

- **Rate based**
 - Frequency of specific events
 - Occurrence/total number of trauma cases
- **Case reviews**
 - Review of specific cases where an audit filter was triggered
- **Concurrent/Point of Care Review**
 - Events should be reviewed concurrently

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TOPIC

Audit Filters

- **Required**
 - Regulatory agency
 - State/Lead agency required
 - Regional/Health System
- **Institution Specific**
 - As defined by your trauma program
 - May vary with changes in population, volume, and geospatial considerations

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Checklists and Drill Down Tools for Complication and Audit Filters Assist in PIPS Processes (example)

	1° or 2° Level Review	Automatic Secondary Level of Review	Review Questions	Review Questions	Review Questions
Deep Vein Thrombosis	1 or 2	Did patient receive chemoprophylaxis if not contraindicated according to CPG? (ordered, dispensed, administered)	Were sequential compression devices in place if not contraindicated?	Was chemoprophylaxis initiated/reinitiated after OR if not contraindicated?	If DVT developed, was it appropriately treated?
Massive Transfusion Protocol	1 or 2	Received more than 1 L of crystalloid	Pt arrival time MTP ordered/activation time Activated by whom? Activation Criteria/which triggers met?	FAST results? Was balanced resuscitation TEG (Thromboelastogram) based?	What were the component blood ratios: 1st 8 hours & 1st 24 hours?

Core Measures for Quality and Patient Safety

- Core Measures focus efforts which utilize data to improve the healthcare delivery process
 - **Process measures**
 - System operations/not clinical in nature
 - Qualitative filters (e.g. satisfaction survey)
 - Institutional filters (e.g. time to CT)
 - **Outcome measures**
 - Clinical/patient focused
 - Quantitative/benchmarks (e.g. VTE rates)

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Analysis of Process Measure Overtriage/Undertriage Cribari Matrix

	ISS < 15	ISS > 15	Total
Highest Activation	A	B	C
Second Tier Activation	D	E	F
No Activation	G	H	I

Over-triage Formula:

$$A \div C$$

Under-triage formula

$$(E + H) \div (F + I)$$

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Need for Trauma Intervention (NFTI) Criteria

65 year old man walks into triage stating he needs stitches after a trip and fall. He has a 6 cm laceration on forehead. Bleeding is controlled. His GCS is 15. He takes a baby aspirin every day. The ED doc orders a CT head which reveals a small intracerebral bleed. After his tetanus shot and suturing by the ED doc, He is admitted to ICU by a non-surgeon with a neurosurgery consult. He is discharged home after 36 hours.



See the TOPIC Manual Appendix for more information

NFTI Criteria

- PRBC within 4 hours
- ED to OR within 90 minutes
- ED to Interventional Radiology
- ED to ICU and LOS > 3 days
- Therapeutic ventilation within 3 days
- Death within 60 hours

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Integration of Cribari and NFTI Matrices

Overtriage (Q1 2020)			
Full TTAs	54		
Cribari (Step 1) ISS >15	AT	OT	
	23	31	
NFTI (Step 2)		POS	NEG
		9	22
22(Negative NFTI)/54 (Total # of Full Activations)= 41%			

Undertriage (Q1 2020)			
Limited/No TTA	424		
Cribari (Step 1) ISS >15	AT	UT	
	378	46	
NFTI (Step 2)		POS	NEG
		11	35
11 (Positive NFTI) / 424 (Total # Limited/ No TTA)= 2.6%			

AT-appropriate triage OT-overtriage UT-Undertriage

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CLASS DISCUSSION

Over/Undertriage Case Review

A 36 year old male is transported to your facility with an isolated gunshot wound to the lower arm with severe bleeding noted by EMS prior to arrival. The patient is not declared a trauma activation prior to arrival. He receives 2 units of blood products within 1 hour of arriving to the Emergency Department and is taken to the OR for hemorrhage control. After coding of his injuries his ISS is noted to be 16.

What Are Your Program's Core Measures/Audit Filters?

- Mandatory/Required
- Institution specific
- Document all core measures/audit filters in your trauma PIPS Plan and update annually



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Required Core Measures

- Mortality rates and Autopsy rate
- Trauma surgeon response to the ED
- Trauma team activation criteria compliance
- Compliance with Neurosurgical and Orthopedic response times
- Over/undertriage
- Admission to non surgical service
- Acute transfers out
- ED physicians covering in house emergencies at Level III

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Required Core Measures (continued)

- Diversion/bypass hours
- Anesthesia availability
- Delay to operating room
- Response time of operating room and post anesthesia care unit staff when responding from outside the hospital
- Rate of change in radiology interpretation: RADPEER
- Response time of CT (30 min), MRI (60 min) and IR (30 min)
- Transfers to higher level of care within the institution
- Solid organ donation rate

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Pediatric Core Measures

Requirement

- > 100 Pediatric patients per year – must have pediatric specific PIPS
- < 100 Pediatric patients per year – each case needs to be reviewed for appropriateness of care

Core Measures

- Solid Organ Injury Management
- Head Injury Outcomes
- Resuscitation (Fluid)
- DVT Prophylaxis
- Non Accidental Trauma
- Radiation Exposure
- Pain Management

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Institution Specific Pediatric Audit Filters (examples)

- Delays in obtaining vascular access
- Screening and brief intervention
- Physician coverage in the PICU
- CT scans – over-scanning
- Delays in transfer



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Institution Specific Resource and Financial Core Measures (examples)

- Delay in discharge disposition
- Hospital readmission within 72 hours
- Transfer to another facility due to lack of inpatient beds
- Reimbursement for trauma activation charges
 - With EMS notification 68XX (XX stands for Level trauma center)
 - Without EMS notification but activated on arrival: 450 code
- Reimbursement for Screening and Brief Interventions
- Physician professional billing and reimbursement

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Institution Specific Trauma System Core Measures/Audit Filters (examples)

- Absence of pre-hospital or referring hospital records
- Prehospital over and undertriage rates
- Timeliness of prehospital treatment of recognized hypotension or hypoxia in traumatic brain injury
- Timeliness of hemorrhage control in prehospital setting
- Timeliness of transfer from non-trauma or a lower level trauma center to a higher level trauma center
- Lack of hospital resources for patients (requires transfers out)

Martin KD, Dorlac WC. Trauma system performance improvement: a review of the literature and recommendations. *J Emerg Crit Care Med.* 2019;3:14.



Collecting, Monitoring, Reporting

- **Collecting**
 - Audit filters ideally are collected concurrently
- **Monitoring**
 - Use your trauma registry to monitor compliance results
 - Use a calendar for reporting data
- **Reporting**
 - Monthly performance dashboard reports
 - Quarterly reports to Trauma Committee
 - Annual report to hospital leadership



See the TOPIC Manual Appendix for more information



Using the Trauma Registry

- Repository for all PIPS activities
 - Patient specific
 - Trauma Program specific
- Daily monitoring of specific audit filters (morning handoff report, daily rounds, EMR rounds)

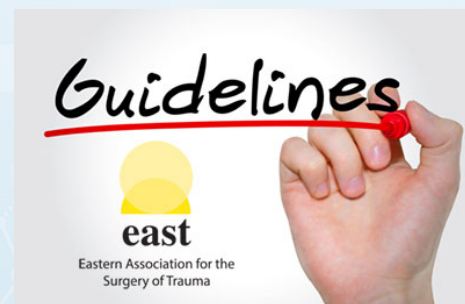


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Clinical Practice Guidelines

- Evidenced based practice guidelines reduce variance in care
- Are a road map for clinical decisions
- Affect outcomes
- Trauma Centers must
 - develop and implement CPGs
 - track compliance
 - monitor effect on outcomes



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Clinical Practice Guidelines Development

- Select a significant guideline that meets your patients' needs
- Select an interdisciplinary work team and a clinical champion
- Clarify purpose, scope, and outcome goals of the guideline
- Gain consensus from all stakeholders
- Assessment of scientific evidence
- Define and track metrics to measure compliance before you implement
- Provide education and implement

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Clinical Practice Guideline Implementation

- All stakeholders must be educated on the use of the guideline

mTBI Pocket Guide

Clinical Practice Guidelines for treatment of mild Traumatic Brain Injury

Features:

- Quick results with coding guidance
- Symptom management lists
- Summary of clinical recommendations
- Patient education resources
- Clinical tools and resources



36 Photo by: National Center for Telehealth & Technology



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Where to Store Guidelines

- Hospital intranet
- Phone app
- Order set “pop up”
- Posters

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Examples of Storing Guidelines Web/Cloud Based

Policies, Procedures, and Clinical Practice Guidelines

NeuroTrauma

- [Neurosurgical Response to Trauma](#)
- [Basilar Skull Fracture](#)
- [Blunt Cerebrovascular Injury](#)
- [Cervical Spine Clearance](#)
- [NeuroTrauma Seizure and DVT Prophylaxis](#)
- [Prioritization for Nursing Notification on Neurotrauma Patients](#)

Ortho Trauma

- [Damage Control Orthopedic Surgery](#)
- [Facial Fracture](#)
- [Geriatric Hip Fracture](#)

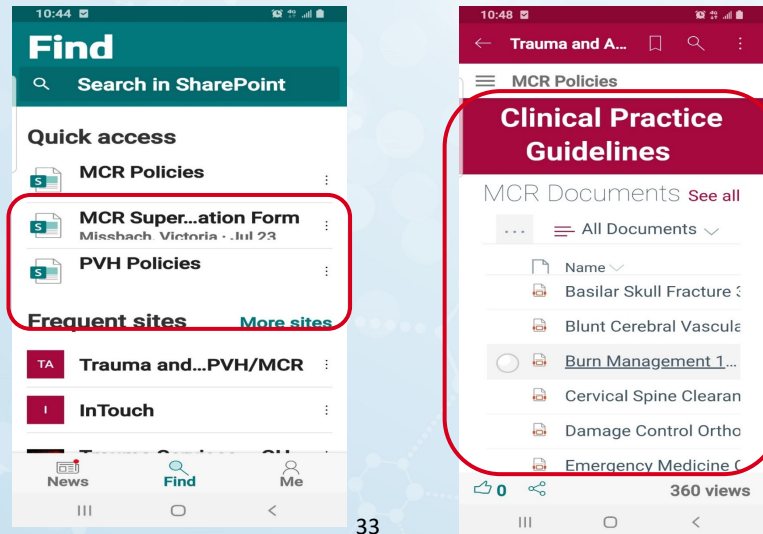
Trauma Continued

- [Management of the Pediatric Trauma Patient](#)
- [Massive Transfusion Protocol - Adult](#)
- [Massive Transfusion Protocol - Pediatric](#)
- [MTP Alert Algorithm](#)
- [MCR TACS Rounding Roles](#)
- [Organ and Tissue Donation](#)
- [Rapid Reversal of Anti-Platelet & Anticoagulant Therapy](#)
- [Palliative Care Consultation in Trauma](#)
- [Pediatric Imaging](#)
- [TEG Guidance for Component Replacement in Acute Trauma Resuscitation](#)
- [Tranexamic Acid Administration for Trauma](#)

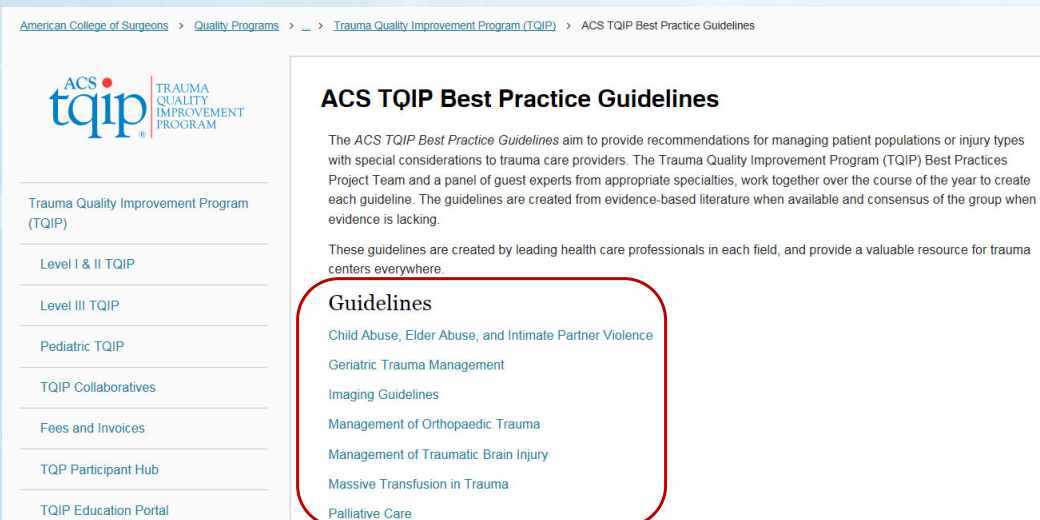
32



Example of Storing Guidelines Sharepoint



Development and Implementation of Clinical Practice Guidelines



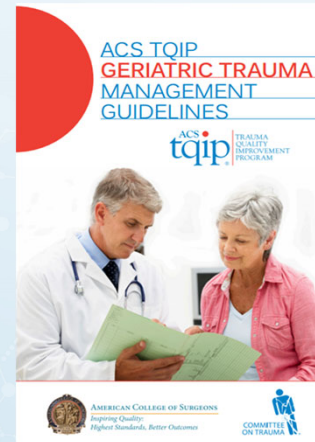
Core Measures for Each CPG

Secondary Survey:

- Medications
- Comorbidities
- Labs
- Imaging
- Anticoagulants/
Reversal

Discharge:

- Plan for transition
- Early discharge planning issues
- Written discharge planning document



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Drill Down/Core Measures CPG: Examples

CPG	Drill Down Questions
Rib Fracture CPG	<p><i>Was a Forced Vital Capacity or Incentive Spirometry ordered in the ED?</i></p> <p><i>Was a Forced Vital Capacity or Incentive Spirometry performed in the ED?</i></p> <p><i>Did the patient meet criteria to be admitted to the ICU?</i></p> <p><i>Was the Rib Fracture CPG treatment followed?</i></p>
Rapid Reversal Anticoagulants	<p><i>Did the patient meet criteria for anticoagulant alert?</i></p> <p><i>Why type of anticoagulant was the patient on?</i></p> <p><i>What was the reversal agent given?</i></p> <p><i>Was CPG Rapid Reversal treatment followed?</i></p>
Massive Transfusion Protocol	<p><i>What was EMS crystalloid volume administered in mL?</i></p> <p><i>What was the ED crystalloid volume administered in mL?</i></p> <p><i>What was the OR crystalloid volume administered in mL?</i></p> <p><i>What was the ICU crystalloid volume administered in mL?</i></p> <p><i>10+ RBCs only: was an ionized calcium obtained?</i></p>

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Clinical Practice Guidelines Tracking Compliance

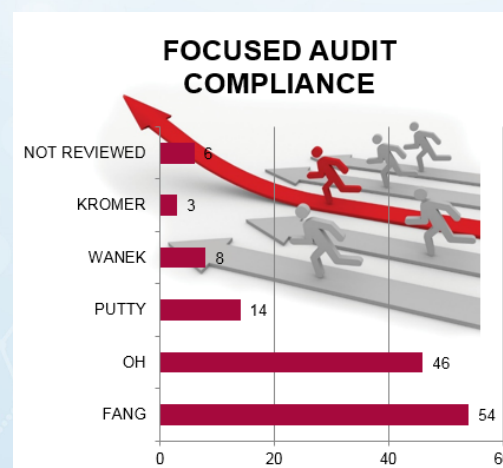
- Rotate tracking; guideline of the month
- Customize trauma registry elements as needed
- Provider or department/unit specific analysis as needed
- Non compliance: look for reasons
- Re-evaluation

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Increasing CPG Compliance

- Review with staff at monthly provider meetings
- Reinforce the 'core measures' that are key to the guideline
- If everyone is having a problem with the guideline, then perhaps revision or appropriate education session is needed
- Competition among providers often drives individual and collective performance improvement



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CPG Tracking Tools

Who will track the guideline?

- Trauma Registrars
- Trauma PI Coordinator
- Trauma Nurse Clinicians
- NPs/PAs
- ED Nurses/ICU Nurses
- Blood Bank
- Physicians
- Research coordinators

How will it be tracked?

- Trauma Registry
- Electronically
- Pulled from EMR
- Concurrent tracking with real time audits (ED flowsheet)

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Reporting CPG Compliance

- Multiple ways to display data
- Depends on the audience
- 1 CPG at a time
- 1 CPG compliance along with complication incidence
- All CPGs at once, grouped by month/quarter/year
- Peer Review Meeting
- Trauma Systems Meeting
- Hospital Quality Committee
- Itemize: Provider or System Related
- Classification
 - Compliance
 - Non-compliance (variance)
 - Acceptable
 - Not acceptable

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CPG Tracking Compliance: Dashboard Example

	2018	2018	2018	2018	2018	2018	2019	2019	2019	2019	2019	2019	Rolling FY 19
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	YTD
% VAP	0.00%	0.00%	0.86%	0.78%	0.97%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.22%
CPG Compliance													
BCVI	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	ND	ND	ND	ND	ND	ND	100.00%
BSF	83.33%	100.00%	100.00%	60.00%	100.00%	80.00%	ND	ND	ND	ND	ND	ND	87.22%
Facial Fx	100.00%	85.71%	100.00%	100.00%	100.00%	90.90%	ND	ND	ND	ND	ND	ND	96.10%
Geriatric Hip Fracture	ND	ND	ND	ND	ND	ND	100.00%	92.31%	100.00%	100.00%	100.00%	ND	98.46%
MTP Crystalloid Limited (≤ 1 L)	80.00%	100.00%	100.00%	75.00%	100.00%	NA	100.00%	NA	0.00%	100.00%	100.00%		83.89%
MTP Ratio (1:1:1) All	60.00%	33.34%	80.00%	75.00%	50.00%	100.00%	33.34%	NA	50.00%	50.00%	50.00%		58.17%
MTP Ratio (1:1:1) ≥ 4 RBC	100.00%	100.00%	100.00%	100.00%	100.00%	ND	50.00%	NA	0.00%	100.00%	50.00%		77.78%
MTP Ratio (1:1:1) ≥ 6 RBC w/in 4 h	0.00%	NA	100.00%	100.00%	100.00%	NA	0.00%	NA	NA	100.00%	50.00%		64.29%
MTP Ratio (1:1 or 1:2) ≥ 6 RBC	100.00%	NA	100.00%	100.00%	100.00%	NA	100.00%	NA	NA	100.00%	100.00%		100.00%
MTP Cryo Replace (≥ 10 RBC)	ND	ND	ND	ND	ND	ND	100.00%	NA	NA	ND	100.00%		100.00%
Open Fx (Abx ≤ 60 min)	28.57%	100.00%	66.67%	75.00%	85.71%	60.00%	100.00%	85.71%	42.86%	83.33%	54.54%	88.89%	72.61%
Open Fx Tdap Administered	ND	ND	ND	ND	ND	ND	100.00%	50.00%	83.33%	100.00%	100.00%	100.00%	88.89%
Rap Rev of Acoag	75.00%	91.67%	85.71%	100.00%	71.43%	100.00%	100.00%	80.00%	100.00%	100.00%	100.00%	100.00%	91.98%
Rib Fx	66.67%	50.00%	80.00%	75.00%	100.00%	80.00%	91.67%	100.00%	55.56%	66.67%	92.86%	80.00%	78.20%
Unstable Pelvic Fx	NA	NA	100.00%	NA	0.00%	NA	NA	NA	NA	NA	100.00%	100.00%	75.00%
VTE Chemoprophylaxis Rate	58.88%	66.91%	72.36%	68.57%	63.30%	59.65%	68.10%	65.85%	67.59%	68.75%	70.25%	70.59%	66.73%

Summary

- Audit filters capture variances in all levels of centers
- The ACS Resources for Optimal Care of the Injured Patient criterion reflects the required audit filters and core measures for verification
- Institutions should choose discretionary filters relevant to their patient population
- A plan for monitoring and reporting the PIPS activities of the trauma center is a vital component of the overall trauma program
- CPG variance tracking evaluates compliance

Module 4:

Committee Structure



Module 4: Committee Structure

TRAUMA OUTCOMES & PERFORMANCE IMPROVEMENT COURSE

Trauma Committee Structure

Required

Optional Committees

Membership

Agendas

Options

Trauma Committee Structure

Required	Optional
<ul style="list-style-type: none">• Multidisciplinary Trauma Peer Review<ul style="list-style-type: none">– Clinical concerns– Case reviews– Provider related events• Multidisciplinary Trauma Systems/Operations<ul style="list-style-type: none">– Process and system focused– Operational events	<ul style="list-style-type: none">• Morbidity and Mortality Conference• Pre-Hospital Trauma PIPS Committee• PI ad hoc work groups

3



Benefits of Integrating Trauma Center PIPS with Hospital Quality PIPS

- Common language: event classification
- Event awareness across departments
- Avoid “silos”
- Halo effect on rest of hospital with a well functioning Trauma PIPS program
- Trauma Program integrated into overall institutional reports
- Integration with hospital incident reporting system

4



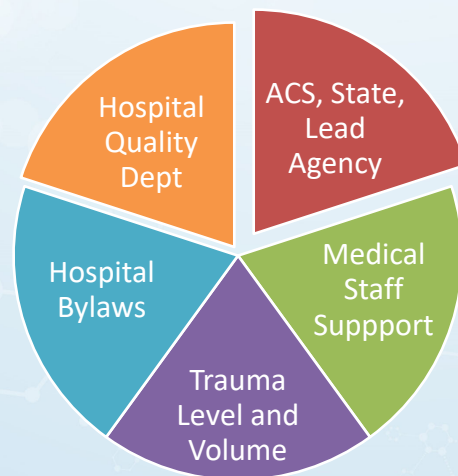
Examples of Hospital Quality Integration

- Integrate Trauma PIPS into the Hospital Quality PIPS Plan
- Refer to other PIPS/peer review committees (EMS, ED, Anesthesia, Orthopedics, Neurosurgery, Nursing)
- Present Trauma Committee reports and annual report to Hospital Quality, Surgery, or ED PIPS
- Distribute PIPS minutes department chairs/liaisons
- Trauma should access Hospital Incident/Event reports



Trauma Committee Structure

- Defined by trauma center level and volume
- Defined by ACS, State Regulations, and the Lead Agency
- Driven by Hospital bylaws
- Supported by medical staff and quality department



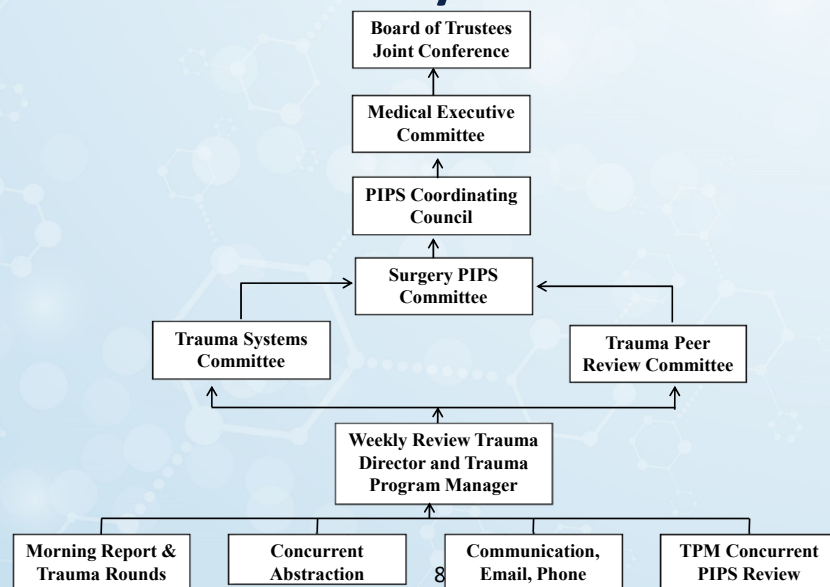
Committee Goals

- Develop a culture that promotes both system and patient care improvements
- Aligns with national standards of care
- Review the performance and patient safety of the trauma center systems
- Review of objective data and processes to improve patient care

7



Example Line of Authority for Trauma PIPS Process



8



A photograph of two healthcare professionals, a woman and a man, both wearing blue scrubs and stethoscopes. They are looking at a clipboard held by the man. The woman is on the left, and the man is on the right. The background is a blurred clinical setting.

CLASS DISCUSSION

Reporting Trauma PI Activity

- How many report up to another oversight committee?
- If so, what is reported?
- What is the frequency of these reports?

Trauma Multidisciplinary Peer Review Committee

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Trauma Multidisciplinary Peer Review Committee

- Purpose: Review the efficacy, efficiency and safety of trauma patient care
- ACS requires Trauma Medical Director Chair (Level I and II)
- Know the state laws governing peer review structure and attendance
- Limited access forum defined by bylaws
- Frequency of meetings should be volume driven and ensure concurrent review
- This is NOT an academic M&M conference

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Trauma Multidisciplinary Peer Review Committee Function

- Review deaths, adverse events, complications, and audit filter fallout that have had a significant impact on the patient's hospital course
- Ensure the meeting minutes capture accurate points of discussion
- Classify events
- Identify action plans
- Refer system events to Trauma Systems Operations Committee

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Trauma Multidisciplinary Peer Review Committee Cases

- All or select deaths
- Select occurrences
- Sentinel events
- Problem trends
- Unusual or uncommon cases
- Unexpected outcomes
- Control charts depicting complications
- TQIP reports with drill down information



Great Saves!

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Trauma Multidisciplinary Peer Review Committee Members (Level I and II)

- Trauma Medical Director *
- Trauma/General Surgeons*
- Orthopedics*
- Neurosurgery*
- Emergency Medicine*
- Anesthesia*
- Critical Care*
- Radiology* / Interventional Radiology
- Pediatrics
- Thoracic
- Plastics
- Medical Examiner
- Rehab Medicine
- Trauma Program Manager
- Trauma Registrar/PI Coordinator
- Invited Sub-Specialist involved with case

*** Minimum 50% attendance**

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Trauma Multidisciplinary Peer Review Committee

Multidisciplinary Peer Review Committee: Sample Agenda – Date:

1. Call to Order	Trauma Medical Director
2. Approval of Minutes	Trauma Medical Director & Committee
3. Review of Attendance Criteria	Trauma Medical Director
4. Trauma Team Activations, Trauma Surgeon Response Times	Trauma Program Manager / PI Coord
5. Consultant Response Times	Trauma Program Manager / PI Coord
6. Case Review of Deaths, Major Complications, Significant Events	Committee Members
7. Control Charts: Complication Trends, Q4	Trauma Program Manager / PI Coord
8. Next Meeting	Trauma Medical Director
9. Adjourn	Trauma Medical Director



Multidisciplinary Peer Review Committee Members (Level III and IV)

- Trauma Medical Director*
- Orthopedics*
- Emergency Medicine*
- Anesthesia*
- Radiology*
- Medical Examiner
- Trauma Program Manager
- Trauma Registrar



** Minimum 50% attendance*

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Multidisciplinary Trauma Peer Review Committee Options for Level III Trauma Centers

- Planned in conjunction with Trauma Operations Committee
- Prepare two separate agendas / minutes
- Document separate attendance
- Held back to back for time management and physician utilization
- Follow peer review protection regulations / policies
- Must be led by Trauma Medical Director

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Multidisciplinary Trauma Peer Review Committee Options for Level IV Trauma Centers

- May be held at time of Medical Staff Peer Review with separate agenda, minutes
- Define physician disciplines
 - Trauma Medical Director
 - Emergency Physicians
 - Specialty surgeons if patient admitted or operative intervention
 - Radiologist

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Multidisciplinary Trauma System Operations Committee

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Multidisciplinary Trauma System Operations Committee

- Chaired by Trauma Medical Director and/or Trauma Program Manager
- Purpose
 - Address operational events / infrastructure events
 - Verification / Designation readiness
- Process-focused
 - Regional/System focused
 - Global system issues
 - Link with hospital systems
- System issues tracked until resolved

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Multidisciplinary Trauma System Operations Committee

- Separate committee from Peer Review (Can be held back to back)
- System and operations focused
- Pre-hospital processes
- Transfers/Diversions
- Data driven
- Process focused
- Systems events referred by peer review
- Not a forum to discuss individual cases

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Multidisciplinary Trauma System Operations Committee Members

- Trauma Surgeons
- Anesthesia
- Specialty liaisons
- Radiology
- Critical Care
- Pediatrics
- Rehabilitation
- Administration
- Trauma Program Manager
- Trauma Registrar
- Pre-hospital/EMS
- Nursing
- Respiratory therapy
- Lab/Blood Bank
- Quality Management
- Pharmacy
- Nutrition
- Information Management

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Multidisciplinary Trauma System Operations Committee Members

- Consider setting an attendance requirement
- Members **MUST** be able to have the authority to make decisions during this meeting
- This means presence of appropriate level of management
- These are active positions

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Trauma Systems Operations Committee: Sample Agenda

TOPIC	Presenter	Action/Informational
Call to Order	Trauma Medical Director	Action
Approval of Minutes	Trauma Medical Director	Action
<ul style="list-style-type: none"> Trauma Program Report Injury Prevention & Outreach Trauma Education 	Trauma Program Manager Injury Prevention Coordinator Trauma Educator	Informational Informational Informational
Trauma Systems (Local, Regional, National)	Trauma Program Manager	Informational
Trauma General Statistics	Trauma Registrar(s)	Informational
Old Business		
New Business: <ul style="list-style-type: none"> Approve revision to MTP protocol TQIP Report New trauma center requirements Annual trauma finance report 	Blood Bank Manager Trauma PI Coordinator TPM & TMD VP, Finance	Action Informational Action Informational

Trauma Systems Operations Committee: Sample Agenda *(continued)*

TOPIC	Presenter	Action/Informational
PIPS Opportunities & Great Saves	Trauma PIPS Coordinator	Action
Trauma Organ Donation Report	One Legacy Coordinator	Informational
Disaster Preparedness Report: State Drill & Roles	Disaster Manager	Action
Closure Diversion Report	Prehospital Care Coordinator	Informational
Open Forum & Round Table	Committee Members	Informational
Next Meeting	Trauma Medical Director	Informational
Adjournment	Trauma Medical Director	Action

Optional Committees

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Trauma Morbidity & Mortality Conference

- Must not take the place of the Multidisciplinary Trauma Peer Review Committee
- May “augment” your trauma PIPS processes, e.g. education
- May feed cases to Multidisciplinary Trauma Peer Review Committee

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Prehospital Trauma PIPS Committee

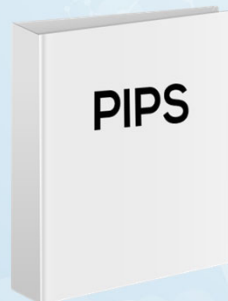
- This committee is optional
- What is required:
 - Interface with prehospital agencies
 - Open dialogue between prehospital agencies and the trauma center
 - Review prehospital care



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TOPIC

Member Roles



Should be defined in Trauma PIPS Plan

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TOPIC

Trauma Medical Director Roles and Responsibilities

- Has authority to direct the PIPS plan
- Directs development of evidence-based practice guidelines
- Selects cases for PIPS committees and referrals
- Performs case reviews
- Analyzes PIPS trends and physician profiles
- Directs PIPS correspondence
- Leads peer review discussions
- Moderates peer review determinations/judgments

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Trauma Medical Director Roles and Responsibilities

- Perform 2nd Level of review prior to Peer Review
- Provide input to Mitigation/Prevention Plan
- Follow up with absent Trauma Surgeons and Liaisons
- Elevate to Medical Staff Peer Review
- Assure a process to disseminate key information to absent members with documentation
- Follow up provider related counseling
- Follow up with trauma privilege issues

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Trauma Program Manager Roles and Responsibilities

- Directs implementation of PIPS plan, defined tools & processes
- Identifies, monitors trends, tracks, analyzes, PIPS data
- Coordinates various PIPS committee meetings
- Participates in peer review discussions & meeting
- Responsible for the meeting minutes
- PI through the Trauma Continuum
- Ensures validation of registry data
- Participates in operationalizing practice guidelines
- Facilitates resolution/loop closure
- Represents trauma program on hospital and system committees
- Manages follow-up on PIPS system issues and peer review issues
- NOTE: many of these items will be shifted to a trauma PI Coordinator if that position is under Trauma

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Trauma PI Coordinator

- The TPM needs to advocate for dedicated staff support in order to fulfill the mandatory requirements for PIPS at a trauma center
- The Trauma PI Coordinator
 - Is usually an RN with trauma clinical experience
 - Reports to the TPM
 - Meets routinely with the TPM and TMD
- Will handle many details of the PIPS process supporting the TMD and TPM

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Trauma Surgeons & Liaisons Roles & Responsibilities

- Structured orientation to PIPS plan and process
- Understand defined *event* reviews, definitions of complications, and the language of defined judgment or review determination
- Report identified *events* and occurrences to trauma team
- Shared responsibility for review of cases being presented at the PIPS meeting
- Participate in peer review discussion and determinations
- Participate in developing corrective action plans
- Providing routine feedback (weekly, monthly, annually)

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How to Run a Meeting

- Focus and re-focus on the purpose and objectives
- Members have a collective identity and responsibility for supporting PIPS
- Chair of the meeting is well prepared
- Professional courtesy (what cases are on the agenda)
- Never “sandbag” people



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Use of Information Technology in Trauma PIPS Meetings

- Email notifications and agendas
- LCD screen/computer with link to EMR, Labs, Radiographic image
- Teleconferencing or video teleconferencing



Case courtesy of Dr Sajoscha Sorrentino, Radiopaedia.org

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PIPS Data Storage and Protection of Confidentiality

- Ensure all PIPS information is secured
- Examples:
 - Robust trauma data and PI security policy
 - Locked offices
 - Locked files
 - All PIPS information contains the State language for peer review protection / confidentiality



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PI Case File

- For all cases that undergo a PI review, ensure there is a secure method to retain and retrieve this information
- Most trauma registry software have PI screens
- Best practice:
 - All PI activity pertaining to one case is contained in one file (preferably an electronic file within the trauma registry)
 - This is user friendly and efficient when retrieving case information

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Contents of a PI Case File Example

- Case summary
- Events identified
- Registry data, e.g., injuries, ISS
- Correspondence regarding event or care
- Referrals for review and follow up / action
- Meeting minutes with determinations
- Corrective action(s)
- Documentation of event resolution



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Summary

- Committee structure must be defined in PIPS plan
- Committee membership defined by institution and level of verification / designation
- Must have trauma peer review and systems review
- Clear confidentiality and security measure must be in place

Module 5: Data Management - Supporting the Trauma PIPS Process



Module 5: Data Management - Supporting the Trauma PIPS Process

TRAUMA OUTCOMES & PERFORMANCE IMPROVEMENT COURSE

Definition of Trauma Registry

“...disease-specific data collection composed of a file of **uniform data elements** that describe the injury event, demographics, pre-hospital information, diagnosis, care, outcomes, and costs of treatment of injured patients.”

-Resources for Optimal Care of the Injured Patient, 2014



<https://www.slideserve.com/oshin/national-trauma-data-standard-everything-you-powerpoint-ppt-presentation>

Purpose of the Trauma Registry

Ensure that all aspects of trauma center and trauma systems are data driven and evidence based

Trauma Registry

Data Driven

Evidence Based

Optimal Patient
Care

3



Trauma Registry Functions

- Support PIPS process in evaluating clinical care and outcomes
- Data repository for clinical and systems research
- Public health and injury prevention resource
 - Frequency and patterns of injury to target community education and outreach
- Administrative evaluation of care to include trauma cost analysis and resource utilization
- Supports trauma center verification process

4



Trauma Registry

- Data must be collected and analyzed
- Data collection must be concurrent
- ACS-CD15-6 states at a minimum, 80% of cases must be entered within 60 days of discharge
- States may require a tighter deadline

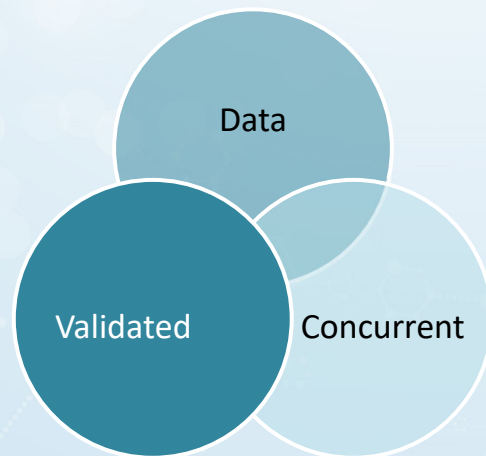


5



Trauma Registry

- The goal is to create and sustain a concurrent data process
- If backlog exists, must have plan to become concurrent



6



Month	Total DHS Yes Patients	Total # Completed	Total Number of Inpatient Admissions Incomplete	# of Inpatients still In-House	Total number of ED DC's	Total # of incomplete ED Discharges	Initial and Date When You Have Updated the Count (Update the count weekly: FRIDAY's)
October	156	156	0	0	29	0	MT – 9/13/19
November	146	146	0	0	27	0	
December	147	147	0	0	17	0	
January	109	109	0	0	17	0	
February	110	110	0	0	16	0	
March	126	126	0	0	26	0	
April	115	115	0	0	20	0	
May	114	114	0	0	19	0	
June	135	134	1	1	25	0	
July	159	157	2	1	27	0	1 Chart Pending Sequence #
August	136	134	2	1	30	0	1 Chart Pending Sequence #
September	53	35	18	18	12	0	8 Chart Pending Sequence #'s
			TOTAL: 23	TOTAL: 21	TOTAL: 265	TOTAL: 0	

Implementing a Trauma Registry

The basic components needed:

- Institutional financial commitment and continued support for an optimal trauma data process
- Trauma Registrar(s) (1) FTE for each 500 patient encounters annually
- Appropriate hardware (PC, LAN, virtual storage capacities etc.)
- Trauma Registry Software Database
- Data Dictionary and internal hierarchy of data sources
- Effective data collection and validation process
- Good technical support from the vendor
- Data security policy
- Secure office area

Trauma Registry Software

- Optimal functionality
- Should be trauma registry vendor/database
- Provides process to ensure validity and reliability
- Produces PIPS reports
- Has robust report writing capabilities
- Has ability to interface between EMR and trauma registry

9



Optimize Work Processes

- Laptops, tablets, dual monitors
- Seamless interfacing with the electronic medical record (EMR)
- Interfacing with the pre-hospital electronic medical record



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Trauma Registrar

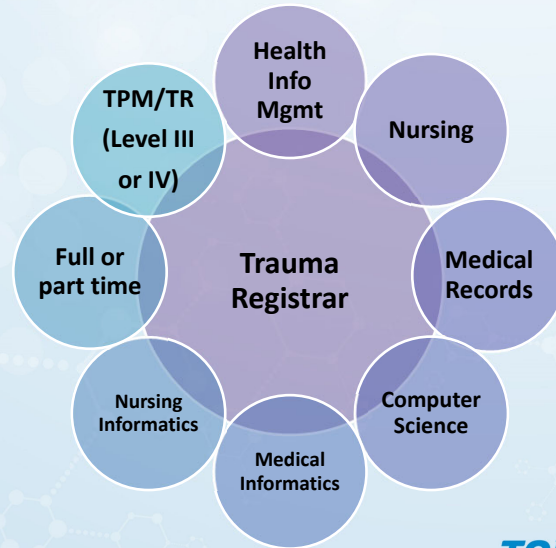
Background

- Health Information
- Nursing
- Paramedics
- Informatics

Training*

- National/State Recognized Registrar Course
- AAAM Injury Scaling Course

*Within 12 months of hire



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Trauma Registrar Job Description

Must include:

- Trauma Registry duties (all inclusive)
- Close interface with TPM and TMD
- Data support for all PI activity
- Report writing and generation for research, injury prevention activities, hospital trauma activity
- Expertise in spreadsheet utilization and graphics
- Administrative requirements
- Regulatory requirements
- Interface (State, Regional, NTDB, TQIP)

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Trauma Registrar Interface

Trauma Registrars need to be fully integrated into:

- Trauma PIPS Processes
- Event/issue identification
- Data element, data field updates
- Data validation processes
- Data reporting

Hospital staff and PI representatives need to understand:

- Roles and responsibilities of the trauma registrars
- Inclusion criteria
- Audit filters
- Committee reports

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Trauma Registrar: The Team Approach

- Include the trauma registrar(s) in:
 - Trauma bedside rounds / weekly case conferences as appropriate
 - Daily communication and information sharing on clinical and PI issues
 - System operations committee meetings
 - Multidisciplinary peer review committee meeting as appropriate
 - Educational opportunities
- This inclusion and integration leads to improved trauma data

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Trauma Registry Support of Trauma PIPS

The trauma registrar supports the trauma PIPS process by:

- Concurrent event identification of complications, deaths, etc.
- Reporting of PI issues through routine reports (weekly, monthly, annually)
- Analysis and report generation of issues, complications, core measures, etc.
- Meeting the risk adjusted benchmarking requirements
- Meeting the trauma system PIPS requirements



Accurate, validated, concurrent data is
the foundation for Trauma PIPS.



Staffing Models

Centralized Registry

- Hospital system may centralize registry staff in one location
- Data management and oversight still provided by TPM
- Must maintain staffing ratio (1 registrar per 500 encounters)

Outsourcing

- Requires close supervision and data validation
- Registrars must be engaged in the team and PIPS process
- May be valuable to relieve backlog



Staffing Models

- **Traditional**
 - Registry staff is on-site
 - Engaged with trauma program staff daily
- **Remote**
 - Trauma program staff not physically on-site
 - Participate in program via technology (conf calls, computer access, etc.)
 - Requires robust oversight by the TPM



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Data Validation is...

- A process to ensure the trauma registry data is correct; to prove or disprove accuracy
- A review of data for completeness and appropriateness with the elimination of erroneous values
- The process of identifying suspicious or invalid data points, variables, and data values



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Why Validate Your Trauma Data?

The process of developing, implementing, and refining a registry data validation system is integral to optimal trauma registry operations



Goal: significant reduction / complete elimination of avoidable errors

Protetch, J, Chappel, D. (2008) Trauma Registry Data Validation: Building Objectivity. *Journal of Trauma Nursing*, 15 (2), 67-71.

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Registry Data Validation

- Strategies for monitoring data validity are essential
- Perform audit of the registrar and data processes
 - Inter-rater reliability: re-abstraction of patient records (5-10% per month)
 - Software validation
 - NTDB reports
 - Comparative data point analysis
 - Report on missing data elements
- The registry staff and TPM should discuss the findings and corrective actions

20



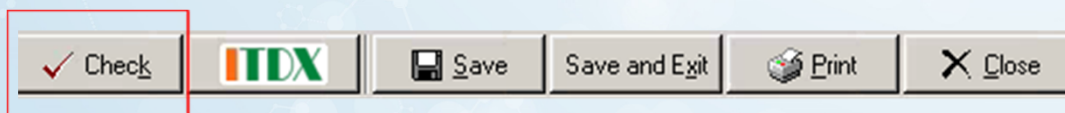
Record Completion (example)

Trauma Registrar	TR 1	TR 2	TR 3	TR 4	Grand Total
Blank Data Fields	1	5	0	11	17
Completed Records	47 (90%)	64 (82%)	29 (60%)	54 (87%)	194 (80.8%)
Total Records	52	78	48	62	240

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Software Validation



Checks

ALTERNATE RESIDENCE should not be blank.

Next Check Validate Exit

Alternate Residence

Telephone

ICD9 ICD10

AIS Version ISS NISS TRISS

Checks

AIS VERSION should not be blank.

Next Check Validate Exit

22



Data Validation Abstraction Tool

Data Validation Abstraction Tool

Re-Abstractor: Medical Record:

Pre-Hospital

Were the vitals taken on the scene of injury? ☐ Y ☐ N

Blunt ☐ Penetrating ☐ Burn ☐

External Cause Code Correct? ☐ Yes ☐ No

Pre-Hospital Transport Decision: TC ☐ MAR ☐ Other ☐

Emergency Department

Meets Trauma Registry Criteria: ☐ Yes ☐ No

Trauma Team Activated: ☐ Yes ☐ No ☐ N/A Activation Time:

ED Vital Signs: Within 30 Minutes? ☐ Yes ☐ No

BP: HR: RR:

GCS: E: V: M:

Trauma Surgeon Called Time: TRS Arrival Time:

NES Called Time: NES Arrival Time:

ORT Called Time: ORT Arrival Time:

Signs of Life on Arrival: ☐ Y ☐ N

Admitting Service: Next Phase After ED:

Hospital

Total Vent Days:

ICU Arrival Date 1: ICU Discharge Date 1:

ICU Arrival Date 2: ICU Discharge Date 2:

Consults:

D/C Date: D/C Time: D/C To:



See the TOPIC Manual Appendix for more information



23

Institution: St Elsewhere			
Educational Site Visit Date: 08/28/2019	Chart #1	Chart #2	
Record Trauma Number:	20190044	20190090	
Demographic Data			
Total Possible	24	24	
Total Correct	24	24	
Prehospital Data			
Total Possible	108	108	
Total Correct	105	106	
Process of Acute Care			
Total Possible	140	140	
Total Correct	140	140	
Clinical Data			
Total Possible	35	35	
Total Correct	33	34	
Outcome Data			
Total Possible	45	45	
Total Correct	44	45	
Anatomical Diagnoses			
Total Possible	10	10	
Total Correct	10	10	
Procedures			
Total Possible	24	24	
Total Correct	24	24	
Payor Class			
Total Possible	2	2	
Total Correct	2	1	
Receiving Facility			
Total Possible	2	2	
Total Correct	2	2	
Total Data Points Possible	390	390	
Total Data Points Correct	384	386	
Chart Percentage Accuracy	98.5	99	
Overall Total Accuracy	98.75		

Inter Rater Reliability – Re-abstract records for registry accuracy.

Clinical Data

The response to *When was nutrition initially started?* - Time of 23:00 was incorrect.

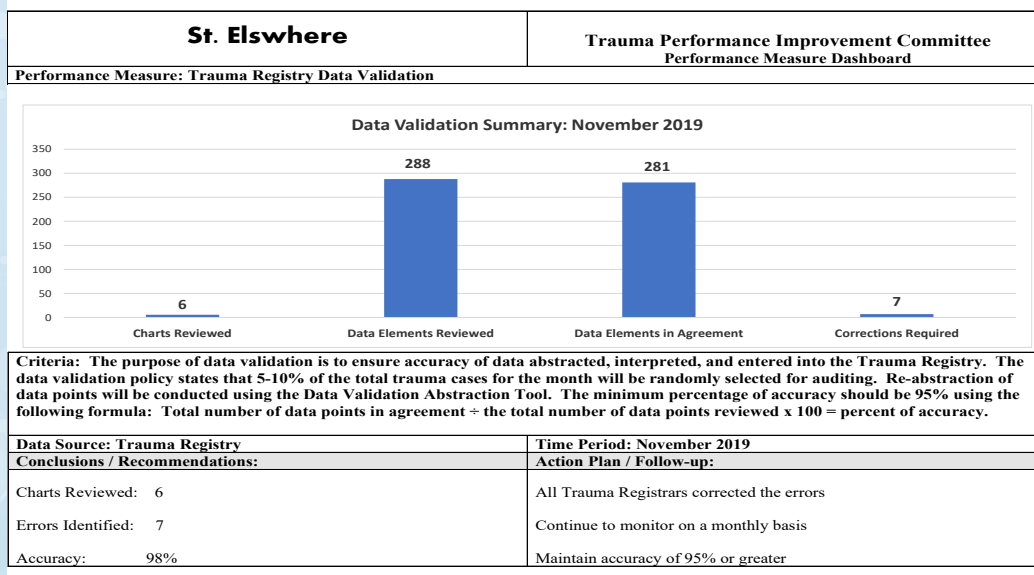
22:00



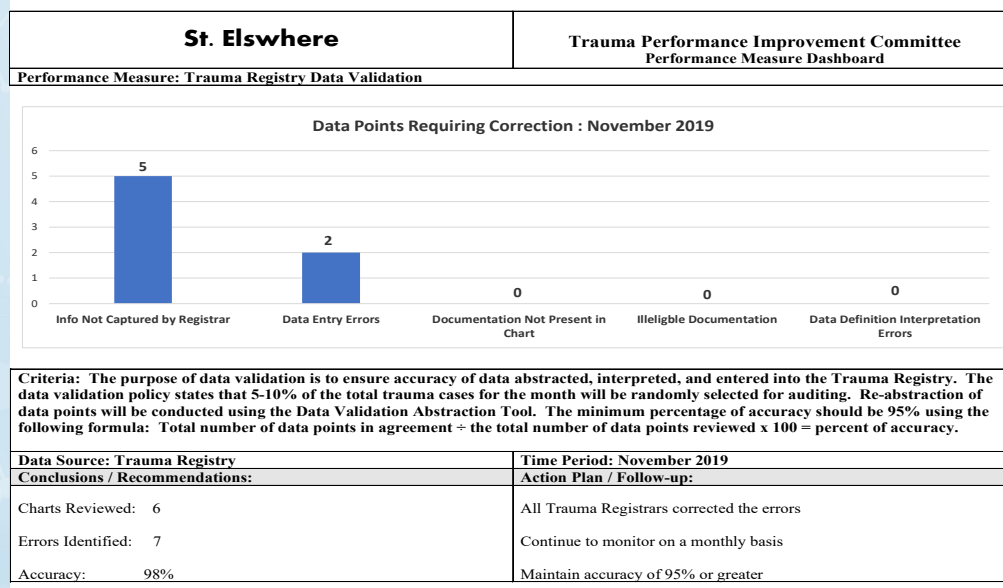
See the TOPIC Manual Appendix for more information



24



25



26



NTDB/TQIP Validation Report

Offline Validation Report - 2019
Offline Validation Channel_2019

Schema Errors - Level 1

Facility	Record	TagName	Id	Message
153105	88125	Diagnosed10[]	Diagnosed10 60203	At least one diagnosis must be provided and meet inclusion criteria. (ICD-10 CM only)

Record Passed Validation.

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Regional, State, and National Trauma Registries

- Valuable component of an effective trauma system
- Aggregate of registry data from participating trauma centers and hospitals
- Regional and State trauma registries used for trauma system PIPS
 - Needs assessment
 - Epidemiologic purposes
 - Region and State-wide research projects

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Protection of the Trauma Data

- Ensure data is secure at all times
 - Physically locked office and desk space
 - Password protection
- Develop and maintain a trauma data security policy consistent with the hospital's data security policies
- Create and maintain data request and release policy
- Limit access to the trauma registry to protect patient privacy and ensure integrity of the data
 - **Recommend TPM, TMD, and PI Coordinator, and Trauma Registrars only**

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Trauma Registry Data Request (example)

Libraries Related Documents Registry FAQs Data Dictionaries Lists Calendar Helpful Links Change Log Registry Request Log Tasks Discussions Recycle Bin All Site Content	Date Requested *	11/6/2017
	Requestor(s) *	<div>Separate user names with semicolons.</div> <div>Once complete press the Enter key on your keyboard or the person with check mark icon on the right.</div>
	Project/Study Name	
	Reason for Report *	
	HSC# *	<div><input type="checkbox"/> N/A</div> <div><input type="checkbox"/> Specify your own value:</div> <div></div> <div>Unless you provide a HSC# you will not receive de-identified data.</div>
What will you use this report for? *	<div><input type="checkbox"/> Clinical operations</div> <div><input type="checkbox"/> Financial</div> <div><input type="checkbox"/> Productivity/Performance Improvement</div> <div><input type="checkbox"/> Research</div> <div><input type="checkbox"/> Inquiry</div> <div><input type="checkbox"/> Other (see following row, Other report usages)</div> <div>Select all that apply</div>	
Other Report Usages	<div></div> <div>Complete only if you selected Other in the previous field. If not, enter N/A.</div>	



How to Maintain a Concurrent Data Process

- TPM and TMD advocate for appropriate trauma registrar staffing ratios
- Ensure a current data dictionary
- Revitalize outdated trauma data work flow processes
- Plan carefully and aggressively for an appropriate trauma data model
- TPM to monitor and provide careful oversight to the trauma registrars to support their roles and responsibilities

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Summary

- The trauma registry is the foundation of the trauma program and trauma performance improvement.
- Appropriate staffing levels, training, continuing education, and institutional support is crucial.
- Implement and maintain a concurrent data model and ensure work processes are optimized.
- Integrate the trauma registry staff into the various aspects of the trauma program such as rounds, education, and case conferences.
- Data validation is essential to trauma registry management.

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Module 6: Trauma PIPS Reports



Module 6: Trauma PIPS Reports

TRAUMA OUTCOMES & PERFORMANCE IMPROVEMENT COURSE

Getting Started

Ask Yourself:

- Do you have accurate data? How do you know?
- Do you have timely and meaningful data?
- Who is your target audience?
- What do you want your audience to get from your data?
- Who is presenting the data? How well do they know the data?
- What message do you want to convey?
- What is the goal of the report?

Process of Data Presentation



3



Tips for Creating Meaningful Reports

- Spend time thinking about how you want to communicate your data
- Display the data so it is easy to read
- Determine what type of graph best displays a particular data set
- Avoid presenting raw data
- Show everything in context
- When in doubt, annotate
- Place labels in close proximity to the actual data
- Reference sources of data

4



Presenting the Trauma Data

- Who will be presenting the data?
- How well do they really know the data?
 - This should be taken under consideration when the reports are compiled
- Who is the audience?
- Practice
- Anticipate questions



5



Trauma Report Types

Basic Hospital Reports

- Census by month with comparison to the previous year
- ED disposition
- Hospital disposition
- Hospital and ICU length of stay
- Mechanism of injury
- Demographics
- Trauma team activations

Trauma PIPS Reports

- Events
- Brief summary analysis on a dashboard report
- Complication dashboard control charts (by month or quarter)
- Deaths using trauma taxonomy

6



Types of Trauma PIPS Reports

Complications

- Data should be collected and presented in a concurrent fashion
- monthly or quarterly, depending on volume
- Control charts show trends over time
- Include individual provider-specific complication rates in the annual credentialing process or physician report card



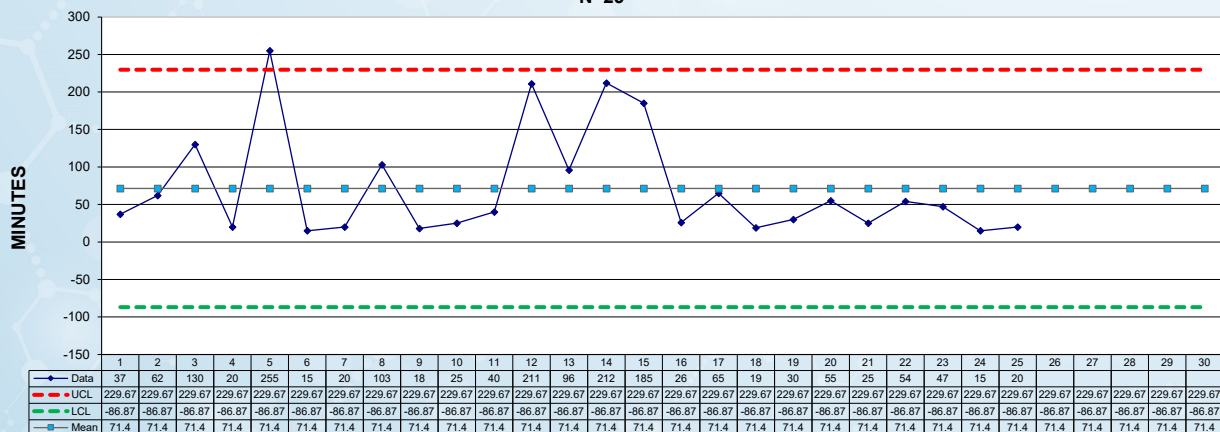
See the TOPIC Manual Appendix
for more information

7



Control Charts

TIME TO DEFINITIVE CARE
TIME OF ADMIT UNTIL TIME PATIENT LEFT ED FOR OR
N=25




8




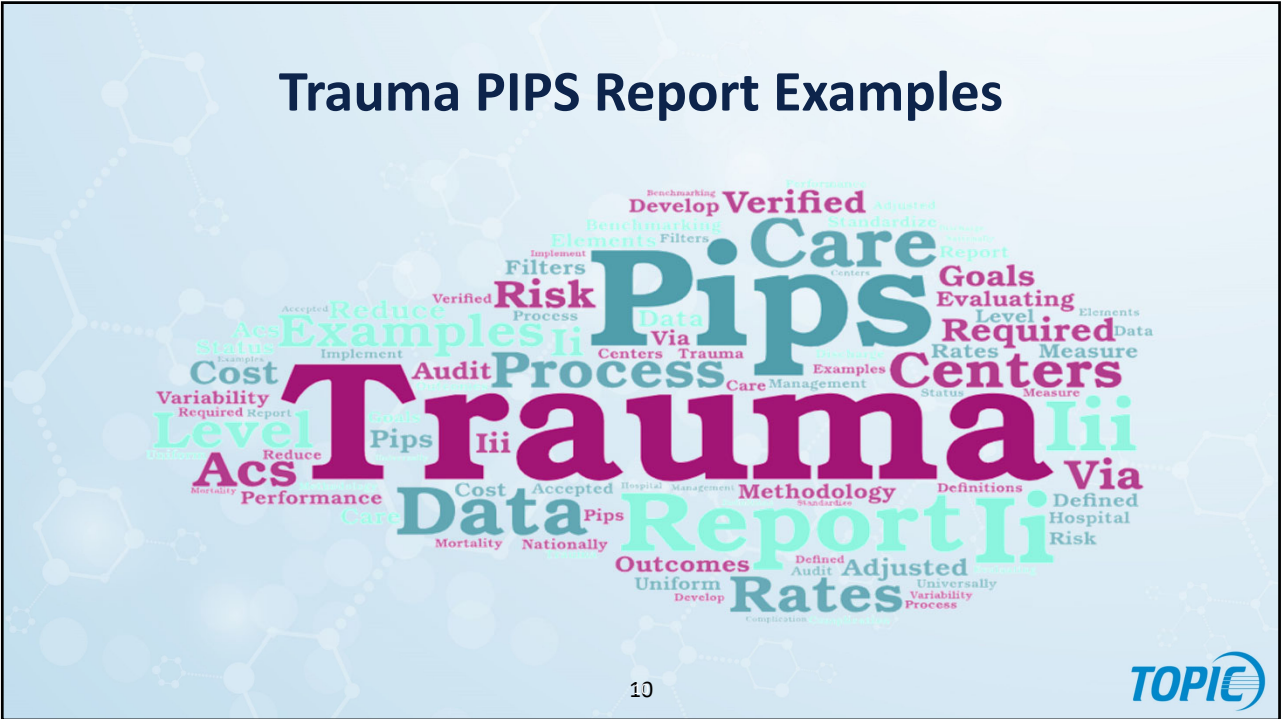
Customized PIPS Reports

- Consultant response times
- Timeliness to OR
- Compliance with documentation of vital signs protocols
- Timeliness of interventions and diagnostics
- Special populations core measures

9

The TOPIC logo is located in the bottom right corner of the slide. It consists of the word "TOPIC" in a bold, blue, sans-serif font, followed by a circular icon containing a stylized white 'C' shape.

- # Customized PIPS Reports
- Consultant response times
 - Timeliness to OR
 - Compliance with documentation of vital signs protocols
 - Timeliness of interventions and diagnostics
 - Special populations core measures
- 9
- 
- The TOPIC logo is located in the bottom right corner of the slide. It consists of the word "TOPIC" in a bold, blue, sans-serif font, followed by a circular icon containing a stylized white 'C' shape.

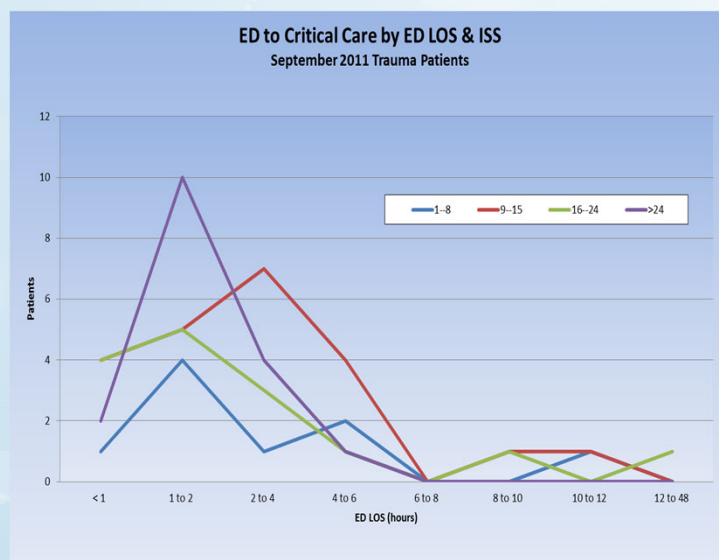
[illegible]

Consider How Your Data Looks in Table vs. Graph

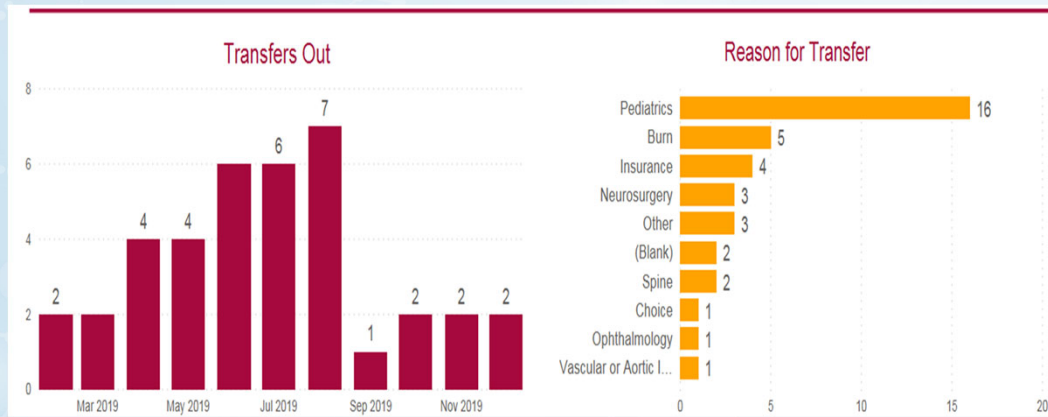
ED to Critical Care by ED LOS Sep 2011 Trauma Patients					
	ISS Range				
Hours	1-8	9-15	16-24	>24	Total
< 1	1	4	4	2	11
1 to 2	4	5	5	10	24
2 to 4	1	7	3	4	15
4 to 6	2	4	1	1	8
6 to 8	0	0	0	0	0
8 to 10	0	1	1	0	2
10 to 12	1	1	0	0	2
12 to 48	0	0	1	0	1
Total	9	22	15	17	63



Same Information in a Graph



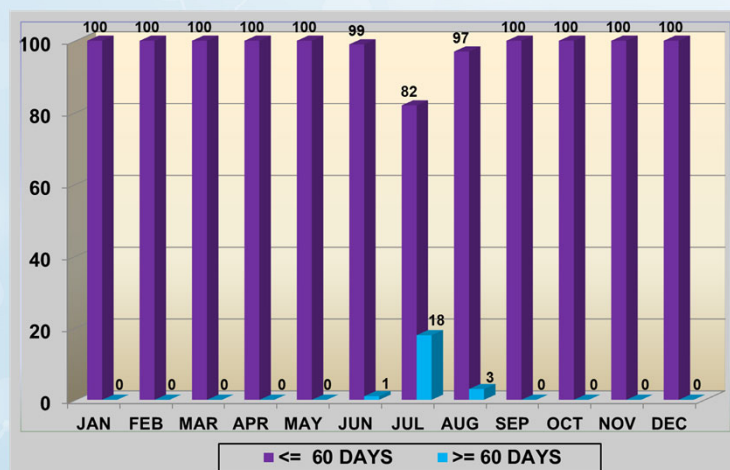
Bar Graphs



13



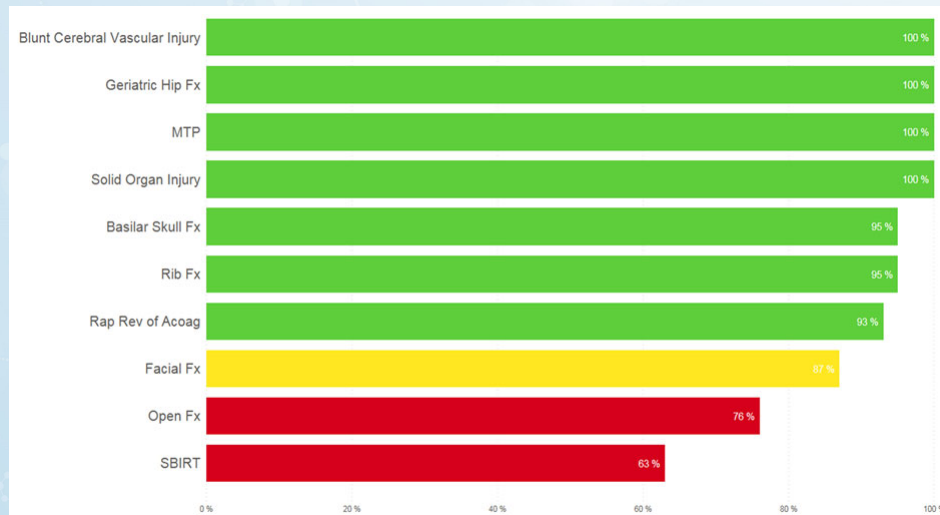
Complete Chart Abstraction Within 60 Days of Discharge (ACS Requirement – 80%)



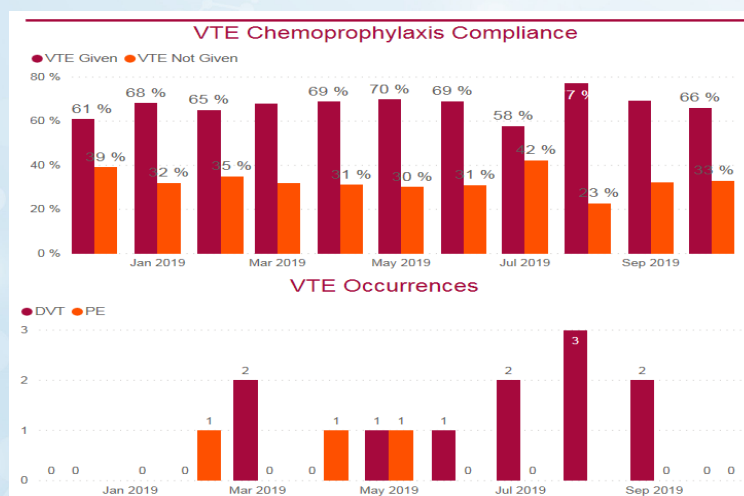
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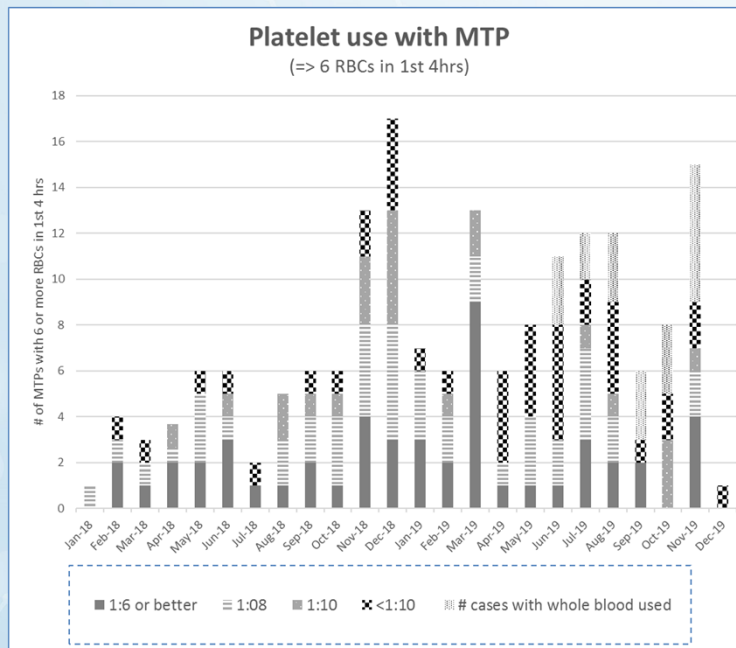


Clinical Practice Guideline Compliance Rolling 12 Months

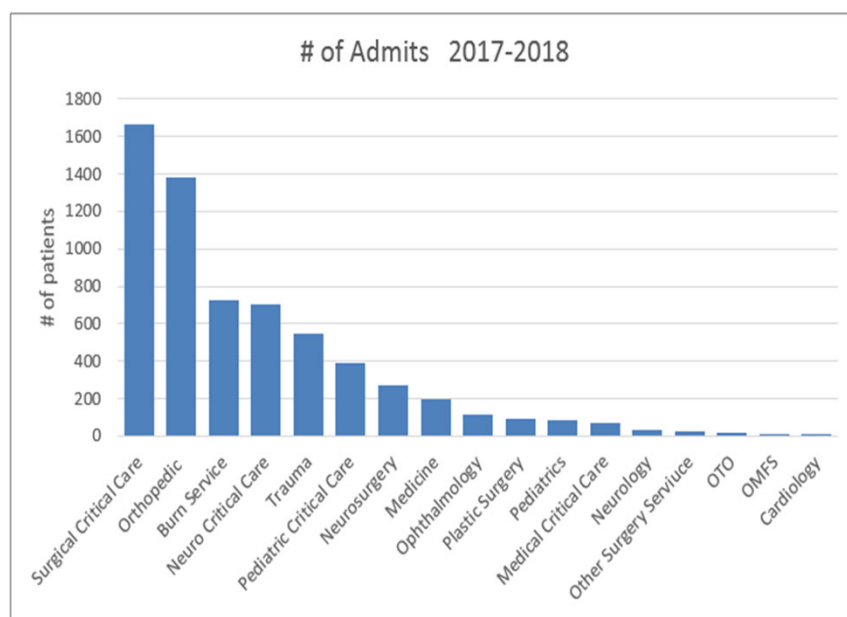


VTE CPG Compliance Paired with VTE Occurrences

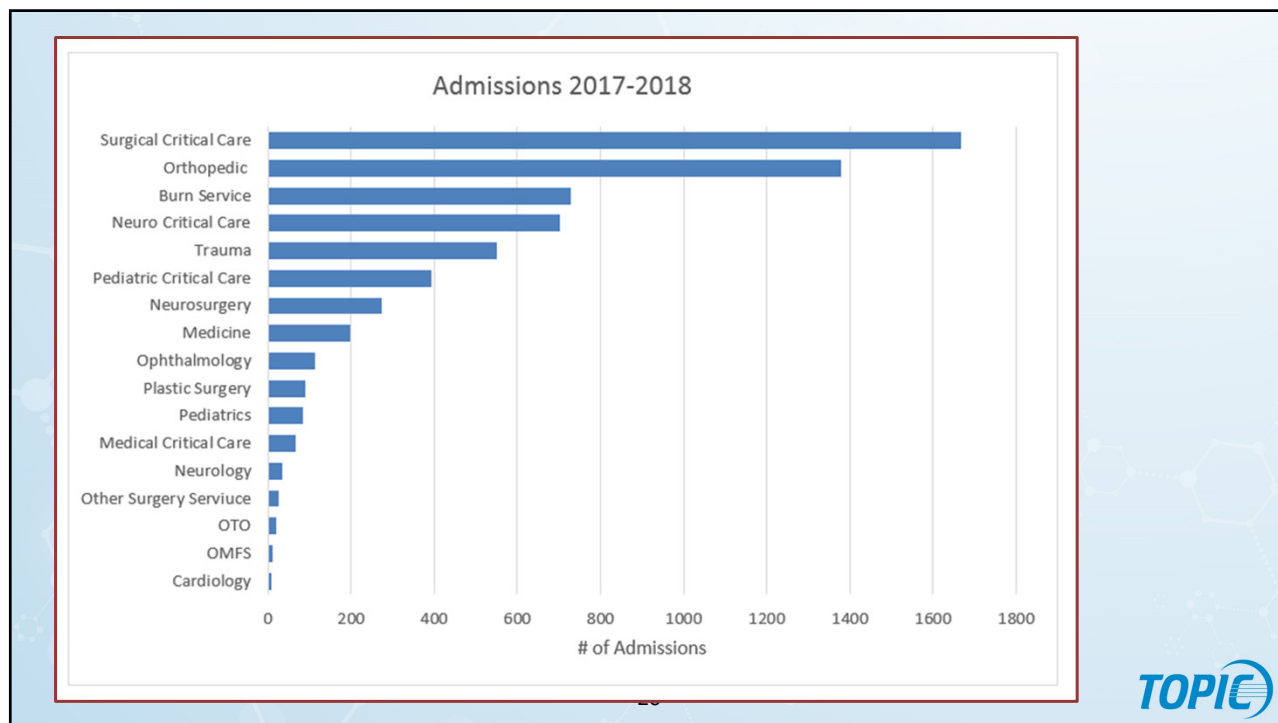
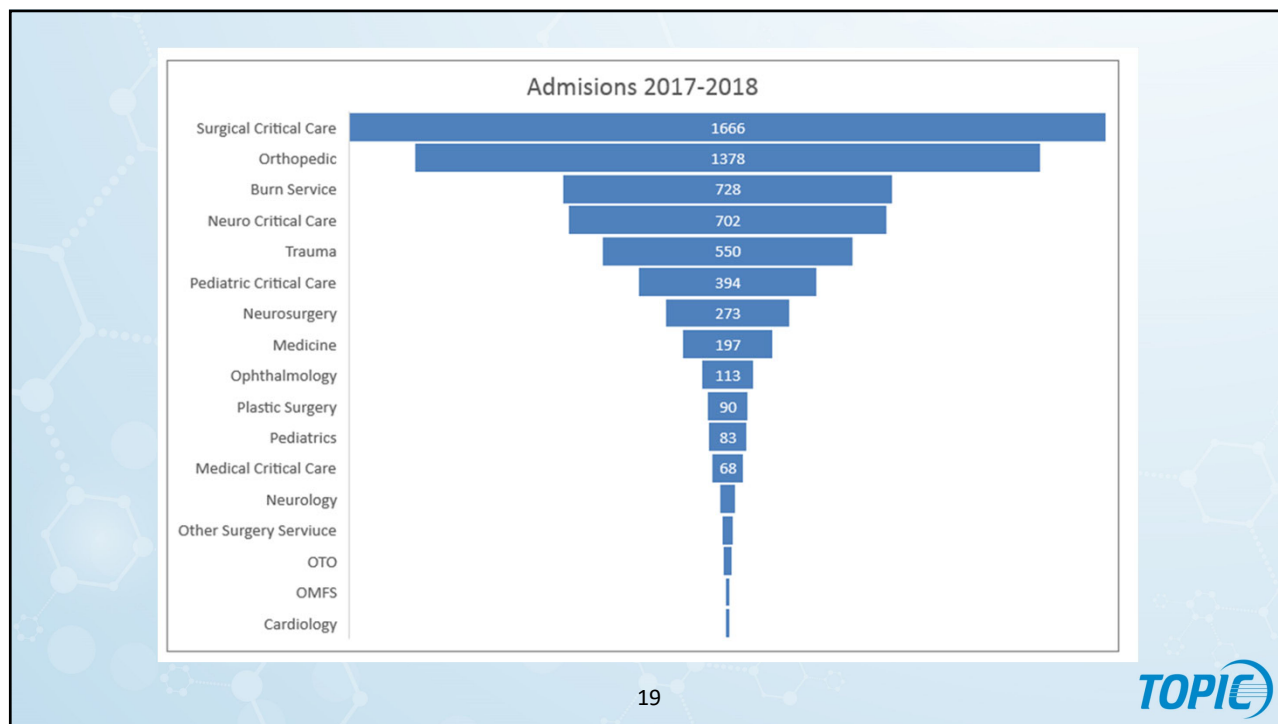




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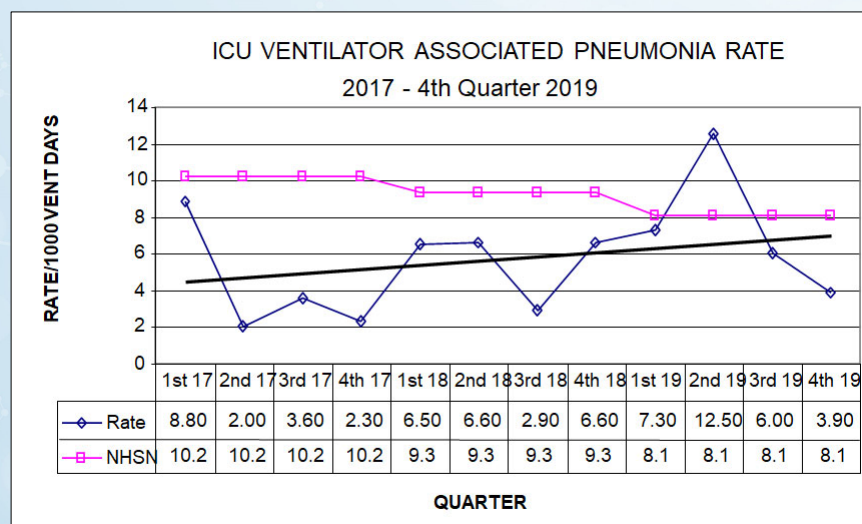
Matrix Method for Under/Overtriage

Year				
Under/Overtriage MATRIX				
CRITERIA MET	NOT MAJOR TRAUMA (ISS < 15)	MAJOR TRAUMA (ISS > 15)	TOTAL	OVER TRIAGE 59%
HIGHEST LEVEL TTA	262	183	445	
MIDLEVEL TTA	245	60	305	UNDER TRIAGE 13%
NO TTA	782	96	878	

21



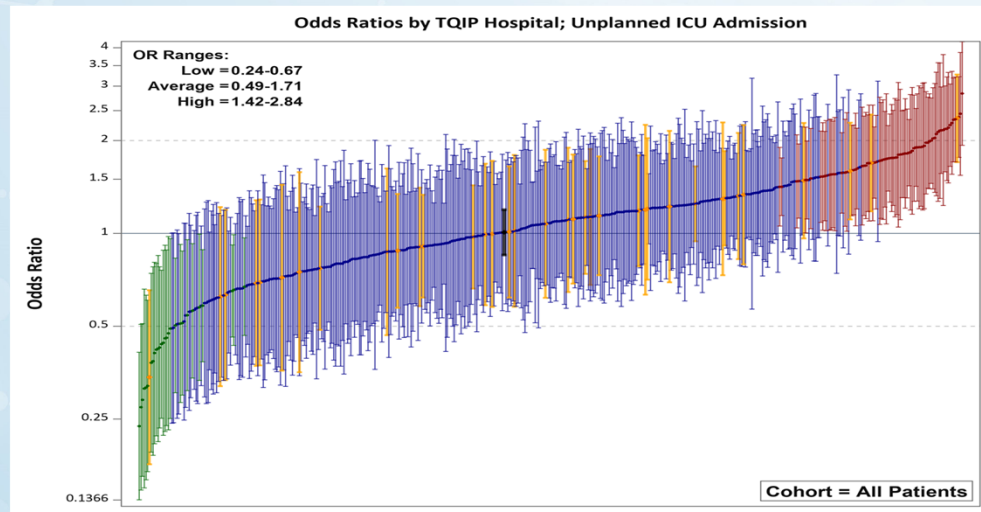
Line Graphs



22



Caterpillar Graph

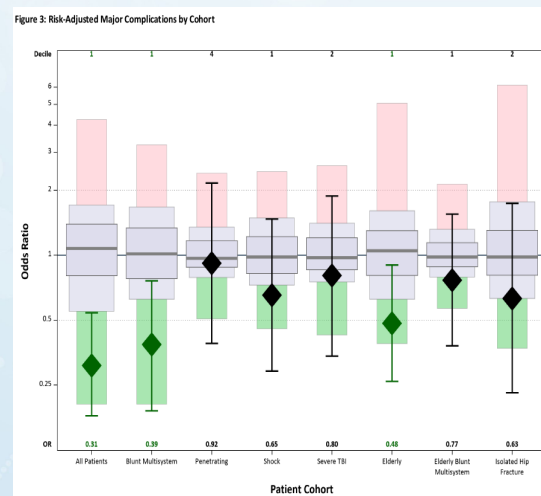


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Trauma PIPS Collaboratives

- Quality Collaboratives, focused on trauma quality improvement
- Consolidation of multiple facilities' risk adjusted data
- State, regional or health system inter-institutional collaboration
- ***Learn from other centers' PIPS successes and failures***

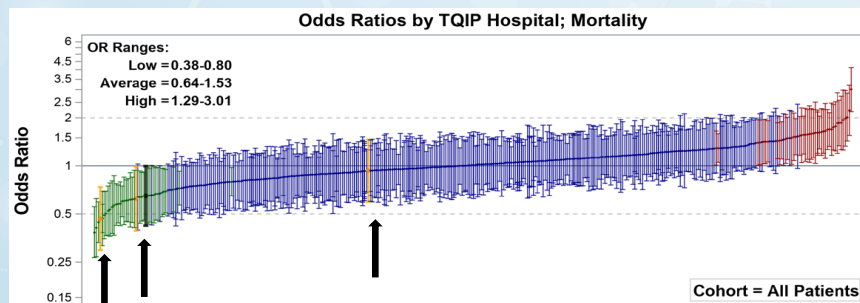


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Trauma PIPS Collaboratives

- Embrace transparency of Collaborative outcomes and reciprocal sharing of data, OFI and best practices
- Important for team to come face to face and learn best practices from high performance centers



General Benchmark Comparison Report Examples

Administrative

- Patient demographics
- Hospital demographics
- Blunt vs. penetrating percentages
- ED disposition
- Hospital disposition
- MOI and restraint usage
- Survivors vs. non-survivors:
 - LOS
 - Median ISS & ICU days
 - Age

Outcome Measures

- Hospital discharge status
- Mortality rates
- Complication Rates



Benchmarks and Measurements: Outcome Data

- Functional status on discharge (FIM Scores)
- Results of patient satisfaction surveys
- Complication rates
- Compliance with practice management guideline
- Mortality and morbidity
- Severity-adjusted mortality and morbidity
- Unplanned return to OR
- Unplanned upgrade to an intensive care unit
- Unplanned hospital readmission
- Surgical wound infections
- Organ donation activity



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Risk Adjusted Benchmarking

- Required at Level I, II, and III centers verified by ACS
- Methodology for evaluating risk adjusted performance and benchmarking
- Reduce variability in trauma process/outcomes/cost
- Goals
 - Develop data elements to measure processes of care
 - Standardize care management via trauma centers nationally
 - Implement uniform defined audit filters and universally accepted data definitions

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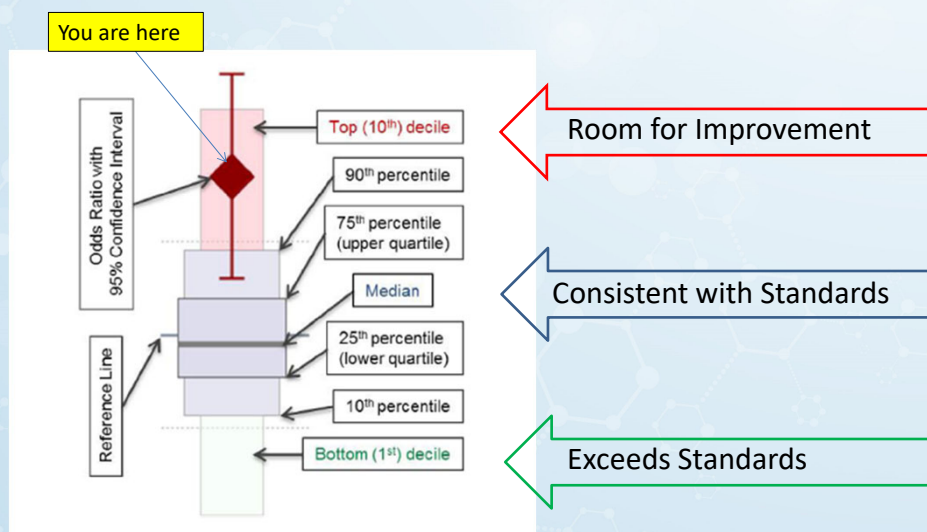
TQIP Report Components

- **Cohorts**
 - Specific Population of Patients
 - Understanding of the criteria for the cohort
- **Outcome Measures**
 - Mortality/ Event rates in comparison to other centers
- **Process of Care Measures**
 - Traumatic brain injury
 - VTE prophylaxis
 - Hemorrhage control
 - Withdrawal of care

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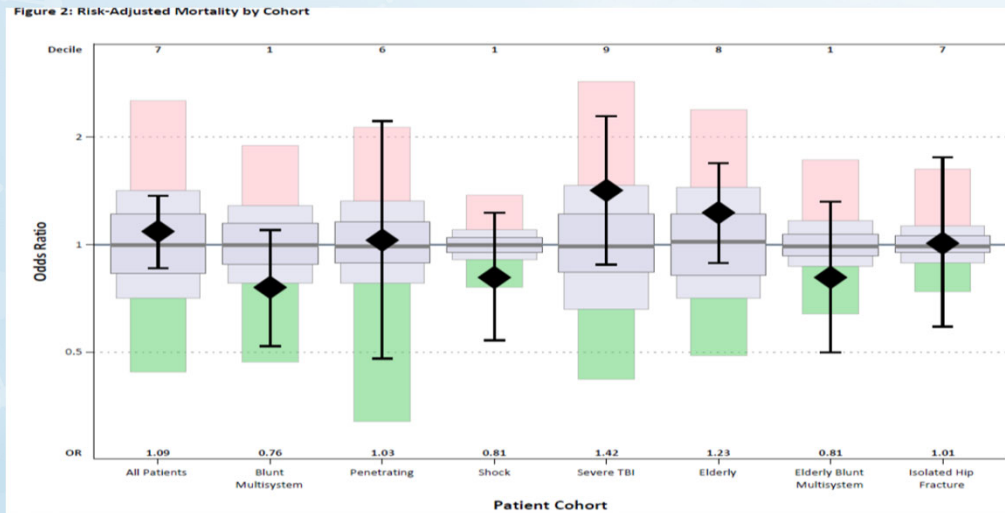
TQIP



30



Example TQIP Benchmark



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Summary

- Plan carefully when creating a report
- Understand your target audience
- Ensure your data is accurate
- Use clear labeling and appropriate types of graphs to display the data
- Practice presenting the reports

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Module 7: Classification System for Trauma PI Events



Module 7: Classification System for Trauma PI Events

TRAUMA OUTCOMES & PERFORMANCE IMPROVEMENT COURSE

Taxonomy

Definition of taxonomy (tax·on·o·my | \ tak-'sä-nə-mē \)

1. the study of the general principles of scientific classification : systematics
2. classification especially: orderly classification of plants and animals according to their presumed natural relationships

The Evolution of “Trauma Taxonomy”

Trauma
taxonomy

Trauma event
classification

Goal:
A national
standardized
nomenclature
for trauma PI
event
classification

3



Current Status

- Using “trauma taxonomy” is **not** currently a requirement
- There is no national data dictionary for trauma event classification
- Some trauma systems and centers have initiated this process
- However, it is important to classify PI events (issues)
 - allows for optimal tracking, trending, reporting
 - helps to focus PI efforts
 - considered a trauma PI best practice

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Where Did the Concept of “Taxonomy” Come From?

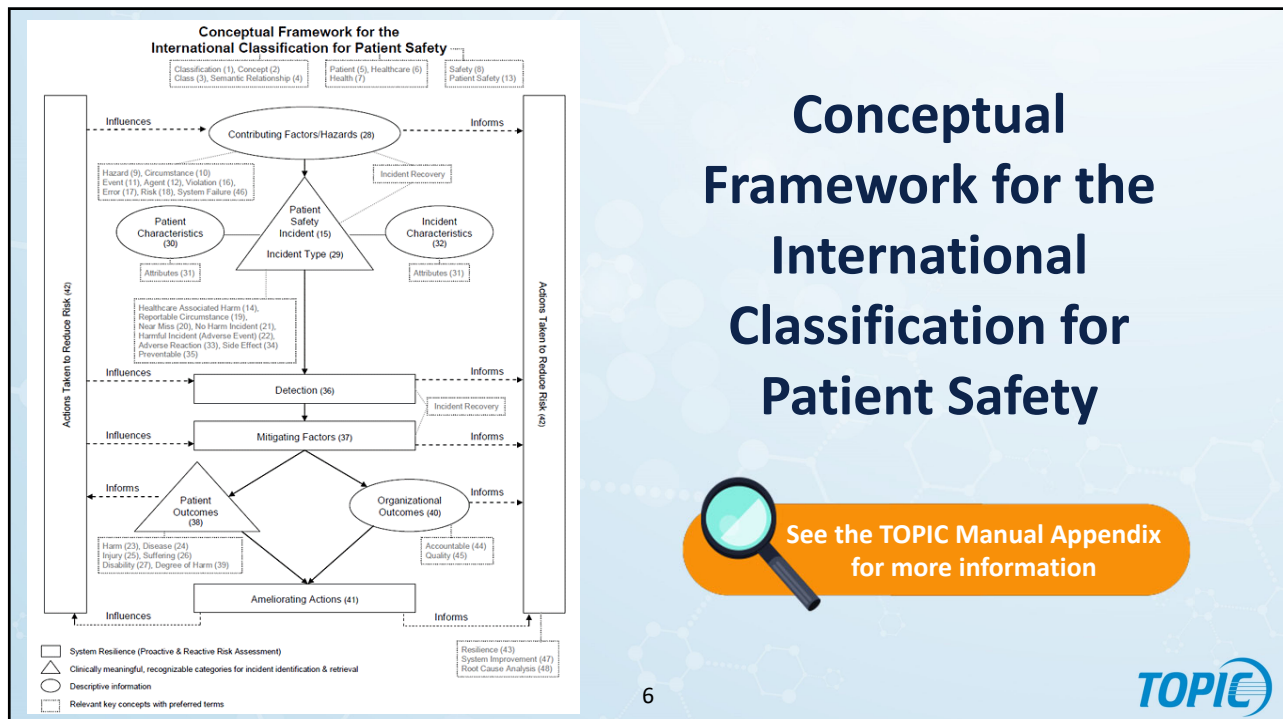
- The Joint Commission, Division of Research developed a common terminology and classification schema to:
 - promote consistency in reporting.
 - facilitate root cause analysis.
- The National Quality Forum endorsed this taxonomy.

(Ivatury, et al., 2008)



See the TOPIC Manual Appendix for more information

5



6





CLASS DISCUSSION

How Do You Classify Events at Your Center?

5 Categories of the Classification

Impact: *outcome or effect of the event (level of harm)*

Type: *processes that were faulty*

Domain: *the location and time of the incident (event/issue)*

Cause – factors: *system & human factors leading to the event*

Prevention or mitigation: *corrective action plan*

Another Way to Look at Classification...

What was the level of harm?

What process was involved?

When did the event occur and who was involved?

Was the event Provider/ System/ Disease related?



ACTION:
What are we going to do about it?

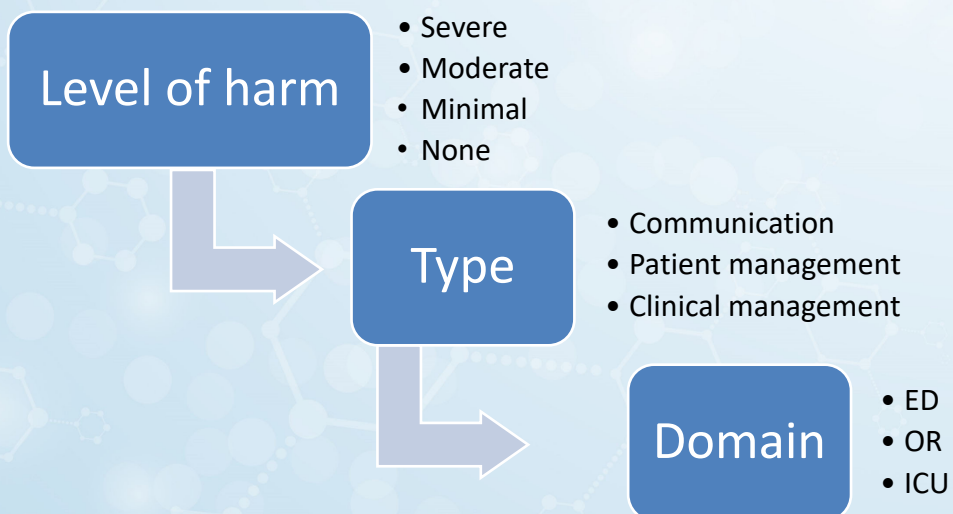
Subcategories

- Each category has subcategories
- This enables more accurate classification of PI events
- Some classification models have an extraordinarily large number of categories
- Start simple.
 - keep it clear
 - ensure adherence to definitions
 - ensure process is electronic (in the trauma registry)
 - this will help with consistency and more accurate PIPS reporting

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Subcategories Example: Death



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Classification of PI Events (Issues)

Getting Started

- Classify deaths according to verification and designation requirements
 - Mortality/ Event without opportunity for improvement (OFI)
 - Mortality/ Event with opportunity for improvement (OFI)
 - Additional stratification is helpful
- Should you classify all PI events / issues?
 - Yes, this is a best practice
 - Not every event needs 3rd level review
 - Consider the time factor for your staff

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Classification of PI Events (Issues)

Getting Started

- Example (Death)
 - Provider related
 - System related
 - Patient related, e.g., nature of disease
- Additional classification categories:
 - Location of event, e.g., emergency department, time of day / shift
 - Level of harm: none, minimal, moderate, severe, permanent, death
 - Type of event : communication, patient management, provider performance
- Note: when classifying, events may fall into many categories

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Classification of PI Events (Issues)

The Reality

- It can be difficult for providers to classify events
- Tools may assist the peer review committee members
- This will help to ensure there is fairness and consistency



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Classification Tool Example

Event/ Mortality Determination:		
<ul style="list-style-type: none"> ○ Without Opportunity for Improvement: to a reasonable degree of medical certainty outcome would have been the same regardless of any errors made. ○ With Opportunity for Improvement: Errors made & identified, more likely than not, outcome would have been the same regardless of errors made. ○ Unanticipated with Opportunity for Improvement: Critical errors made & identified, to a reasonable degree of medical certainty issue would not have occurred had the identified errors been avoided. 		
Care Determination:		Determination (Factors):
<input type="checkbox"/> Care Appropriate <input type="checkbox"/> Care Inappropriate		<input type="checkbox"/> Disease Related <input type="checkbox"/> System Related <input type="checkbox"/> Provider Related
Harm (Impact):		Type:
* See reverse for harm reference <input type="checkbox"/> No Harm <input type="checkbox"/> Minimal Harm <input type="checkbox"/> Moderate Harm <input type="checkbox"/> Severe Harm <input type="checkbox"/> Temporary <input type="checkbox"/> Permanent <input type="checkbox"/> Death (Event directly contributed to Death)		<input type="checkbox"/> Communication <input type="checkbox"/> Patient Management <input type="checkbox"/> Clinical Performance



See the TOPIC Manual Appendix for more information



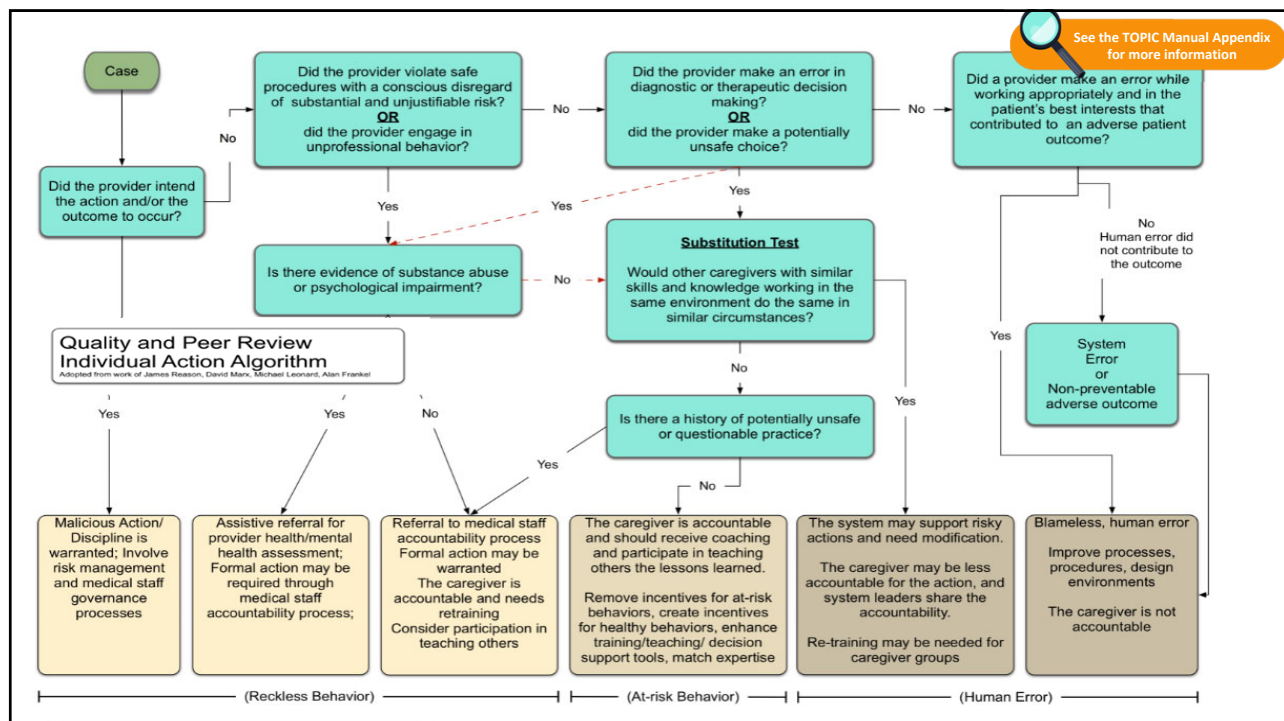
Levels of Harm and Outcome



See the TOPIC Manual Appendix for more information

Level of Harm	Outcome Definition	Suggested Follow Up/ Review
Death	Unexpected mortality	Tertiary Review in conjunction with hospital quality
Severe Harm	Patient outcome symptomatic requiring LIFE SAVING intervention	Tertiary Review in conjunction with hospital quality
Moderate Harm	Patient outcome symptomatic requiring intervention (i.e. operative, therapeutic treatment)	Tertiary Review in conjunction with hospital quality
Minimal Harm	Patient outcome symptomatic requiring minimal or no intervention (i.e. observation, minor treatment)	Primary and Secondary Level Review
No Harm/ Near Miss	No symptoms detected, no treatment required	Primary and Secondary Level Review

****Level of harm and outcome should be related and factored into the level of review and follow up****



Event Classification The Reality

- Classifying trauma PI events (issues) is not just a task that is done at a meeting
- **Trauma event classification is a best practice**
- It should be part of our daily conversation in determining levels of review, monitoring, trending, reporting, Ongoing Professional Practice Evaluation (OPPE), and all patient safety activities

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The Way Forward...

- Implement trauma PI processes according to TOPIC principles
- Include Lead Agency requirements for trauma PI
- Abide by ACS and Lead Agency requirements for classifying events
- Use options for classification from trauma registry software vendors
- Ensure consistent definitions for **every** classification category
- Educate
- Test of change; adjust as needed

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Summary

- Classify trauma PI events according to Impact, Type, Domain, Cause, Prevention
- Adhere to ACS and Lead Agency PI requirements
- Classification of events can benefit your program significantly
- Implementation of trauma classification is considered a best practice

Module 8: Action Plans- Action Plan/Prevention: Development and Implementation



Module 8: Action Plans

Action Plan/Prevention: Development and Implementation

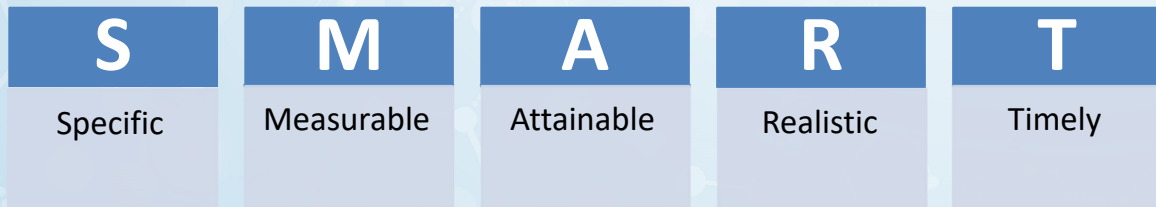
TRAUMA OUTCOMES & PERFORMANCE IMPROVEMENT COURSE

Action Plan Process



Action Plans

Should have clear goals that are:



3



Mitigation and Prevention

Mitigation corrective action is a reaction to a problem that has already occurred

- The event may have a chance of occurring again
- Mitigation recognizes an event may/will occur again and seeks to lessen the consequences

Preventive corrective action is initiated to stop a potential problem from occurring

- Prevention seeks to truly eliminate future events
- The process used for corrective actions and preventive actions is very similar

4



A photograph of two healthcare professionals, a woman and a man, both wearing blue scrubs and stethoscopes. They are looking at a clipboard held by the man. The woman is on the left, and the man is on the right. The background is a blurred clinical setting.

CLASS DISCUSSION

Mitigation and Prevention

What are some examples of “prevention” and “mitigation” that you might use in your trauma hospital?

Prevention and Mitigation Corrective Action

Examples:

- Guideline / protocol development or revision
- Education
- System enhancements (resources)
- Counseling
- Peer review presentation
- External review
- Focused workgroup
- Ongoing profession practice evaluation (OPPE)
- Change in provider privileges
- Participation in collaborative

7



Appropriately Match the Corrective Action to the Issue

Specific Issue



Appropriate Corrective Action



Safe Patient Care and Prevention of Future Occurrences

8



Guideline / Protocol Development

- Evidence-based practice
- Decrease variation in practice/outcomes
- There are multiple resources available
 - American Association for the Surgery of Trauma (AAST)
 - Eastern Association for the Surgery of Trauma (EAST)
 - Pediatric Trauma Society (PTS)
 - Western Trauma Association (WTA)

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Education

- Patient teaching rounds
- Conferences
- Visiting professors/nurses
- Trauma Grand Rounds
- Journal clubs
- Case presentation
- Hospital newsletters
- Social Media
- Unit posters/ storyboards
- Video options
- Internal Online Education
- Focused readings

10



System Enhancements

Examples

- Check lists
- Handoff reports every shift
- Increase or adjustments to staffing patterns and coverage
- Purchase of new equipment
- Cohorting trauma patients in one specific location:
 - Creating a “trauma ward” to provide specialized trauma care
 - This is consistent with all other specialty wards, e.g., cancer, cardiac

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Counseling

Behavioral events

- Difficult
- Necessary
- Limited effectiveness
- Time sensitive
- Face to face

Delivered by:

- Trauma Director
- Section Chief
- Administrator



**Most events are systems related
not behavioral**

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Peer Review Presentation



Case Presentation

Constructive

Educational

Not punitive

Non-accusatory environment

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External Review

- American College of Surgeons
- Local EMS Agency
- Specialty group from another hospital
- Consultant (subject matter expert)
- Lead hospital in a health care system
- Specialty focused review, e.g., Neurosurgery
- Mock surveys

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Focused Workgroup

- Focus specific to an identified issue
- Time limited
- Identify a workgroup champion
- Identify key stakeholders
- Complete data analysis
- Utilize evidence-based information
- Develop plan, accountability, and deadlines



Routine status reports “up” to
Trauma Systems-Operations Committee

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Example of Health System Initiative Driven by a Collaborative

VTE rates

- Health System VTE Prophylaxis Clinical Practice Guideline
- Electronic Medical Record VTE prophylaxis order set
- Health Systemwide Nursing education related to preventing held or missed doses of VTE prophylaxis
- Health System wide Trauma Nursing Grand Rounds on VTE initiatives
- Health System wide CPG variance tracking

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Barriers to Collaborative Success

- **Trust**
 - Sharing negative variances makes institutions vulnerable
- **Competition**
 - Competing health system or trauma centers could look poorly on centers with negative variances
- **Lack of Authority**

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Ongoing Professional Practice Evaluation Example

Trauma PI & Peer Review:

Deaths per individual surgeon for this report are defined as those patients that died in ED, died in OR, or died in ICU within 24 hours:

Category	Provider Related	System Related	Total
Mortality without opportunity for improvement			
Mortality with opportunity for improvement			
SAE – deaths			
Total deaths			

General Clinical Care Comments:

The TMD and TPM must ensure that PI issues are appropriately attributed to a provider.



See the TOPIC Manual Appendix
for more information

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Ongoing Professional Practice Evaluation (OPPE)

How do you attribute issues/events to providers?

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Privileges / Credentials Review

- Critical Step
- Includes trended events
- Consistent with medical staff bylaws
- Consistent with policies for remediation
- Integration into hospital PIPS program
- May step down voluntarily
- Education
- Focused area of study
- External courses
- Mentoring

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System Corrective Actions

Proposing solutions

- TPM and TMD can lead or participate in making the business case for proposed solutions
- Use data and PI information
- Don't simply present the problem to senior management
- Present the issue, the solution, and budgetary impact
- All for the benefit of the patient / patient safety

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System Corrective Actions

Example

- The trauma team is late or not responding when the pagers are activated
- Multiple occurrences identified that included patient safety issues
- TPM completed a root cause analysis in collaboration with Telecommunications Manager and vendors
- Recommended corrective action:
 - Replace trauma pagers with special trauma cell phones
- Due to the expense of the new equipment, staff training, and high risk for patient safety issues, a comprehensive plan was developed for purchase, programming, usage, and safety checks

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System Corrective Actions

- Multiple factors may contribute to system PI issues / events
- Corrective actions may be complex
- May require collaboration and unusual partnerships
- Use evidence and best practices when available



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Nursing and Other Personnel

- All staff that interface with the trauma patient are to be included the trauma PI process
- Ensure there are processes established to deal with non-physician provider related issues
- Departmental leadership in each area/unit have the authority and responsibility



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Nursing and Other Personnel

Example



- A trauma nurse in the ICU has made the same error repeatedly
- Multiple corrective actions have occurred without resolution
- The Nurse Manager for this Unit is responsible for moving this issue through the education, counseling, and disciplinary process

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Summary

- Action plans are structured and written (formalized)
- Action plans must influence change
- Match the corrective action to the issue
- Multiple models:
 - Choose the correct event
 - Choose the correct people
 - Choose the correct action
- Identify specific solutions, timeframes and assign accountability
- Re-evaluate and confirm resolution

Module 9: Event Resolution/Loop Closure



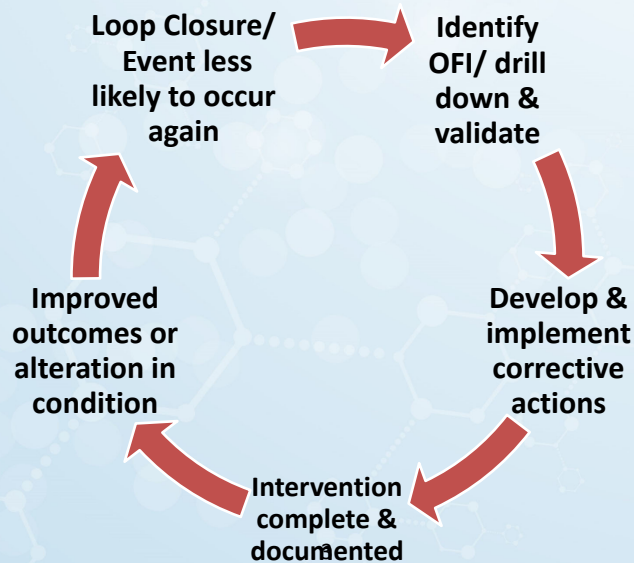
Module 9: Event Resolution/Loop Closure

TRAUMA OUTCOMES & PERFORMANCE IMPROVEMENT COURSE

Event Resolution (Loop Closure)

- Loop refers to the cycle of monitoring, fixing and monitoring again
- Some events require ongoing monitoring: e.g., mandated audit filters
- Failure to document resolution may result repeat errors, patient harm and site survey deficiency
- Developing and implementing the corrective action plan is not resolution

Event Resolution (Loop Closure)



Event Resolution: Process

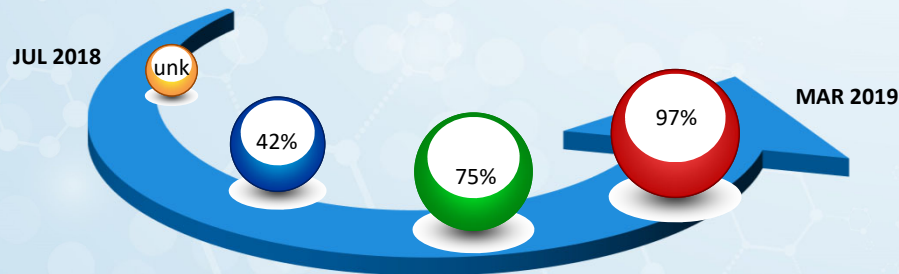
Event resolution includes multiple processes:

- Name those responsible to spearhead the PIPS process
- Drill down on factors contributing to the event
- Include measures that will prevent future errors
- Determine time frames for completion of assignments
- Implement corrective actions
- Benchmark with appropriate sources (historical, state, national)
- Monitor for repeated events, trend data for future reporting



Nursing Documentation Trauma Flowsheet: Example

*Goal Statement: Improved Trauma Flowsheet
Documentation Compliance will be at 95% within 6 months*



- Redesign FS with Key Area shading
- Physical Assessment Checkboxes
- Response to Intervention Checkboxes
- Education/Train the Trainer/Training
- Implement Real Time
- Audit (end of each shift)
- Audit tied to Staff Evaluations
- >95% compliance with key metrics

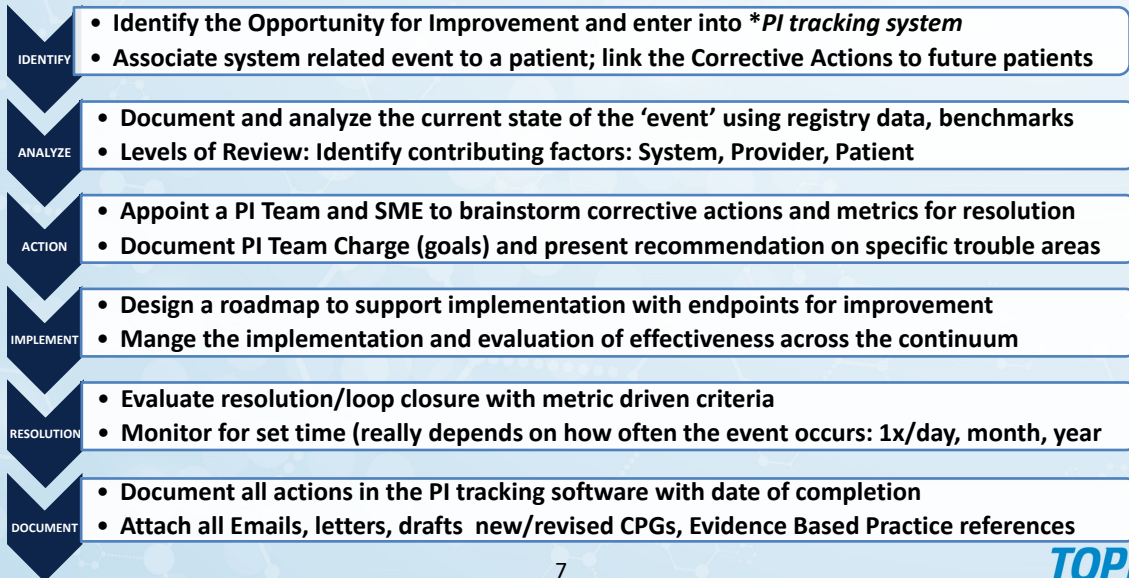


Event Resolution

- Implementing corrective actions (**is not resolution**)
- Event identification, analysis, reviewed at committee, and plan for corrective action is **NOT** loop closure
- Did the corrective action work?
- Did you measure the outcome?
- Was the intended outcome/goal achieved and sustained?



Event Resolution Process



7



Event Resolution: Process Steps



- Identify the opportunity for improvement and enter into **PI tracking system*
- Associate system related event to a patient; link the corrective actions to future patients

8



Event Resolution: Process Steps

ANALYZE

- Document and analyze the current state of the 'event' using registry data, benchmarks
- Levels of review: identify contributing factors: system, provider, patient

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Event Resolution: Process Steps

ACTION

- Appoint a PI team and subject matter expert (SME) to brainstorm corrective actions and metrics for resolution
- Document PI team charge (goals) and present recommendation on specific trouble areas

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Event Resolution: Process Steps

IMPLEMENT

- Design a roadmap to support implementation with endpoints for improvement
- Manage the implementation and evaluation of effectiveness across the continuum

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Event Resolution: Process Steps

RESOLUTION

- Evaluate resolution/loop closure with metric driven criteria
- Monitor for set time (depends on how often the event occurs: daily, monthly, yearly)

12



Event Resolution: Process Steps

DOCUMENT

- Document all actions in the PI tracking software with date of completion
- Attach all Emails, letters, drafts new/revised CPGs, evidence based practice references

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Event Resolution and Monitoring

- After desired impact is reached, determine when ongoing monitoring stops
- Monitoring includes
 - Ensuring the contributing factors that led to the event have been appropriately corrected
 - Ensuring the corrective measures taken to prevent and mitigate adverse events are metric driven, effective and supported
- Set realistic time frames for monitoring
 - Re-analyze PIPS data periodically to ensure mitigation/corrective actions are sustainable and continue to be evidence based

14



Event Resolution (Loop Closure)

Guiding Principles:

- Focus on the endpoint, not just the plan
- When is the event resolved?
- What is an appropriate timeframe to reach the desired goal?
- What is appropriate reporting of event resolution?
- How is this documented and who is this reported to?
- Who determines if the event is resolved?
- Add this comment to your loop closure documentation

15



What are the most common events you face?

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Examples of Events Requiring Resolution

Provider Event

1. Delay in response times
2. Delay diagnosis
3. Delay in treatment
- 4. Admit to NSS: high %**
5. Unplanned return to OR
6. Iatrogenic injury
7. Non-compliance with CPG

System Event

- 1. Undertriage by EMS**
2. Diversion due to lack of beds
3. Diversion due to lack of nursing resources
- 4. Peer Review Attendance**
5. Craniotomy equipment unavailable
6. Delay in transfer out
7. Films not available from referring facility

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Admit to Non-Surgical Service: High %

- Level III Trauma Center
- 70% admit over the age of 65
- 37% admit to NSS
- 1 TPM/PI Coord, 1 Registrar
- Implemented **Nelson Score**
- Customized trauma registry to calculate the 7 point score
- Score 6-7 Level 1 review
- Score 4-5 Level 2 review
- Score 1-3 Level 3 review

NELSON SCORE

1 point	Age >65 years
1 point	3 or more comorbidities
1 point	ISS<10
1 point	MOI ground level fall
1 point	No ICU admission
1 point	No surgical intervention
1 point	No blood products

<https://images.journals.lww.com/journaloftraumanursing/Original/00043860-201805000-00010.T1-10.jpeg>



See the TOPIC Manual Appendix
for more information



Corrective Actions for High Percentage Admit to Non-Surgical Service

- Admit to NSS CPG implemented
- Targeted education to ED, Trauma, Orthopedics and Hospitalists
- Providers focused on valid patients to admit to Trauma
- Decreased rate to <10%
- No patients with score of 1-3 admitted to a NSS
- Met review requirement "centers with >10% admit to NSS" resolution

NELSON SCORE

1 point	Age >65 years
1 point	3 or more comorbidities
1 point	ISS<10
1 point	MOI ground level fall
1 point	No ICU admission
1 point	No surgical intervention
1 point	No blood products



Case Example

Undertriage by ED Physician

- Level II Trauma Center
- 1 TPM, 1 PI Coord, 2 Registrars
- Event identified through concurrent PI process
- Level 1 review, drill down on cases and compliance with CPG
- Level 2 review, TPM and TMD discussed, and then discussed with ED provider
- Level 3 review, committee agreed, event with OFI
- Is this loop closure?



Pull this all together in PI file



Case Example

Undertriage by ED Physician

- Trauma Activation policy reviewed and found to be evidence based
- Over/undertriage by provider data reviewed and presented
- TMD provided targeted education with ED Provider
- Focused review of provider and ED compliance for 3 months
- Resolution Outcome was an increase in compliance; specific provider with 0% undertriage



Pull this all together in PI file



Examples of Successful Event Resolution

- **Documentation of surgeon and anesthesia response times**
 - Improved documentation of trauma response following implementation of new swiping-in process
- **High Rate of VTE Events**
 - Decrease VTE complication rate with increased CPG compliance and new order set
- **Extended Length of Stay at Referring Facilities**
 - Reduced length of stay at referring centers following regional system development
- **Extended Length of Time to Get Blood In ED for MTP**
 - Reduced time to implement MTP after purchase of trauma bay blood refrigerator

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Why do trauma centers fail to close the loop?

25



Reasons for Unsuccessful Event Resolution

- If I ignore it, maybe it will go away
- Provider refuses to change
- No support to improve system event
- No improvement in patient outcomes
- Stagnant or ineffective action plans
- Inappropriate action for identified event
- Failure to involve appropriate departments in action plan
- Lack of authority/accountability for staff involved
- Competing priorities

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Event Resolution Documentation

- “Folder” to file event resolutions (log, database)
- When multiple patients involved (ie-ED documentation, hypothermia, admit to non-surgical service, CPG noncompliance)
- Graphed data showing event with improvement over time
- New policy or CPG developed and implemented
- Dashboard of physician compliance
- Capture discussion in minutes

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CASE SCENARIOS



Case Scenarios

TRAUMA OUTCOMES & PERFORMANCE IMPROVEMENT COURSE

Case Scenarios

- Practice the PIPS process in a small group format
- Fictitious cases are based on the most frequent PIPS events

Instructions

1. Divide into groups
 - Read the case scenario
 - Identify a group spokesperson
2. Utilizing the Case Scenario Worksheet, complete the PI process for two issues per case scenario
3. Present the case to the class for open discussion
 - Summarize the scenario
 - Describe the PI Components

3



Case Scenario Worksheet

CASE SCENARIO WORKSHEET	
EVENT	
PRIMARY / FIRST LEVEL OF REVIEW:	
Issue / Audit Filler:	
SECONDARY / SECOND LEVEL OF REVIEW:	
WHO:	
WHEN:	
WHAT/Details:	
Level of Harm / Impact: <input type="checkbox"/> None <input type="checkbox"/> Minimal <input type="checkbox"/> Moderate <input type="checkbox"/> Severe <input type="checkbox"/> Death	
TERTIARY / THIRD LEVEL OF REVIEW: <input type="checkbox"/> Not Applicable	
Committee:	
QUATERNARY / FOURTH LEVEL OF REVIEW: <input type="checkbox"/> Not Applicable	
CLASSIFICATIONS:	
Factors: <input type="checkbox"/> Disease Related <input type="checkbox"/> System Related <input type="checkbox"/> Provider Related	
Determination: <input type="checkbox"/> Without Opportunity for Improvement <input type="checkbox"/> With Opportunity for Improvement <input type="checkbox"/> Unanticipated with Opportunity for Improvement	
ACTION PLAN:	



Additional Discussion

- Of the events identified in the case scenario, which one is the priority and why?
- Are there any barriers that might prevent implementation and success of the action plans?
- How might you mitigate those barriers?

5



Questions?

6



Closing Remarks

- Look for email regarding CE
- Evaluation is very important to us

7



Thank You!

8



Case Scenario 1

2035 - A 17-year-old male was transported to this level 2 trauma center via EMS with multiple stab wounds to the abdomen, stable condition. Pre-hospital called for medical command and was instructed that the patient would be assessed in the Emergency Department upon arrival. The patient was initially seen in the ED where quick exam was completed by the ED staff which revealed three penetrating wounds on the left lower side of the abdomen. A trauma alert, highest activation was then called.

2045 - The trauma team arrived and assumed care. ATLS assessment included a clear/patent airway with no difficulty breathing, 2 large-bore IVs with NSS initiated, normal pulses, no active bleeding from the three penetrating wound sites and stable vital signs. There were no additional injuries identified.

2050 - Portable chest and pelvic x-ray completed. No abnormalities identified.

2110 - The patient was transported to CT for imaging of the abdomen and pelvis.

2140 - The patient was transported back to the trauma bay. An immediate call from the Radiologist reported the CT scans were negative for abdominal/pelvic/vascular injuries.

2215 - A member of the trauma team called the ED physician to report the patient would be admitted for overnight observation. They would be coming to enter orders. A second set of vital signs were stable.

2330 & 0005 & 0035 - The ED nurse paged the junior trauma resident to come and enter admission orders. No response to pages.

0050 - The ED nurse paged the supervising trauma resident. The supervising resident called back and indicated they would personally contact the junior resident.

0150 - The junior trauma resident arrived and entered orders for admission.

0240 - The patient was transferred to the floor.

Case Scenario 2

1300 - An 88-year-old male was brought to the ED at a Level 3 trauma center by private vehicle complaining of mild abdominal pain (3 out of 10). Vital Signs: BP 90/60, P 105. He reported a history of anticoagulant therapy. The ED nurse triaged the patient to the acute care area of the ED.

1320 - The ED physician examined the patient. A history of a fall down three steps one day prior was obtained. The physician ordered a CBC, Basic Metabolic Panel, U/A, and chest x-ray. An IV was placed and NS was administered at a controlled rate.

1400 - A portable chest x-ray was obtained. Second set of Vital Signs: BP 100/64, P 98.

1450 - CBC results returned and a Hgb of 7.9 was noted. Review of the medical record showed the patient's last Hgb during his previous primary care visit two weeks ago was 11.9. The ED physician ordered a CT abdomen/pelvis.

1530 - CT imaging was completed and patient returned to the ED. Third set of Vital Signs: BP 102/58, P 104.

1700 - The Radiologist called the ED physician to report the imaging revealed a grade IV splenic laceration. The trauma surgeon was paged.

1710 - The trauma surgeon arrived. Repeat Hgb with a type and crossmatch was drawn. Fourth set of Vital Signs: BP 95/50, P 112. The surgeon stated he will make arrangements for an operating room.

1800 - Fifth set of Vital Signs: BP 80/60, P 120. Repeat Hgb was 7.0. Type and crossmatch completed and 1st unit of packed red blood cells hung. The ED was notified that the surgeon was waiting for the OR to be available.

1830 - First unit of blood continued to infuse at a controlled rate due to patient's age and a history of heart disease. Sixth set of Vital Signs: BP 85/65, Pulse 120. Anesthesia arrived to assess the patient for surgery.

1920 - Second unit of packed cells initiated. Seventh set of Vital Signs: BP 80/60, P 122. OR now available and patient taken for laparotomy.

Case Scenario 3

1400 - A 55-year-old male was brought to the Level 1 trauma center via EMS following a rollover motor vehicle crash. A trauma activation, highest level, was called prior to patient arrival with an ETA of five minutes.

1405 - The full trauma team arrived, including the trauma surgeon. Primary and secondary ATLS exams were completed, which noted that the patient had no sensation to light touch or pain in his bilateral lower extremities. Extensive contusions, abrasions, and swelling noted on right lower extremity. Portable chest and pelvis x-rays were obtained.

1430 - Patient transported to CT for imaging of head, c-spine, chest, abdomen, and pelvis.

1515 - The patient returned to the trauma bay with scans positive for multiple spine fractures. Neurosurgery was called for a stat/emergent consult.

1600 - Plain x-rays of right leg are obtained while the patient waited for NS evaluation. No fractures identified.

1620 - The neurosurgical resident evaluated the patient and informed the team that the patient will go directly to the OR from the ED for management of an unstable c-spine fracture.

1730 - Transported to OR with Neurosurgery.

2145 - Admitted to the ICU post-operatively.

2205 - The ICU nurse noted a bruised, swollen, cold, mottled right leg and foot, and notified the trauma team.

2230 - Trauma resident arrived to evaluate the patient. Orthopedics called in for consult.

2355 - The orthopedic resident was concerned for compartment syndrome. Right leg anterior compartment pressure measured at 55 mmHg.

0055: - The patient was taken to the OR for fasciotomy of the affected compartment.

The next morning moderate myonecrosis of right leg was noted on dressing change. Patient underwent debridement of the affected area and a wound vac was applied.

Two days later the patient was taken to the OR for evaluation and wound vac change. Extensive worsening of the right leg myonecrosis was noted. The leg was determined not to be salvageable and patient underwent right above knee amputation

Case Scenario 4

1537 - EMS was dispatched for a report of a 30-year-old female pedestrian struck by a vehicle.

1545 - EMS arrived on scene to find the patient lying on the ground moaning. Bystanders relay the patient was walking a dog when a car came around the corner too fast and hit her. She was thrown 20 feet.

1550 - EMS completed manual stabilization of c-spine and placed the patient on a long board. Patient became uncooperative and tried to hit the medics when they attempted cervical collar placement, so this was deferred. The neck did not seem tender to palpation. Oxygen via nasal cannula was applied but patient again became agitated so it was deferred. Initial Vital Signs: BP 200/100, P 100, R 14, GCS 12.

1600 - Physical exam was documented as no obvious injuries. IV attempted X 2, one successful with #20 G in right hand. IV infusion of NSS started at a controlled rate. Cardiac monitor placed which was recorded as normal sinus rhythm.

1615 - The ambulance departed the scene. Patient GCS was noted to be 10. Enroute to the hospital the patient had generalized seizure activity and then became apneic. Bag-valve mask ventilations were initiated. The patient became pulseless. The Level 2 trauma center was called and notified of a code in progress.

1616 - A Trauma Alert, highest level was activated.

1645 - Patient arrived at trauma center with CPR in progress. The full trauma team was present. The patient was intubated, had bilateral needle decompressions, and two IO catheters inserted in preparation for massive blood transfusion. A rapid ATLS evaluation noted injury to the occipital region of the head with a depressed skull fracture. Ecchymosis was noted on the firm abdomen. The pelvis was unstable.

1650 - FAST exam revealed no cardiac motion. It was noted that CPR had been in progress for over twenty minutes in a patient with blunt traumatic arrest. Measures halted and patient pronounced dead.

The autopsy described the cause of death as multisystem blunt trauma including subdural hematoma, pelvic fracture, splenic injury grade V, rib fractures, and pulmonary contusions.

Case Scenario 5

A 40-year-old man arrived to the Level 1 trauma center via EMS after an ATV rollover. Highest-Level activation.

2000 - Vital Signs stable, GCS 14, drowsy with a strong odor of ETOH. ALTS assessment only remarkable for abdominal tenderness. Portable chest and pelvic x-rays did not identify injuries. FAST was normal. Labs within normal limits: H&H 13/38. ETOH 0.245.

2015 - Transported to CT for imaging of abdomen and pelvis. Radiology read as positive for Grade IV splenic laceration with blush and fluid in pelvis. Second set of Vital Signs stable.

2050 - Third set of Vital Signs stable. Transported to angiography suite for splenic artery coiling.

2200 - Admitted to ICU post-procedure. Repeat labs on admission and Q6 hours ordered.

2245 - ICU Nurse contacted the attending trauma surgeon with lab results of H&H 8.5/25. Surgeon ordered 2 units of PRBC.

0400 - Blood infused and labs repeated: ICU Nurse contacted the attending trauma surgeon with lab results of H&H 9.0/27, BP 95/60, P 94. Surgeon ordered 2 additional units of PRBCs.

1000 - Blood infused and labs repeated: ICU Nurse contacted the attending trauma surgeon with lab results of H&H 9.5/28, BP 95/60, P 94. Surgeon ordered 2 additional units of PRBCs.

1300 - ICU Nurse called the attending trauma surgeon with concern of increased abdominal tenderness and decreased urine output. Surgeon ordered 2 additional units of PRBC's.

1600 - The attending trauma surgeon was at the bedside for rounds. Exam revealed abdomen firm, tender and distended. Vital Signs: BP 90/40, P 112. Most recent H&H 7.0/25. Patient immediately taken to the OR for a splenectomy.

Discharged 3 days later. Screening and Brief Intervention not completed.

Case Scenario 6

A 48-year-old-male was involved in a high-speed motor vehicle crash and brought to the Level 2 trauma center by EMS. The paramedics reported that the patient was amnesic to the event but there was no witnessed loss of consciousness. GCS was 15 during transport. The paramedics also identified a deformity of the right femur and tenderness over the right lateral chest. During transport Vital Signs: BP 115/74, P 96, R 18.

There was no indication on the trauma flow sheet as to what time the trauma center was notified about the patient, what time the patient arrived, nor what time the team members arrived.

ED first recorded Vital Signs: BP 112/76, P 98, R 18. No recorded G C S or temperature during the entire stay in the trauma resuscitation area.

X-ray of chest and right femur completed, Labs sent: CBC, electrolytes, coagulation studies, and UA. Lab results of hemoglobin 11.

Initial reports from radiology identified a right midshaft femur fracture and no evidence of acute findings on the chest x-ray. Orthopedic surgery was consulted. Traction splint applied to the right leg. Admitted to the hospital three hours after arrival. Orthopedics plan was for OR within 24 hours.

Later that afternoon a consult was placed for internal medicine for pre-op clearance. The internist discovered an amended note for the chest x-ray noting a widened mediastinum, 2 right rib fractures, and a small pleural effusion in the left hemithorax.

A stat repeat chest x-ray was obtained which showed an increase in size of the mediastinal hematoma and concern for aortic disruption. Interventional radiology was immediately consulted. Immediate arteriography performed with success.

Case Scenario 7

1245 - EMS arrived on scene to find a 32-year-old woman in distress screaming that she was shot. Rapid trauma assessment reveals a large penetrating wound to the left upper quadrant with actively bleeding. Skin cool and pale

1248 - Initial Vital Signs: BP 110/palpation, P 126 and weak, R 26. Patient refused pulse oximetry.

1250 - The patient was fully immobilized on a spine board with c-collar.

1300 - Patient placed into the ambulance for transport. 22g IV placed in left hand, 1-liter NSS hung opened wide. Oxygen via non-rebreather mask attempted but patient agitation interfered with its use. Dressing applied to abdominal wound.

1315 - Ambulance departed the scene. The Level 2 trauma center was called and report given that they were transporting a patient who meets highest level activation criteria. ETA 10 minutes.

1325 - Arrived at the trauma center. Full trauma team present. The patient moaning that someone shot her in the stomach. ATLS primary survey revealed decreased breath sounds on the left with tracheal deviation. Active bleeding from abdominal wound in the left upper quadrant. Skin cool, moist, and pale. First set of Vital Signs: BP 60/palpation, P 146, R 30.

1330 - Needle chest decompression on left. Then left chest tube inserted with 600cc blood returned immediately. Patient became unresponsive and without a pulse. Central line access immediately obtained and massive transfusion protocol initiated. Patient taken immediately to the OR where she died two hours later.

Autopsy pending.

Case Scenario 8

An 85-year-old female was brought to the Level 3 trauma center by EMS after a fall from standing. The patient's only complaint was pain in the left hip. The patient's daughter accompanied her to the hospital and provided a history of coronary artery disease with a stent placed approximately 2 years ago. Currently on Plavix and sees the cardiologist on a regular basis. EMS reported that the patient experienced a brief loss of consciousness on scene with mild confusion noted during transport. Vital Signs: BP 174/90, P 84, R 18.

Arrived to the ED awake but drowsy. First set of Vital Signs: BP 172/86, P 86, Temp 96.8, Respiratory R 18.

Evaluated in the ED by the emergency medicine physician, who identified the following injuries:

- Hematoma above the left orbit to the mid left temporal-parietal area
- Pain in the left hip/proximal femur without obvious deformity

Labs sent: CBC, coagulation studies, electrolytes, and UA. X-rays of the chest, pelvis and left femur completed showing a normal chest radiograph, and fracture of the left femur proximal to a previous left hemiarthroplasty. Lab results include hemoglobin 13 and INR 1.1.

Orthopedic surgery consulted and determined need for operative reduction and internal fixation of the fracture. Due to history of cardiac disease, she was admitted to internal medicine. Anticoagulation held until after the OR. Due to pain with the fracture sequential compression devices were not applied.

During the evening the patient complained of pain in her left hip which was managed by increasing doses of morphine. The night nurse noted that morphine made the patient increasingly "groggy" with a drop of O2 saturation to 90%. Placed on oxygen via nasal cannula, however the patient was agitated and confused, and kept removing the nasal cannula.

Taken to the preoperative area in the morning where significant hypoxia noted with oxygen saturation 82%. Difficult to arouse and left pupil was significantly dilated compared to the right. The surgical procedure was canceled and she was transferred to the ICU where her hypoxia continued to worsen. In the ICU she became hypotensive and unresponsive. Several hours later the family elected to withdraw care and the patient expired. Autopsy was refused by family.

Case Scenario 9

12-year-old female (estimated weight 35 kg) driving an ATV without a helmet ran into a tree at 40 mph. On EMS arrival they found the patient to be awake but confused with GCS of 14 (minus one point for Verbal).

Pre-hospital Vital Signs: BP 100/60, P 130 and R 28.

C-spine stabilized, placed a 20g IV, and gave 20 ml/kg normal saline bolus.

EMS contacted the Level 1 trauma center. From the EMS report, the trauma center determined the patient did not meet trauma activation criteria.

On arrival the patient was found to be confused and pale. GCS 13. A trauma activation, highest level, was called.

First set of Vital Signs: BP 92/50, P 118, R 20, GCS 14, and Temp. 96.0 °. Second IV fluid bolus of 20 ml/kg normal saline given and placed on 100% oxygen by non-rebreather mask. ALTS assessment revealed a tender, slightly distended abdomen.

Second set of Vital Signs: BP 98/60, P 118, R 24 and T 95.2°.

Transported to radiology. A head CT demonstrated a parietal skull fracture with no intracerebral hemorrhage. Abdominal CT with IV contrast showed grade 2 splenic laceration.

Transported to the PICU. Upon arrival the patient continued to be confused. She was pale, cool, and with a prolonged capillary refill on exam.

Vital Signs: BP 92/58, P 128, R 30 and Temp 95.0°. Third fluid bolus of warm normal saline at 20 ml/kg given. Bair Hugger and warming blankets were applied. Following interventions, the patient's heart rate and temperature improved. Her GCS returned to 15.

Case Scenario 10

A 3-year-old (15 kg) child was transported to the local hospital after being struck by a car. It was reported that she ran between two cars chasing after a ball. Witnesses on scene stated she was thrown approximately 20 feet landing on her head and shoulder. The BLS providers identified the patient was crying (V on AVPU scale), Airway patent, Skin pale and cool, Pulse rapid and weak, Respirations rapid.

The ED staff assessment noted bruising and swelling on left side of head, skin abrasions on all extremities, and moaning on abdominal palpation, especially on the right. Vital signs: BP 72/palpation, P 160, R 26, and Temp 36 (96.8).

Supplemental oxygen given and a 22g IV was established followed by a one-liter normal saline bolus. Portable chest and pelvis x-rays were obtained.

30 minutes after arrival - The child was taken to CT for head, cervical spine, chest, abdomen, and pelvis imaging.

90 minutes after arrival - Radiology results called to the ED physician by the tele-radiologist service. CT identified a skull fracture, small subdural hematoma, and a grade IV splenic laceration. The ED physician immediately called the closest level 1 pediatric trauma center and a helicopter was dispatched to transfer the child.

The child arrived at the tertiary care facility three hours after her injury and 2.5 hours after presentation at the sending emergency department. Upon arrival, the patient was immediately taken to the Operating Room for a splenectomy. She was discharged home three days later.

Case Scenario 11

A 23-year-old male was involved in a house fire and sustained partial and full thickness burns to his neck, arms, chest and abdomen. The patient was carried from the house by firefighters.

Time of injury/burn was estimated to be 2145. At the scene given 100% oxygen via non-rebreather mask. EMS was unsuccessful in obtaining IV access due to burns on both arms. Scene Vital Signs: BP 109/78, P 119, R 28, SaO₂ 92% and GCS 14. 10 mg of Morphine was given IM for pain.

2215 - Arrived at the local hospital. Burns estimated to be 65% Total Body Surface Area (TBSA) including arms, chest, abdomen, and neck. Weight was 210 lbs. (95 kg). A subclavian central line was placed and an IO line was placed in the left leg. Fluid resuscitation was initiated with Normal Saline. First set of Vital Signs: BP 102/84, P 124, R28, SaO₂ 92%, Temp 35.5 C and GCS 13. The ED physician documented "suspicion for inhalation was low as the patient was still awake and had no complaints of shortness of breath. With O₂ saturations greater than 90% it was decided there was no need to intubate." IV Morphine PRN pain was ordered, with 2 doses of 15mg each given within 15 minutes of arrival. The patient became hypotensive and low dose vasopressors were started. The burns were cleaned and dressed with silver sulfadiazine dressings. Transfer to the regional burn center was arranged via ground ambulance.

0310 - Transported to the regional burn center 45-minute ETA. Fluid resuscitation continued and additional dose of IM morphine given.

0355 - Arrived at the receiving Burn Center. First set of Vital Signs: BP 100/86, P 129, R 12, SaO₂ 86%, Temp 35 C, and GCS 12. IV fluid was infusing (the IV bags were labeled #10 and #11). Shortly after arrival the patient had decreasing level of consciousness and dropping oxygen saturations. Intubated. Rapidly admitted to the Burn ICU. Referral facility dressings were removed. Reassessment of the burns revealed partial thickness burns to the anterior arms bilaterally, mixed partial / full thickness burns to the anterior neck, abdomen and chest. TBSA 30%.

Case Scenario 12

2345 - A 4-year-old female (19.5 kg) was holding a firecracker in her hand when it went off. Family submerged the child's hand in ice water and drove 50 miles to the local ED via private vehicle.

0124 - Patient arrived at the local ED. Documentation notes the patient's right hand was red and swollen with second degree burns to the thumb, first 2 fingers, and inside palm.

0140 - First set of Vital Signs: BP 126/98, P 124, R 24, SaO₂ 100%, Temp 98.1 and GCS 15. Pain score 10.

0151 - Fentanyl 28.5mcg given intranasal.

0202 - GCS 15.

0203 - Pain score 10.

0209 - Pain score 5.

0232 - X-ray of right hand obtained.

0325 - Plastic Surgeon paged for consult.

0334 - Plastic Surgeon via phone determined injury required immediate transfer to burn center. No additional orders.

0341 - Second set of Vital Signs: BP 104/53, P 98, R 20, SaO₂ 95%, Temp 98.4, and GCS 15.

0406 - Patient accepted by the burn center and report called.

0526 - Third set of Vital Signs: BP 105/48, P 71, R 18, SaO₂ 100%, Temp 97.1, and GCS 15.

0706 - Social worker at bedside. Transport arrangements pending.

0722 - Fourth set of Vital Signs: BP 86/51, P 78, R 20, SaO₂ 99%, Temp 97.9 and GCS 15.

0812 - Patient transferred to burn center via ambulance.

0915 - Arrived at burn center. Pain score 8.

Case Scenario 13

3-year-old female (13.6 kg) taken to Level 2 trauma center via private vehicle by mom with hot water burns to buttocks and bilateral feet. Mom reported patient was in the care of a babysitter who shared that she accidentally spilled hot water on the patient and her sister.

1810 - Arrived to ED via private vehicle accompanied by her mother and sister. Trauma alert, highest activation called.

1812 - First set of Vital Signs: BP 115/57, P 107, R 107, SaO2 100%, Temp 98.3 and GCS 15. Pain score 10.

1815 - Trauma surgeon arrived.

1820 - Warm blankets applied. Pain score 10.

1827 - IV placed in left hand.

1829 - Morphine 1.5mg IV given.

1841 - Pain score 5.

1845 - Silvadene and Xeroform applied to burned areas. Decision to admit for pain management.

1853 - Morphine 1mg IV given.

1909 - Second set of Vital Signs: BP 97/59, P 105, R 24, SaO2 97% and Temp 98.8.

1941 - Osseous survey obtained per order – no obvious bone abnormalities noted.

2038 - Third set of Vital Signs: BP 88/61, P 87, R 24, SaO2 97% and Temp 98.8.

2042 - GCS 15. Report called to floor nurse.

2045 - Patient transported to the floor via stretcher with parents. Second degree burns to buttocks and bilateral feet.

Day 2

0730 - Vital Signs stable. Pain score 7. Bruising noted to bilateral upper extremities.

2015 - Social Work consulted. Health and Human Services notified.

Day 3

0800 - Transfer to burn center initiated.

1300 - Patient transferred to burn center via EMS.

Case Scenario 14

A 70-year-old female arrived at a Level 4 trauma center by EMS after falling off of a chair she stood on while attempting to change a lightbulb. With complaints of left hip pain, the prehospital crew immobilized with a c-collar and long-board. Trauma alert called.

ATLS assessment by the ED physician revealed a left acetabular fracture. Orthopedic surgeon was consulted, who determined via remote imaging review, that the injury exceeded his capabilities, and the patient should be transferred to the Level 1 trauma center for surgical repair and management.

The Emergency physician called the transfer/communication center at the Level 1 trauma center, and was notified that unfortunately, a winter blizzard prevented the immediate transfer. The expected time for transfer delay was eight hours. The transfer center would contact the Emergency Physician when transport was available.

The patient was admitted to the medical-surgical floor at the Level 4 trauma center, to the hospitalist service, while awaiting transfer. The hospitalist completed admission orders, including vital sign monitoring and pain management. The patient was transferred to the Level 1 trauma center eight hours later.

Upon arrival at the Level 1 trauma center, it was identified that the patient was still on the original pre-hospital longboard. When she was log-rolled off of the board, a pressure ulcer was noted on her sacrum. Approximately two hours later, she underwent an uncomplicated operative procedure to fix the acetabular fracture, and remained in the hospital for eight days, including wound management of the sacral ulcer.

CASE SCENARIO WORKSHEET

EVENT
PRIMARY / FIRST LEVEL OF REVIEW: <i>Issue / Audit Filter:</i>
SECONDARY / SECOND LEVEL OF REVIEW: <i>WHO:</i> <i>WHEN:</i> <i>WHAT/Details:</i> Level of Harm / Impact: <input type="checkbox"/> None <input type="checkbox"/> Minimal <input type="checkbox"/> Moderate <input type="checkbox"/> Severe <input type="checkbox"/> Death
TERTIARY / THIRD LEVEL OF REVIEW: <input type="checkbox"/> Not Applicable <i>Committee:</i>
QUATERNARY / FOURTH LEVEL OF REVIEW: <input type="checkbox"/> Not Applicable
CLASSIFICATIONS: Factors: <input type="checkbox"/> Disease Related <input type="checkbox"/> System Related <input type="checkbox"/> Provider Related Determination: <input type="checkbox"/> Without Opportunity for Improvement <input type="checkbox"/> With Opportunity for Improvement <input type="checkbox"/> Unanticipated with Opportunity for Improvement
ACTION PLAN:
METRICS TO DEMONSTRATE RESOLUTION / LOOP CLOSURE:

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APPENDIX A



The Committee on Trauma



OPTIMAL PERFORMANCE IMPROVEMENT PLAN

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Goals

The primary purpose of the trauma performance improvement program is to assure optimal care is delivered to victims of trauma-related incidents. The care of injured patients depends on a complex network of people working together as a team. The emergent nature of trauma care relies on each member of the team to perform well on a regular basis. The performance improvement program is designed to monitor the system and improve care.

If the system does not function optimally, the performance improvement program should identify that deficiency. A plan based on the findings should be formulated to address, improve and maintain optimal care. An effective performance improvement process not only identifies that there is an issue, but determines why the issue exists and mediates the issue in a dignified manner, leading to sustained improvement in outcome.

The performance improvement process must be an inclusive process that draws from the expertise of each individual member of the trauma care team. The performance improvement program must always function in a fair and autonomous manner. The principles of a blameless culture include: objectivity, evidence-based process, issue oriented process, efficiency, effectiveness, and constructive, education-oriented feedback.

Multi-disciplinary engagement of the trauma care team is critical to successful implementation of the performance improvement program. Each member of the trauma care team will be able to directly enhance the system of care by offering expertise as to how it can function better within their own institution. The net result of the process should be a system of trauma care that allows team members to provide care in an effective and efficient manner.

Mission

To provide trauma centers across the U.S. with practical, objective guidance for the development and integration of a comprehensive performance improvement plan that will ensure high quality and compassionate care of the injured patient.

Vision

We strive to improve the care of injured patients before, during, and after hospitalization.

Scope and Authority

The trauma performance improvement process is under the direction of the Trauma Program. The Trauma Medical Director (TMD), the Trauma Program Manager (TPM) and the Performance Improvement (PI) Manager share responsibility for the development and execution of the trauma PI process. A structure is required to ensure responsible reporting of pertinent information to hospital risk management. The Trauma Medical Director must have overall institutional responsibility and authority for trauma quality, the PI process and the trauma registry. The trauma PI

process must integrate with the hospital PI program. The TMD, TPM and PI Manager must participate in departmental and hospital PI committees. The scope of the trauma PI process includes all patients meeting ACS trauma inclusion standards as determined by the National Trauma Data Standard (NTDS). Trauma centers may broaden that scope if desired.

Trauma Team Credentialing

The credentialing of clinicians is essential in order to ensure practitioners have demonstrated both a competency, and commitment to participate in the care of the injured patient. For additional physician and nursing requirements, see Resources for Optimal Care of the Injured Patient, 2018.

Physicians

Physician performance in the management of a trauma patient is determined by outcome analysis in the peer review process through annual (shorter intervals are acceptable) Ongoing Professional Practice Evaluation (OPPE).

The Trauma Medical Director is responsible for recommending both physician appointment and removal from the trauma service, along with the medical staff credentials committee (CD 5-11).

Nursing

The Chief Nursing Officer (or comparable nurse leader) is responsible for overseeing the credentialing and continuing education of nurses working on units that admit injured patients. Trauma nursing orientation and continuing education may include completion of in TNCC, ATCN, ENPC, PALS, ABLIS, TCRN and unit-based competencies.

PI Team Members

Trauma Medical Director- The TMD is a general surgeon who leads the multidisciplinary activities of the trauma program. The TMD's responsibility extends far beyond the technical skills of surgery. The TMD must have the authority to manage all aspects of trauma care (CD 5–9). The TMD must chair and attend a minimum of 50 percent of the multidisciplinary trauma peer review committee meetings (CD 5–10). The TMD authorizes trauma privileges for the on-call panel, works in cooperation with the nursing administration to support the nursing needs of trauma patients, develops treatment protocols along with the trauma team, and coordinates the performance improvement and peer review processes. The TMD, in collaboration with the TPM, must have the authority to correct deficiencies in trauma care and exclude from trauma call the trauma team members who do not meet specified criteria (CD 5–11). In addition, the TMD must perform an annual (shorter intervals are acceptable) assessment of the trauma panel providers in the form of Ongoing Professional Practice Evaluation (OPPE) and Focused Professional Practice Evaluation (FPPE) when indicated by findings of the PIPS process (CD 5–11). As early in the PI process as possible, provider related issues should be identified as such and addressed using these evaluation tools. Ultimate accountability for all activities of the trauma program resides with the TMD. For additional responsibilities and requirements, see Resources for Optimal Care of the Injured Patient, 2018, Chapter 16.

Trauma Program Manager- The TPM is fundamental to the development, implementation, and evaluation of the trauma program. In addition to administrative ability, the TPM must show evidence of educational preparation and clinical experience in the care of injured patients (CD 5–22). The TPM works in close collaboration with the TMD and complements the director's efforts. A constructive, mutually supportive relationship between these key leaders is important to the success of the program. The TPM assumes day-to-day responsibility for process and performance improvement activities as they relate to the trauma program, trauma nursing and ancillary personnel involved in trauma care. The role of the TPM in the educational, clinical, research, administrative, and outreach activities of the trauma program is determined by the needs of the TMD and the institution. For additional responsibilities and requirements, see Resources for Optimal Care of the Injured Patient, 2018, Chapter 16.

Performance Improvement Manager- The primary responsibility of the Trauma PI Manager is to support the Trauma Program through analysis of predetermined triggers and monitors developed through the criteria in the Resources for the Optimal Care of the Injured Patient, review of TQIP quarterly reports and other trauma related PI data collected by the hospital. The PI Manager assists in the documentation of the trauma programs' performance improvement. The PI Manager assures that appropriate review processes are in place for event resolution/loop closure and continued monitoring phases. Centers with more than 1200 admissions should have a full time dedicated PI manager. Small programs (<600 admissions) or Level III or IV centers can have a part-time PI manager. Options include sharing staff with the hospital PI program, the TPM or management staff with dedicated time for trauma PI.

Trauma Registrar- It is important to acknowledge that high-quality data begins with high-quality data entry, and it is the trauma registrar who is responsible for performing this task. The amount of time and effort that will be necessary to maintain the registry should not be underestimated. A dedicated and well-trained trauma registrar is critical to the success of a registry and the PI program. One full-time equivalent employee devoted to the registry must be available to process the data capturing the NTDS data set for each 500–750 admitted patients annually (CD 15–9). This staffing need increases if additional data elements are collected. The trauma registrar must attend orientation to the registry, TQIP and PI principles.

Trauma Registrar Supervisor (Lead)- In addition to the registrar or registrars, the trauma program may utilize other personnel, such as a Trauma Registry Supervisor, as an educational resource for the other registrars, for concurrent data abstracting, data analysis, and report development in conjunction with the trauma PI program. Other tasks could include data analysis and validation, research assistance, and meeting various submission requirements as well as to assure the integrity and quality of registry data that are used for prevention, PIPS, and other essential aspects of the trauma program.

Trauma Liaison- Representative from subspecialty services, such as emergency medicine, orthopedics, neurosurgery, anesthesia, critical care and radiology, must actively participate in the trauma PIPS program. The named liaison on the multidisciplinary trauma peer review committee must attend a minimum of 50

percent of the committee's meetings. Attendance may be met through teleconferencing or videoconferencing participation by exception but in-person attendance is desired, thus virtual conferencing should be limited. The liaison should facilitate the review of referred cases and previously identified problems and report back to trauma PIPS program for review. The liaison, in conjunction with the trauma team, should develop, distribute and regularly update written treatment protocols for the care of patient with trauma injuries, particularly patients requiring multiple specialty care. Liaisons must maintain board certification through the appropriate CME process integrating trauma specific education in the Maintenance of Certification process.

Identification of Trauma Patients

The trauma center must identify all trauma patients so that their care and outcomes can be reviewed (CD 15–1). Although the definition of a trauma patient may vary among states and regions, the National Trauma Data Standard (NTDS) definitions of the ACS-COT are recommended for use (see the current definition at www.ntdsdictionary.org/data_elements/datasetdictionary.html). These definitions can be supplemented by a rudimentary data set describing all patients with traumatic injury. This “denominator” helps to quantify the institution’s trauma patient volume. See attachment 1.

Data Collection

Primary data collection is achieved through the program’s trauma registry. Quality indicators for continuous or periodic evaluation of aspects of care are determined from the American College of Surgeons specific audit filters that are designed to evaluate care provided to the injured patient and audit filters developed by the trauma PI program. Complications are defined utilizing clear, concise, and explicit definitions, as described by NTDS data dictionary.

Sources

Data abstraction is a daily process whereby all activities in the trauma center are evaluated, abstracted and entered directly into the trauma registry. Any part of the trauma care system that does not perform well should be identified in a timely and accurate manner. In order to achieve this goal, several mechanisms are needed. These include but are not limited to the following:

- Trauma Morning Report/Rounds
- Multi-faceted Reporting System – discussion with hospital and medical staff or via Email
- Concurrent chart review
- Diagnostic interpretations (lab, x-ray, etc.)
- Analysis of trend reports from trauma registry

Trauma Morning Report serves as an ideal initial venue for the performance improvement process as well as accurate patient handoff. This meeting allows the flexibility for patient care needs, and will provide an efficient, timely and accurate method of concurrent issue identification (clinical and system). In an

ideal situation, the off-going trauma team and attending, the on-coming trauma team and attending, and the trauma program staff, will meet and evaluate the following:

- Review all trauma admissions/trauma team activations/consults from the last 24 hours
- Review all transfer issues including EMS and transferring facilities.
- Review system issues identified from last 24 hours
- Identify any lab or radiology issues from last 24 hours
- Clarify any complications or audit filters from last 24 hours

Data Analysis

The trauma program analyzes information identified through the peer review process. This information is ideally tabulated on a monthly basis. Trend analysis will be computed and compared with the trends identified in the concurrent process and reported at the Multidisciplinary Peer Review Committee.

Once information has been abstracted, it is analyzed and the identified events are reviewed in the context of deficiencies in care or process. Recurrent deficiencies should be identified and reported to the trauma PI program. The PI team may identify several of the following factors to make this determination:

- occurrence based
- audit filter based
- system issue based
- provider specific
- trended data relevant to the issue
- resource deficiency

Trauma PI Team Members Responsible for analysis of data:

Trauma Medical Director
Trauma Program Manager
Trauma Surgeons
PI Manager
Trauma Registrar Supervisor
Trauma Registrars
Liaisons from other services involved in trauma care

Data Management

Data is collected and organized for review under the direction of the Trauma Medical Director and the Trauma Program Staff. The primary source of trauma data is the Trauma Registry. The Trauma Registrars enter all data into their respective trauma registry. National benchmark comparisons can be performed via National Trauma Data Bank (NTDB®) and/or Trauma Quality Improvement Program (TQIP®). In Level I, II, and III trauma centers, the trauma registry must submit the required data elements to the National Trauma Data Bank® (NTDB®) (CD 15–2). All trauma centers must use a risk-adjusted benchmarking system to measure performance and outcomes (CD 15–5) via the Trauma Quality Improvement Program (TQIP®) of the ACS.

Data Validation and Inter-rater Reliability

The Trauma Program Manager, PI Manager and/or Trauma Registry Supervisor/Lead routinely abstract data elements and audit filters to review accuracy at regular intervals. Complications are reviewed for consistency with data dictionary definitions. All data abstracted from the registry for reporting is validated on an on-going basis. Another option for validation is to drill down in TQIP benchmark reports using the trauma centers high and low outliers which should determine PI priorities. A benchmark report demonstrating any high outliers should result in examination the data points and elements that relate to that subset of patients. The current data dictionary criteria and correct mapping should be confirmed. The low outliers are used to identify processes that demonstrate program strength and well-functioning PI practices.

Concurrent and Retrospective Review

Major complications, deaths, complex cases, system issues and unexpected outcomes must be reviewed. Judgments are rendered based upon the American College of Surgeons definitions and the input of identified clinical experts. Identified opportunities will lead to development and/or revision of Clinical Practice Guidelines, standard operating procedures (SOP) development, counseling or education that is then implemented as indicated.

Concurrent

1. Review of PI issues takes place on a daily basis and all trauma patients are reviewed from the previous 24 hours. A defined team consisting of the trauma program leadership and members of the trauma registry undertakes this process of event identification along with other key stakeholders
2. Events are presented to the team for discussion and validation.
3. Registry identified patients will be reviewed for appropriateness of inclusion into the registry. Any deviations from practice guidelines, or care issues identified are referred to the appropriate specific individuals.

Retrospective

1. Review of PI issues takes place on an episodic basis and all trauma patients are reviewed from the previous time frame at scheduled intervals, not necessarily while the episode of care is ongoing. A defined team consisting of the trauma program leadership and members of the trauma registry undertakes this process of event identification along with other key stakeholders
2. Events are presented to the team for discussion and validation.
3. Registry identified patients will be reviewed for appropriateness of inclusion into the registry. Any deviations from practice guidelines, or care issues identified are referred to the appropriate specific individuals.

Levels of Review

Levels of review can be determined by degree of harm to the patient. See diagram on page 23. A few general definitions to be taken into consideration when choosing the highest level of review needed for an event include:

Missed injury - An injury discovered after the patient is discharged or after death (includes those found on autopsy).

Delayed diagnosis - An injury found after completion of the first trauma tertiary survey, but before the patient leaves the hospital.

Temporary - Condition resolves prior to discharge from the trauma admission or there is an expectation that it will resolve within 6 months of the event

Permanent - Condition is present at discharge and does not resolve within 6 months of the complication or event, is not expected to resolve, and may or may not be lifelong.

Minimal harm* - Noninvasive intervention (for example, administration of medications) but does not require higher-level care.

Moderate harm* - Invasive intervention and/or higher level of care (e.g., transfer to ICU, higher-level center, specialty center, or need for surgery, interventional radiology, etc.)

Severe harm* - Organ failure and/or prolonged (>48 hours) need for higher level of care

*- see page 13 for more detailed definition

Primary level of review (Event Validation)

Primary review of performance issues is typically designated to trauma program staff concurrently with data abstraction and collection while care is being delivered. Events are identified and validated, as they occur in a real-time fashion. This may occur during morning report, patient care rounds, chart review, and direct staff and patient interaction. It also should include any pre-hospital issues or post-discharge complications to include unplanned readmission. Changes in patient's plan of care or implementation of clinical guidelines may be influenced immediately. Prompt feedback to providers should occur in parallel, especially for performance related issues and addressed using the OPPE and FPPE process. Some retrospective review may be necessary, but in certain cases they may also be able to be closed. No harm, potential harm and minimal harm events can be closed at this level of review.

Secondary level of review (physician review)

Issues which have been identified concurrently may require additional review, input from various providers, and/or review by the Trauma Medical Director, Liaisons to the trauma program or other trauma program staff (Trauma Program Manager and PI Manager). Issues are validated, additional information collected, analyzed, and in some cases the issue may be closed. If peer review is indicated, the case is forwarded to the monthly Multidisciplinary Peer Review Meeting. See attachment 3. Moderate harm events can be closed at this level of review

Tertiary level of review (committee review)

Criteria for determining which cases go to Multidisciplinary Peer Review conference are (CD 16-4):

- Deaths
- Selected complications
- Adverse events, including all sentinel events
- Problem trends
- Select cases involving multiple specialties

Cases are reviewed, factor determinations made, preventability and judgment is determined, surgical grading defined, corrective actions developed, and loop closure is completed, if indicated at the time. Issues that are determined to have no opportunity for improvement are tracked on the Consent Agenda. A consent agenda is a collective list of all issues and complications that can aid in periodic monitoring (tracking and trending). If an issue is determined to have opportunity for improvement the issue is added to the agenda for discussion and action plan. See attachment 3. Severe harm and selected other lower level harm cases as deemed appropriate by the trauma program leadership are brought to this level of review.

Examples of other committees where trauma tertiary review may occur include specialty M/M meetings (e.g. orthopedics, emergency medicine), hospital mortality, and EMS committee reviews. Minutes from meetings where trauma cases are reviewed must be kept with all PI documentation on that case. Ideally a member of the trauma PIPS team is in attendance at any tertiary level of review meeting.

Quaternary level of review

A review by a hospital quality committee or external peer review. Examples of quaternary review forums include regional or state PI committees, affiliate hospital reviews, hospital med staff reviews.

Event Identification

Fundamental to the performance improvement process is monitoring and measurement of the outcome of specific processes or procedures related to trauma care to improve efficiency, increase effectiveness, or reduce real or potential harm, as well as to improve outcomes. Process and outcome measures, referred to as *audit filters*, require defined criteria and metrics. They can be derived by monitoring trauma-related institutional clinical practice guidelines. The trauma program must be able to identify the top 5 complications/issues/events and the top 5 TQIP low outlier complications. In addition, mandatory core measures listed below are required, for more information refer to Resources for Optimal Care of the Injured Patient, 2018, Chapter 16.

Core Measures

- Mortality Review (CD16-6)
- Trauma surgeon response to the emergency department (CD 2-9)
- Trauma team activation (TTA) criteria (CD 5-13)

- All TTAs must be categorized by the level of response and quantified by number or percentage (CD 5-14, 5-15)
- Response times, ideally from trauma registry data, for imaging and procedures, arrival of critical personnel must be monitored. Where applicable, TQIP guidance for timely response should be utilized. (CD 5-16)
 - Trauma surgeon response time to other levels of TTA, and for backup call response, should be determined and monitored (CD 5-16)
 - Response times of computed tomography technologist (30 minutes)/magnetic resonance imaging technologist (60 minutes)/interventional radiology team (30 minutes) when responding from outside trauma center (CD 11-30, 31, 32, 33, 34, 35, 36, 37, and 11-46)
 - Response times of operating room and postanesthesia care unit personnel when responding from outside the trauma center must be routinely monitored (CD 11-16, 11-18, 11-25)
- Potential overtriage and undertriage cases should be identified and reviewed monthly (CD 16-7)
- Trauma patient admissions (NTDS definition) to nonsurgical service should be no higher than 10 percent and must be reviewed monthly (CD 5-18)
- Direct admission of trauma patients with no trauma consult.
- Acute transfers out
- Trauma center diversion-bypass hours must be routinely monitored, documented and reported, including the reason for initiating the diversion policy, and must not exceed 5 percent (CD3-6)
- Availability of the anesthesia service (CD 11-4, 11-7, 11-16, 11-18)
- Delay in operating room availability must be monitored (CD 11-16, 11-18)
- Rate of change in interpretation of radiologic studies should be categorized by RADPEER or similar criteria (describe the process/scoring system used) (CD 11-32, 11-37)
- Transfers to a higher level of care within the institution (CD 16-8)
- Solid organ donation rate (defined as number of organ donations divided by number of potential donors)(CD 16-9)
- Trauma registry- percentage of completed registry records within 2 months of discharge should be determined (the threshold is 80 percent).(CD15-6)
- Multidisciplinary trauma peer review committee attendance (CD16-15)

Audit Filters, Practice Guidelines Variance Tracking

Examples of, but not limited to (there must be a clear definition of precisely what is being tracked):

- Absence of EMS Runsheet
- Inadequate pre-hospital airway
- No documentation of FAST exam
- Inaccurate FAST exam results
- Missing Trauma Flowsheet/H&P
- Emergency Center (EC) LOS >2 hours at referring hospital
- Emergency Room dwell time > 180 minutes
- Initiation of Massive Transfusion Protocol
- Clinical practice guideline variation (identify guideline)
- PT/OT delays

- Tertiary Survey not documented
- Exp Lap >4 hours of EC arrival (>1hour for SBP<90)
- Non-operative management of abdominal injury
- Vaccines not given after splenectomy
- Craniotomy >4 hours of EC arrival for acute/expanding EDH/SDH
- Positive head CT of patient on anti-coagulation, anti-platelets or aspirin without reversal within 2 hours of arrival
- Administration of antibiotics for an open fracture greater than 1 hour of arrival
- Unplanned return to the OR
- Missed Injury
- Delay in Diagnosis
- Reintubation within 48 hours of extubation (excludes planned return trips to the OR)
- Readmission related to the trauma event
- Complications

Determining Opportunities for Improvement

One of the essential tasks of a trauma PI meeting is to identify opportunities for improvement in care. This step is necessary if an effective action plan is to be developed. When confronted with an issue, each forum will use an objective process to determine preventability and/or opportunities for improvement. Each meeting will utilize the following defined criteria:

Mortality without opportunity for improvement

1. Anatomic injury or combination of injuries considered non- survivable with optimal care.
2. Standard protocols followed or if not followed, did not result in unfavorable consequence.
3. Provider related care appropriate or if sub-optimal, did not result in unfavorable consequence.

Mortality with opportunity for improvement

1. Anatomic injury or combination of injuries severe but may be survivable under optimal conditions.
2. Standard protocols not followed, possibly resulting in unfavorable consequence.
3. Provider care considered sub-optimal, possibly resulting in unfavorable consequence.

Unanticipated mortality with opportunity for improvement

1. Anatomic injury or combination of injuries considered survivable.
2. Standard protocols not followed with unfavorable consequences.
3. Inappropriate provider care with unfavorable consequences.

Anticipated with opportunity for improvement death- Proximate cause of death may be known or suspected and may or may not be related to the primary injury/disease process. While the death may still have occurred, an error (event/factor) e.g. system error, judgment error, and/or human error, was identified which may have contributed to the death.

Unanticipated death- Proximate cause of death is known or suspected and may be related to the primary injury/disease process; however, the death would not have been anticipated to result from the injuries/disease process and is in some way related to an error (event/factor) e.g. system error, judgmental error, and/or human error which directly contributed to the death.

Taxonomy

When an issue is determined to have an opportunity for improvement, the Trauma PI meeting should determine which contributory factors were involved in allowing the issue to occur. This is a critical part of the PI process because an effective action plans requires the team to address the factors that led to the deficiency. Classify the relevant factors using the National Quality Forum Taxonomy, see Attachment 2 for a good example. The factors that relate to an issue include but are not limited to the following:

IMPACT

- Physical
- Psychological
- Legal
- Socioeconomic

TYPE

- Communication
- Patient Management
- Clinical Performance

DOMAIN

- Setting
- Phase
- Time
- Staff

SYSTEM FACTORS

HUMAN FACTORS

- Provider
- Patient Factors

DETERMINATION

MITIGATION/PREVENTION PLAN

Levels of Harm

When evaluating deviations in care, it is important to determine the level of harm to the patient to better classify and measure preventable harm.

No Harm – Standard of care provided with some deviations with no impact to the patient

Potential for Harm – Event occurred but did not reach or impact patient; no treatment was necessary.

Minimal Harm – Impact to patient, is symptomatic, symptoms are mild, loss of function, is minimal or intermediate but short term, and no or minimal intervention (extra observation, minor treatment) is required.

Moderate Harm – Patient outcome is symptomatic, requiring intervention (e.g. operative intervention, therapeutic treatment), and increase in the length of stay, or causing long term loss of function; requires high level of care; expected to resolve prior to discharge.

Severe Harm - Patient is symptomatic, requires life-saving intervention or major surgical/medical critical care intervention, shortening of life expectancy or causing major permanent or long term harm or loss of function; error in judgment, deviation from practice, system delays; impact quality of care; quality of life.

Death – Death was caused or brought forward by the event.

Corrective Action Plan Development

At this step in the trauma PI process, an action plan must be developed. The details of the plan do not need to be decided in a formal meeting; however, a decision as to the type of action taken should be discussed. Working with members of the group (composition as deemed appropriate by the Trauma Program within institutional parameters) and appropriate hospital staff, the trauma service can help formulate a plan that meets the specific recommendations of the trauma committee. The following are examples of categories of specific action plans:

- Change in policy or procedure
- Development of best practice guideline
- Development of educational offering
- Additional resources (e.g., equipment purchased/repaired, personnel hired, etc.)
- Development of Best Practice Guideline
- Individual counseling/suspend/revoke privileges termination
- PIPS Workgroup
- Referral to Hospital PI
- Peer Review to include OPPE and or FPPE as appropriate
- Regional System referral
- System committee referral
- Tabulation & tracking for further reporting
- Individual counseling and/or change in privileges

Implementation

Action plans involve numerous individuals and disciplines within the hospital. Therefore, it is essential to have an inclusive process that collaboratively works across all areas of the institute that involve care of the injured patient. The PI process must be able to develop action plans in association with the appropriate people and departments that relate to the issue.

Event Resolution

After implementation of action plan, the process should shift focus back to the data. The plan must include data points that allow the changes made to the system to be monitored. Once the data demonstrates resolution of the issue at hand, the PI event is resolved (i.e., loop closure). After an issue is thought to be resolved, it should be tracked from time to time to ensure that it does not recur. The trauma PI process must be able to follow an issue closely over long periods of time.

Documentation of the entire PI process from issue identification to resolution is imperative. See attachment 3.

Trauma Multi-Disciplinary Peer Review Committee

1. **PURPOSE:** The purpose of the Trauma Multidisciplinary Peer Review Committee is to improve trauma care by having physicians critically review cases in a multidisciplinary setting. Review of trauma deaths, complications, and sentinel events with objective identification of issues and select cases involving multiple specialties. Preventability and judgment is determined and recorded by the group. Loop closure on clinical issues is documented in this setting to ensure implementation of necessary corrective action.

2. **MEMBERSHIP:** will vary depending upon trauma center level; the list below assumes all services/personnel available at a trauma center.

Trauma Medical Director (Chair)*

Trauma Program Manager*

Trauma PI Manager (Recorder)*

Trauma Surgeons*

Liaison, Anesthesia*

Liaison, Emergency Medicine*

Liaison, Orthopedics*

Liaison, Neurosurgery*

Liaison, Radiology*

Liaison, Critical Care*

Representative, Blood Bank/Lab

Representative, Ophthalmology

Representative, Pre-hospital EMS

Representative, Pharmacy

Representative, OB/GYN

(* must attend at least 50% of scheduled meetings)

3. **MINUTES APPROVING AUTHORITY:** Trauma Multidisciplinary Review Committee
4. **ISSUES ELEVATED TO:** Chief Quality Officer (or comparable role)
5. **MEETS:** Monthly (may meet less frequently at low volume centers but at least quarterly for timely event resolution)

6. OFFICE OF RECORD FOR APPROVED MINUTES: Trauma Program Manager
7. COMMITTEE REQUIRED BY: American College of Surgeons - Committee on Trauma

Multidisciplinary Trauma Systems/Operations Committee

1. PURPOSE: To optimize trauma performance through monitoring of trauma related hospital operations via a multidisciplinary committee that includes representatives from all phases of care provided to injured patients. The committee will document the review of operational issues, analyses performed, and corrective actions proposed. This process must identify problems and demonstrate adequate resolution with appropriate loop closure. Suggested membership should include representatives from a broad range of disciplines with daily exposure to trauma patients and may include:
2. MEMEBERSHIP: will vary depending upon trauma center level; the list below assumes all services/personnel available at a trauma center.
 - Trauma Medical Director (Chairperson)
 - Trauma Program Manager
 - Trauma PI Manager
 - Trauma liaisons or designee
 - Core Trauma Staff Physicians
 - Nursing Administrator
 - Representative, Emergency Center Nursing
 - Representative, Ward Nursing
 - Representative, ICU Nursing
 - Representative, Trauma Nursing
 - Representative, Rehabilitation
 - Representative, Blood bank
 - Representative, Radiology
 - Representative, Respiratory Therapy
 - Representative, EMS
 - Trauma Registrar Supervisor
 - Trauma Case Managers
 - Trauma Social Workers
3. MINUTES APPROVING AUTHORITY: Trauma Program Management Team
4. ISSUES ELEVATED TO: Chief Quality Officer (or comparable role within the hospital administrative structure)
5. MEETS: At least Quarterly, but may meet as often as Monthly
6. OFFICE OF RECORD FOR APPROVED MINUTES: Trauma Program Manager
7. COMMITTEE REQUIRED BY: American College of Surgeons – Committee on Trauma

Trauma Morbidity And Mortality Committee

1. **PURPOSE:** The purpose of the Trauma Morbidity and Mortality Committee (which can be combined with Multidisciplinary and/or Systems Committee) is to improve trauma care by reviewing trauma related deaths, specific complications, and sentinel events with trauma surgeons and trainees (residents/fellows).
2. **MEMBERSHIP:** Trauma Medical Director*
Trauma/General Surgery staff and residents/fellows*
Trauma Surgeons*
Trauma Program Manager
Trauma PI Manager
Trauma Case Managers
Trauma Nurse Practitioners and Physicians' Assistants
Liaisons if combining with the multidisciplinary meeting*

(* must attend at least 50% of scheduled meetings)

3. **MINUTES APPROVING AUTHORITY:** Trauma Medical Director (or per trauma center policy)
4. **ISSUES ELEVATED TO:** Multi Discipline Peer Review meeting
5. **MEETS:** Weekly, or as determined by your program (quarterly at a minimum)
6. **OFFICE OF RECORD FOR APPROVED MINUTES:** Trauma Program Manager
7. **COMMITTEE RECOMMENDED BY:** American College of Surgeons - Committee on Trauma

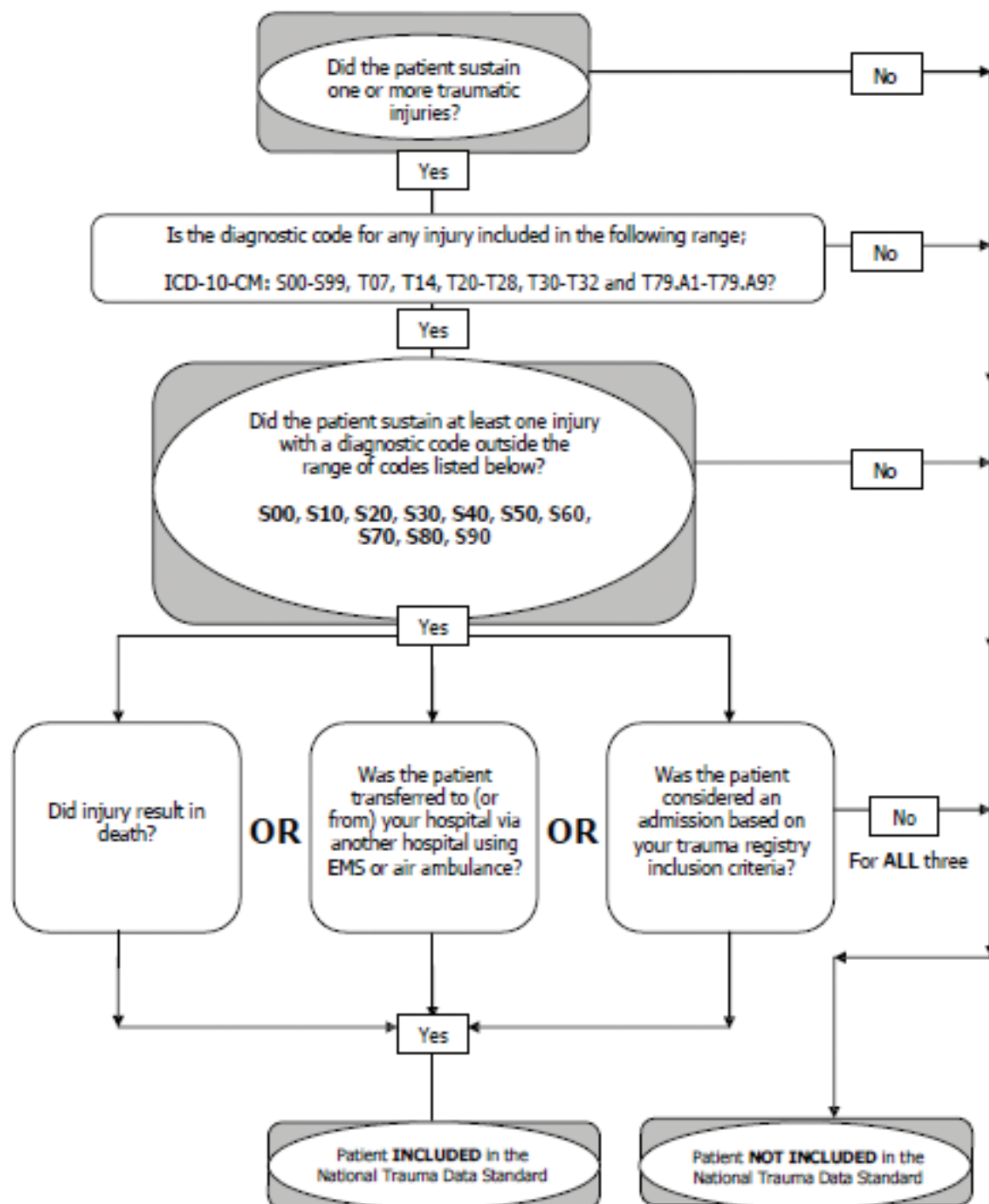
REFERENCES:

- a. American Trauma Society (ATS). <http://www.amtrauma.org/>
- b. National Trauma Data Bank (NTDB®). <https://www.facs.org/quality-programs/trauma/ntdb>
- c. Resources for Optimal Care of the Injured Patient, 2014: Committee on Trauma, American College of Surgeons. <https://www.facs.org/quality-programs/trauma/vrc/resources>
- d. Society of Trauma Nurses (STN). <http://www.traumanurses.org/>
- e. Trauma Center Association of America (TCAA). <http://www.traumacenters.org/>
- f. Trauma Outcomes and Performance Improvement Course: Society of Trauma Nurses Course (TOPIC). <http://www.traumanurses.org/topic>
- g. Trauma Performance Improvement: A Reference Manual; www.facs.org/trauma/handbook.html
- h. Trauma Quality Improvement Program (TQIP®). <https://www.facs.org/quality-programs/trauma/tqip>

GLOSSARY OF TERMS:

ABLS- American Burn Life Support
ACS- American College of Surgeons
ATS- American Trauma Society
CNO- Chief Nursing Officer
CPG- Clinical Practice Guideline
DNI- Do Not Intubate
DNR- Do Not Resuscitate
DOA- Dead on arrival
ENPC-Emergency Nursing Pediatric Course
FAST- Focused assessment with sonography for trauma
FPPE- Focused Professional Practice Evaluation
H&P- History and physical
ICU- Intensive Care unit
LOS- Length of stay
M&M- Morbidity and Mortality conference
NTDB- National Trauma Data Bank
NTDS- National Trauma Data Standard
OPPE- Ongoing Professional Practice Evaluation
PALS- Pediatric Advanced Life Support
PI- Performance Improvement
QA- Quality Assurance
SOP- Standard operating procedure
STN- Society of Trauma Nursing
TCAA- Trauma Center Association of America
TCRN- Trauma Certified Registered Nurse
TFS- Trauma flowsheet
TMD- Trauma Medical Director
TPM- Trauma Program Manager
TNCC- Trauma Nursing Core Course
TQIP- Trauma Quality Improvement Program
VRC- Verification Review Committee
Attachment 1

National Trauma Data Standard Inclusion Criteria



Attachment 2

Trauma Performance Improvement Event Review

Date of report:
Mechanism of Injury
Patient Name:

Medical record No:
Level of Activation:
Age:

Admit Date:
Service:
Gender:

Time:

Injuries

Event:

Other Pertinent Information:

Physician:

Report Completed by:

Impact (v)

Physical

- ☐ No harm
- ☐ Potential for harm
- ☐ Minimal temporary harm
- ☐ Minimal permanent harm
- ☐ Moderate temporary harm
- ☐ Moderate permanent harm
- ☐ Severe temporary harm
- ☐ Severe permanent harm
- ☐ Death

Psychological

- ☐ No harm
- ☐ Minimal temporary harm
- ☐ Minimal permanent harm
- ☐ Moderate temporary harm
- ☐ Moderate permanent harm
- ☐ Severe temporary harm
- ☐ Severe permanent harm
- ☐ Profound mental harm

Legal

- ☐ Legal department contacted
- ☐ Complaint registered w/Patient Affairs
- ☐ Loss of Property

Socioeconomic

- ☐ Delayed disposition
- ☐ Language barrier
- ☐ APS/CPS notified
- ☐ Psych Issues
- ☐ Substance Abuse

Type (v)

Communication

- ☐ Inaccurate or incomplete information
- ☐ Questionable advice or interpretation
- ☐ Questionable consent process
- ☐ Questionable disclosure process
- ☐ Questionable documentation

Clinical Performance

Pre-Interventional:

- ☐ Correct diagnosis, questionable intervention
- ☐ Inaccurate diagnosis
- ☐ Incomplete diagnosis
- ☐ Delayed diagnosis
- ☐ Missed injury

Patient Management

- ☐ Questionable delegation of care or tasks
- ☐ Inadequate patient follow-up
- ☐ Lack of consultation or referral
- ☐ Inadequate resource utilization
- ☐ Non-surgical admission

Interventional:

- ☐ Correct procedure with complications
- ☐ Correct procedure, incorrectly performed
- ☐ Correct procedure but untimely
- ☐ Omission of essential procedure
- ☐ Procedure Contraindicated
- ☐ Procedure not indicated
- ☐ Guideline not followed

Post-Interventional:

- ☐ Unexpected outcome
- ☐ Inadequate post procedural instructions
- ☐ Inadequate discharge instructions
- ☐ Inadequate discharge planning

Domain (v)

Setting

- ☐ Scene
- ☐ Transport
- ☐ Transferring Facility
- ☐ ED
- ☐ Radiology
- ☐ IR
- ☐ OR
- ☐ PACU
- ☐ ICU
- ☐ Step Down
- ☐ Floor
- ☐ Clinic
- ☐ Blood Bank

Phase

- ☐ Pre-hospital/Transfer Transport
- ☐ Triage
- ☐ Resuscitation
- ☐ Acute Care
- ☐ Operative
- ☐ Critical Care
- ☐ Discharge Planning
- ☐ Rehabilitation
- ☐ Follow-up Care

Time

- ☐ Weekday
- ☐ Weekend
- ☐ Day
- ☐ Night
- ☐ Shift Change
- ☐ Mass Casualty Event
- ☐ Holiday

Domain (v) - continued

Staff

Providers:

- ☐ Trauma Surgeon
- ☐ Fellow
- ☐ Resident
- ☐ Advanced Practice Provider
- ☐ EM Physician
- ☐ ICU Physician
- ☐ Anesthesia
- ☐ Neurosurgery
- ☐ Radiology
- ☐ Orthopedics
- ☐ Rehabilitation
- ☐ Transferring Provider

Nurses:

- ☐ Flight Team
- ☐ ER RN
- ☐ Radiology RN
- ☐ IR RN
- ☐ OR RN
- ☐ ICU RN
- ☐ Ward RN

Therapists:

- ☐ Physical therapist
- ☐ Occupational therapist
- ☐ Respiratory Therapist
- ☐ Speech Therapist
- ☐ CT Tech
- ☐ IR Tech
- ☐ Radiology Tech
- ☐ Blood Bank Tech

Others:

- ☐ Pharmacist
- ☐ X-ray technician
- ☐ Lab
- ☐ Transfusion
- ☐ Transport Team

Trauma Performance Improvement Event Review

System Factors (v)

- ☐ Electronic Medical Record - Documentation
- ☐ Registration
- ☐ Medication Event
- ☐ Resource availability/Utilization
- ☐ Equipment Issues
- ☐ Patient safety goal compliance
- ☐ Inadequate/absent police or practice management guidelines
- ☐ Diversion
- ☐ Bed Availability

Referral Process:

- ☐ Incorrect service/consultation
- ☐ Incorrect transfer team
- ☐ Surgeon not available to speak with Referring physician

Trauma Team Activation:

- ☐ Short notification
- ☐ Page confusing
- ☐ Incomplete page
- ☐ Delayed Activation
- ☐ Wrong Level of Activation
- ☐ Missed Activation

Human Factors (v)

Provider/Practitioner factors:

- ☐ Skill based deficiency
- ☐ Rule based deficiency
- ☐ Knowledge based deficiency
- ☐ Protocol non-compliance
- ☐ Regulatory non-compliance
- ☐ Error in Technique
- ☐ Fatigue
- ☐ Negligence

Patient Factors:

- ☐ Uncooperative/non-compliance
- ☐ AMA
- ☐ Left without being seen
- ☐ Incidental finding
- ☐ Family issues
- ☐ Pre-existing disease
- ☐ Injury Severity
- ☐ Homeless
- ☐ Substance Abuse

Determination:

- ☐ Mortality with Opportunity for Improvement
- ☐ Unanticipated Mortality with Opportunity for Improvement
- ☐ Mortality without Opportunity for Improvement
- ☐ Potentially preventable
- ☐ Preventable
- ☐ Missed injury
- ☐ Delay in Diagnosis
- ☐ Incorrect Diagnosis
- ☐ Technical error
- ☐ No error
- ☐ Inadequate Protocol Development
- ☐ Communication Issue
- ☐ System issue
- ☐ Coordination of care issue
- ☐ Lack of Capacity or Resources
- ☐ Arrived with signs of life
- ☐ Arrived without signs of life
- ☐ DNR/Withdrawal of care
- ☐ Hospice

Mitigation/Prevention Plan:

- ☐ Change in policy or procedure
- ☐ Develop Best Practice Guidelines
- ☐ Educational offering
- ☐ Equipment purchased/repared
- ☐ Counseling (OPPE and/or FPPE)
- ☐ PIPS Workgroup
- ☐ Referral to Hospital PI
- ☐ Peer Review
- ☐ Regional System PI Referral
- ☐ Department Referral
- ☐ System Committee Referral
- ☐ Tracking for future reporting
- ☐ Improved resources

Event Timeline Review

Time: **Event:**

Reviewed by: _____

Date: _____

Case Discussion:

Mitigation:

Event Resolution:

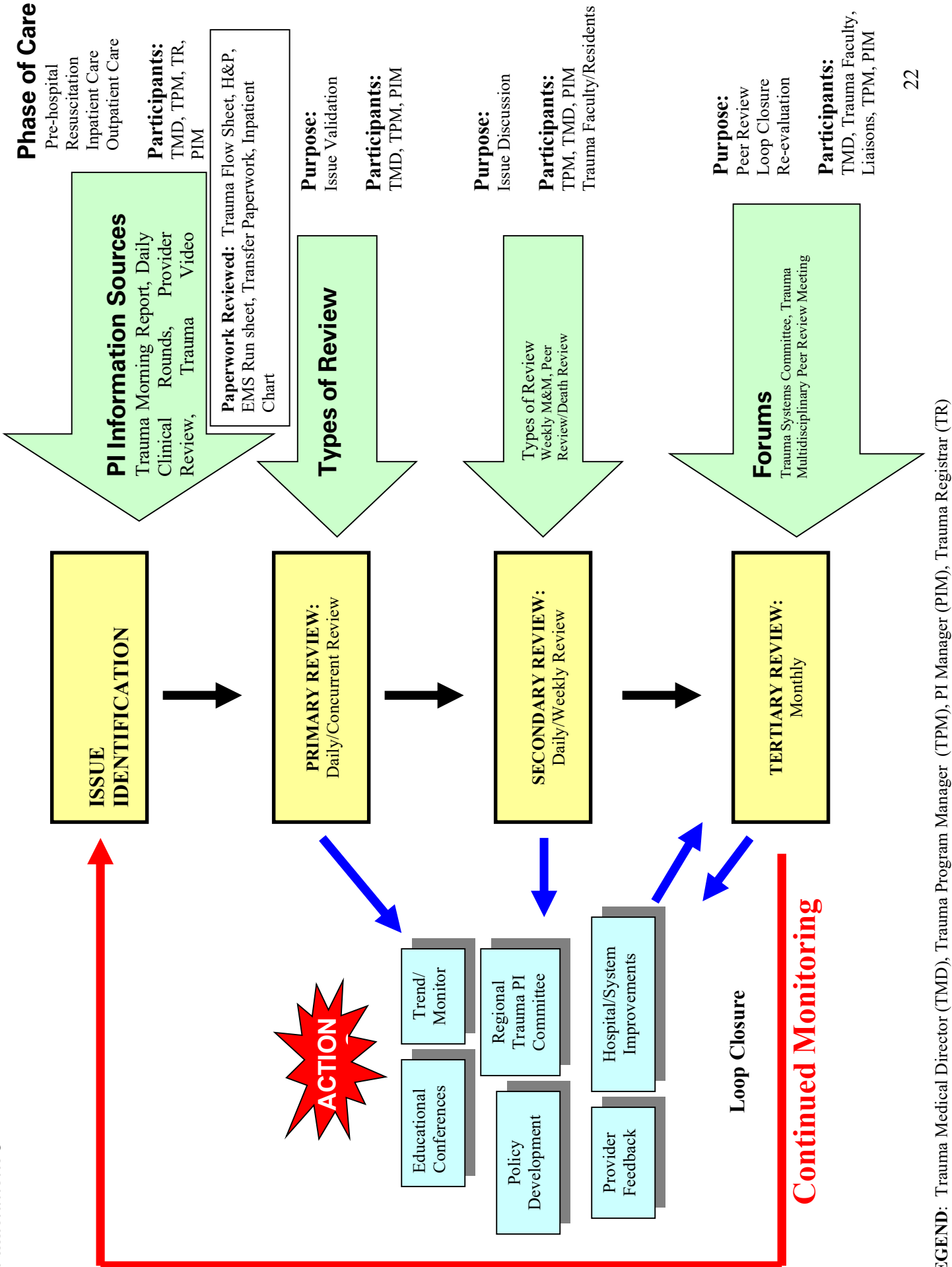
- ☐ Referred to Tertiary Review/Follow-up

TMD Signature: _____ Date: _____

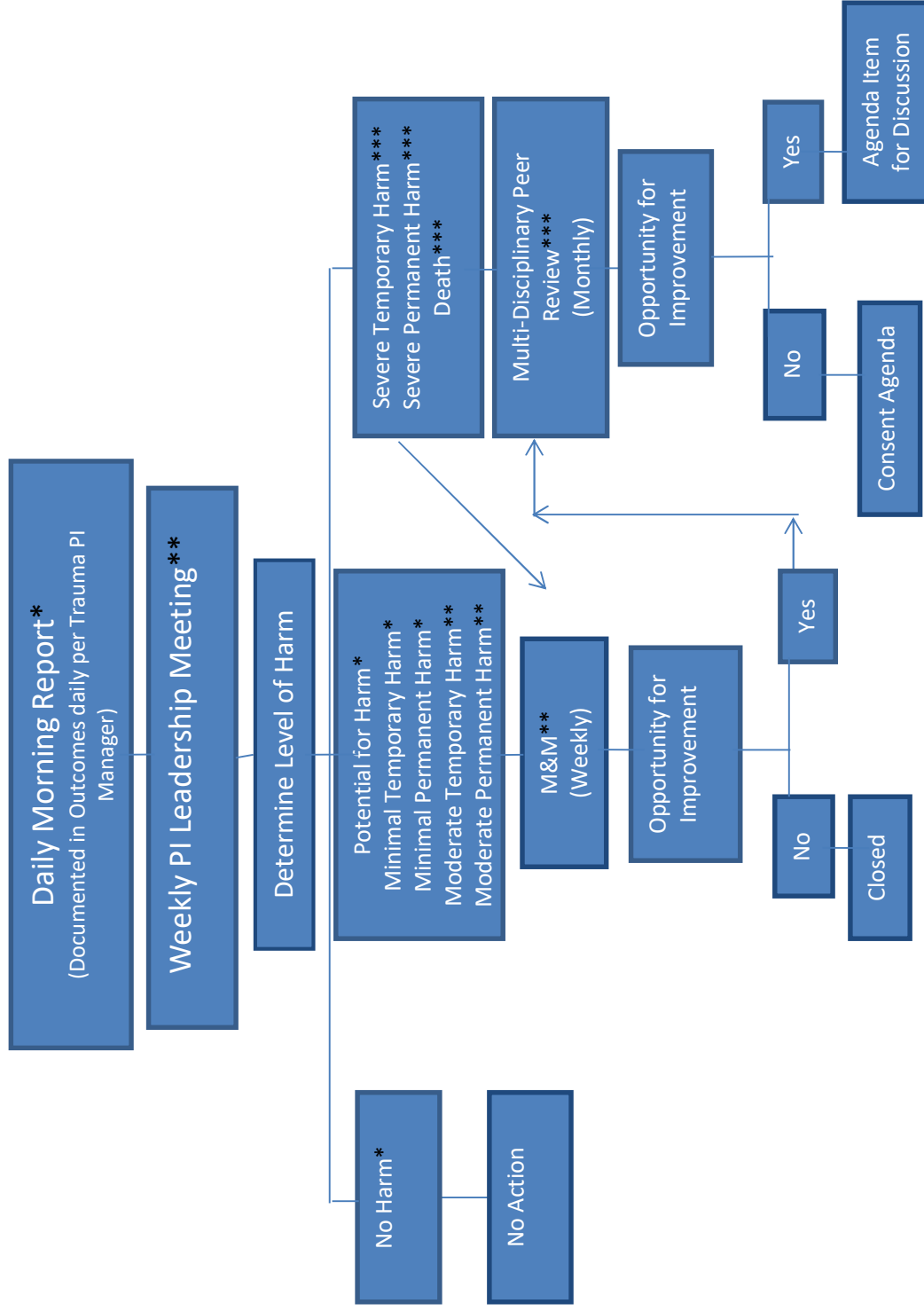
- ☐ Documented in Trauma Registry

TRAUMA PERFORMANCE IMPROVEMENT PROCESS

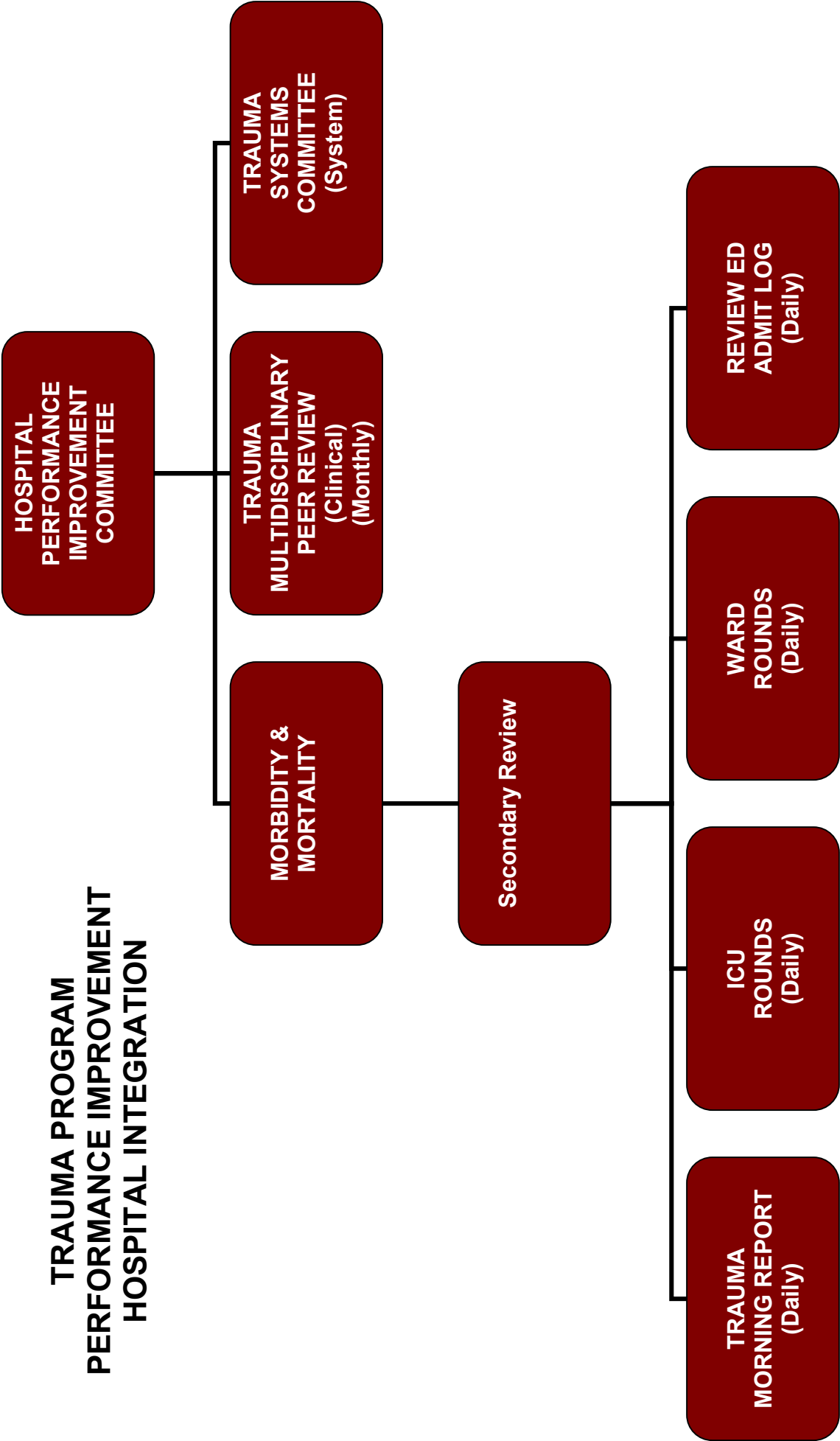
Attachment 3



*Primary Review
 **Secondary Review
 ***Tertiary Review



**TRAUMA PROGRAM
PERFORMANCE IMPROVEMENT
HOSPITAL INTEGRATION**



Trauma and Burn Service Line Annual Report—FY2019

University of Colorado Hospital



uchealth

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- Memorial Hospital North
- Pikes Peak Regional Hospital
- Poudre Valley Hospital
- University of Colorado Hospital
- Yampa Valley Medical Center

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University of Colorado Hospital Trauma Center Burn and Frostbite Center

Level I Trauma designation—American College of Surgeons and the State of Colorado.

Last survey: July 2018.

Next survey: July 2021.

The first and only American Burn Association Verified Burn Center in the Rocky Mountains.

Last survey: December 2018.

Next survey: December 2021.



AMERICAN COLLEGE OF SURGEONS
Verified Trauma Center



Executive summary.

81% increase
in total volume since 2014.

↳ **16%** within the last year.

112% increase
in critically injured patients since 2014.

↳ **4%** increase within the last year.

86% increase
in Burn Center admissions since 2012.

↳ **11%** increase within the last year.

89% increase
in transfers into UCH Trauma Center
since 2014.

↳ **8%** increase within the last year.

55% decrease
in mortality of the most seriously
injured patients, which is in the top
10% of Level I Trauma centers in the U.S.

21 trauma-related publications
by TACS faculty 2018-2019.



Leadership—Trauma services and burn care.



Robert McIntyre Jr., MD, FACS
Trauma Medical Director



Anne Wagner, MD, FACS
*Burn and Frostbite Center
Medical Director and Trauma
Burn Liaison*



Franklin Wright, MD
*Medical Director, Surgery
Trauma Intensive Care Unit*



**Robbie Dumond
BSN, RN, TCRN, AEMT**
*Senior Director of
Trauma Services*



Kelly Bookman, MD
*Emergency Department
Medical Director*



April Koehler, MSN, RN
*Emergency Department
Director*



**Regina Krell
MS, RN, CEN, TCRN**
Trauma Program Manager



**Robyn Wolverton
MSN, RN, CEN, TCRN**
Trauma Outreach Manager



Nancy Biaggi, BA
Burn Outreach Manager



**Elyse Bueno
MS, APRN, ACCNS-AG, CCRN**
*Surgery Trauma Intensive Care
Unit Manager*



**Morgan Aranda
MSN, RN, CMSRN**
*Trauma Surgical Specialties
Unit Manager*



James Kelty, BSN, RN-BC
Burn Unit Manager



Justin Oeth, BSN, RN
*Emergency
Department Manager*

Providers.

Trauma surgeons



Maria Albuja-Cruz, MD, FACS



Lisa Ferrigno
MD, MPH, FACS



Laura Harmon, MD, MS



Juan-Pablo Idrovo, MD



Paul Montero, MD, FACS



Christopher Raeburn, MD



Lauren Steward
MD, MHSA, MPHS



Catherine Garrison
Velopulos, MD, MHS, FACS
Director of Trauma Research

Burn surgeons



Patrick Duffy, MD



Arek Wiktor, MD, FACS



Robert Neuman, MD
*Neuro-Intensive Care
Unit Director*

Neurocritical care

Trauma liaisons



Fareed Azam, MD
Trauma anesthesia liaison



Thomas Borges, MD
Trauma radiology liaison



Wayne Gluf, MD
*Director of
Neurosurgical Trauma*



Jason Stoneback, MD
*Chief of Orthopedic Trauma and
Fracture Surgery Service
Director, Limb Restoration Program*

Trauma and acute care surgery physician assistants

Veronica DeMary, PA-C
Andrea Gordon, PA-C
Brennen Griffin, PA-C

Jeff Huber, PA
Erin Lennon, PA, BS

Sarah Longyhore, PA-C, MMS
Chris Shults, PA-C

Burn and frostbite care advanced practice providers (APPs)

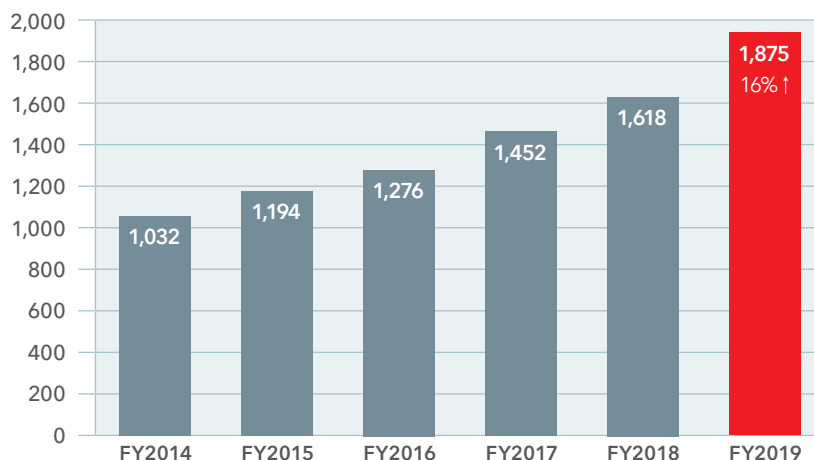
Amber Kohler, NP (APP Lead)
Julie Henderson, NP
Meghan Houlihan, PA

Kathryn Moser, NP
Maureen Scott, NP

Keturah Sloan, NP
Jennifer Stalilonis, PA

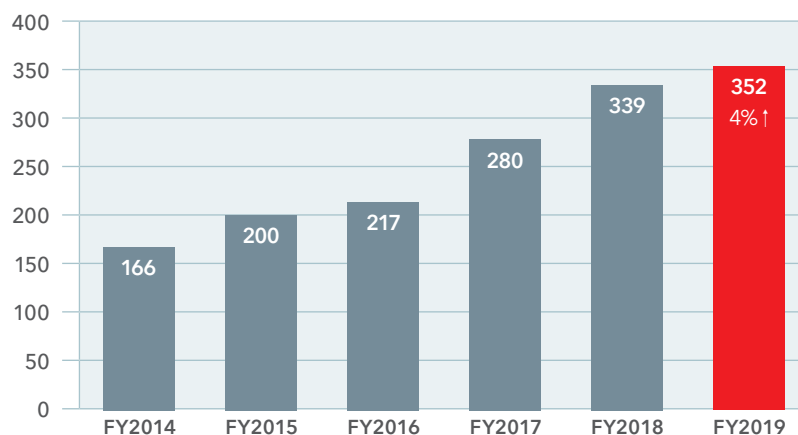
Trauma services and burn care patient volume.

81% increase since FY 2014.



Critically injured patient volume.

112% increase since FY 2014.

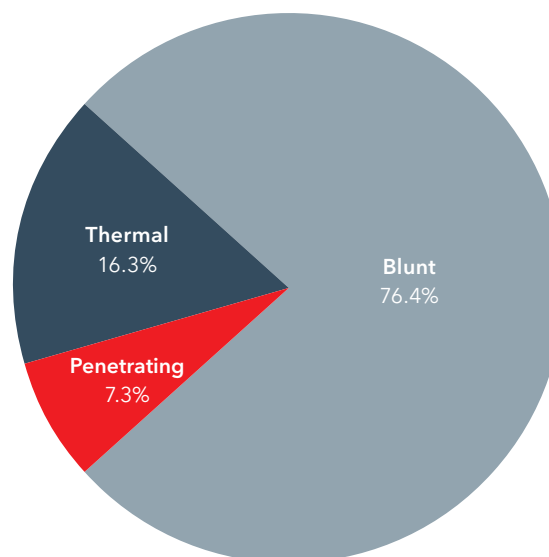


Critically injured patients = injury severity score greater than 15.

Top traumatic mechanisms of patient injury.

Causes:

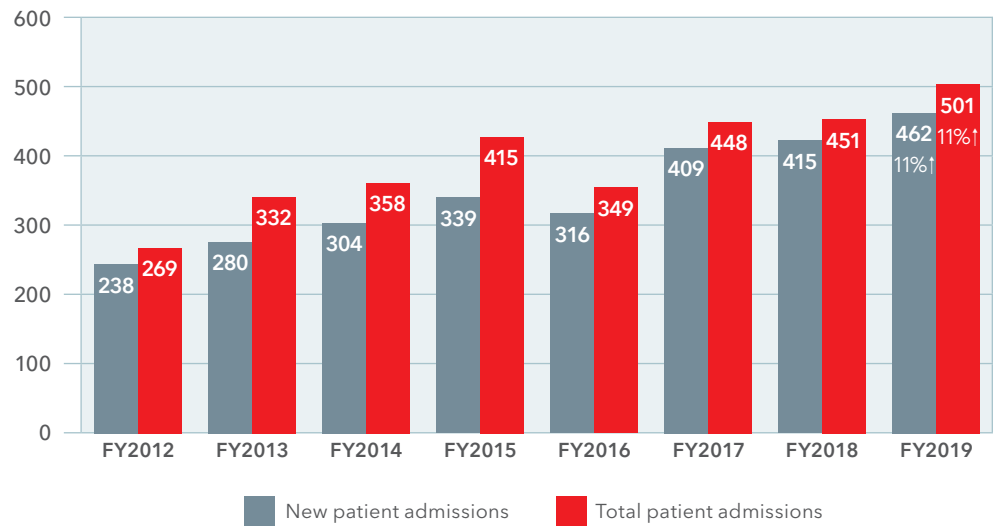
- Falls
- Assault
- Motor vehicle crash
- Motorcycle crash
- Pedestrian
- Fire
- Chemical exposure
- Gunshot wounds
- Stab wounds
- ATV, snowmobile or other vehicle



Burn and Frostbite Center volumes.

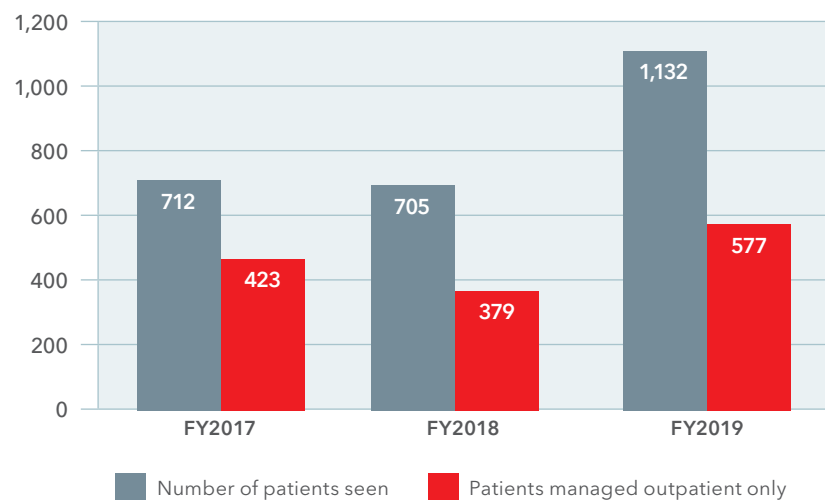
Center admissions

86% increase
since FY 2012.



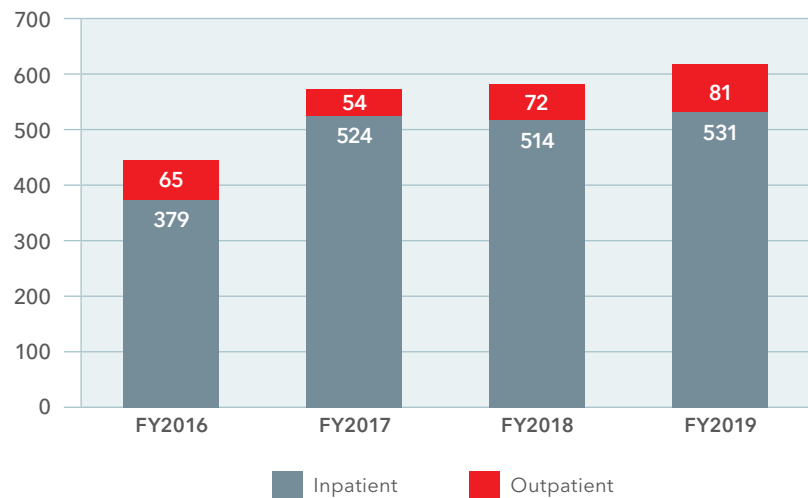
Clinic volume

60% increase in number
of patients seen.



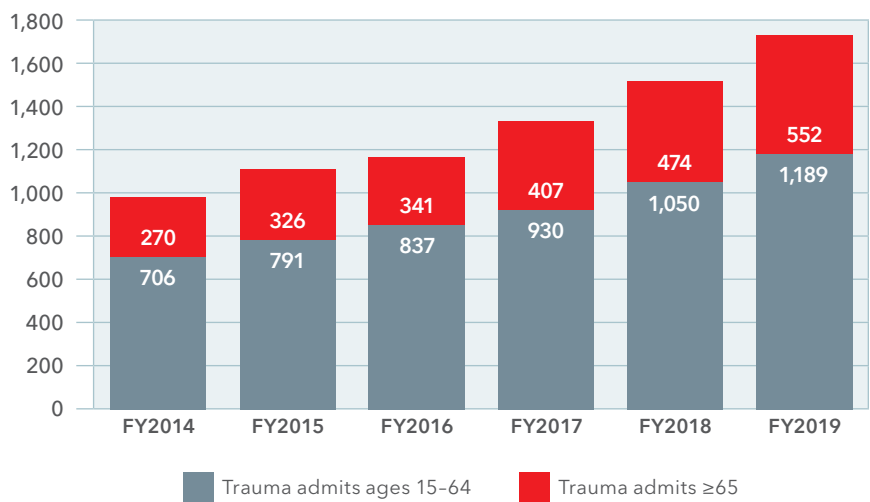
Operative cases

38% increase since FY 2016.



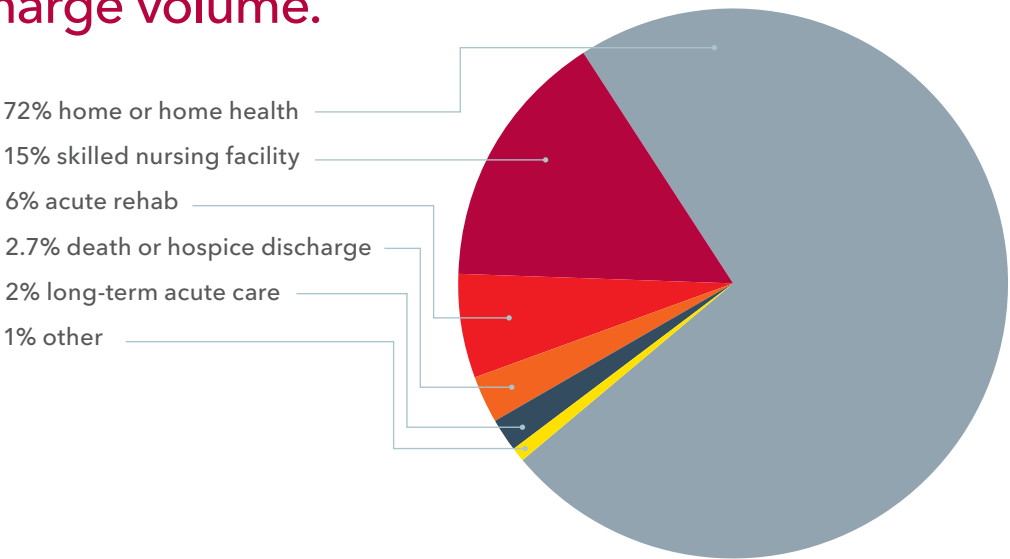
Trauma services and burn care patient demographics.

Admissions by age
(31% of admissions are greater than or equal to 65 years of age).



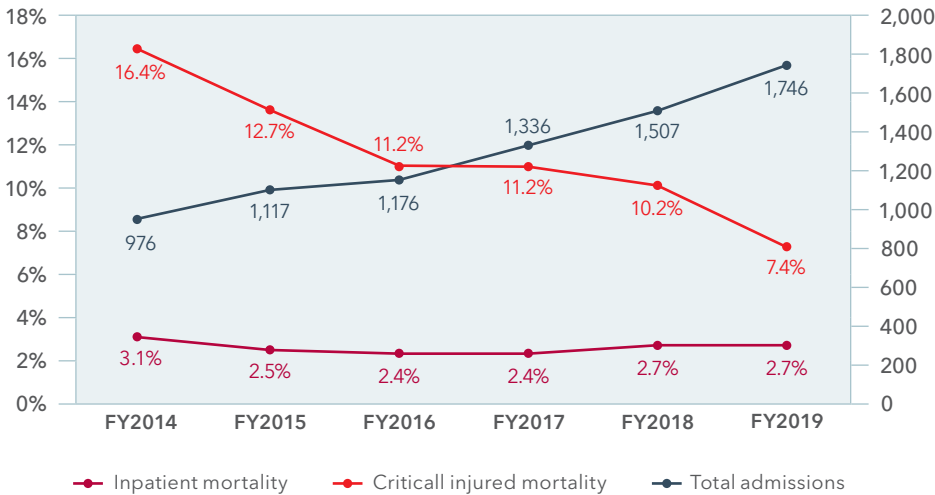
Inpatient discharge volume.

78% of patients are discharged to home or rehabilitation.



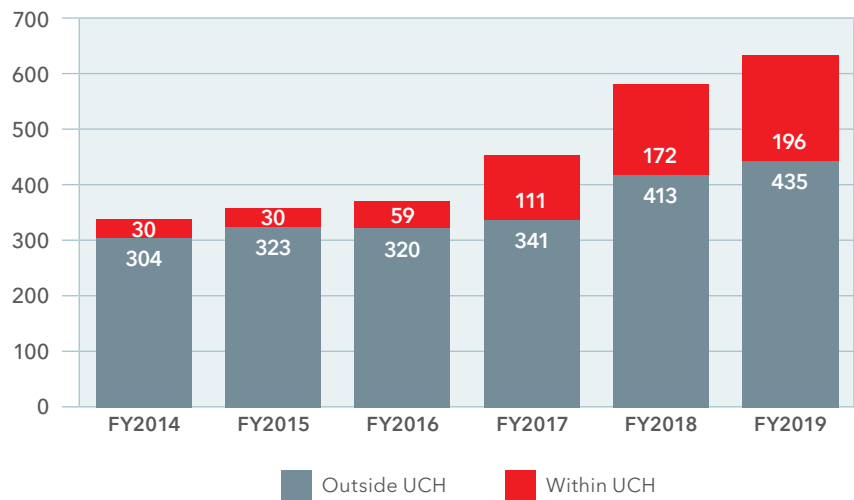
Total mortality versus critically injured mortality rates.

Top 10% mortality rate in U.S., with a 55% decrease in critical injury mortality since FY 2014. Which means 24 more lives saved.



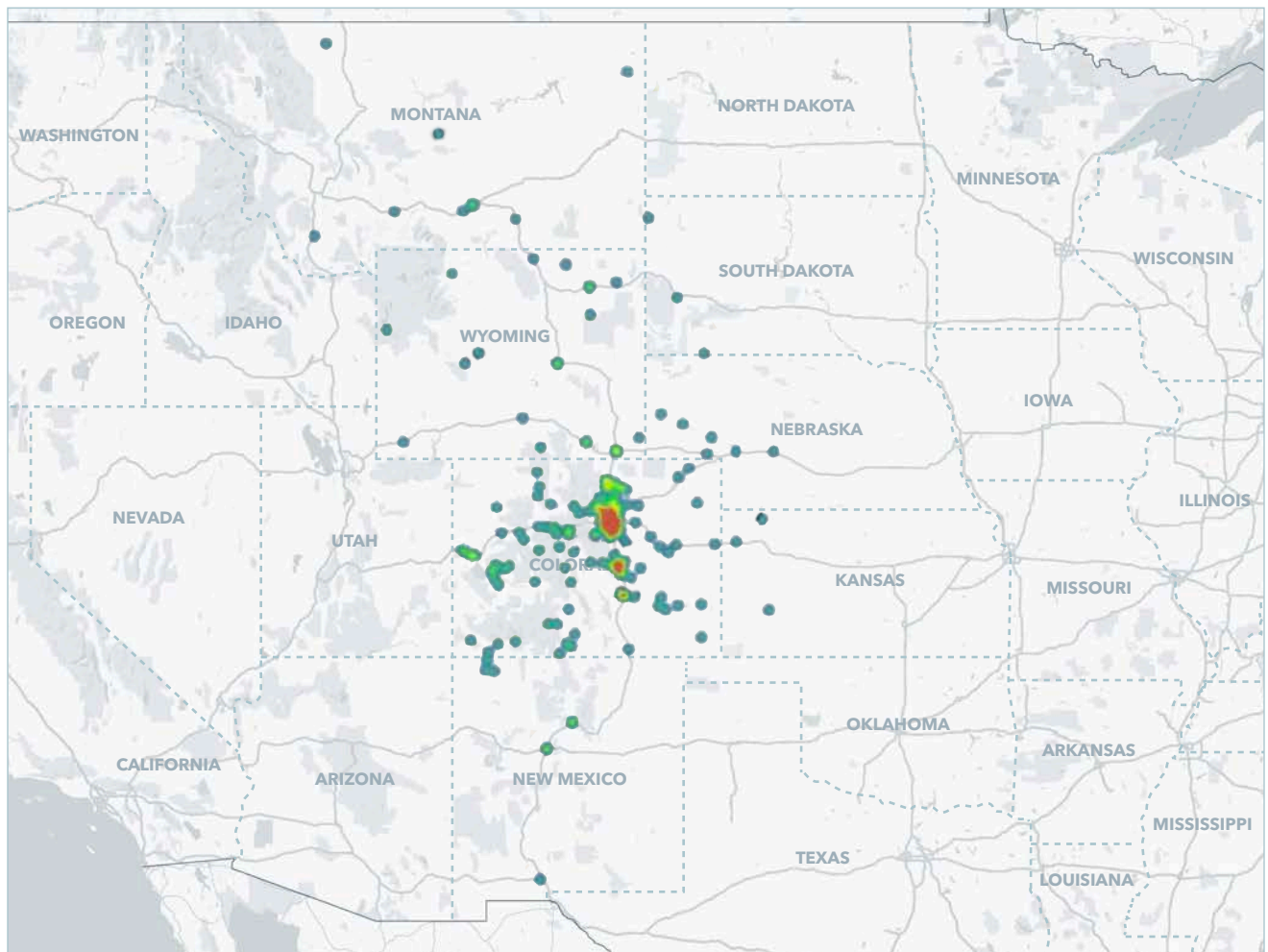
Referrals in.

89% increase in transfers since FY 2014.



Trauma and burn transfers (FY 2019).

University of Colorado Hospital received transfers from 107 facilities in nine states and Canada.



Trauma injury prevention (FY 2019).

- Statewide injury prevention collaboration
 - Colorado Young Drivers Alliance.
 - Safe Kids subcommittee–Denver metro teen drivers.
 - Colorado Trauma Network injury prevention subcommittee.
 - SEMTAC injury prevention committee.
 - Ambulatory Services Patient and Employee Safety (ASPES fall protection).
- Stop the Bleed®
 - 931 people now know how to Stop the Bleed.
 - Training for course instructors.
- Fall prevention–Stepping On and tai chi for arthritis.
 - Five seven-week programs, one tai chi class, 54 participants.
- “What do you consider lethal?”
 - Four presentations, 809 participants.
- P.A.R.T.Y.–preventing alcohol and risk-related trauma in youth
 - 26 programs, 892 students and staff.
 - Featured on 9News.



Burn education and injury prevention.

- 44 Grand Round and Conference presentations in six states
- Advanced Burn Life Support (ABLS)
 - Five courses, 85 providers, nurses and EMS providers in two states.
- Electrical lineman education
 - Seven courses, 210 workers reached.
- American Burn Association
 - Three podium and four poster presentations.
- Frostbite prevention for the homeless
- “It happens in seconds.”–training for firefighters



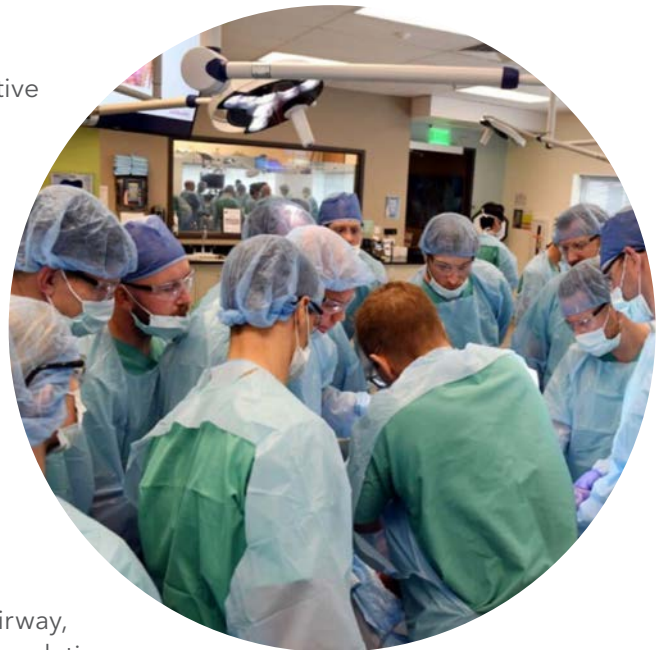
Trauma education.

- Physician/resident: ATLS, ASSET
 - ATLS—two courses, 32 participants.
 - ASSET—two courses, 16 participants.
- Nursing: Trauma Nursing Core Course and Trauma Care After Resuscitation
 - TNCC—five courses, 85 nurses.
 - TCAR—40 nurses.
- Grand Rounds
 - Nine Department of Surgery trauma-related Grand Rounds, including three Visiting Professors.



EMS cadaver training.

FBI and EMS providers specializing in responding to active shooters, hostage crises, airline hijackings and terrorist attacks, among other emergencies, came from around the country to the Center for Surgical Innovation on the Anschutz Medical Campus on two separate occasions in FY2019 to learn, through hands-on training with CU School of Medicine/UCHealth trauma surgeons and emergency medicine physicians, how to triage and manage patients with life-threatening injuries. Among those involved in the training were UCHealth EMS Medical Director Daniel Willner, MD, and UCHealth Trauma Surgeons Laura Harmon, MD, and Erik Peltz, DO.



Each training session involved extensive didactic and hands-on training with a focus on the management of airway, breathing and circulation status in the injured patient population. One after the next, the FBI agents and EMS providers practiced intubation skills. After his turn, an FBI agent from Los Angeles explained, "Being able to interact with a cadaver—real tissue—is invaluable, priceless training. The mannequin's rigid plastic. There's no feel. There's no tongue that gets in the way. You're not looking them in the eye. When I do this, I think about my kids: How am I going to save one of their lives?" The trauma program at University of Colorado Hospital will continue to support these courses and hopes to offer them more frequently in the coming years.

Source: uchealth.org/today/fbi-learn-from-cadavers

Trauma services and burn care outreach (2019).

- Conferences and symposiums
 - 20 appearances, over 3,000 attendees.
- Outreach visits
 - 53 outreach visits, six states.
- 2020 conference lineup
 - Eagle County EMS Conference
 - EMS and Fire Conference, Grand Junction
 - Rocky Mountain Rural Trauma Conference, Bozeman, MT
 - South Dakota State Trauma Conference
 - Santa Fe Trauma Conference
 - UCHealth Disaster Conference
 - UCHealth Trauma, Critical Care and EMS Symposium
 - Vail Health Mini-Conference
 - Valley View Trauma Conference
 - Wyoming Trauma Conference



Trauma and burn services department.



Regina Krell, MS, RN, CEN, TCRN
Trauma Program Manager



Robyn Wolverton MSN, RN, CEN, TCRN
Trauma Outreach Manager



Nancy Biaggi, BA
Burn Outreach Manager



Laurie Lovedale, MPH
Trauma Injury Prevention Coordinator



Shane Urban, BSN, RN
Trauma Research Coordinator RN II



Elizabeth Weber BSN, RN, CCRN
Burn Program Coordinator



Stephanie Vega MBA, BSN, RN, CCRN-K, CSTR
Trauma Clinical Quality Specialist



Eve Lindemann BSN, RN, CCRN
Trauma Nurse Clinician



Pamela Michelli, BSN, RN
Trauma Nurse Clinician



Emily Quigly, BSN, RN
Trauma Nurse Clinician

Trauma services and burn care registrars



Michelle Bowers
CSTR, CAISS



Peggy Clark, BSN, RN



Kathy L. Hoyland
CSTR, CAISS



Zac Lensgraf
Administrative Assistant



Lori Kennard
RHIA, CSTR, CAISS



Bethany Schmoker



Angela Vasilatos, BS

The 11th Annual John H. and Cynthia H. Schultz Lectureship in Surgery.



Ronald M. Stewart, MD
*University of Texas Health,
San Antonio*

Firearm Injury Prevention Strategy and Process From the American College of Surgeons Committee on Trauma

Dr. Stewart has actively led the development of an integrated civilian-military trauma system that serves all of South Texas, covering more than 26,000 square miles. In 2001, he was appointed by then Governor George W. Bush to the Texas Governor's EMS and Trauma Advisory Council, where he served for 15 years as the Chair of the Systems committee. He was a founding member of the National Trauma Institute. For the last 20 years he has served on the American College of Surgeons (ACS) Committee on Trauma (COT). Currently he is the ACS Medical Director of Trauma Programs.

During his tenure as the ACS COT Chair, he spearheaded a plan to implement a National Trauma Action Plan aimed at eliminating preventable trauma deaths by 1) improving trauma systems, 2) increasing high-quality trauma research, 3) increasing the quality of trauma patient data and 4) advancing trauma education and training in both military and civilian settings. He worked to lead an approach to firearm injury prevention that has encouraged collegial, professional and substantive dialogue from surgeons and citizens from all points of view, with the goal of reducing the burden of firearm injury and death.

The 3rd Annual Sarah V. and Ernest E. Moore Trauma Lectureship.



Alden H. Harken, MD
*Professor Emeritus
of Surgery
University of California,
San Francisco-East Bay*

The Value of Asking Questions

Dr. Harken is Professor Emeritus of Surgery in the UCSF-East Bay Surgery Program. He is board-certified by the American Board of Surgery and the American Board of Thoracic Surgery. In 2005 and 2006, surgical residents voted Dr. Harken the Julia Burke Outstanding Teacher of the Year. Recently, Dr. Harken was honored with the Lifetime Achievement Award from the Society of University Surgeons (SUS).

After completing his undergraduate work at Harvard College in 1963, Dr. Harken graduated from Case Western Reserve Medical School in 1967. He completed surgical and pediatric cardiovascular residencies at the Peter Bent Brigham Hospital and the Boston Children's Medical Hospital in 1973; then he joined the Walter Reed Army Institute of Research in Washington, D.C., where he was an investigator, and gained the rank of Lieutenant Colonel.

In July 1976, Dr. Harken accepted a position at the University of Pennsylvania in the Division of Cardiothoracic Surgery, where he became well known as a dedicated and highly respected scientist. In 1983, Dr. Harken accepted the position of Chairman of the Department of Surgery at the University of Colorado Health Sciences Center, and for the next two decades as a vigorous advocate of surgical residency training, he promoted multiple surgical programs and served as the Principle Investigator of Colorado's NIH Trauma Program Project Grant and Surgical Research Training Grant.

Trauma visiting professors lectures.



Surgical Rescue

Andrew B. Peitzman, MD

- Distinguished Professor of Surgery
- Mark M. Ravitch Endowed Chair in Surgery Vice Chair, Clinical Services, Department of Surgery Executive Vice Chairman University of Pittsburgh, School of Medicine



The Global Burden of Trauma—Perspectives From Experiences Working With Doctors Without Borders

John Lawrence, MD

President, Doctors Without Borders-USA

- Doctors Without Borders
- Pediatric surgeon, Maimonides Medical Center



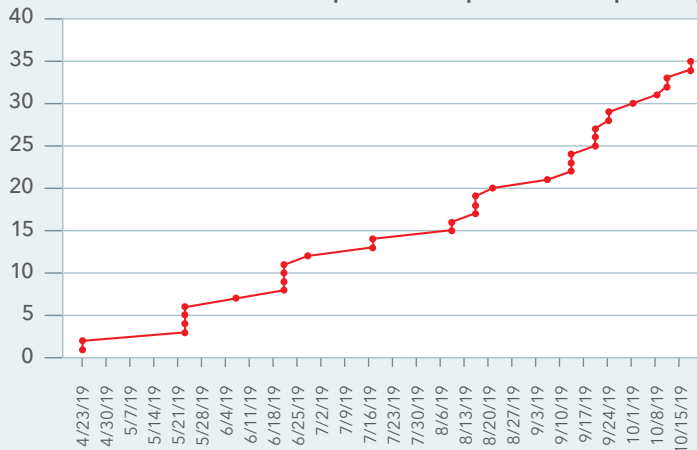
2019 Global Humanitarian
Surgical Skills Workshop

Burn laser therapy for scar rehabilitation.

Laser therapy is a new and innovative program led by Patrick Duffy, MD. Dr. Duffy and his team provide patients with effective, less invasive options for management of challenging post-burn scar symptoms, including pain and itch.

Two state-of-the-art systems are being used, including a 10,600nm CO₂ laser and intense pulsed light (IPL) device to treat symptomatic hypertrophic hypervascular burn scars.

Laser therapy cases where patients experienced a reduction in medication use and improved itch, pain and scar pliability.



- 25 patients treated with 30 operative sessions in the first five months.
- Each patient treated generates an average of eight reconstructive procedures for scar rehabilitation.
- Additional operative resources obtained to meet increased demand.
- Follow-up from laser scar therapy provides opportunities for additional surgical scar management with tissue rearrangements, contracture releases and scar resurfacing when laser alone is inadequate.



Limb Restoration Program.

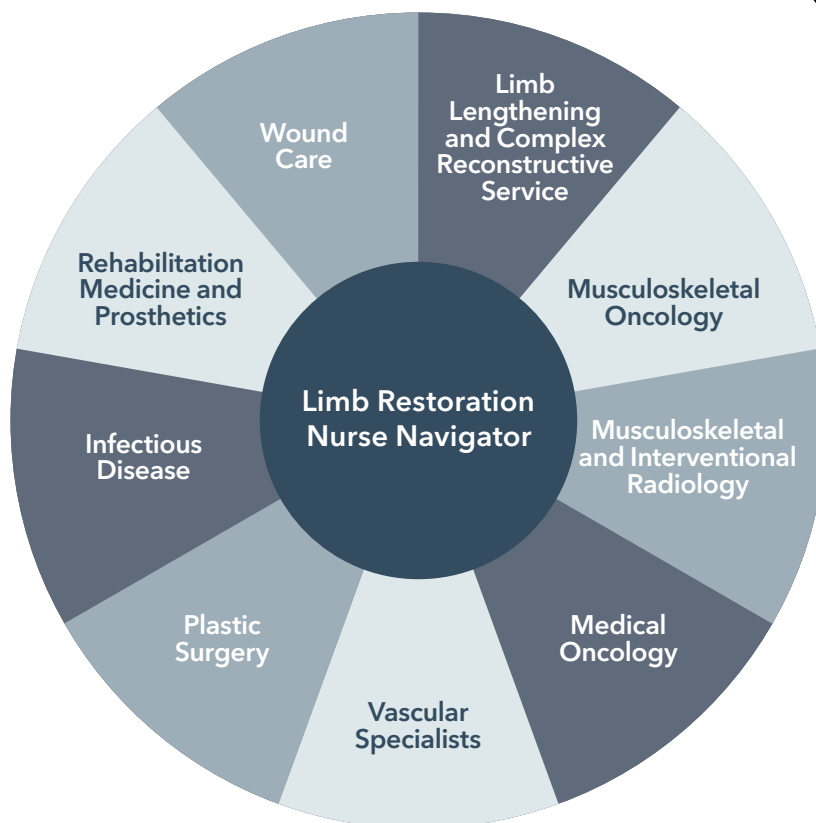
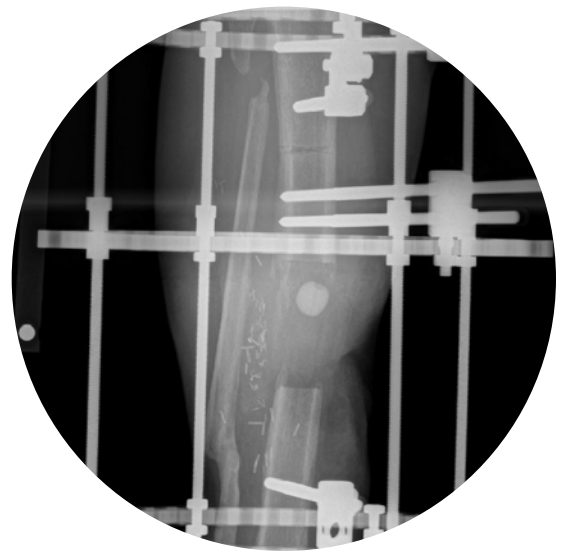
Our internationally recognized multidisciplinary Limb Restoration Program, led by Dr. Jason Stonback, is dedicated to restoring patients' limbs, returning them to function and giving them back any quality of life they have lost. The program has more than 20 experts in their respective specialties; our team cares for patients in 30 states and six countries.

With state-of-the-art treatment options and the multidisciplinary collaboration of several specialty services, the Limb Restoration Program allows us to diagnose and treat the most challenging cases, including being one of the few programs in the world to offer osseointegration for amputees.

Our limb restoration team meets every week to review and consult on all cases, ensuring that patients receive the best custom treatment plan possible for their situation.

Conditions treated:

- Bone infections
- Nonunions/malunions
- Limb lengthening and deformity correction
- Vascular diseases
- Chronic wounds
- Congenital conditions/deformities
- Amputated extremities

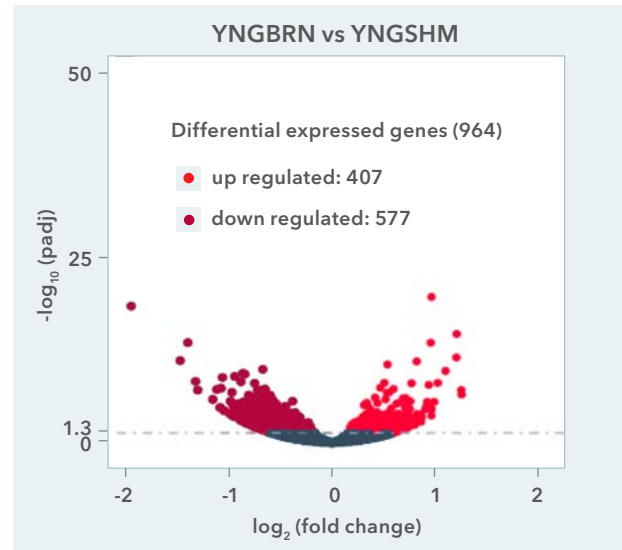


Elizabeth J. Kovacs, PhD

Burn, alcohol and aging research lab

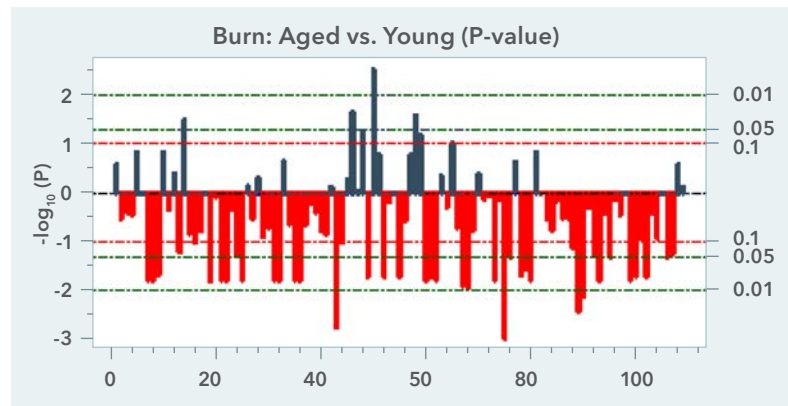
Research focus:

- Multi-organ system response in burn patients and murine models.
 - Ethanol effects on recovery from injury (NIH R01).
 - Aging, macrophage mediators and burn trauma (NIH R01).
 - Mesenchymal stem cells and inflammation after burn (NIH R21).
 - Multi-organ inflammatory response after burn trauma (VA Merit Award).
- Alcohol and aging and response to infection.
 - Alcohol and lung immunity in the aged (NIH R21).
 - Ethanol and pulmonary innate immunity in a murine model of aging (NIH F31, sponsor).



Accomplishments in the last 12 months:

- Seven scientific presentations
- One Presidential address
- One international and two national conferences
- Two university visiting professor presentations
- 14 manuscripts published/in press
- 19 abstracts at national/international conferences
- Trainees
 - Six short oral presentations
 - Four travel awards



Grants:

- Continuing: NIH, NIA R01 Age & Burn YR15; NIGMS R01 Alcohol Burn YR18; NIAAA R21 MSC & Burn YR2
- New and approved to fund: NIAAA R21 Alcohol & Aging; VA Merit Award Burn Biomarkers; NIAAA R13 Meetings Grant
- NIGMS R35 MIRA Burn Microbiome; NIA R01 Age & Burn
- Trainees: NIH F31 H Hulsebus (alcohol, aging and lung infection); NIH K08 J-P Idrovo (age, burn and liver)

Team:

- Elizabeth J. Kovacs, PhD—professor
- Juan-Pablo Idrovo, MD—assistant professor
- Rachel McMahan, PhD—assistant research professor
- Trainees
 - Kiran Dyamenahalli, MD/PhD—fellow
 - Devin Boe—MSTP student
 - Holly Hulsebus, MPH—PhD student
 - Kevin Najarro, MS—lab manager
 - Juliet Mullen—PRA
- Major collaborators
 - Ellen Burnham, MD, MS
 - Mashkoor Choudhry, PhD
 - Sean Colgan, PhD
 - Dan Frank, PhD
 - Anne Wagner, MD
 - Arek Wiktor, MD
 - Cara Wilson, MD

Catherine G. Velopulos MD, MHS, FACS

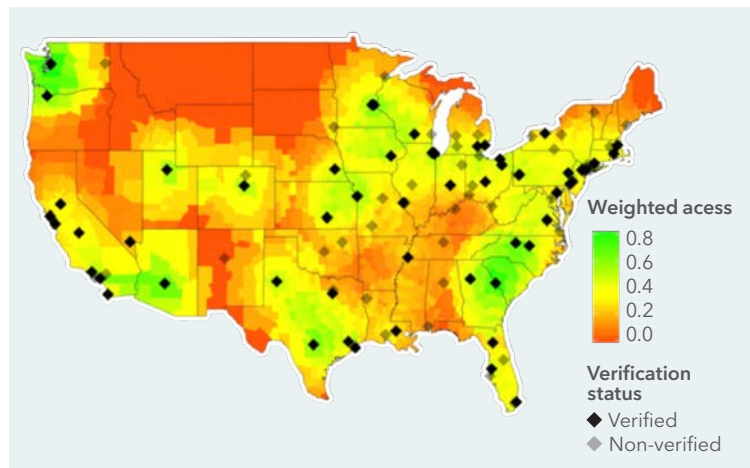
Health services research lab

Research focus:

- Examining disparities in surgical outcomes/access to care.
- Hospital-based violence-intervention programs/intimate-partner violence.
- Geographic information systems.
- Mentoring CU-UNITE urban underserved track.

Accomplishments in the last 12 months:

- 10 national scientific presentations—five full-podium, three quick shots and two posters.
- 11 publications—four first authored by research resident, two first authored by medical students.
- Two manuscripts in revision.
- Awarded as Co-I on \$950,000 Department of Justice grant to evaluate Denver Health Hospital-Based Violence Intervention Program (AIM).
- Dr. Carmichael sponsored by SOAR for ACS Health Services research course.
- R01 surgical disparities submitted—modifiable factors in emergent presentation of potentially elective general surgical disease for patients who are insured or insurance-eligible.



Team

- Catherine G. Velopulos, MD, MHS, FACS—associate professor, Vice-Director Surgical Outcomes & Applied Research (SOAR), Director of Trauma Research
- Shane Urban BSN, RN—trauma research nurse
- Heather Carmichael, MD—research resident
- Collaborators with CDPHE
 - Kirk Bol, MSPH
 - Ethan Jamison, MPH
- Medical and undergraduate students
 - Joshua Abolarin, MS2
 - Samantha Klaas
 - Andrea Kramer
 - Martin Moe
 - Allison Moore, MS2
 - Sara Muramoto, MS3
 - Billy Tran, MS4
 - Lesley McClafferty

Burn unit clinical research

Research focus:

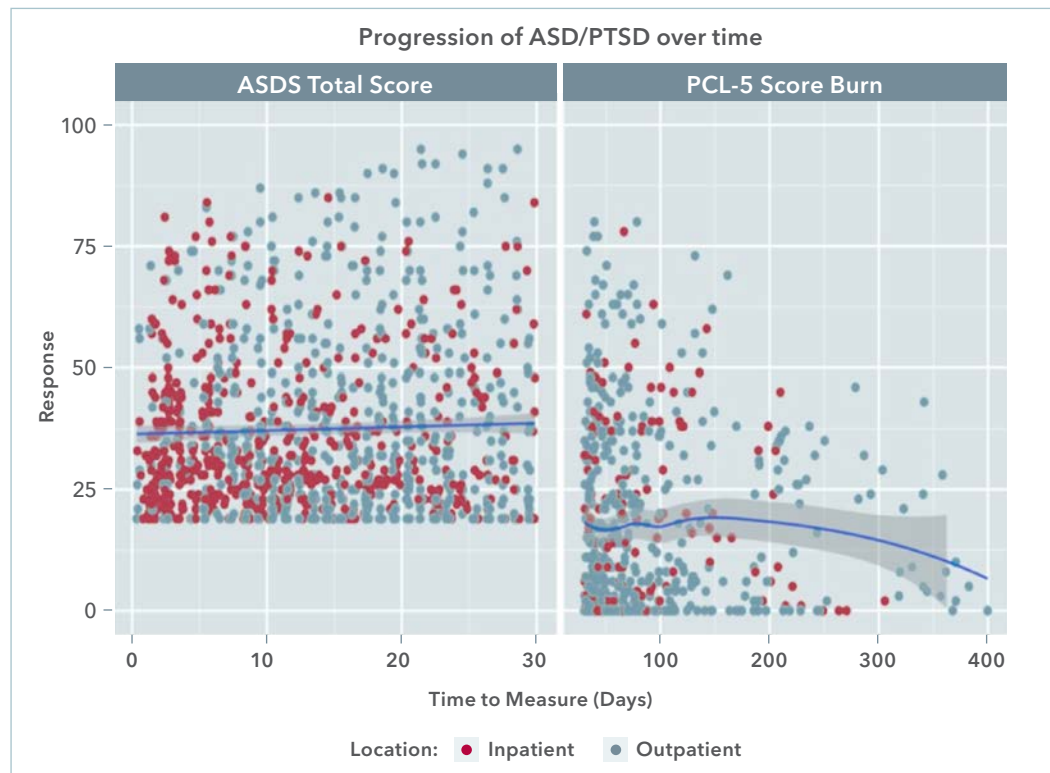
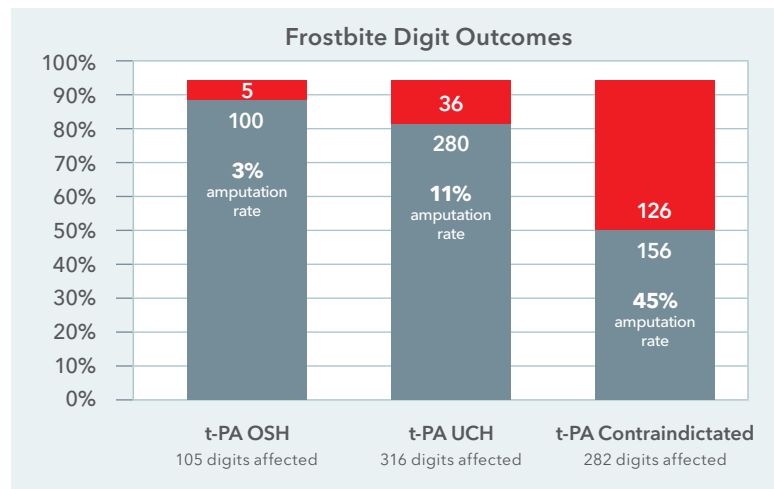
- Early frostbite therapy (TPA).
- ASD/PTSD in burn survivors.
- Drugs of abuse in burn and frostbite populations.
- Mobile app technology for triage.
- Elderly burn care.
- Burn resuscitation and coagulopathy.
- Glutamine supplementation in burn patients (ReEnergize Trial).

Accomplishments in last 12 months:

- 10 abstracts accepted at three national conferences.
- Five podium presentations.
- Three published manuscripts.
- 5th highest enroller of patients in ReEnergize trial (out of 80 sites worldwide).

Team:

- Anne Wagner, MD—Burn and Frostbite Center Medical Director
- Arek Wiktor, MD—Assistant Medical Director, Burn and Frostbite Center
- Patrick Duffy, MD—Assistant Professor of Surgery
- Heather Carmichael, MD—Research resident
- Julia Coleman, MD—Research resident
- Kiran Dyamenahalli, MD—Research resident
- Tyler Smith—PRA



Franklin Wright, MD

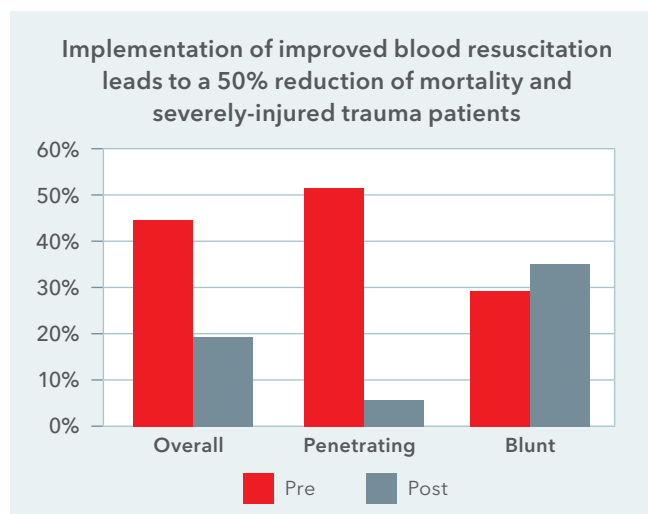
Pre-hospital and trauma/ICU quality improvement research lab

Research focus:

- Pre-hospital trauma.
- Quality improvement and process improvement projects.
- Optimizing early trauma care (EMS and ED/trauma bay) and ICU care.

Accomplishments:

- Five scientific presentations—four national, one local and two full-podium.
- One publication, one manuscript in revision and one in submission.
- Co-investigator on faculty CEPS grant.
- Ongoing ICU QI/PI projects with nursing leadership.



Team:

- Franklin Wright, MD—Assistant professor
- Erik Peltz, DO—Assistant professor
- Heather Carmichael, MD—Research resident
- Allie Kovar, MD—Research resident
- Jacob Mago, MS4—Medical student

Comparison of Pre-Hospital MTP Activation Triggers

	EMS-G (≥ 3 points)	Pre-hospital ABC score (≥ 2 points)	Shock index
Sensitivity	89% (72-98%)	46% (27-66%)	85% (78-92%)
Specificity	84% (78-89%)	94% (89-96%)	79% (76-82%)
ROC area	0.866 (0.803-0.930)	0.827 (0.786-0.868)	0.822 (0.782-0.861)

Research impact (FY 2019)

21 publications

54 invited lectures

22 research presentations

9 book chapter contributions

UCHealth University of Colorado Trauma Center

12505 E. 16th Ave.
Anschutz Inpatient Pavilion 2, 1st Floor
Aurora, CO 80045

UCHealth Burn and Frostbite Center - Anschutz Medical Campus

12605 E. 16th Ave.
Anschutz Inpatient Pavilion, 3rd Floor
Aurora, CO 80045

For more information about the University of Colorado Hospital Trauma and Burn Service Line Annual Report (FY2019), please call 720.848.4805.

Trauma and Burn Care

uchealth.org

Trauma Program Data Validation Abstraction Tool

Re-Abstractor:	Medical Record:
----------------	-----------------

Pre-Hospital

Where vitals taken on the scene of injury? Y N

Blunt Penetrating Burn

External Cause Code Correct? ☐ Yes ☐ No

Pre-Hospital Transport Decision: TC MAR Other

Emergency Department

Meets "Exhibit C" Criteria: ☐ Yes ☐ No

Trauma Team Activated: ☐ Yes ☐ No ☐ N/A Activation Time:

TPS Rationale Correct? ☐ Yes ☐ No

ED Vital Signs: Within 30 Minutes? ☐ Yes ☐ No

BP: HR: RR:

GCS: E: V: M:

Trauma Surgeon Called Time: TRS Arrival Time:

NES Called Time: NES Arrival Time:

ORT Called Time: ORT Arrival Time:

Signs of Life on Arrival: Y N

Admitting Service: Next Phase After ED:

Hospital

Total Vent Days:

ICU Arrival Date 1: ICU Discharge Date 1:

ICU Arrival Date 2: ICU Discharge Date 2:

Consults:

D/C Date: D/C Time: D/C To:

3 Highest Body regions ICD – 10 Diagnoses

List:

Total ISS:

Pre-existing Conditions (especially FDHS)

List:

Documentation Issues with Pre-existing Conditions

Unknown or Not clear documentation

Hospital Events

List:

TQIP Process Measures

Traumatic Brain Injury: Y N

Highest GCS Total on calendar day after ED/Hospital arrival:

Highest GCS Motor on calendar day after ED/Hospital arrival:

Initial ED Pupillary Response (Within 30 Minutes of ED Arrival): (Select One)

Venous Thromboembolism Prophylaxis: Y N

Type of 1st Dose of VTE Prophylaxis: (Select One)

Date of 1st VTE Prophylaxis Dose: Time of 1st Dose:

Hemorrhage Control

PRBC/ Whole Blood Within 4 Hours: Y N

Lowest ED SBP within the first Hour of arrival:

☐ Angiography ☐ Surgery for Hemorrhage Control

Date of Procedure: Time of Procedure:

Miscellaneous

Withdrawal of Life Supporting Treatment ? ☐ Yes ☐ No

Date: Time:

SBIR completed? Y N

Comments: (eg: type of error found – omission, data entry, coding error, etc.)

Reviewed with initial abstractor? Y N

Registry Updated with Changes? ☐ Yes ☐ No

Trauma Registry Data Request Sheet

The Trauma Registry is happy to provide you with the reports you need. Providing aggregate data without patient identifiers is not an issue. Any report that has identifiable protected health information (PHI) must comply with HIPAA requirements. In addition, compliance to the following conditions is mandatory:

1. You agree to protect the confidentiality of all patient data as defined by HIPAA and any Hospital regulations
2. No trauma registry data will be released to organizations outside of the Hospital without the approval of Hospital's administration
3. You agree to acknowledge the assistance of the Trauma Registry contribution when you use the data in projects and published papers
4. All research projects must have gone through the IRB approval process and the IRB number must be provided on the request form
5. Registry data for any research project will not be released without the Trauma Research Coordinator's knowledge
6. Pre-research must have an authorization form attached
7. Data pulled for any quality/process improvement project cannot be used for research projects or in publishing papers

Signing this request form signifies that you agree to comply with all (#1-7) listed above.

Requests will be processed in the order they are received. Plan to meet with the Clinical Informaticist to make sure your request is complete and any questions or concerns are addressed. This meeting will help ensure that your request can be processed in a timely manner.

Please plan time appropriately to ensure requests are submitted well in advance of any deadlines. Reports are available within 10 working days depending on registry workload and the complexity of your request.

Report Requester's Signature

Date

Trauma Services Director Signature

Date

Trauma Research Director Signature

Date

Adult Trauma Medical Director Signature

Date

Pediatric Trauma Medical Director Signature

Date

Trauma Registry Data Report Information

Requested By: _____

Requested For: _____

Department: _____

Date of Request: _____

Requesters Phone #: _____

Requesters E-Mail: _____

1. Data requested for:

☐ Pre-Research - Must attach a copy of completed paperwork

☐ Research Project - Must attach a copy of protocol

☐ IRB#: _____

☐ Non - Human Subject Research

☐ Non - Research

☐ Quality/Process Improvement - Must attach a copy of completed paperwork

2. Give a brief description of what the research project is about to include any questions:

3. Date presented to Trauma Research Group: _____

4. Provide a description of the patient population needed for your project:

Age range: _____ MOI: (ex. MVC): _____

Type of injury (ex. Fracture): _____

Any additional filter (ex. ETOH positive): _____

5. Date range for your patient population: _____

6. Data fields in report: See attached sheet for list of available data elements.

7. Report results: Information will be exported into an Excel spread sheet.

8. Data delivery will be by secure e-mail.

Administrative Use Only	
Name of Report:	Name of Query:
Date Completed:	Completed By:
Additions/Revisions to the Original Report	
Date:	Requested By:
Contact Information:	Reason for Revision:
Date Completed:	Completed By:

Trauma Registry Data Elements

To assist you in identifying those data elements that may meet your request needs, the following list has been provided. Review the list and check the elements that you want included in your final report. Please note that not all trauma patients meet the criteria for inclusion in the registry. Registry data elements are collected based on our registry data dictionary so every field may not meet your research criteria. Select only the elements that are approved in your IRB paperwork.

Demographic & Injury Information			
Name	Age	Primary Mechanism	
Medical Record Number	Gender	Secondary Mechanism	
Visit Number	Race	Cause of Injury (Narrative)	
City: <input type="checkbox"/> Residence <input type="checkbox"/> Injury	Ethnicity	Injury Type (Blunt, Penetrating, Burn)	
State: <input type="checkbox"/> Residence <input type="checkbox"/> Injury	Injury Date	Protective Devices	
County: <input type="checkbox"/> Residence <input type="checkbox"/> Injury	Injury Time	Work Related?	
Zip Code: <input type="checkbox"/> Residence <input type="checkbox"/> Injury	Place of Injury		
Pre-Hospital Information			
Primary Scene EMS Agency	Secondary Scene EMS Agency	Scene Systolic Blood Pressure	
Transport Mode	Transport Mode	Scene Pulse Rate	
Transport Role	Transport Role	Scene Respiratory Rate	
Dispatch to Scene Time	Dispatch to Scene Time	Scene Oxygen Saturation	
Arrive to Scene Time	Arrive to Scene Time	Supplemental Oxygen	
Left Scene Time	Left Scene Time	Intubated?	
GCS: <input type="checkbox"/> Eye <input type="checkbox"/> Verbal <input type="checkbox"/> Motor <input type="checkbox"/> Total	GCS: <input type="checkbox"/> Eye <input type="checkbox"/> Verbal <input type="checkbox"/> Motor <input type="checkbox"/> Total		
Transfer Information			
Immediate Referring Facility	Departure Date	ETOH Testing	
Arrival Date	Departure Time	ETOH Level (mg/dl)	
Arrival Time	Transport EMS Agency	Drug Testing/Results	
Emergency Center Information			
Direct Admission?	Trauma Team Activation	Systolic Blood Pressure	
Hospital Arrival Date	Admitting Service	Pulse Rate	
Hospital Arrival Time	Admitting Physician	Respiratory Rate	
Emergency Center Arrival Date	Trauma Surgeon	Oxygen Saturation	
Emergency Center Arrival Time	Height/Units	Supplemental Oxygen	
Emergency Center Discharge Date	Weight/Units	Intubated?	
Emergency Center Discharge Time	Body Mass Index (BMI)	ETOH Testing	
Emergency Center Length of Stay (Hours)	GCS: <input type="checkbox"/> Eye <input type="checkbox"/> Verbal <input type="checkbox"/> Motor <input type="checkbox"/> Total	ETOH Level (mg/dl)	
Post Emergency Center Destination	Temperature/Unit/Route	Drug Testing/Results	
Mode of Arrival			
Outcome Data	Diagnosis/Procedures	Scores	
Hospital Discharge Date	Diagnoses	Injury Severity Score (ISS)	
Hospital Discharge Time	Pre-Existing Conditions	Abbreviated Injury Score (AIS)	
Hospital Discharge Destination	Non-Trauma Diagnoses	Trauma Injury Severity Score (TRISS)	
Ventilator Days	Procedures		
ICU Days	Complications		
Hospital Days			
Payor			

Trauma Performance Improvement Event Review Tool

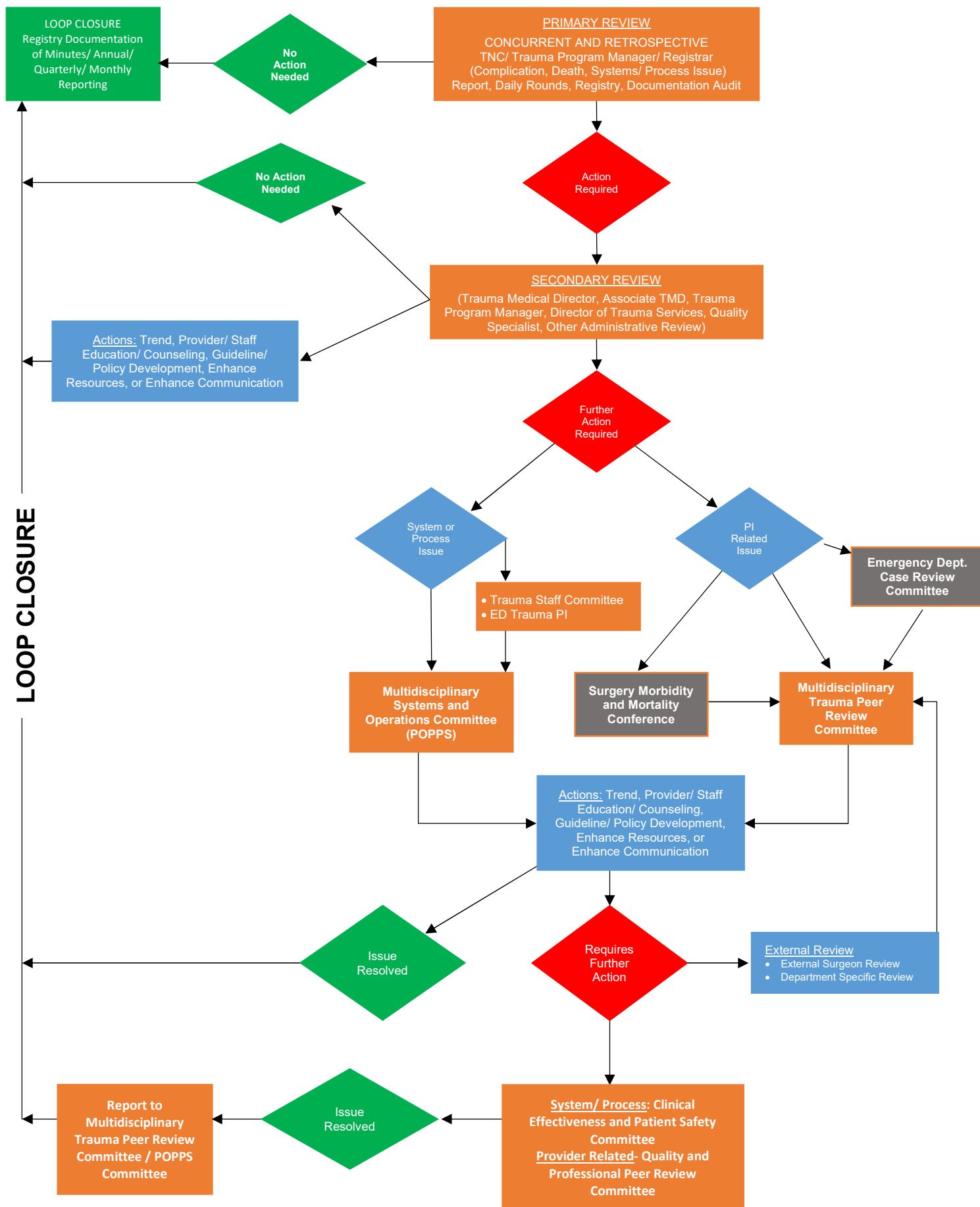
<u>Event/ Mortality Determination:</u>	
<ul style="list-style-type: none"> ○ Without Opportunity for Improvement: to a reasonable degree of medical certainty outcome would have been the same regardless of any errors made. ○ With Opportunity for Improvement: Errors made & identified, more likely than not, outcome would have been the same regardless of errors made. ○ Unanticipated with Opportunity for Improvement: Critical errors made & identified, to a reasonable degree of medical certainty issue would not have occurred had the identified errors been avoided. 	
<u>Care Determination:</u>	<u>Determination (Factors):</u>
<input type="checkbox"/> Care Appropriate <input type="checkbox"/> Care Inappropriate	<input type="checkbox"/> Disease Related <input type="checkbox"/> System Related <input type="checkbox"/> Provider Related
<u>Harm (Impact):</u> * See reverse for harm reference	<u>Type:</u>
<input type="checkbox"/> No Harm <input type="checkbox"/> Minimal Harm <input type="checkbox"/> Moderate Harm <input type="checkbox"/> Severe Harm <input type="checkbox"/> Temporary <input type="checkbox"/> Permanent <input type="checkbox"/> Death (Event directly contributed to Death)	<input type="checkbox"/> Communication <input type="checkbox"/> Patient Management <input type="checkbox"/> Clinical Performance
<u>Recommended Corrective Action:</u>	
<input type="checkbox"/> None Needed <input type="checkbox"/> Counseling <input type="checkbox"/> Change in provider privileges or credentials <input type="checkbox"/> External Review <input type="checkbox"/> Enhanced resources, facilities, or communication <input type="checkbox"/> Guideline, protocol or pathway development or revision <input type="checkbox"/> Letter sent/no response requested <input type="checkbox"/> Letter sent/response requested	<input type="checkbox"/> Other <input type="checkbox"/> QI Referral (EDCRC, Ortho, or NSGY review) <input type="checkbox"/> Risk Management Referral <input type="checkbox"/> Systems Project <input type="checkbox"/> Trend Provider/ Service <input type="checkbox"/> Targeted education (rounds, conferences, journal clubs) <input type="checkbox"/> Trauma Tertiary Review <input type="checkbox"/> Trauma M&M <input type="checkbox"/> Trauma.ED Case Conference

Levels of Harm Tool

Levels of Harm- Definitions		
Level	Outcome	Suggested Follow Up*
Death	Unexpected death, not related to the natural or expected course of patient illness or underlying condition.	Tertiary Review (Peer Review, Systems/ Operations Committee), Root Cause Analysis, Quality Department Collaboration
Severe Harm (Temporary or Permanent)	Patient Outcome symptomatic, requiring life saving intervention or major medical surgical intervention, shortening life expectancy or causing major permanent or temporary harm or loss of function.	Tertiary Review (Peer Review, Systems/ Operations Committee), Root Cause Analysis, Quality Department Collaboration
Moderate Harm (Temporary or Permanent)	Patient Outcome is symptomatic, requiring intervention (e.g. additional operative procedure or therapeutic treatment), increased length of stay, causing permanent or temporary harm, or loss of function.	Tertiary Review (Peer Review, Systems/ Operations Committee), Root Cause Analysis, Quality Department Collaboration as needed
Minimal Harm (Temporary or Permanent)	Patient Outcome is symptomatic, symptoms are mild, loss of function or harm is minimal or intermediated, but short term, and minimal or no intervention is needed (e.g. extra observation, investigation, review, or minor treatment)	Secondary Review with Tertiary Review as needed, Systems/ Operations Committee for systems issues, Quality Department Collaboration as needed
No Detectable Harm	Outcome is asymptomatic, no symptoms are detected, and no treatment is required.	Primary Review with referral to Secondary/ Tertiary Review as needed for educational purposes. Referral to Systems/ Operations Committee as needed for educational purposes.

*Analysis of data related to devised action plans will be utilized to determine when event resolution has occurred.

Trauma Performance Improvement and Patient Safety Review Process



Trauma Service

Ongoing Professional Practice Evaluation (OPPE)

Practitioner: _____

Trauma Review Period (yr): _____

Trauma Response:

Level I Trauma Activations during the review period = (\leq 15 minutes of patient arrival)

#of activations: _____ #timely responses: _____ %

Level II Trauma Activations during review period= (\leq 30 minutes of patient arrival)

#of activations: _____ #responses < 30 minutes: _____ %

Activations:

Average ED LOS _____ Average patient ISS _____

Meeting Attendance:

_____ %

Continuing Medical Education Requirements: Note: CME for Verification Period

CME Total: 2015 _____ 2016 _____ 2017 _____

_____ Meets _____ Does Not Meet

Hospital OPPE:

Hospital Review Period: _____ # cases reviewed _____

Adverse Outcomes: Yes No Disciplinary Action: Yes No

Operative cases: Total all services _____ Total trauma _____

Reviewed by TMD: _____ Date _____

Concerns/Comments: _____

Recommendation(s):

- ☐ Continue without recommendations
- ☐ Continue with recommendations

FPPE: _____

Complete _____ number of trauma CME hours

- ☐ Not recommended for Trauma Call Panel

TMD: _____

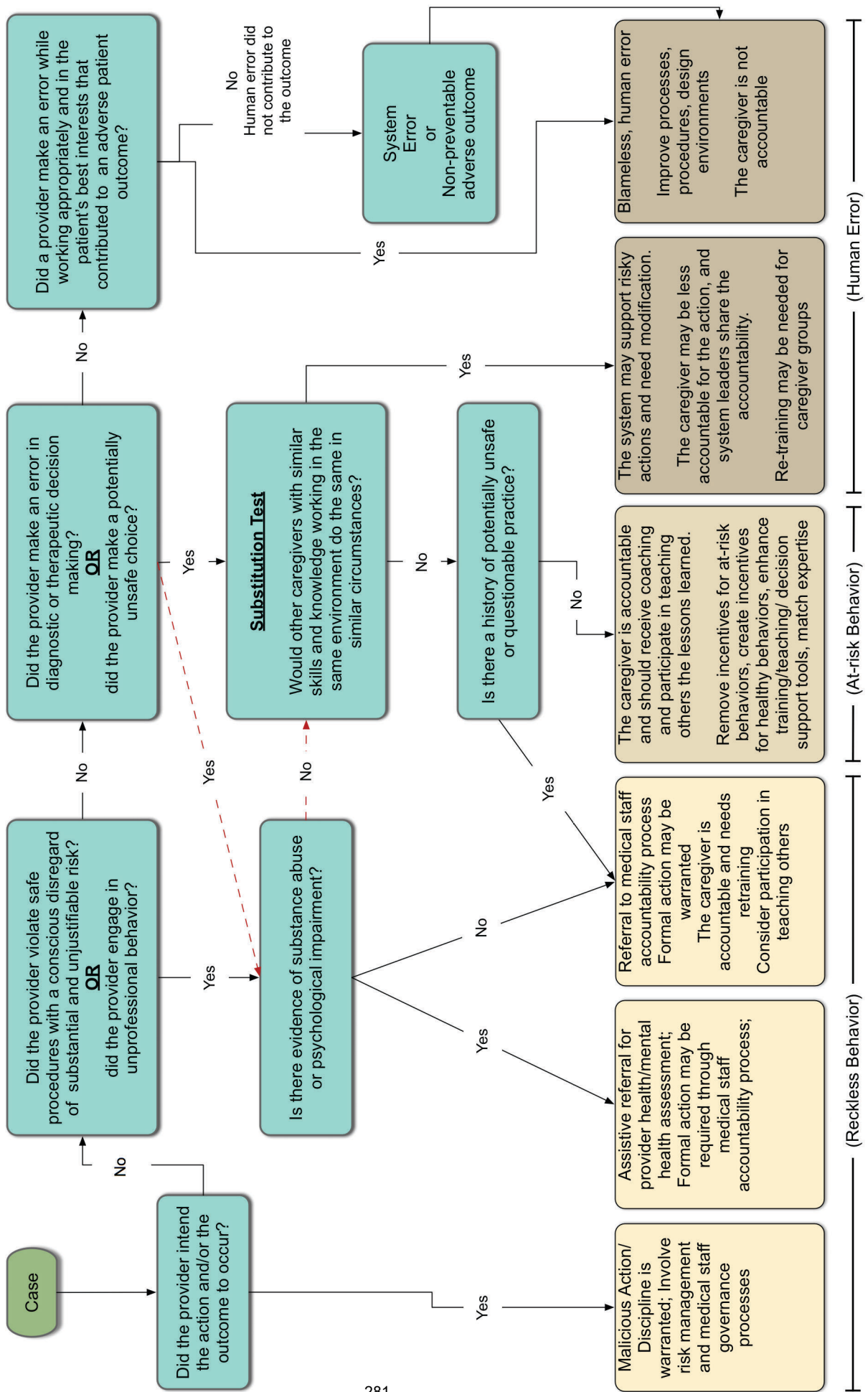
Practitioner _____

Date _____

Date _____

Quality and Peer Review Individual Action Algorithm

Adopted from work of James Reason, David Marx, Michael Leonard, Alan Frankel



APPENDIX B

Rethinking the definition of major trauma: The need for trauma intervention outperforms Injury Severity Score and Revised Trauma Score in 38 adult and pediatric trauma centers

Jacob Watkin Roden-Foreman, Nakia R. Rapier, Michael L. Foreman, MD, Alicia L. Zagel, PhD, Kevin W. Sexton, MD, William C. Beck, MD, Constance McGraw, Raymond A. Coniglio, Abigail R. Blackmore, Jeremy Holzmacher, MD, Babak Sarani, MD, Joseph C. Hess, PhD, Cynthia Greenwell, Charles A. Adams, Jr, MD, Stephanie N. Lueckel, MD, Melinda Weaver, Vaidehi Agrawal, PhD, Joseph D. Amos, MD, Cheryl F. Workman, David J. Milia, MD, Annette Bertelson, Warren Dorlac, MD, Maria J. Warne, John Cull, MD, Cassie A. Lyell, Justin L. Regner, MD, Michael D. McGonigal, MD, Stephanie D. Flohr, Sara Steen, Michael L. Nance, MD, Marie Campbell, Bradley Putty, MD, Danielle Sherar, and Thomas J. Schroepel, MD, Dallas, Texas

BACKGROUND:	Patients' trauma burdens are a combination of anatomic damage, physiologic derangement, and the resultant depletion of reserve. Typically, Injury Severity Score (ISS) >15 defines major anatomic injury and Revised Trauma Score (RTS) <7.84 defines major physiologic derangement, but there is no standard definition for reserve. The Need For Trauma Intervention (NFTI) identifies severely depleted reserves (NFTI+) with emergent interventions and/or early mortality. We hypothesized NFTI would have stronger associations with outcomes and better model fit than ISS and RTS.
METHODS:	Thirty-eight adult and pediatric U.S. trauma centers submitted data for 88,488 encounters. Mixed models tested ISS greater than 15, RTS less than 7.84, and NFTI's associations with complications, survivors' discharge to continuing care, and survivors' length of stay (LOS).
RESULTS:	The NFTI had stronger associations with complications and LOS than ISS and RTS (odds ratios [99.5% confidence interval]: NFTI = 9.44 [8.46–10.53]; ISS = 5.94 [5.36–6.60], RTS = 4.79 [4.29–5.34]; LOS incidence rate ratios (99.5% confidence interval): NFTI = 3.15 [3.08–3.22], ISS = 2.87 [2.80–2.94], RTS = 2.37 [2.30–2.45]). NFTI was more strongly associated with continuing care discharge but not significantly more than ISS (relative risk [99.5% confidence interval]: NFTI = 2.59 [2.52–2.66], ISS = 2.51 [2.44–2.59], RTS = 2.37 [2.28–2.46]). Cross-validation revealed that in all cases NFTI's model provided a much better fit than ISS greater than 15 or RTS less than 7.84.
CONCLUSION:	In this multicenter study, NFTI had better model fit and stronger associations with the outcomes than ISS and RTS. By determining depletion of reserve via resource consumption, NFTI+ may be a better definition of major trauma than the standard definitions of ISS greater than 15 and RTS less than 7.84. Using NFTI may improve retrospective triage monitoring and statistical risk adjustments. (<i>J Trauma Acute Care Surg.</i> 2019;87: 658–665. Copyright © 2019 American Association for the Surgery of Trauma.)
LEVEL OF EVIDENCE:	Prognostic, level IV.
KEY WORDS:	Major trauma; trauma burden; trauma severity indices; multicenter.

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Outcomes of traumatic injury depend on anatomic damage, physiologic derangement, and depletion of patient reserve,¹ which collectively form a patient's total trauma burden. Quantifying trauma burden is important for several reasons: retrospectively identifying patients with major trauma to ensure they were taken to trauma centers for appropriate, high-level care; verifying activation criteria captured major traumas to limit undertriage; and adjusting for differences in case severity to discern the generalizability of research findings in other patient populations (i.e., risk adjustment). Despite the importance of measuring trauma burden, common metrics face substantial limitations.¹⁻³

Anatomic injury is typically measured with Injury Severity Score (ISS).⁴ Despite its ubiquity, ISS has several limitations, including giving equal importance to its six body regions and not accounting for multiple injuries to the same region. Physiologic derangement is commonly measured with Revised Trauma Score (RTS)—or at least its components, Glasgow Coma Scale (GCS), systolic blood pressure (SBP), and respiratory rate (RR).⁵ Revised Trauma Score also suffers limitations, namely, difficulty calculating and interpreting it in intubated or sedated patients.

Unlike anatomy and physiology, where there are numerous measures in addition to those above, measurement of patient reserve has proven to be largely elusive, likely in part because of the vagueness of the concept.¹ A recent measure, Need For Trauma Intervention (NFTI),⁶ however, takes a novel approach to detecting reserve depletion by assuming the intensity of intervention is proportional to the relative impact of trauma on reserve and therefore indicative of trauma burden. Thus, NFTI identifies a major depletion of reserve based on early consumption of critical resources used to replenish a depleted reserve. The NFTI criteria (see Major Trauma Variables section of Methods) largely overlap with non-ISS-based definitions of major trauma suggested by the American College of Surgeons, Committee on Trauma,⁷ and NFTI's use is supported by single-center research.⁶ This multicenter study compared ISS, RTS, and NFTI as predictors of patient outcomes to validate NFTI as an indicator of major trauma burden. We hypothesized NFTI would have stronger associations and provide a better fit to the data than ISS and RTS.

METHODS

Sample

A convenience sample of 38 trauma centers (25 adult only, 3 pediatric only, and 10 combined) in the United States joined this retrospective cross-sectional study in response to a posting on the Society of Trauma Nurses website. After institutional review board approval, centers submitted data for 99,412 encounters arriving January 1, 2015, to December 31, 2016. Direct admissions, transfers out from the emergency department (ED) for definitive care, or encounters with International Classification of Diseases, Ninth or Tenth Revision primary cause codes for poisoning, adverse medication effects, suffocation, or drowning were excluded ($n = 686$; 0.7%). Cases missing age, sex, injury mechanism, ISS, GCS, SBP, RR, NFTI, or any outcome were excluded because these variables were missing not at random ($n = 10,238$; 10.3%).

Major Trauma Variables

Injury Severity Score is calculated from the highest Abbreviated Injury Scale (AIS) severities in up to three anatomic regions. These severity scores are squared then summed to form ISS. One exception to this calculation is that any AIS severity of six automatically results in an ISS of 75. The ISS ranges from 0 to 75 with higher scores indicating more anatomic damage. Injury Severity Score >15 was proposed to define major trauma because it predicted 10% mortality⁸; that cutoff has since become the standard definition for major (anatomic) trauma.

Revised Trauma Score is calculated by coding GCS (13–15 = 4; 9–12 = 3; 6–8 = 2; 4–5 = 1; 3 = 0), SBP ($>89 = 4$; 76–89 = 3; 50–75 = 2; 1–49 = 1; 0 = 0), and RR (10–29 = 4; $>29 = 3$; 6–9 = 2; 1–5 = 1; 0 = 0) into categories.⁵ These coded values are entered into Formula 1 to calculate RTS. The RTS ranges from 0 to 7.84 with lower scores portending worse outcomes. Any coded RTS category <4 , the equivalent of RTS <7.84 , is recommended to identify patients needing emergent transport to a trauma center and defines major physiologic trauma in this study.⁵ This study used initial ED GCS, SBP, and RR to calculate RTS.

Formula 1: $RTS =$

$$(GCS_{coded} \times 0.9368) + (SBP_{coded} \times 0.7326) + (RR_{coded} \times 0.2908)$$

The NFTI criteria are: (1) receiving packed red blood within 4 hours of arrival; (2) ED discharge to operating room (OR) within 90 minutes; (3) ED discharge to interventional radiology; (4) ED discharge to intensive care unit (ICU) with ICU length of stay (LOS) ≥ 3 calendar days; (5) nonprocedural mechanical ventilation within 72 hours of arrival; and (6) mortality within 60 hours of arrival. Patients meeting any NFTI criteria are classified NFTI+ and considered to have injuries that severely depleted their reserves, indicating major trauma; otherwise, they are NFTI–.

Outcomes

Dichotomous outcomes included (1) discharge to a continuing care facility (long-term care facility, skilled nursing facility, inpatient rehabilitation, nursing home, hospice, or other hospital facility) versus home (home with or without care services, law enforcement, inpatient psychiatric facility, or discharge against medical advice) and (2) experiencing a complication (acute kidney injury, acute respiratory distress syndrome, cardiac arrest, decubitus ulcer, deep vein thrombosis, extremity compartment syndrome, myocardial infarction, pulmonary embolism, severe sepsis, stroke/cerebrovascular accident, unplanned return to OR, or unplanned ICU admission). Complications were defined per the National Trauma Data Standard (NTDS)⁹; other complications in the NTDS were excluded from the above operational definition as they could result from meeting NFTI criteria (e.g., ventilator-associated pneumonia) or were not considered surrogates of injury burden (e.g., drug withdrawal). The only continuous outcome was total LOS. Analyses of discharge disposition and LOS were conducted on survivors. These outcomes were selected because they are among the few clinically meaningful outcomes that are not confounded with NFTI.

Statistical Analysis

Generalized linear mixed models (GLMMs) were used to estimate the associations of ISS > 15, RTS < 7.84, and NFTI+ on the outcomes. In this and the Results sections, all references to ISS, RTS, and NFTI refer to the variables dichotomized at those cutoffs unless otherwise stated. Fixed effects for the GLMMs were ISS, RTS, NFTI, sex, linear and quadratic age effects, and the number of encounters from each hospital. The two age terms controlled for nonlinear age effects. The number of encounters from each hospital controlled for informative cluster size.¹⁰ The GLMMs had random intercepts for hospital and primary injury mechanism. The random intercept for hospital controlled for the clustered nature of the data. The random intercept for injury mechanism was nested within the hospital random intercept as an interaction to account for different levels of familiarization with injury types (e.g., burns treated at burn centers versus nonburn centers). Additionally, an observation-level random intercept was added to control for overdispersion.^{11,12}

The GLMMs were fit in two steps: (1) univariable models including ISS, RTS, or NFTI; and (2) adjusted models that added sex, age terms, and injury mechanism to each univariable model. All GLMMs included the hospital and observation-level random effects, and the fixed effect for number of encounters.

Model performance/fit was assessed via leave one cluster out (LOCO) cross validation of the adjusted models. This procedure involves removing one of the hospitals from the data set, then refitting the adjusted models using data from the remaining 37 hospitals; this is repeated for every hospital, producing 38 LOCO models. For each LOCO model, we calculated the Bayesian Information Criterion (BIC). Smaller BIC values indicate better fit, and a BIC difference of 10 indicates there is very strong evidence one model is better than another.¹³ We report the median BIC from the LOCO cross-validation models.

Binary outcomes were modeled with binomial GLMMs with logit links. After winsorizing outliers beyond the 99th percentile (i.e., setting outliers equal to the value of the 99th percentile), quantile-quantile plots were used to assess the distribution of LOS. Accordingly, LOS was modeled with Poisson GLMMs with log links.

Sensitivity analyses included pediatric (age < 15 years) and geriatric (age > 64 years) subset analyses. Due to quasi-complete separation in the binomial GLMMs for these subsets, Bayesian versions of these models were used that penalized ISS, RTS, and NFTI's associations to the outcomes.¹⁴ Specifically, the prior probability distributions for ISS, RTS, and NFTI were normal with a mean of 0.0 and standard deviation of 0.1; the other priors were normal with a mean of 0.0 and standard deviation of 10.

To set a conservative alpha level, significance was assessed at $p < 0.005$, which aligns with the evidentiary threshold typical of Bayesian analyses¹⁵; for this reason, 99.5% confidence intervals (CIs) are reported. *P*-values between 0.05 and 0.005 were considered of suggestive significance.

Analyses were conducted with R (version 3.4.3; R Foundation for Statistical Computing, Vienna, Austria) using the packages lme4,¹⁶ blme,¹⁷ and MASS.¹⁸

RESULTS

Description of Sample

Of the 99,412 encounters submitted, 88,488 (89.6%) met inclusion criteria and had nonmissing data for analysis. Table 1 provides a description of the sample's clinical information. The frequencies of ISS, RTS, and NFTI are cross-tabulated in Table 2. An anonymized description of the centers is given in Supplemental Digital Content 1, <http://links.lww.com/TA/B433>.

Complication

The adjusted odds ratios (AORs) indicate all definitions of major trauma were associated with increased odds of complication (Table 3; all $p < 0.001$). Specifically, in the adjusted models, NFTI was associated with a 9.44-fold increase in the odds of experiencing a complication (99.5% CI: 8.46–10.53), ISS was associated with a 5.94-fold increase (95% CI: 5.36–6.60), and RTS was associated with a 4.79-fold increase (95% CI: 4.29–5.34). The LOCO cross-validation revealed that the NFTI model provided the best fit to the data, with a median BIC of 24,375. The ISS model provided the next best fit (25,750) followed by the RTS model (26,531).

Discharge to Continuing Care Facility

Due to the high prevalence of continuing care discharges (25.8%), the models' results are presented with adjusted relative risk (ARR). Among survivors ($n = 85,766$), meeting any of the definitions of major trauma was associated with significantly higher risk of discharge to a continuing care facility versus to home compared with those not meeting major trauma definitions (Table 4; all $p < 0.001$). In the adjusted models, NFTI was associated with a 2.59-fold increase in the risk of a continuing care discharge (99.5% CI: 2.52–2.66), ISS was associated with a 2.51-fold increase (99.5% CI: 2.44–2.59), and RTS was associated with a 2.37-fold increase (99.5% CI: 2.28–2.46). While the association was stronger for NFTI than ISS, the CI indicated NFTI's association was not greater than ISS's at $p < 0.005$; only at 98.5% confidence (i.e., at $p = 0.015$) do NFTI and ISS's CIs no longer contain the other's point estimate, suggesting NFTI's association likely is significantly stronger than ISS's. Nonetheless, the LOCO cross-validation indicated the NFTI model (median BIC = 63,669) was a much better fit to the data than the ISS (64,348) or RTS (65,750) models.

Length of Stay

Also among survivors ($n = 85,766$), the adjusted incidence rate ratios (AIRRs) in Table 5 indicate that while all three definitions of major trauma were positively associated with LOS, NFTI had the strongest association, followed by ISS then RTS (all $p < 0.001$). The adjusted models indicate that NFTI+ survivors were admitted 215% longer than NFTI– survivors (99.5% CI: 208%–222%); survivors with ISS greater than 15 were admitted 187% longer (CI: 180%–194%); and survivors with RTS less than 7.84 were admitted 137% longer (CI: 130%–145%). Median LOCO cross-validation BICs indicated NFTI (387,165) provided substantially better fit to the data than ISS (392,364) and RTS (399,390).

TABLE 1. Description of Sample

	ISS < 15	ISS > 15	RTS = 7.84	RTS < 7.84	NFTI–	NFTI+	Overall
Frequency	74,597 (84.3)	13,891 (15.7)	77,797 (87.9)	10,691 (12.1)	71,760 (81.1)	16,728 (18.9)	88,488 (100)
ISS	5 [4, 9]	22 [17, 27]	5 [4, 10]	13 [5, 25]	5 [4, 9]	14 [9, 25]	8 [4, 10]
ISS > 15	0 (0.0)	13,891 (100)	9,063 (11.7)	4,828 (45.2)	5,782 (8.1)	8,109 (48.5)	13,891 (15.7)
RTS	7.8 [7.8, 7.8]	7.8 [6.8, 7.8]	7.8 [7.8, 7.8]	6.8 [4.1, 7.3]	7.8 [7.8, 7.8]	7.8 [5.9, 7.8]	7.8 [7.8, 7.8]
RTS < 7.84	5,863 (7.9)	4,828 (34.8)	0 (0.0)	10,691 (100)	4,382 (6.1)	6,309 (37.7)	10,691 (12.1)
GCS	15 [15, 15]	15 [11, 15]	15 [15, 15]	11 [3, 15]	15 [15, 15]	15 [8, 15]	15 [15, 15]
SBP	135 [119, 152]	130 [111, 149]	135 [120, 152]	119 [90, 140]	135 [120, 152]	130 [110, 150]	134 [118, 151]
RR	18 [16, 20]	18 [16, 21]	18 [16, 20]	20 [16, 30]	18 [16, 20]	18 [16, 21]	18 [16, 20]
NFTI+	8,619 (11.6)	8,109 (58.4)	10,419 (13.4)	6,309 (59.0)	0 (0.0)	16,728 (100)	16,728 (18.9)
NFTI criteria met							
PRBC	1,029 (1.4)	2,291 (16.5)	1,406 (1.8)	1,914 (17.9)	0 (0.0)	3,320 (19.9)	3,320 (3.8)
ED to OR	2,352 (3.2)	1,330 (9.6)	2,573 (3.3)	1,109 (10.4)	0 (0.0)	3,682 (22.1)	3,682 (4.2)
ED to IR	13 (0.0)	40 (0.3)	35 (0.0)	18 (0.2)	0 (0.0)	53 (0.3)	53 (0.1)
ED to ICU	3,614 (4.8)	4,720 (34.0)	5,403 (7.0)	2,931 (27.4)	0 (0.0)	8,334 (49.8)	8,334 (9.4)
Ventilation	3,051 (4.1)	3,739 (26.9)	3,035 (3.9)	3,755 (35.1)	0 (0.0)	6,790 (40.6)	6,790 (7.7)
Death in 60 hrs	345 (0.5)	1,325 (9.5)	237 (0.3)	1,433 (13.4)	0 (0.0)	1,670 (10.0)	1,670 (1.9)
Age, years	45 [22, 69]	47 [26, 66]	47 [23, 70]	34 [17, 58]	45 [21, 69]	47 [26, 66]	46 [23, 68]
Age < 15 years	12,605 (16.9)	1,022 (7.4)	11,200 (14.4)	2,427 (22.7)	12,346 (17.2)	1,281 (7.7)	13,627 (15.4)
Age > 64 years	22,088 (29.6)	3,719 (26.8)	23,836 (30.6)	1,971 (18.4)	21,312 (29.7)	4,495 (26.9)	25,807 (29.2)
Male sex	43,845 (58.8)	9,538 (68.7)	46,237 (59.4)	7,146 (66.8)	41,904 (58.4)	11,479 (68.6)	53,383 (60.3)
Primary injury mechanism							
Blunt	67,255 (90.2)	12,588 (90.6)	70,658 (90.8)	9,185 (85.9)	66,021 (92.0)	13,822 (82.6)	79,843 (90.2)
Burn	598 (0.8)	72 (0.5)	543 (0.7)	127 (1.2)	550 (0.8)	120 (0.7)	670 (0.8)
Other	360 (0.5)	45 (0.3)	332 (0.4)	73 (0.7)	318 (0.4)	87 (0.5)	405 (0.5)
Penetrating	6,384 (8.6)	1,186 (8.5)	6,264 (8.1)	1,306 (12.2)	4,871 (6.8)	2,699 (16.1)	7,570 (8.6)
Complication	1,707 (2.3)	1,767 (12.7)	2,292 (2.9)	1,182 (11.1)	1,181 (1.6)	2,293 (13.7)	3,474 (3.9)
Continuing care*	16,878 (22.8)	5,269 (44.2)	19,066 (24.7)	3,081 (35.2)	15,909 (22.2)	6,238 (43.5)	22,147 (25.8)
LOS, d*	2.0 [0.8, 4.1]	6.5 [3.6, 12.6]	2.4 [0.9, 4.8]	4.2 [1.4, 11.4]	2.0 [0.8, 4.0]	6.9 [3.7, 12.9]	2.6 [0.9, 5.0]

* Among survivors (n = 85,766).

Continuous variables described with median [interquartile interval]; categorical variables described with frequency (percent).

PRBC, receiving packed red blood within 4 hours of arrival; ED to OR, discharge from the emergency department to the operating room within 90 minutes; ED to IR, discharge from the emergency department to interventional radiology; ED to ICU, discharge from the emergency department to the intensive care unit (ICU) and remaining in the ICU for ≥ 3 calendar days; ventilation, initiation of nonprocedural mechanical ventilation within 72 hours of arrival; death in 60 hrs, death within 60 hours of hospital arrival; continuing care, discharge to a continuing care facility (long-term care facility, skilled nursing facility, inpatient rehabilitation, nursing home, hospice, or other hospital facility) versus home (home with or without care services, law enforcement, inpatient psychiatric facility, or discharge against medical advice).

TABLE 2. Cross-Tabulated Frequencies of ISS >15, RTS <7.84, and NFTI+

Definitions of Major Trauma Met	Frequency (percent)
None	62,163 (70.3)
ISS >15 only	5,215 (5.9)
RTS <7.84 only	3,815 (4.3)
NFTI+ only	6,571 (7.4)
ISS >15 and RTS <7.84	567 (0.6)
ISS >15 and NFTI+	3,848 (4.3)
RTS <7.84 and NFTI+	2,048 (2.3)
ISS >15, RTS <7.84, and NFTI+	4,261 (4.8)

Pediatric Subset Analysis

There were 13,625 (15.40%) encounters with age <15 years. NFTI had nonsignificantly stronger associations with complication and continuing care discharge than ISS or RTS. When examining LOS, ISS was most strongly associated (AIRR: 5.19; 99.5% CI: 4.75–5.68), NFTI had a strong association (AIRR: 4.35; 99.5% CI: 4.01–4.73), and RTS had the weakest association (AIRR: 2.42; 99.5% CI: 2.22–2.64). The NFTI provided the best fit to the data for complications and the second best fit for continuing care discharge and LOS; ISS had the best fit for continuing care discharge and LOS. Complete results are available in Supplemental Digital Content 2, <http://links.lww.com/TA/B434>.

Geriatric Subset Analysis

There were 25,807 (29.16%) encounters with age >64 years. Results for the geriatric sample mirrored the primary analysis with NFTI having the strongest associations and best fit, followed by ISS and RTS. See Supplemental Digital Content 3, <http://links.lww.com/TA/B435>, for complete results.

DISCUSSION

In this study of 38 adult and pediatric trauma centers, ISS >15, RTS <7.84, and NFTI+ were all positively associated with the odds of complication, survivors' risk of discharge to a continuing care facility, and survivors' LOS. Although NFTI did not significantly differ from ISS >15 on the risk of discharge to continuing care, NFTI had stronger associations with all outcomes and consistently provided the best fit to

TABLE 3. Summary of GLMMs Predicting Complication

	Univariable Models AOR (99.5% CI)	Adjusted Models AOR (99.5% CI)
ISS >15	5.80 (5.23–6.42)	5.94 (5.36–6.60)
RTS <7.84	4.37 (3.93–4.87)	4.79 (4.29–5.34)
NFTI+	9.02 (8.10–10.03)	9.44 (8.46–10.53)

All $p < 0.001$; univariable models included ISS, RTS, or NFTI, and adjusted for hospital effects, overdispersion, and number of encounters at each hospital; adjusted models included ISS, RTS, or NFTI, and adjusted for sex, linear and quadratic age, as well as injury mechanism, hospital effects, overdispersion, and number of encounters at each hospital.

TABLE 4. Summary of GLMMs Predicting Discharge to a Continuing Care Facility Among Survivors

	Univariable Models ARR (99.5% CI)	Adjusted Models ARR (99.5% CI)
ISS >15	1.93 (1.86–1.99)	2.51 (2.44–2.59)
RTS <7.84	1.61 (1.54–1.68)	2.37 (2.28–2.46)
NFTI+	1.84 (1.78–1.90)	2.59 (2.52–2.66)

All $p < 0.001$; univariable models included ISS, RTS, or NFTI, and adjusted for hospital effects, overdispersion, and number of encounters at each hospital; adjusted models included ISS, RTS, or NFTI, and adjusted for sex, linear and quadratic age, as well as injury mechanism, hospital effects, overdispersion, and number of encounters at each hospital.

the data. Therefore, as hypothesized, NFTI appears to largely outperform the standard anatomic and physiologic definitions of major trauma.

Since 1974,⁴ ISS has remained the gold standard—albeit tarnished—for measuring anatomic trauma severity largely because it provides a reasonable and convenient summary. Although there are several superior alternatives, they purchase accuracy at the price of increased complexity, making them too complex to be easily implemented, especially outside of research.^{19–23} Further, few have established cutoffs defining major trauma. The convenience of ISS, however, comes with myriad limitations: giving equal importance to the six body regions; not accounting for multiple injuries to the same regions; inability to account for frailty; vastly differing mortality rates for the same ISS resulting from different AIS triplets^{2,24}; consensus-based AIS severities¹; a nonmonotonic relationship with mortality (e.g., 15% mortality for ISS = 16 versus 10% for ISS 17–24, and 38% for ISS = 25 versus 26% for ISS 26–34)²⁵; and the mathematical impossibility of 31 (40.8%) of the values in the range of 0 to 75. The issue of frailty is particularly problematic for ISS as it means an anticoagulated, geriatric patient and an otherwise healthy athlete can have identical injuries—and thus equal ISS—despite the two having very different injury burdens. Nonetheless, ISS >15 remains a useful cutoff to identify major anatomic trauma that had reasonably strong associations with the outcomes, and it provided the second best fit to the data.

Though RTS does not face as many competitors as ISS, it faces nearly as many limitations: RTS is also nonmonotonically related to mortality¹; it offers little improvement over simply

TABLE 5. Summary of GLMMs Predicting Total Length of Stay Among Survivors

	Univariable Models AIRR (99.5% CI)	Adjusted Models AIRR (99.5% CI)
ISS >15	2.81 (2.74–2.88)	2.87 (2.80–2.94)
RTS <7.84	2.17 (2.10–2.23)	2.37 (2.30–2.45)
NFTI+	3.00 (2.93–3.07)	3.15 (3.08–3.22)

All $p < 0.001$; univariable models included ISS, RTS, or NFTI, and adjusted for hospital effects, overdispersion, and number of encounters at each hospital; adjusted models included ISS, RTS, or NFTI, and adjusted for sex, linear and quadratic age, as well as injury mechanism, hospital effects, overdispersion, and number of encounters at each hospital.

using GCS, SBP, and RR¹; it is difficult to calculate and interpret in intubated or sedated patients; and despite ranging 0 to 7.84, only 12.1% of patients have an RTS <7.84, making it difficult to detect differences. Comorbidities can be especially troublesome for RTS as interpretation of vital signs is not without caveat. Vital sign thresholds can be less reliable in geriatric trauma patients, regardless of comorbidities.^{3,26} But an SBP of 80 mm Hg is scored identically whether in an untreated hypertensive or a patient with a baseline SBP of 90 mm Hg. Nonetheless, RTS improves on ISS by not giving equal importance to its components. As shown in Formula (1), RTS places the most importance on GCS as a surrogate measure of brain function, whereas ISS can only measure the anatomic disruption to brain, and sometimes only to the skull or neck. Lastly, unlike ISS and NFTI, RTS can be utilized during initial patient contact, which gives it a unique advantage. Despite these advantages, RTS <7.84 frequently had weaker associations than ISS >15 or NFTI+, and it provided the worst fit to the data.

Because NFTI has not been subjected to the combined seven decades of investigation ISS and RTS have endured, less is known about it. Results indicate NFTI works well in adult and geriatric populations, but less so in pediatric settings—possibly because of treatment differences.²⁷ Focusing on the treatment of injury results in a dynamic metric because as providers update their care based on patient pathophysiology and response, NFTI is updated too. Thus, NFTI effectively incorporates clinical judgment into its definition of major trauma. Being NFTI+ was more common than ISS >15 or RTS <7.84, which could indicate low specificity. However, it appears more likely that ISS >15 and RTS <7.84 have low sensitivity to detect major trauma given the overlap between the three metrics: as shown in Table 2, 2.3% of encounters had both RTS <7.84 and NFTI+ but were missed by ISS >15; 4.3% were NFTI+ and had ISS >15 but were missed by RTS <7.84; but only 0.6% had ISS >15 and RTS <7.84 but were missed by NFTI+. Thus, NFTI appears to capture the largest and miss the smallest portion of cases with major anatomic injury, physiologic derangement, and/or reserve depletion. Additionally, NFTI has an advantage ISS and RTS do not: it can be calculated from incomplete data. If a patient meets any NFTI criterion, he or she is NFTI+ even if data for other criteria are missing. Beyond this, we have only anecdotal experience.

Occasional peculiarities in registry coding or definitions result in a NFTI- patient although slight modifications make the patient NFTI+ (e.g., ED to OR within 91 minutes instead of 90). That example is one of the follies of NFTI being an inherently binary measure, and categorization generally. Additionally, the criterion ED to OR within 90 minutes appears slightly prone to false positives. Whilst designed as a surrogate for urgency of treatment, serendipitous operative availability also triggers this criterion. Similarly, operative delays can lead to false negatives on this criterion, however, severe delays may trigger other NFTI criteria. Lastly, NFTI makes several large assumptions: (1) clinicians provide timely and appropriate care, (2) documentation is sufficiently detailed and accurate, and (3) registry staff properly enter the registry elements required to calculate NFTI. Should any of the links in that chain fail, NFTI likely will fail too. Regarding (1), however, rescue attempts following initial failure to appropriately treat the injured patient may trigger

other NFTI criteria; failure to rescue may result in death within 60 hours. Additionally, despite NFTI's dependence on resource availability, it performed well in this heterogeneous sample of trauma centers.

Another potential critique of NFTI is that, due to its apparent simplicity, it may not appear to tell clinicians anything that cannot be intuited. This critique applies to many trauma severity measures. For example, despite the value of clinical gestalt, the components of RTS are formally assessed. Similarly, for ISS, clinical evaluation produces an impression of anatomic severity. Nonetheless, injury grades are formally assessed by trained coders to ensure standardization. Thus, the job of a trauma severity metric is not to tell clinicians something that cannot be intuited but to ensure that—by standardizing definitions and measures—there is common understanding of patients' injury severities.

While intuitive and simplistic, NFTI provides an accurate and comprehensive set of criteria that capture the pathophysiologic response to significant injury and represent injury burden. Certainly, there are myriad potential criteria that might indicate significant injury. However, these six criteria were selected through a combination of data mining and clinical expertise because they parsimoniously capture nearly every variation of severe injury.⁶ Additionally, in developing NFTI, it was recognized that while there were several very accurate measures of trauma severity, none appeared to be in regular clinical use. It was surmised this was a function of the more accurate measures being vastly more complex. Accordingly, we sought to keep NFTI as simple as possible while maintaining accuracy.

While defining major trauma may seem an academic endeavor, there are clinical and epidemiologic implications. That ISS >15, RTS <7.84, and NFTI+ occurred at different rates (15.7%, 12.1%, and 18.9%, respectively) means one may miss a substantial portion of major traumas depending on the metric used. Thus, studies and quality improvement databases (e.g., Trauma Quality Improvement Program data) excluding patients based on lower ISS cutoffs (commonly <9 or <4) to reduce noise in the data or focus on patients with nonnegligible traumas may inadvertently exclude many patients with major nonanatomic trauma burdens. For example, 29.8% of encounters with RTS <7.84 had an ISS <9, and 12.5% had ISS <4. Similarly, 21.5% of NFTI+ encounters had an ISS <9, and 5.7% had ISS <4. Lastly, as NFTI was consistently found to fit the data better substantially better than ISS and RTS, even analytically rigorous risk-adjusted benchmark reports may be less accurate by not accounting for all three aspects of trauma burden (anatomic damage, physiologic derangement, and depletion of reserve). Adding NFTI to benchmark reports may improve their accuracy and influence performance improvement initiatives.

This study faces several limitations, most notably the use of retrospective data. Although a prospective study may increase data quality, it would be unlikely to include many smaller centers or centers with limited research support, making it prone to selection bias. In contrast, this study included ten level III and IV centers to achieve a heterogeneous, and potentially more generalizable, sample. Additionally, 10.3% of encounters were excluded for missing data. This may have introduced some bias. Further, 2,865 cases (3.24% of total sample; 50.44% of site's sample) in this study were part of the single-center development

sample for NFTI, which could result in NFTI overperforming in these cases. However, these cases were included because (1) the single-center study⁶ used different covariates and outcomes and (2) sensitivity analyses (not reported) showed similar results with the center's data excluded. Lastly, one may question the appropriateness of using ISS >15 and RTS <7.84 as cutoffs to compare against NFTI. If these three measures are indeed measuring the same underlying construct of trauma burden, and the selected cutoffs correspond to comparable levels of severity, one would expect them to co-occur at approximately equal rates. Indeed, this was the case: ISS >15 occurred in 15.7%, RTS <7.84 in 12.1%, and NFTI+ in 18.9%. More notable, however, are the conditional rates. ISS >15 occurred in 45.2% of patients with RTS <7.84 and 48.5% of NFTI+ patients. Likewise, RTS <7.84 occurred in 34.8% of patients with ISS >15 and in 37.7% of NFTI+ patients. Lastly, NFTI+ occurred in 58.4% of patients with ISS >15 and in 59.0% of patients with RTS <7.84. We think it unlikely for the above pattern to occur if the selected cutoffs did not correspond to approximately equal levels of severity. Nonetheless, future studies should evaluate other cutoffs for ISS and RTS.

CONCLUSION

This multicenter study shows NFTI to be largely superior to ISS and RTS as an indicator of major trauma as evidenced by better model fit and stronger associations with complication, discharge to a continuing care facility, and LOS. The ISS and RTS remain useful adjuncts and add depth to the global model of injury burden. However, NFTI appears to provide the best single definition of major trauma and is a useful tool that should be adopted and studied. Trauma centers may be able to use NFTI as part of the performance improvement and patient safety process, such as when performing case reviews. **Although NFTI relies on precise registry elements, all are defined in the NTDS and regularly collected. This makes implementing NFTI relatively simple as it can be automatically calculated with registry software.** To aid trauma centers in this, the authors developed an Excel file instructing users how to add NFTI to TraumaBase (Supplemental Digital Content 4, <http://links.lww.com/TA/B436>). Research should continue to better quantify trauma burden as both a comprehensive measure and in terms of its components (anatomy, physiology, and reserve). However, if such research is to be implemented clinically, the measures must not only have high sensitivity and specificity, history suggests they must also have reasonable levels of simplicity.

AUTHORSHIP

J.W.R.F. was responsible for design, analysis, interpretation, and article preparation. All authors contributed data and were involved in critical review.

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DISCLOSURE

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Asking a Better Question: Development and Evaluation of the Need For Trauma Intervention (NFTI) Metric as a Novel Indicator of Major Trauma

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ABSTRACT

Many existing metrics, such as Injury Severity Score (ISS), cannot fully describe many trauma patients because of comorbidities. This study developed and evaluated the Need For Trauma Intervention (NFTI) metric as a novel indicator of major trauma. The NFTI metric was developed from an analysis of 2,396 trauma patients at a Level I trauma center. Six commonly recorded registry variables were found to be indicative of major trauma and comprised the NFTI criteria: receiving packed red blood cells within 4 hr; discharge from the emergency department (ED) to the operating room within 90 min; discharge from the ED to interventional radiology; discharge from the ED to the intensive care unit (ICU) with an ICU length of stay (LOS) of 3 or more days; mechanical ventilation outside of procedural anesthesia within 3 days; or death within 60 hr. Patients meeting any NFTI criteria are classified as having major traumas and, therefore, needing

trauma activations (NFTI+). Need For Trauma Intervention was tested in an overlapping sample of 9,737 patients. Being NFTI+ was associated with higher trauma activation levels, older age, higher ISS, worse ED vitals, longer hospital LOS, and mortality. Only 13 of 561 deaths were not NFTI+ and all were in patients with do not resuscitate (DNR) orders; using ISS greater than 15 missed 73 mortalities, 46 with DNR orders. Results suggest that NFTI provides a comprehensive view of both anatomy and physiology in a manner that self-adjusts for age, frailty, and comorbidities as long as care teams adjust their treatments. Need For Trauma Intervention appears to be a unique, simple, and effective tool to retrospectively identify major trauma, regardless of ISS.

Key Words

Major trauma, Medical resource utilization, Trauma severity indices

A 60-year-old, obese, anticoagulated smoker falls from standing and strikes his head. Upon presentation to the emergency department (ED), his Glasgow Coma Scale (GCS) score is 10 and he requires intubation. Simultaneously, a healthy, 25-year-old triathlete ambulates into the ED after crashing her mountain bike with multiple rib fractures; a self-splinted, closed forearm fracture; and a moderate, contained liver laceration. What level of trauma team activation do these patients need?

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Reviews of the appropriateness of trauma activation decisions, such as these, are based on whether the patient suffered major trauma. The definition of major trauma is typically based on anatomic injury severity with an Injury Severity Score (ISS) greater than 15 considered a major trauma that warrants the highest level of trauma team activation. In the introductory vignettes, the former is clearly in need of rapid, meaningful trauma interventions, whereas the latter is sitting patiently, albeit in pain, in the waiting room. However, under this paradigm, the 60-year-old would be classified as overtriaged if he received a full trauma team activation because he had an ISS of 9. Conversely, if the 25-year-old did not receive a full trauma team activation, she would be undertriaged because her ISS was 22. These hypothetical cases illustrate the flaw of relying solely on anatomic injury severity to express physiologic needs. Although ISS does work relatively well for the majority of cases (Bull, 1975; Bull, 1978; Dick & Baskett, 1999; Gabbe et al., 2005; Semmlow & Cone, 1976) and is the accepted standard in trauma, these patients exemplify two categories in which it does not: first are the patients who—due to age, comorbidities, or both—have minimal physiologic

reserves and consequently have systems that start to fail after relatively less severe or otherwise minor injuries; the second group consists of healthy, young, active patients with systems that are far more robust to the pathophysiological insults of injury. As such, a Grade 3 injury in the first group poses more danger than an identical Grade 3 injury in the second group. Because there is more than just anatomic injury severity to consider when assessing the appropriateness of a trauma activation, these clinical presentations are not fully described by ISS. This is because ISS is only partially associated with resource consumption and outcomes (Baxt & Upenieks, 1990) and performs even worse in geriatric traumas (McMahon, Schwab, & Kauder, 1996). Likewise, physiologic indicators that work well in younger patients to signal major trauma are less reliable in geriatric trauma patients (Lehmann, Beekley, Casey, Salim, & Martin, 2009; Martin, Alkhoury, O'Connor, Kyriakides, & Bonadies, 2010). These points are especially troubling given increases in the number of elderly trauma patients in the United States and the country's aging population (Ortman, Velkoff, & Hogan, 2014; Rhee et al., 2014).

The American College of Surgeons, Committee on Trauma (ACS-COT) tacitly acknowledges the shortcomings of ISS-based triage assessments and recommends using the ISS cutoff of 15 with case review to make further over- and undertriage determinations, which are based on the absence or presence of major trauma, respectively (Rotondo, Cribari, & Smith, 2014). However, these case reviews are largely subjective and entirely unstandardized. As such, an injury that constitutes major trauma at one center might not at another. Therefore, if over- and undertriage rate comparisons between institutions are to be valid, a new and standardized definition of major trauma is needed.

PURPOSE

The objective of this study was to develop and evaluate the Need For Trauma Intervention (NFTI) metric as a novel indicator of major trauma that can be used independently or to standardize the case review process.

METHODS

Metric Creation

Based on the premise that the need for rapid interventions and high levels of care might more reliably characterize patients than would anatomic or physiologic indicators, it was decided that the optimal approach was to create a metric on the basis of acute phase resource utilization and survival. Thus, by measuring resource consumption, NFTI would self-adjust for a patient's overall clinical condition—provided that care teams adjusted their treatments to account for age, frailty, comorbidities, and physiology. In

addition, by measuring survival in the early phases of hospitalization, the metric should also be able to detect mortalities that are likely attributable to the trauma—but not later complications that are likely less relevant to trauma team activation—and do so even if care teams fail to adjust their treatments. Furthermore, to ensure that NFTI had clearly defined cutoffs, a binary (i.e., yes/no) metric was considered optimal.

With these goals in mind and under an institutional review board–approved protocol for retrospective database review, the prospectively maintained registry of a large, urban, ACS-verified Level I trauma center in Texas was used to query data for all patients receiving a full or partial trauma activation between July 1, 2014, and January 12, 2016 ($n = 2,396$). Existing registry variables thought to be associated with the need for full trauma activation were initially selected *a priori*. The rates of the resulting NFTI metric were compared against activation criteria and mechanism of injury in this sample. The NFTI criteria were then adjusted over several iterations until the resulting NFTI rates were congruent with clinical judgment and experience.

The final NFTI criteria are:

- receiving packed red blood cells (PRBC) within the first 4 hr of arrival;
- being discharged from the ED to the operating room (OR) within 90 min of arrival;
- being discharged from the ED to interventional radiology (IR);
- being discharged from the ED to the intensive care unit (ICU) and having a total ICU length of stay (LOS) of 3 or more calendar days;
- receiving mechanical ventilation for reasons other than procedural anesthesia within the first 3 days; and/or
- death within 60 hr of hospital arrival.

Patients meeting any one criterion or any combination of the criteria are classified as NFTI positive (NFTI+) and are deemed highly likely to have needed trauma activations regardless of ISS (i.e., suffered major trauma). Patients meeting none of these criteria are labeled as NFTI negative (NFTI–) and are considered highly unlikely to have needed trauma activations (i.e., not suffered major trauma).

Statistical Analyses

Statistical analyses of the finalized NFTI criteria were performed in an overlapping sample of all new trauma patients presenting to the ED of the aforementioned hospital between January 1, 2013, and August 21, 2016, and who met local trauma registry inclusion criteria ($n = 9,738$). These dates were selected because of a Trauma Quality Improvement Program (TQIP) registry field that was

added in 2013 to indicate whether a patient received PRBC within 4 hr. One patient had missing variables that prevented NFTI from being assessed and was removed from analyses. This resulted in a final sample size of 9,737.

Data management and variable calculations were performed using TraumaBase (version 9, Clinical Data Management, Inc., Conifer, CO). All statistical analyses were performed using SPSS (release 19.0.0, IBM, Corp., Armonk, NY).

RESULTS

As shown in Table 1, there was a significant association between NFTI and tiered trauma response level ($\chi^2=2,671.87$, $p < .001$). Full-team activations were NFTI+ 62.8% of the time; partial-team activations, 22.3%; trauma surgery consults, 7.9%; subspecialty surgical consults (e.g., orthopedic surgery without trauma surgery involvement), 6.3%; and nonsurgical patients, 1.0%. Of those who were NFTI+, the majority (60.6%) met only one criterion, most commonly the ICU criterion (Table 2).

To test NFTI's associations with multiple clinical variables, including demographics, anatomy, physiology, resource consumption, and outcome, a binary logistic regression was performed. This revealed that being NFTI+ was significantly associated with older age, higher activation levels, penetrating trauma, higher ISS, a faster initial ED pulse, lower initial ED mean arterial pressure (MAP), lower initial ED GCS score, longer total hospital LOS, and mortality (Table 3).

However, given that deaths within the first 60 hr of arrival are automatically captured by the NFTI metric and accounted for 71.8% (403/561) of all fatalities, the regression was rerun after excluding patients who died in the first 60 hr (Table 4). This revealed that NFTI was significantly associated with mortality after 60 hr as well. Only 13 of the 561 total deaths (2.3%) were classified NFTI-. All of the NFTI- deaths occurred in patients with do not resuscitate (DNR) orders and significant end-of-life care limitations, with a median (IQR) age of 81 (72-90) years, and who died after 7 (5.5-13.5) days. Comparatively,

using only the ISS greater than 15 cutoff missed 73 total mortalities. In these 73 patients, 46 had DNR orders, median age was 72 (60-85) years, and the median LOS was 4 (1-8) days. After the first 60 hr, the ISS cutoff of greater than 15 missed 41 deaths, 36 of whom had DNR orders, with median age of 81 (67-88) years and median LOS of 8 (5.5-15) days. As shown by the fact that the 99% confidence intervals of the odds ratios on Table 5 do not overlap, NFTI was able to detect overall mortality and mortality after 60 hr better than was the ISS cutoff of greater than 15 at a significance level of $p < .01$. Using 99.9% confidence intervals, NFTI also outperformed ISS greater than 15 for overall mortality (69.815-446.225 vs. 19.594-45.604; $p < .001$) but not with mortality after 60 hr (17.942-121.562 vs. 6.977-23.339; $p > .001$). Also shown in Table 5 are the results of area under the curve (AUC) analyses. These revealed that NFTI had a larger AUC than ISS greater than 15 for mortality and mortality after 60 hr. Need For Trauma Intervention also had better sensitivity, but not specificity, for overall mortality and mortality after 60 hr.

DISCUSSION

Similar to the prehospital mantra of bringing the right patient to the right place at the right time, every trauma center aims to ensure that the right resources are available for the right patient at the right time. To this end, each institution establishes criteria for trauma team activation, generally in a tiered fashion, to preemptively mobilize resources on the basis of anticipated patient needs. Given that overtriage can waste resources and fatigue staff, and that undertriage can put patient care at risk, trauma centers are charged with honing these criteria to minimize over- and undertriage, with accepted rates of less than 5% undertriage and no more than 35% overtriage (Rotondo et al., 2014). The question is, how you define over- and undertriage?

Historically, the answer was that any patient with a major trauma, as indicated by an ISS greater than 15, who did not receive the highest level of trauma team activation

TABLE 1 NFTI Rates by Trauma Response Level			
	NFTI+	NFTI-	Row Total
Full-team activation	1,419 (62.8%)	841 (37.2%)	2,260 (23.2%)
Partial-team activation	523 (22.3%)	1,825 (77.7%)	2,348 (24.1%)
Trauma surgery consult	311 (7.9%)	3,645 (92.1%)	3,956 (40.6%)
Subspecialty surgical consult	62 (6.3%)	916 (93.7%)	978 (10.0%)
Nonsurgical admission	2 (1.0%)	193 (99.0%)	195 (2.0%)
Column total	2,317 (23.8%)	7,420 (76.2%)	9,737 (100%)
Note. NFTI = Need For Trauma Intervention.			

TABLE 2 Frequency (Percent) of Criteria Met for NFTI+ Patients

One criterion met	1,405 (60.6%)
PRBC only	69 (3.0%)
OR only	295 (12.7%)
IR only	10 (0.4%)
ICU only	580 (25.0%)
Ventilator only	258 (11.1%)
Death only	193 (8.3%)
Two criteria met	685 (29.6%)
PRBC, OR	123 (5.3%)
PRBC, IR	3 (0.1%)
PRBC, ICU	26 (1.1%)
PRBC, ventilator	25 (1.1%)
PRBC, death	30 (1.3%)
OR, ventilator	32 (1.4%)
ICU, ventilator	367 (15.8%)
ICU, death ^a	1 (0.0%)
Ventilator, death	78 (3.4%)
Three criteria met	201 (8.7%)
PRBC, ventilator, death	39 (1.7%)
PRBC, OR, death	24 (1.0%)
PRBC, OR, ventilator	54 (2.3%)
PRBC, IR, ventilator	3 (0.1%)
PRBC, ICU, ventilator	67 (2.9%)
ICU, ventilator, death ^a	14 (0.6%)
Four criteria met	25 (1.1%)
PRBC, OR, ventilator, death	18 (0.8%)
PRBC, IR, ventilator, death	2 (0.1%)
PRBC, ICU, ventilator, death ^a	5 (0.2%)
Five criteria met	1 (0.0%)
PRBC, OR, ICU, ventilator, death ^a	1 (0.0%)

Note. ICU = intensive care unit; IR = interventional radiology; OR = operating room; PRBC = packed red blood cells.

^aDeaths occurred within 60 hr but three ICU days were accumulated because of postnoon ICU admissions that resulted in the ≤60-hr ICU stay spanning three calendar days.

available, was undertriaged, and that any patient with an ISS less than 15 but received the highest level of trauma team activation available was overtriaged. The initial—and only apparent—studies on this method (Cribari & Gujral, 2006; Cribari, Martin, Bonta, & Dean, 2006) showed that this was an effective way to classify patients as measured by hospital LOS and mortality. As stated in

the background, although this method may be effective for most cases, there are many potential instances when it will not. Although there are myriad other metrics that outperform ISS (Champion et al., 1996; Osler, Baker, & Long, 1997; Rutledge, Osler, Emery, & Kromhout-Schiro, 1998), few are as easily calculated as ISS and fewer still have established cutoffs that allow for them to be used to quantify major trauma. Avoiding these last two issues while also being able to avoid the flaws of ISS was among the main goals of this project, hence, the simple, binary metric that is no more than a checklist of early resource consumption and outcome.

The NFTI metric is heterodoxical in that, unlike other clinical metrics, it does not directly measure any part of the patient's anatomy or physiology. Instead, NFTI incorporates the treatment of injury pathophysiology via a six-item checklist of care resource consumption and early mortality. By taking a more global view of the needs of the patient that focuses on neither anatomy nor physiology, NFTI appears to be able to provide a practical view of both. On measures of physiology, meeting NFTI criteria was associated with a faster pulse, lower MAP, and a lower GCS score. On measures of anatomy, being NFTI+ was associated with higher ISS and penetrating trauma. The NFTI+ rates were also associated with higher trauma activation levels. Finally, and perhaps most importantly, NFTI was associated with mortalities—both those captured by its death within 60-hr criterion and those occurring after the first 60 hr. This last point is particularly appealing given that, despite NFTI being a relatively conservative metric with fewer than 24% of patients being NFTI+, only 13 deaths in a 3.5-year period did not meet NFTI criteria—and perhaps appropriately so based on age, DNR status, and time from arrival to death.

Given that NFTI appears to be unique as a measure of early-stage resource consumption and outcome for trauma, there is, unfortunately, no real gold standard against which to compare it. Despite this, some credence may be appropriate given that NFTI largely overlaps with suggested non-ISS-based definitions of major trauma in *Resources for Optimal Care of the Injured Patient* (Rotondo et al., 2014, pp. 28 and 121). These suggestions included any trauma patient death, blood transfusion during initial resuscitation, intubation, hospital LOS greater than 2 days, ICU admission, intracranial pressure monitoring, any operative intervention, or catheter-based hemorrhage control.

By comparison, NFTI uses death within the first 60 hr rather than any death. In so doing, NFTI likely captures deaths directly related to injury that are more likely to be avoided with high-level interventions instead of deaths from later complications. Similarly, NFTI's use of nonprocedural mechanical ventilation within 3 days provides a reasonable cutoff to identify patients who likely needed

TABLE 3 Multivariable Associations With NFTI+^a

	β (SE)	Wald χ^2 (df)	<i>p</i>	OR (99% CI)
Full-team activation (referent)		224.129 (4)		
Partial-team activation	−0.626 (0.093)	45.556 (1)	<.001	0.535 (0.421–0.679)
Trauma surgery consult	−1.471 (0.100)	214.450 (1)	<.001	0.230 (0.177–0.298)
Subspecialty surgical consult	−0.762 (0.160)	22.578 (1)	<.001	0.467 (0.309–0.706)
Nonsurgical admission	−4.737 (1.531)	9.576 (1)	.002	0.009 (<0.001–0.452)
Age	0.006 (0.002)	9.369 (1)	.002	1.006 (1.001–1.011)
Male gender	0.133 (0.082)	2.653 (1)	.103	1.143 (0.925–1.411)
Penetrating trauma	1.081 (0.100)	117.495 (1)	<.001	2.949 (2.281–3.813)
ISS	0.077 (0.005)	224.439 (1)	<.001	1.080 (1.066–1.094)
Pulse rate	0.007 (0.002)	13.030 (1)	<.001	1.007 (1.002–1.011)
MAP	−0.005 (0.002)	8.507 (1)	.004	0.995 (0.990–0.999)
GCS	−0.387 (0.020)	372.164 (1)	<.001	0.679 (0.645–0.715)
Total LOS	0.110 (0.006)	326.731 (1)	<.001	1.117 (1.099–1.134)
Overall mortality	3.111 (0.330)	88.997 (1)	<.001	22.440 (9.598–52.461)

Note. CI = confidence interval; GCS = Glasgow Coma Scale; ISS = Injury Severity Score; LOS = length of stay; MAP = mean arterial pressure; OR = odds ratio.

^aExcludes 257 patients with missing ED vital signs; *n* = 9,476; area under the curve = 91.5%.

the therapy as a result of trauma. This can also act to capture patients with deteriorations that might have been interrupted with earlier intervention. Furthermore, by using the cutoff of three or more ICU calendar days after ICU admission from the ED, NFTI likely excludes patients who were merely receiving intensive, short-term observation, which could easily span two calendar days. This is because the National Trauma Data Standard (NTDS) defines ICU LOS in integer calendar days that are rounded up (American College of Surgeons Committee on Trauma, 2016). Under this definition, an ICU admission at 11:59 p.m. on a Monday that lasts for 2 min would span two calendar days (1 min on Monday night and until 12:01 a.m. on Tuesday). Optimally, one would measure ICU LOS in at least hours, if not minutes, but one of the main goals of NFTI was to work within the existing system so as to be easily implemented across trauma centers. Thus, although NFTI is slightly more conservative than the suggestions in *Resources for Optimal Care of the Injured Patient* (Rotondo et al., 2014), NFTI likely focuses more on the critical nature of the patient after trauma, which allows it to filter out factors that are potentially related more to complications or other factors, and less to the injuries themselves. However, both NFTI and the 2014 suggestions are reliant on proper treatments.

As noted, one of the main goals of NFTI was to use variables that most, if not all, trauma centers would already

record and that are defined by the NTDS—although the NTDS does not differentiate between OR and IR for ED discharge dispositions as of 2017 admissions (American College of Surgeons Committee on Trauma, 2016). However, it is worth noting that NFTI's blood transfusion criterion is required only for centers that are members of TQIP—although there is no reason why nonmembers could not record this field as well. Thus, many trauma centers should be able to implement NFTI as an automatically calculated variable in their registry software or, if not, run it using common spreadsheet software. To aid in adding NFTI to registries, Supplemental Digital Content 1, available at: <http://links.lww.com/JTN/A1>, contains an Excel spreadsheet with a short questionnaire that generates the code to calculate NFTI in TraumaBase, as well as instructions on adding the code (301 KB). This includes an option for centers that are not members of TQIP to approximate the TQIP transfusion field based on PRBC being given within 1 day of arrival and as one of the first five procedures. This also allows the criterion to be approximated in patients arriving prior to 2013, when the TQIP field was added. Interested centers that use other registry software are encouraged to contact their vendors.

LIMITATIONS

Although the results of this study are encouraging, it does have its limitations. Although the primary limitation of this

TABLE 4 Multivariable Associations With NFTI+ Excluding Mortalities Within 60 hr^a

	β (SE)	Wald χ^2 (df)	<i>p</i>	OR (99% CI)
Full-team activation (referent)		215.657 (4)		
Partial-team activation	−0.628 (0.093)	45.762 (1)	<.001	0.533 (0.420–0.678)
Trauma surgery consult	−1.472 (0.101)	214.347 (1)	<.001	0.230 (0.177–0.297)
Subspecialty surgical consult	−0.759 (0.160)	22.391 (1)	<.001	0.468 (0.310–0.708)
Nonsurgical admission	−19.241 (2933.234)	0.000 (1)	.995	4.4E-9 (4.9E-196–4.2E+188)
Age	0.006 (0.002)	9.309 (1)	.002	1.006 (1.001–1.011)
Male gender	0.127 (0.082)	2.404 (1)	.121	1.135 (0.919–1.402)
Penetrating trauma	1.084 (0.100)	117.524 (1)	<.001	2.955 (2.285–3.823)
ISS	0.077 (0.005)	221.736 (1)	<.001	1.080 (1.065–1.094)
Pulse rate	0.007 (0.002)	13.459 (1)	<.001	1.007 (1.002–1.012)
MAP	−0.005 (0.002)	7.244 (1)	.007	0.995 (0.991–0.999)
GCS	−0.385 (0.020)	364.856 (1)	<.001	0.680 (0.646–0.717)
Total LOS	0.112 (0.006)	330.829 (1)	<.001	1.118 (1.101–1.136)
Mortality after 60 hr	2.468 (0.341)	52.398 (1)	<.001	11.805 (4.904–28.414)

Note. CI = confidence interval; GCS = Glasgow Coma Scale; ISS = Injury Severity Score; LOS = length of stay; MAP = mean arterial pressure; OR = odds ratio.

^aExcludes 252 patients with missing ED vital signs and all mortalities within 60 hr; *n* = 9,082; area under the curve = 89.7%.

study might appear to be the use of retrospective data, this is not the case given that NFTI is intended for use as a retrospective metric. Accordingly, although measuring resource consumption and outcome may provide a more accurate assessment of trauma patients in later case reviews, this approach precludes the use of NFTI for field or ED triage decisions. However, ISS and others suffer from this same issue by relying on diagnosis codes that are only assigned later. The main weakness of this

study is the single-center nature of the data, and NFTI may not be as successful at other institutions—although multi-institutional studies are planned. In addition, NFTI is reliant on the appropriate treatment being provided to the individual patient, as well as both proper documentation of these treatments in the medical record and on these treatments being correctly entered into the registry. As such, if any of these crucial links fails, NFTI can become unreliable. The selected criteria, however, are commonly

TABLE 5 Odds Ratios and AUC Results of Overall Mortality and Mortality After 60 hr for NFTI+ and ISS Greater Than 15

	Statistic	Overall Mortality	Mortality After 60 hr
NFTI+	OR (99% CI)	176.503 (85.396–364.809)	46.702 (22.086–98.756)
	AUC (99% CI)	0.892 (0.879–0.905)	0.862 (0.829–0.896)
	Sensitivity	0.977	0.918
	Specificity	0.807	0.807
ISS >15	OR (99% CI)	29.893 (21.477–41.607)	12.761 (7.955–20.471)
	AUC (99% CI)	0.844 (0.822–0.866)	0.779 (0.726–0.831)
	Sensitivity	0.870	0.741
	Specificity	0.817	0.817

Note. AUC = area under the curve; CI = confidence interval; ISS = Injury Severity Score; NFTI = Need For Trauma Intervention; OR = odds ratio.

recorded by registry staff and are well defined. Thus, they are likely less prone to misinterpretation, unlike the complex subtleties involved with diagnosis coding systems (e.g., International Classification of Diseases, or Abbreviated Injury Scale), which can be inaccurate 16%–80% of the time (Curtis, Bollard, & Dickson, 2002; Ewing et al., 2015; Misset et al., 2008; O'Malley et al., 2005). In spite of its limitations, this study suggests that NFTI has both face and internal validity as an indicator of major trauma.

CONCLUSIONS

As noted in the discussion, NFTI is unlike other clinical metrics. Instead of measuring anatomy or physiology, NFTI measures resource consumption and outcome in the early phases of hospitalization. Purely anatomic scales—especially those based on anatomic diagnoses—can be inaccurate because of physiologic differences and the amount of subjectivity involved in coding. Physiologic scales can be similarly inaccurate due to idiosyncrasies, such as baseline bradycardia in athletes or from β -blockers. Likewise, scales that combine both are likely to suffer the weaknesses of both, not just gain their strengths. In contrast, measuring resource consumption may provide a method to avoid many of these issues. Future research should consider the potential benefits of this approach to measuring disease severity. Indeed, NFTI may even replace or supplement the current Cribari matrix method of measuring over- and undertriage. Before making such a change, however, NFTI needs to be evaluated with multi-institutional data.

It is worth noting that one of the reasons that NFTI appears to work so well is that it does not try to give a better answer to an old question. Thus, despite—or perhaps thanks to—its departure from measuring anatomy and physiology, NFTI appears to be a unique, simple, and valuable tool that can standardize and expedite the case review process and is likely better able to account for factors that can befuddle other metrics (e.g., age, frailty, comorbidities). Therefore, rather than asking the typical question of how severely injured the patient was, NFTI asks a new and perhaps better question: Did the patient actually need a trauma activation? This should allow centers to better identify major trauma. In short, the NFTI metric's simplicity, NTDS-defined variables, and effectiveness combine to make it a truly *nifty* metric.

- The Need For Trauma Intervention (NFTI) metric attempted to avoid these issues by measuring acute-phase resource consumption and mortality. The NFTI criteria are receiving PRBC within 4 hr; discharge from the ED to the OR within 90 min; discharge from the ED to IR; discharge from the ED to the ICU with an ICU LOS of 3 or more days; mechanical ventilation outside of procedural anesthesia within 3 days; or death within 60 hr. Patients meeting any criteria are classified as needing a trauma activation (NFTI+); patients meeting none of these criteria are considered unlikely to have needed a trauma activation.
- Being NFTI+ was associated with higher trauma team response levels, older age, higher ISS, worse ED vitals, longer hospital LOS, and mortality. NFTI outperformed the standard ISS cutoff of greater than 15 for detecting mortality: only 13 of 561 deaths were not NFTI+ and all were in patients with DNR orders; using ISS greater than 15 missed 73 mortalities, 46 with DNRs.
- The NFTI metric appears to be a better indicator of major trauma by avoiding many of the issues that hinder other metrics, and it provides a standardized metric to use during second-level case reviews.

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KEY POINTS

- The preexisting anatomic and physiologic metrics used in trauma are often unreliable due to age, frailty, comorbidities, or a combination thereof. For example, if a healthy 20-year-old and an anticoagulated 60-year-old suffer the same head injury, the 20-year-old is far less likely to need a full trauma team than the older patient.

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The JCAHO patient safety event taxonomy: a standardized terminology and classification schema for near misses and adverse events

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Abstract

Background. The current US national discussions on patient safety are not based on a common language. This hinders systematic application of data obtained from incident reports, and learning from near misses and adverse events.

Objective. To develop a common terminology and classification schema (taxonomy) for collecting and organizing patient safety data.

Methods. The project comprised a systematic literature review; evaluation of existing patient safety terminologies and classifications, and identification of those that should be included in the core set of a standardized taxonomy; assessment of the taxonomy's face and content validity; the gathering of input from patient safety stakeholders in multiple disciplines; and a preliminary study of the taxonomy's comparative reliability.

Results. Elements (terms) and structures (data fields) from existing classification schemes and reporting systems could be grouped into five complementary root nodes or primary classifications: impact, type, domain, cause, and prevention and mitigation. The root nodes were then divided into 21 subclassifications which in turn are subdivided into more than 200 coded categories and an indefinite number of uncoded text fields to capture narrative information. An earlier version of the taxonomy ($n = 111$ coded categories) demonstrated acceptable comparability with the categorized data requirements of the ICU safety reporting system.

Conclusions. The results suggest that the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) *Patient Safety Event Taxonomy* could facilitate a common approach for patient safety information systems. Having access to standardized data would make it easier to file patient safety event reports and to conduct root cause analyses in a consistent fashion.

Keywords: patient safety, standardized terminology and classification, taxonomy

Introduction

Concerns about safety in patient care have called attention to the need for governmental agencies and private sector accrediting bodies to work together with health care organizations to coordinate the monitoring, reporting, and analysis of medical errors. The 2003 Institute of Medicine report, *Patient Safety: Achieving a New Standard of Care* [1], recommends that standardization and better management of information on patient safety—including near misses and adverse events—are needed to inform the development of strategies that reduce the risk of preventable medical incidents. However, patient safety incident reporting systems differ in design and therefore in their ability to define, count, and track adverse

events [2]. Among reporting systems, there are often disparate data fields, conflicting patient safety terminologies, classifications, characteristics, and uses that make standardization difficult. In addition, each source of data on near misses and adverse events usually requires different methods for interpreting and deconstructing these events [3]. Finally, misused terminology in the research literature, conference papers and presentations, and media contributes to widespread misunderstandings about the language of patient safety.

The proliferation of reporting systems has created a pressing need for organization of patient safety information systems and terminology. Unfortunately, much of the work to date has fallen short in meeting identified needs for epidemiological data [4]. Given the current state of the art, it is

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extremely difficult to achieve broad-based and timely improvements in patient safety, since there is no standard determination as to which events to capture and report [5,6]. Additionally, the lack of a common patient safety terminology is a critical obstacle to sharing and aggregating data to support patient safety.

The concept of a taxonomy combines terminology and the science of classification—in the case of patient safety, the identification and classification of things that go wrong in health care, the reasons why they occur, and the preventive strategies that can minimize their future occurrence. There is consensus that standardization of patient safety data would facilitate improvements in incident reporting, tracking, and analysis [7,8]. The core set of terms in patient safety, like other health disciplines, should incorporate both theoretical concepts and generally accepted vocabulary.

Several methods have been developed to define and classify medical errors, adverse events, near misses, and other patient safety concepts and terms [9,10]. However, these methods have tended to be, with notable exceptions, narrowly and predominantly focused on specific areas of health care—medication errors [11–13], transfusion reactions [14], primary care [15,16], and nursing care [17,18].

In this project we developed and applied a method of classification that is based on evaluations of extant taxonomies and reporting systems with feedback from individuals who would use the taxonomy. This approach sought to identify similarities and gaps in the terminology and classification to create a multidimensional taxonomy that encompasses diverse health care settings and incident reporting systems.

Methods

Terms and definitions used in patient safety were gathered from a wide range of print and web resources (e.g. book glossaries, published journals). Current, practical, and colloquial terms that underlie the communication among users were listed in a comparative glossary. Because the terms and their definitions are extensive, they are not reproduced herein. However, this patient safety dictionary is available electronically from the authors.

A comprehensive literature search was performed in Medline (PubMed) and Excerpta Medica (Embase). Literature that describes approaches to the definition of medical errors, adverse events, near misses, and other patient safety concepts and terms, including existing classification schemes on patient safety, was retrieved. The searches were not limited to articles published in the English language or within a particular geographical area. The databases were searched for articles with publication dates between January 1993 and June 2003. In addition to database searches, the Internet sites of Departments of Public Health, Ministries of Health, and Patient Safety Organizations and Groups in Africa, Asia, Australia, Europe, and North America were searched. The reference lists of major reports were also scanned for relevant publications that date from the 1980s.

A total of 512 distinct references were identified from the Medline search. The Embase search resulted in 15 additional unique references. The titles and/or abstracts of these articles were initially scanned, and inclusion/exclusion decisions made. Based on the review of the abstracts, we eliminated 429 articles on the following criteria: (i) not relevant to the field of patient safety/medical error/adverse event classification; (ii) relevant to the field of patient safety/medical error/adverse event classification but did not provide adequate description of the components needed to define a coherent classification scheme; (iii) classifications that are in the early stages of development; (iv) unpublished classifications. The very few exceptions to this are classifications that hold particular conceptual or methodological interest in the development of the field.

Methodological concerns

Of the 96 full articles that were reviewed, 73 were eliminated according to the above criteria. Eleven formal classification schemes identified in the remaining 23 articles that address the frequencies, types, causes and contributing factors, consequences, and prevention of medical/medication errors are summarized in a report prepared for the World Health Organization [19].

The 11 classifications of medical and medication errors, patient safety events, and incident reporting systems were reviewed and compared for homogeneity. The semantic relationships, equivalent categories, and linkages among these classifications schemes were identified and used to construct the overarching framework of a preliminary taxonomy. This version also referenced human factors and safety research.

We reviewed data collected by the Joint Commission's Sentinel Event Program from January 1995 to December 2002 to validate the construct of the preliminary taxonomy. This was supplemented by recommendations from a nominal expert advisory taxonomy workgroup (see Acknowledgements for composition of workgroup). We asked the workgroup to assess the content and face validity of an initial iteration of the taxonomy. They offered a checklist of five attributes to be used in judging appropriateness of the elements of the taxonomy; these judgments involved subjective assessments rather than statistical analyses. Input was also solicited from medical specialty societies, business groups, government health care agencies, and health care organizations.

Since it is difficult, if not impossible, to prove formally that the items chosen were representative of all relevant terms and classifications, subjective tests of linguistic clarity were used to indicate whether the terminology of the classifications was clear. In the absence of a 'gold standard' to test criterion validity, we conducted a simplified item analysis of each variable of the taxonomy against those found in an established classification in one US hospital. Responses were coded as follows: 'unmatched' = 0, 'extrapolated' = 1, 'related' = 2, 'synonymous' = 3, and 'identical' = 4. Results of this work were used to inform the development of a beta version of the patient safety event taxonomy.

Results

Our review of the literature reinforces the fact that various approaches used in the health care sector to define and classify near misses, adverse events, and other patient safety concepts have generally been fragmented [20]. Early efforts to define and classify ‘error’ or ‘mistakes’ were burdened by theoretical and methodological flaws. The model of medical error was largely unspecified. Where classification instruments were described, their validity was found to be modest and their reliability not reported. A systematic review of classification schemes used in primary care by Elder and Dovey [10], found a limited number of studies that attempted to categorize medical errors, including near misses and adverse events [21–25]. Most of these studies were not designed with the development of a functional classification scheme in mind; thus, they did not offer a conceptual explanation of what they had classified.

Busse and Wright [26] proposed a more promising classification methodology and an enhanced evaluation approach for the Edinburgh Incident Classification. Focusing on in-depth analysis and a search for multiple levels of causation and contributing factors, including the identification of active and latent failures, this classification model exemplifies a theory-driven analytical framework that integrates, functionally and technically, with an incident reporting system. This systematic approach to classification in patient safety did not become the *de facto* standard for quite some time, and is still often neglected.

The classification of error types framework and theoretical and technical foundation for in-depth analysis of root causes of adverse events did not materialize until after the publication of the seminal works by Reason [27], Rasmussen [28], and Hale [29]. Contributions from aviation [30] and high-technology/high-risk industries have also been instrumental in advancing the reporting, analysis, and classification of adverse events in health care. A few more theoretically based studies—such as those reported by Makeham [15], Battles [31], and Victoroff [32]—have focused on more rigorous classification schemes and give greater consideration to validity and reliability issues. Like the earlier classifications, however, the process and outcome ‘root causes’ of adverse events in these schemes were only described where a significant impact was recorded [33].

Finally, Runciman and colleagues [34] have developed a structured approach based on Reason’s model and framework of contributory and causative factors to draw out all of the relevant information about an incident and to describe patient safety phenomena in terms that can be analyzed statistically.

Homogeneous elements of these models—which comprise terms and the relationships between terms that make up the building blocks of a classification scheme—were categorized into five complementary root nodes, or primary classifications.

1. Impact—the outcome or effects of medical error and systems failure, commonly referred to as harm to the patient.
2. Type—the implied or visible processes that were faulty or failed.

3. Domain—the characteristics of the setting in which an incident occurred and the type of individuals involved.
4. Cause—the factors and agents that led to an incident.
5. Prevention and mitigation—the measures taken or proposed to reduce incidence and effects of adverse occurrences.

The root nodes were then divided into 21 subclassifications, which were in turn subdivided into more than 200 coded categories and an indefinite number of non-coded text fields to capture narrative information about specific incidents.

The ‘Impact’ classification (shown in Figure 1) comprised three subclassifications that could discriminate between 18 types of outcomes or effects (harm). The harm index was based on the NCC-MERP Medication Error Taxonomy [12], and is characterized by the degree of harm—ranging from no harm to temporary or permanent impairment of physical or psychological function. Broad distinctions were also made between medical (psychological or physical) and non-medical (legal, social, or economic) impacts.

The ‘Type’ classification included three levels that address communication, patient management, and clinical performance (see Figure 2). The ‘communication’ subclassification identified communication problems that exist between provider and patient, provider and patient’s proxy, provider and non-medical staff, and among providers. The ‘patient management’ node classified substandard patient management that involved improper delegation, failure in tracking or follow-up, wrong referral or consultation, or questionable use of resources. The ‘clinical performance’ subclassification included the full range of failures that could lead to iatrogenic events during the pre-intervention, intervention, and post-intervention phases of care. Analysis of Joint Commission sentinel event data (reported from 1995 to 2002) related to wrong-site surgeries ($n = 209$) showed that these adverse events could be classified in the following principal groups: (i) Communication—including communication with the patient and among members of the surgical team; availability of information; and operating room hierarchy; (ii) Patient management—such as preoperative assessment of the patient; and (iii) Clinical performance—including orientation and training, the procedures used to verify the operative site, and distraction. Alternatively, these areas could represent the clinical or management processes that are associated with events without any judgments about root causes within those processes.

The ‘Domain’ classification included the types of health care professionals commonly involved in patient care and the demographics of patients in a variety of health care settings where events might have occurred (see Figure 3). Analysis of voluntarily reported sentinel events showed that they occur most frequently in the following settings: general hospital (64%); psychiatric hospital (13%); psychiatric unit (6%); outpatient behavioral health (5%); emergency department (4%); long-term care facility (4%); home care service (3%); and ambulatory care setting (1.5%). From this, we postulated a link between where the event took place (>10 coded categories) and which medical specialty was involved (>21 coded

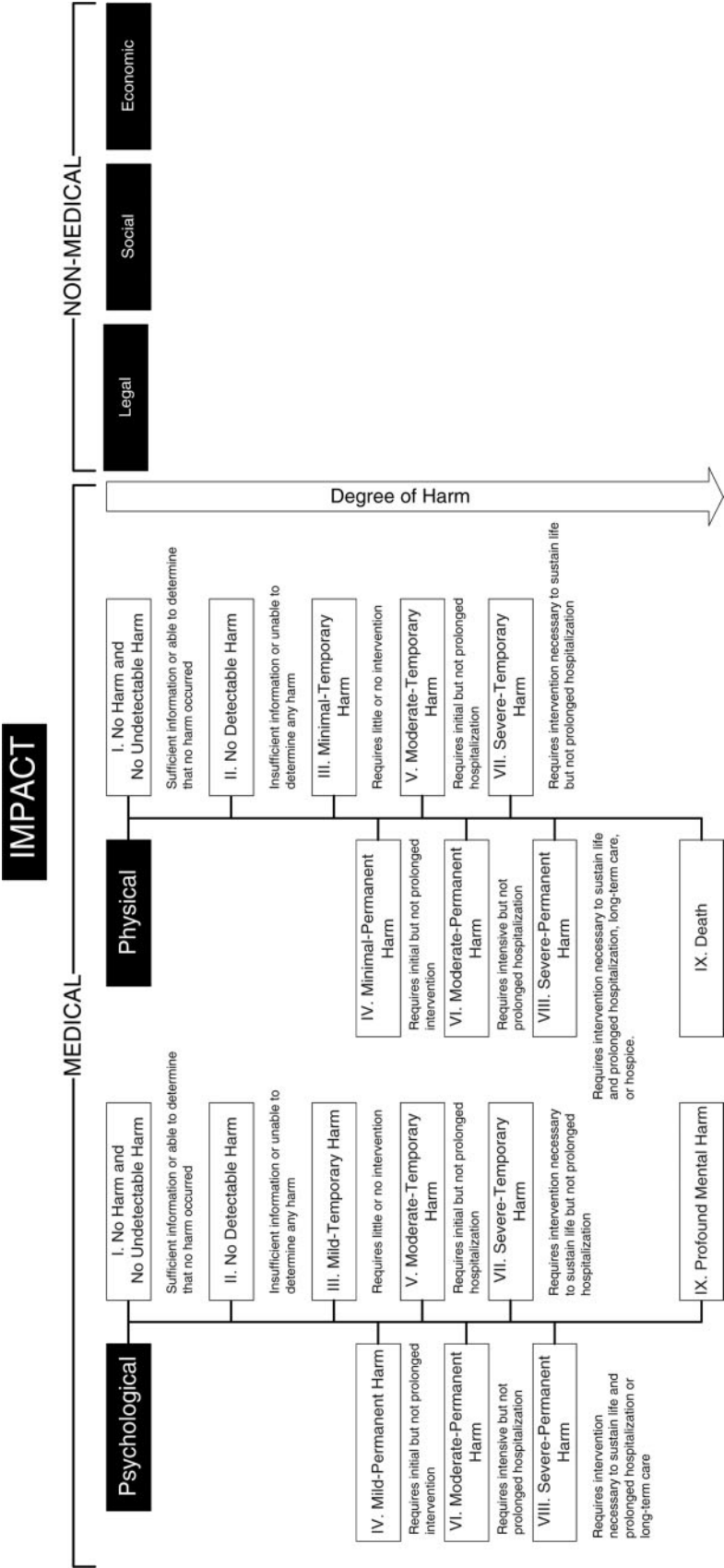


Figure 1 Classification of impact.

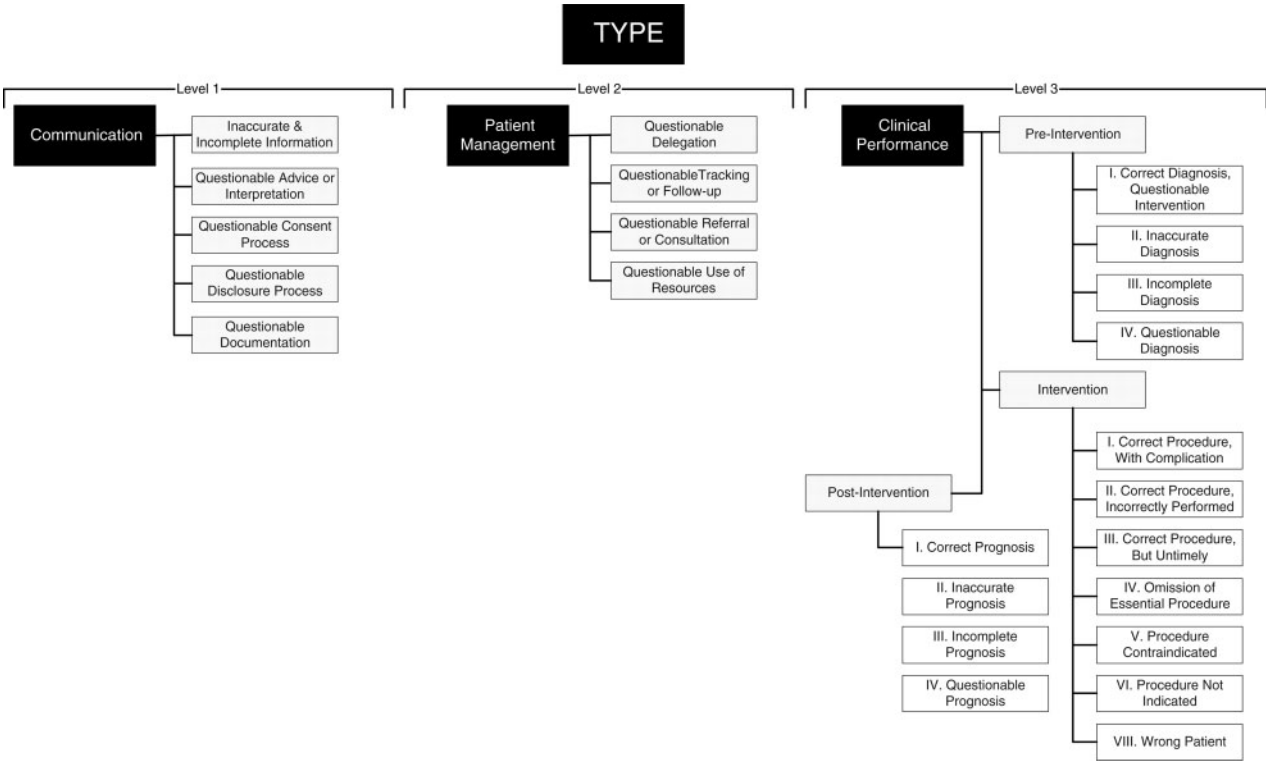


Figure 2 Classification of type.

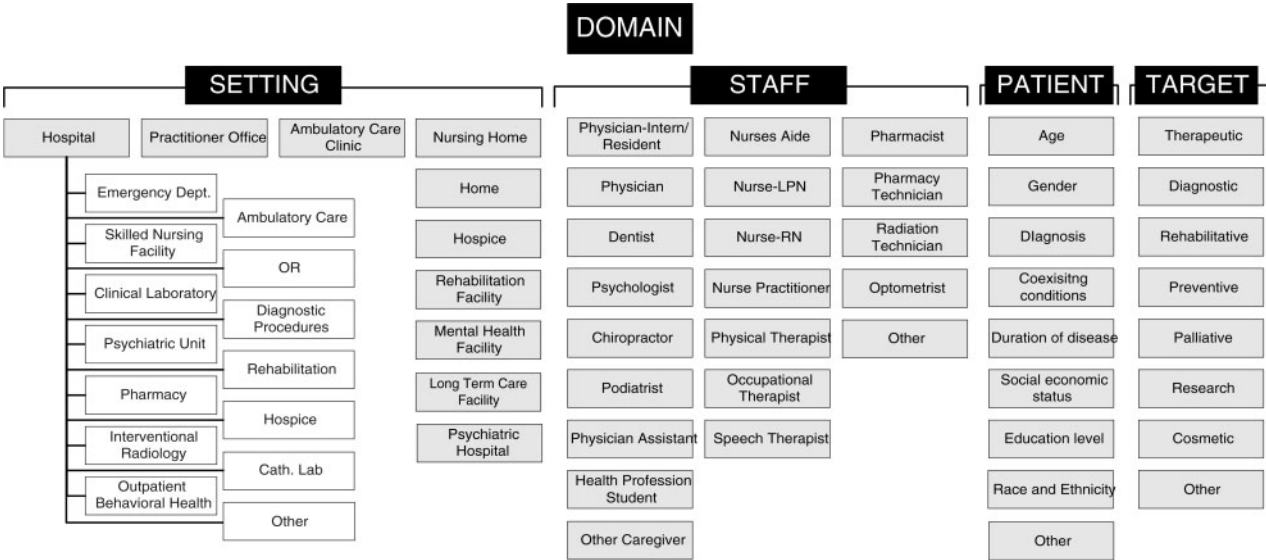


Figure 3 Classification of domain.

categories). In addition, we specified the intended patient care intervention (eight coded categories—therapeutic, diagnostic, rehabilitative, preventive, palliative, research, cosmetic, and other), which pre-existing conditions the patient had (ICD-9-CM coded categories), and the associated causes and outcomes delineated in the other four primary classifications.

The classification of ‘Causes’ is shown in Figure 4. Root cause analyses of sentinel events in all categories showed that the underlying causes of these events could be classified into

two principal groupings: system failures and human failures. The principal nodes of the ‘Cause’ classification comprised two subclassifications: system (process/structure) failures and human failures. System failures are remote from the direct control of the clinician and are usually the distal cause of structure and process failures among reported sentinel events (e.g. orientation/training, availability of information, staffing levels; physical environment, alarm systems, organizational culture). System failures are errors in the design, organization,

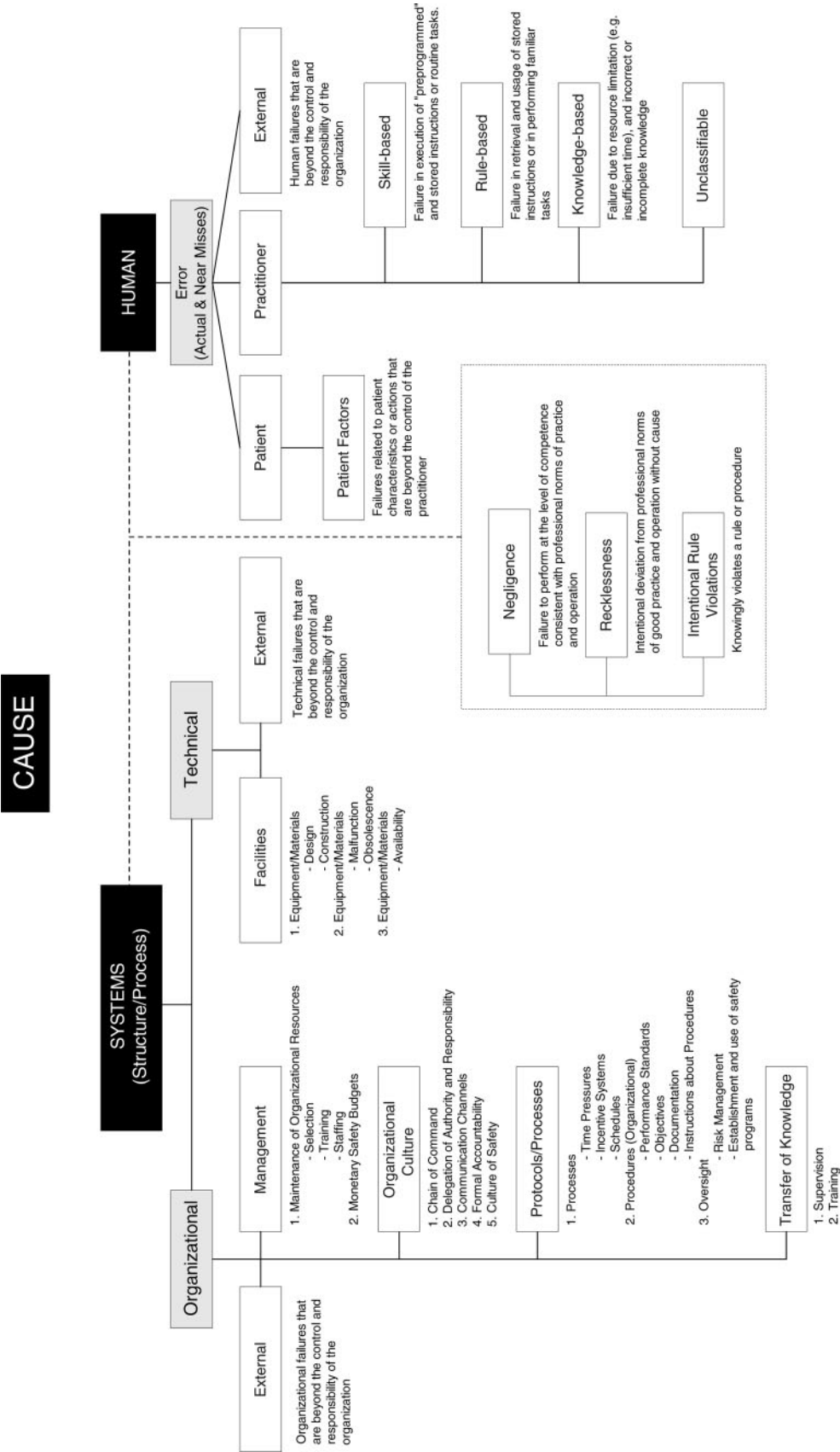


Figure 4 Classification of cause.

training, or maintenance that lead to operator errors. Those failures involving direct contact with the patient—human failures—are often part of the proximate cause of an event [35]. The root cause analysis data yielded groupings that included communication, patient assessment, and continuum of care, among others. The subclassification, ‘latent organizational failure’, included five coded categories: (i) management, (ii) organizational culture, (iii) protocols and processes, (iv) transfer of knowledge, and (v) external factors. Two categories for latent technical failure—facilities and external factors—were derived from the Eindhoven Classification System [31].

Terminology for the ‘Prevention and Mitigation’ classification was adopted from the definitions proposed by Gordon [36] for physical disease prevention. In this classification, three types of prevention and mitigation were identified: universal, selective, and indicated. The ‘universal’ subclassification covered preventive and corrective measures that are designed for everyone in the eligible population. Prevention and mitigation measures that are directed toward a subgroup of the population whose risk of adverse events is above average were grouped in the ‘selective’ subclassification. Lastly, the ‘indicated’ subclassification combined interventions that are targeted to specific high-risk individuals identified as having a minimal but detectable risk for sustaining an adverse event. Figure 5 illustrates how the preventive strategies of the Joint Commission’s 2004 National Patient Safety Goals [37] could be classified according to this scheme.

The proposed interrelationships depicted in Figure 6 show the assumptions underlying the *Taxonomy* framework. The linkages in this visual analytical framework provide an organized approach to guide the retrospective process of identifying the factors (causes) that contribute to systems failures (type) and adverse events, or to prospectively identify potential risk factors and devise preventive strategies (prevention) and corrective actions (mitigation) to protect the patient (in a domain) from harm (impact). The linkages are not meant to lead to premature conclusions about an event, nor are they intended as the only analytical framework. Although the linkages define the specific types of queries, they do not identify precise data sources nor which units of data should populate the taxonomy.

A preliminary test of the alpha version taxonomy conducted at one hospital with an active incident reporting system (Stanford’s ICUrs) demonstrated acceptable correlation between its coded categories ($n = 111$) and the categorized data requirements of the system. Thirteen (12%) categories were identical, 42 (38%) were synonymous, 45 (41%) were related, and six (5%) had to be extrapolated. Five (4%) categories were unmatched—date and time of incident, patient or family dissatisfaction, and two patient identifiers—and were therefore omitted from the taxonomy.

Using the desirable attributes of patient safety taxonomy identified by the expert advisory workgroup (see Box 1), the face validity of the terminology and classifications inferred from the comments of the experts who reviewed their clarity and completeness was judged to be high. The workgroup recommended inclusion of external factors that are perceived to influence patient safety. The workgroup concluded that the *Taxonomy* was well suited to meet the need for integration of

patient safety data from disparate sources. A variety of patient safety stakeholders concurred in the taxonomy’s suitability and feasibility for application in incident investigation, reporting, tracking, and analysis at US hospitals and elsewhere.

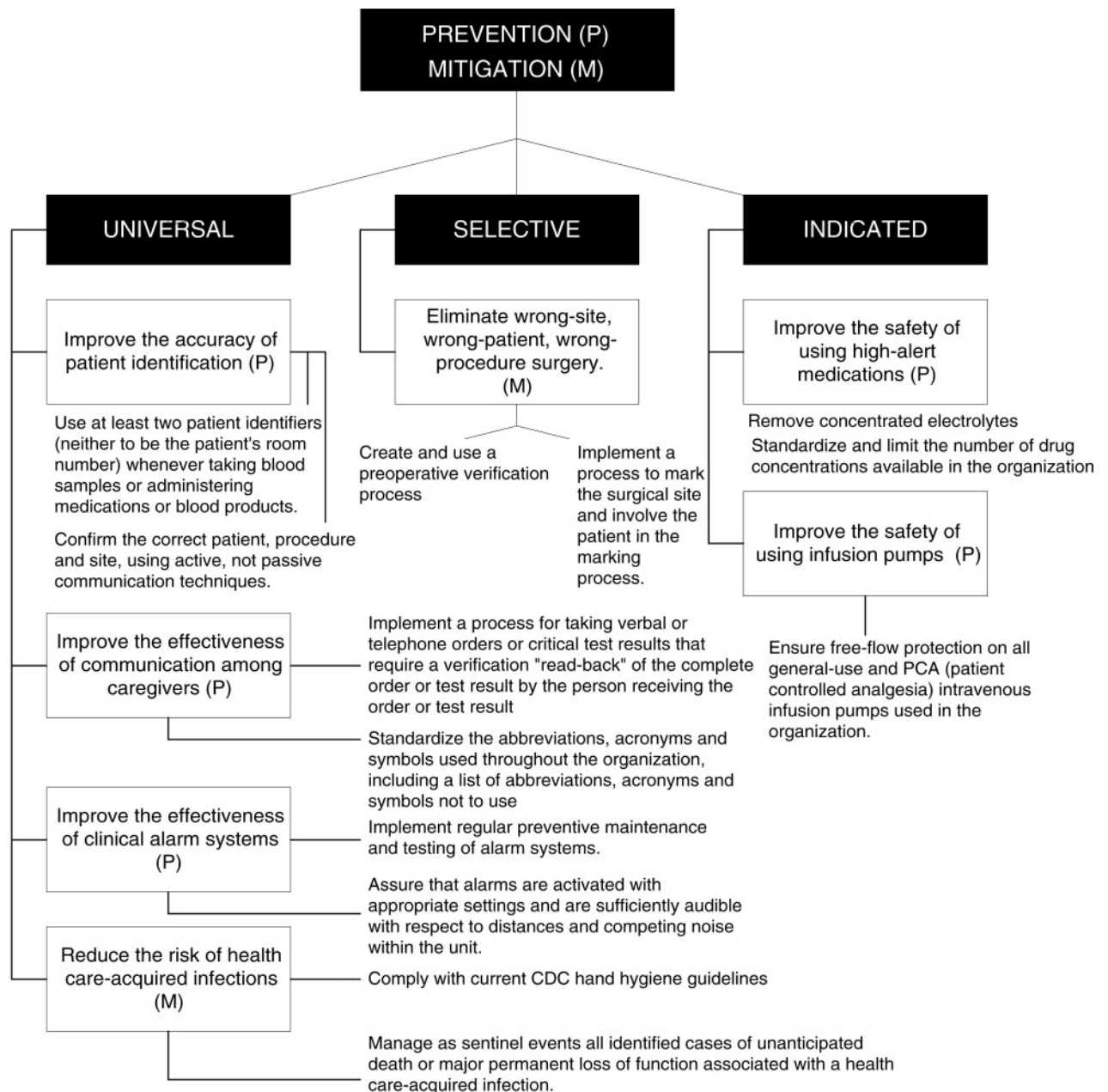
Discussion

The *Patient Safety Event Taxonomy* developed and tested in this study represents a synthesis of traditional, hierarchical classifications represented by single topic areas and settings and the heuristic, multidimensional/multisetting classifications that rely on a systems approach to understanding patient safety [38]. It includes all events that are not due to an underlying physiological or pathological process and is sensitive to minor variations among similar events. This approach compels the user to make explicit, *a priori* decisions about the key variations in structure and process that relate to any given patient safety event. It also allows others to judge whether important variables were overlooked. Finally, it makes explicit the relationships between these variables and their relevance as valid markers of patient safety.

The number of relevant categories constituting the optimum classification scheme or how best to deconstruct an adverse event will always be subject to debate [39]. Hobgood [40], using a modified Delphi process to differentiate between specific classes of medical error common to emergency medicine practice, found that cognitive errors in medical decision-making can be difficult to identify, and suggested that consensus on terminology and classification may be challenging. One source of difficulty we encountered in choosing logical data variables to link disparate terminologies and classifications is that they are all loosely attached in an intricate network of information characterized by events, settings, individuals, and teams of people, protocols, procedures, policies, and communications that function in an uncertain environment. Understanding these relationships could provide a useful basis to guide the development and improvement of information about near misses and adverse events, and use of the information to make health care safer for patients.

We critiqued existing taxonomies on several grounds. Most were developed in relative isolation from other classification approaches for a specific medical specialty, and few were improvements of earlier work. In this regard, we believe that research that compares different classification schemas constitutes a crucial stage in consolidating the discipline of patient safety event reporting.

Aggregating data gathered through different measurement methods into the framework of a standardized taxonomy has been used successfully by epidemiologists to detect nosocomial infections [41], and is likely to be useful in detecting trends and patterns in patient safety. In a number of studies, there appears to be an evolving effort to build a science of patient safety measurement that is equivalent to health measurement or psychometrics. This is important because decisions affecting the welfare of patients and the expenditure of public funds are based on the results of patient safety measurements [42].



Adapted from the Joint Commission's 2004 National Patient Safety Goals

Figure 5 Classification of prevention and mitigation.

The potential applications for patient safety event information vary widely depending on the identity of the user—e.g. internal evaluations, oversight bodies, patient safety managers, patients, ethicists, and lawyers, among others. In order to meet the needs of these diverse audiences it is essential to identify a common language that is widely applicable and straightforward. The vocabulary adopted for the *Taxonomy* closely resembles the lexicon commonly used among various users today, and avoids pejorative terms.

In its simplest form, the *Taxonomy*'s classifications can represent individual fields for the front end of paper-based or electronic reporting systems with individual incidents comprising the records. At its broadest application, the *Taxonomy* describes processes that determine the quality of incident reports, the effectiveness of reporting systems, and the success of intervention strategies. The significance is that the *Taxonomy* could potentially be used as a common backbone when mapped to disparate reporting systems unifying terminologies and classifications. This allows aggregated data to be

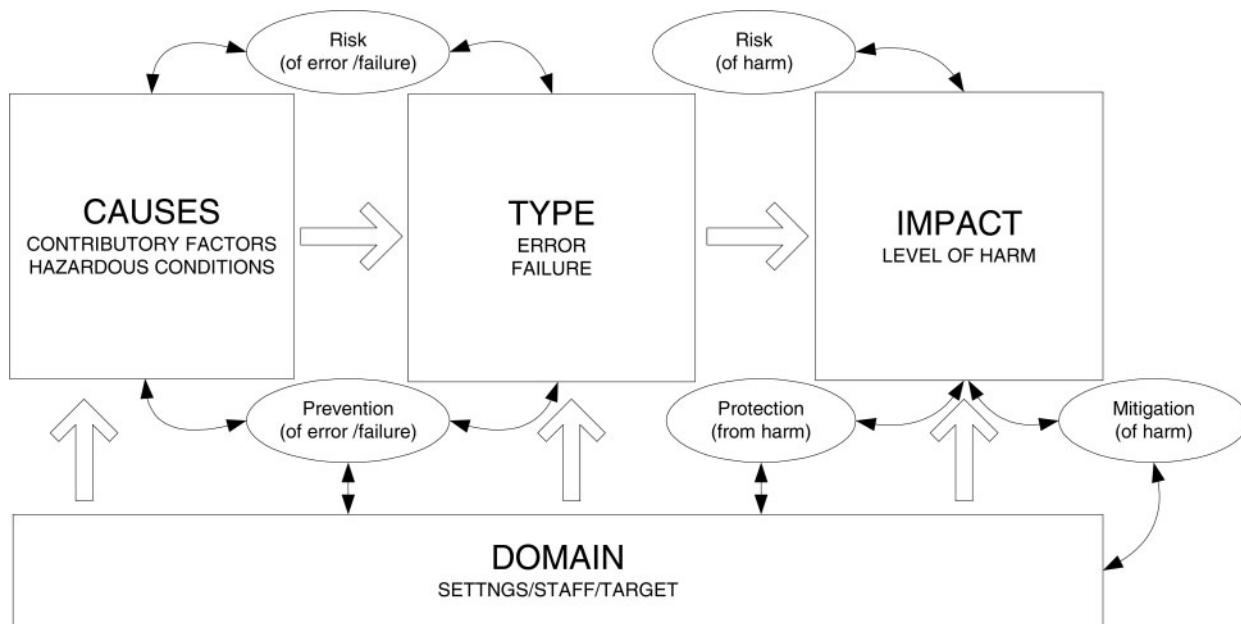


Figure 6 Analytical framework of the JCAHO patient safety event taxonomy.

Box 1 Desirable attributes of a patient safety event taxonomy

Based on unambiguous and generally agreed terminologies and classifications.

Useful for analyzing the processes and outcomes that underlie an event, including its root causes and contributing factors. Facilitates consistent collection and analysis of near miss and adverse event data across the continuum of health care delivery settings.

Facilitates expedient data exchange and dissemination of patient safety information.

Useful for identifying priority areas for remedial attention and opportunities to improve patient safety.

combined and tracked over time, provides for consistency across reporting systems, and structures data documentation and presentation using a standardized format. Applied to an electronic health record system, the taxonomy offers a means for interoperability, facilitating exchange of patient safety data across systems.

A decentralized approach to patient safety reporting, using a standardized terminology and classification framework, would simplify the development and maintenance of a coding structure for reporting. Reconciling the data collected by local or focused reporting programs to a national standard would provide a means to integrate the already existing data collection efforts relating to health care errors and systems failures. The framework of the *Taxonomy* will also lessen the burden on patient safety organizations that operate in multiple states and/or must be responsive to multiple government agencies, private oversight bodies, and group purchasers, without requiring expensive re-engineering of existing reporting systems.

Limitations

Health care error classification systems are not free of their own problems. For example, they partition categories more coarsely than do keywords, and users, who are accustomed to

the everyday colloquial language of patient safety used in the workplace environment, may not be fluent in the terminology of the classifications. The finite number of elements in the *Taxonomy* nevertheless encompasses a broad range of areas that could possibly be classified, but there are still likely many areas that could escape detection and reporting. Furthermore, because the anatomy of an event is multidimensional, its deconstructed components may not be mutually exclusive to each of the classifications, subclassifications, coded categories, and narrative fields in the taxonomy. In addition, the multi-tiered features may be too complicated for some audiences to use. For example, wrong-site surgery not only results in physical harm, but may also affect the emotional (psychological) and functional status of the patient, and his or her ability to return to work (economics). Near misses in the taxonomy are assumed to have the same root causes as the much smaller subset that actually develops into adverse events. Arguably, the very advantage of using near-miss data to provide information on how an incident 'recovered' from a potential adverse event also has a downside. Adverse events are by definition near misses that failed to be recovered in time [43]. By contrast, the events that a hospital successfully prevents from occurring will be just those events that will never be identified in a near-miss information system. Thus,

the *Taxonomy* must be clear on just what near misses have in common, or not, with adverse events. Notwithstanding the potential limitations of near-miss data, near misses are sufficiently clear precursors of adverse events to point the way to identification of specific individual and systems failures.

Conclusion

The Joint Commission *Patient Safety Event Taxonomy* focuses on the most salient terminologies and classifications. Its design will permit the progressive incorporation of new patient safety data and information over time. However, additional field-testing will be required to bring the taxonomy to full maturity and permit it to realize its overall objectives.

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Clinical Science

Classifying errors in preventable and potentially preventable trauma deaths: a 9-year review using the Joint Commission's standardized methodology



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KEYWORDS:

Trauma preventable deaths;
Avoidable errors;
Joint Commission taxonomy of avoidable medical errors

Abstract

BACKGROUND: Benchmarking and classification of avoidable errors in trauma care are difficult as most reports classify errors using variable locally derived schemes. We sought to classify errors in a large trauma population using standardized Joint Commission taxonomy.

METHODS: All preventable/potentially preventable deaths identified at an urban, level-1 trauma center (January 2002 to December 2010) were abstracted from the trauma registry. Errors deemed avoidable were classified within the 5-node (impact, type, domain, cause, and prevention) Joint Commission taxonomy.

RESULTS: Of the 377 deaths in 11,100 trauma contacts, 106 (7.7%) were preventable/potentially preventable deaths related to 142 avoidable errors. Most common error types were in clinical performance (inaccurate diagnosis). Error domain involved primarily the emergency department (therapeutic interventions), caused mostly by knowledge deficits. Communication improvement was the most common mitigation strategy.

CONCLUSION: Standardized classification of errors in preventable trauma deaths most often involve clinical performance in the early phases of care and can be mitigated with universal strategies.

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Trauma is the leading cause of death in patients younger than 45 years and uses significant healthcare resources. However, diverse performance improvement (PI) efforts, particularly in the area of preventable deaths, have improved the

management of injured patients worldwide.^{1–3} Nevertheless, for such initiatives to result in improved trauma outcomes, clear identification and characterization of avoidable errors must be possible and reporting of these events must be standardized across trauma centers.⁴ Awareness of patient safety issues is steadily rising in all medical fields, and institutions. Governments and regulatory bodies are increasingly demanding rigorous reporting of avoidable errors to develop mitigation strategies and improve delivery of care.^{5,6}

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Although trauma care is well advanced in this field with more than 30 years of published PI initiatives, current reporting of avoidable errors leading to death remains center-dependent and lacks a common terminology. Most trauma centers separate trauma patient deaths into 3 categories: preventable, potentially preventable, and non-preventable by benchmarking care to accepted guidelines (eg, Advanced Trauma Life Support^{7,8}) or by determining risk of death⁹⁻¹¹ using severity scores (Injury Severity Scale [ISS]¹² and Trauma Score - Injury Severity Score [TRISS]¹³).

Regardless of methodology, efforts at trauma PI are contingent upon the identification of avoidable errors management of trauma patients. In this context, preventable deaths are those directly caused by an avoidable error^{2,14-16} and potentially preventable deaths are those in which an avoidable error is found, but the death would likely have occurred despite this error.¹⁷

In an effort to standardize the reporting of avoidable errors in health care, the Joint Commission (JC, formerly known as the Joint Commission on Accreditation of Healthcare Organizations) established in 2005 a taxonomy to classify errors in 5 interacting root nodes: impact, type, domain, cause, and prevention.¹⁸ This standardized reporting of preventable errors has since been used in multiple medical fields including the Committee on Trauma of the American College of Surgeons (ACS) and has become the benchmark of patient safety error reporting globally.¹⁹⁻²¹

In a review of the trauma literature, only one report directly applied the complete JC taxonomy to analyze avoidable errors leading to preventable and potentially preventable deaths in trauma. Ivatury et al²² reported a 5-year account of 76 deaths in the trauma service at the Virginia Commonwealth University Medical Center classifying errors in the 5 domains of the JC taxonomy. Others^{4,8,23-32} have used their own tiered classification schemes to analyze avoidable errors in trauma, many bearing resemblances to the JC classification system but often omitting certain elements considered important in patient safety analysis. Unfortunately, the lack of uniformity in these different reports renders difficult comparisons between studies and universal applicability of results when gauging quality of the management of trauma patients across centers. Repeated appeals have been made to standardize the reporting of preventable mortality in trauma.^{25,26}

In this study, we sought to characterize the preventable mortality in a mature urban trauma center in a 9-year review. Our secondary objective was to categorize all avoidable errors identified in these cases using the common language of quality standards proposed by the JC. We hypothesized that preventable deaths were not uncommon and were primarily associated with management errors by physician providers in the early phases of resuscitations.

Patients and Methods

Study setting

The Trauma Center at Penn is a level-I trauma center accredited by the Pennsylvania Trauma Systems Foundation (PTSF), the sole accrediting authority of trauma centers in the state of Pennsylvania. The Trauma Center at Penn is based at the Hospital of the University of Pennsylvania (HUP), an academic tertiary care medical center in Philadelphia, Pennsylvania. The trauma service evaluates all patients meeting field triage criteria for trauma as established by the state bureau of Emergency Medical Services. Additionally, as a level-I trauma center, HUP is a regional resource for trauma referrals from other hospitals. The trauma registry captures all injured patients meeting the criteria of the Pennsylvania Trauma Outcomes Study, as mandated by the PTSF (<http://PTSF.org>). HUP has a 24/7/365 in-house attending trauma surgeon responding to all trauma activations including alerts (highest tier/full trauma team at bedside), responses (less serious but also requiring part of the trauma team at bedside), and consults (limited trauma team present at bedside). The trauma team typically consists of a nurse and paramedic, a senior/chief and junior resident (with a trauma fellow in some cases), and for alerts also summon the emergency department (ED) airway team (attending, senior resident, respiratory technician) and the automatic dispatch of blood products. A 128-slice CT scan and fully staffed angiography suite are adjacent to the ED and prioritize trauma requests at all times. All multisystem injured patients are admitted to the trauma service and only single system injuries are considered for admission to subspecialty services. Patients admitted to subspecialty services are also reviewed in trauma PI activities.

Data on all trauma patients admitted to the hospital are entered in the hospital trauma registry that contributes entries to the Pennsylvania Trauma Outcomes Study registry and the National Trauma Data Bank. The Trauma Program Medical Director (P.K.K.) and 2 PI Coordinators (J.M.) are collectively responsible for all PI efforts of the division and actively maintain the PI database.

Trauma performance improvement process and database

The PI program has been an integral component of the trauma center since its inception. The PI program is led by a PI Medical Director and PI coordinator(s), but all trauma providers participate in its processes. PI occurrences are defined in the PTSF Data Dictionary. PI issues, identified through a variety of methods, are reviewed on an ongoing basis by PI coordinators and the PI Medical Director. PI issues requiring further discussion are peer-reviewed by an attending trauma surgeon not involved in the patient's care. The peer surgeon, guided by a dedicated checklist,

Table 1 Trauma admissions and deaths at the Hospital of the University of Pennsylvania during the 9-year period studied

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Total admissions	1,115	1,089	1,252	1,309	1,360	1,186	1,190	1,292	1,307	11,100
Mean ISS	13.07	13.12	13.3	13.8	13.4	14.3	13.56	13.21	12.58	13.37
Total deaths	125	151	148	154	204	175	155	150	115	1,377
Nonpreventable deaths	117	135	137	143	193	158	135	140	111	1,271
Preventable/potentially preventable deaths	8	14	11	11	11	17	20	10	4	106

ISS 5 Injury Severity Scale.

comprehensively reviews the medical record with particular attention to examining the cause of death and antecedent events. On a monthly basis, the findings of peer review are discussed in the committee (Trauma PI Conference [TPIC]), with all attendings participating. The TPIC meetings are multidisciplinary and assemble a variety of trauma care providers including trauma surgeons (8 full-time attending staff), emergency physicians, trauma nurses, and subspecialty surgeons (orthopedics, neurosurgery, etc) and seek to identify avoidable errors in each case. Autopsy reports are consulted where available. Peer review concludes with the determination of preventability and identification of opportunity for improvement, if it exists. Detailed conference notes and determinations of death preventability are entered into the dedicated database, POPIMS (Pennsylvania Outcomes Performance Improvement Monitoring System). Events found to be associated with possible or definite errors in management are communicated to the specific provider by the medical director and this exchange is documented in the database and used to determine appropriate system or provider corrective actions.

Preventable, potentially preventable, and nonpreventable deaths

Deaths are classified by the TPIC as preventable if they are found to be caused directly by (an) avoidable error(s). The group uses criteria and audit filters promulgated by the ACS including survivability of injuries, stability of the patient on arrival, proper use of algorithms (Advanced Trauma Life Support), time spent in the ED, time to arrival of team members, and unexplained return to the operating room (OR).³³ To ascertain potentially preventable deaths, the TPIC uses 3 key criteria outlined by MacKenzie³⁴ as follows: (1) the injury must be survivable, (2) the delivery of care was suboptimal, and (3) the error must be directly or indirectly implicated in the death of the patient.

Database queries

Approval by the Institutional Review Board of the University of Pennsylvania was obtained before the study activity. The trauma PI database was queried for all

in-patient deaths that occurred between January 1, 2002 and January 1, 2011. For each case, the electronic medical record was reviewed for patient demographics (age, sex), history (comorbidities), injury information (date, mechanism of injury, ISS, and revised trauma scores), and conditions surrounding the death. The POPIMS database was further queried to obtain a summary of the discussions conducted by the TPIC particularly to determine death preventability and identification of avoidable errors.

Classification of errors using the Joint Commission taxonomy

Five interacting nodes form part of the JC taxonomy and each error identified was classified in one or multiple categories using this methodology.¹⁸ The error *impact* or outcome/harm to the patient was death in all cases. Error *type* describing the implied or observed events/processes that failed or were faulty was divided into diagnosis, intervention, or prognosis errors. Error *domain* referring to the setting in which the incident occurred categorized the hospital location of the event, the discipline of staff providers involved, as well as the target of the intervention (therapeutic or diagnostic). The error *cause* referring to the factors and agents that led to the incident were divided into human (knowledge, rule, and skill-based settings) and system (organizational or technical) errors. Finally, *prevention* or mitigation measures enacted to prevent further occurrence of the event were further subclassified as universal, selective, or indicated.

Data analysis

Data collected were entered in the POPIMS database. All descriptive analyses present data as means with standard deviation (SD) (continuous variables) and percentages (categorical variables).

Results

Patient population and demographics

Annual trauma visits in the study time period ranged from 2,253 to 3,162 with a mean of 2,708 trauma contacts

per year. A total of 11,100 trauma patient admissions were identified in the registry in the specified time period, of which 1,377 (12.4%) in-hospital deaths were reported. Of these, 18 (1.3% of all deaths, .16% of all trauma admissions) were classified as preventable, 88 (6.4% of all deaths, .79% of all trauma admissions) as potentially preventable, and 1,271 (92.3% of all deaths, 11.5% of all trauma admissions) as nonpreventable (Table 1) deaths. For study purposes, only data from the 106 preventable or potentially preventable deaths were analyzed and PI data were available for all 106 cases. Mean (SD) age of the cohort was 23.2 (52.6) years with a preponderance of men (76.4%, 81 cases). Mean (SD) ISS was 17.9 (27.3)

with 78 (73.6%) patients injured by blunt and 28 (26.4%) patients by penetrating mechanisms of injury.

Qualifying avoidable errors by Joint Commission taxonomy

The main causes of preventable and potentially preventable deaths were multiple organ failure (28.3%) and hypovolemic shock (21.7%) (Table 2). One hundred forty-two (142) avoidable errors were identified by the TPIC and are summarized in Table 3.

These avoidable errors were then classified using the JC taxonomy 1st by error *type* (Table 4). The most common error type was in clinical performance (132 errors), an inaccurate diagnosis, a procedure not indicated, untimely correct procedures, and omission of an essential procedure). Forty-six management errors involved primarily questionable follow-up (23 cases) and 37 communication deficiencies were identified including 20 that involved a questionable advice or interpretation.

The most frequent *domain* setting was the ED (59 cases) followed by the intensive care unit (ICU) (42 cases) and involved cases such as delayed recognition of a tension pneumothorax resulting in cardiac arrest/cerebral anoxia and a recently extubated patient requiring reintubation for respiratory failure (Table 5). The most often involved care providers were physicians (122 cases) with only 5 cases where a bedside nurse was identified as the primary provider involved. The targets were primarily therapeutic (104 cases), a colon anastomotic leak resulting in multiorgan failure and death, a femur fracture not immobilized before ED departure) and diagnostic (26 cases),

Table 2 Cause of death for 106 preventable or potentially preventable deaths identified during study period

Cause of death (n 5 106)	n (% incidence)
Multiple organ failure	30 (28.3)
Hypovolemic shock	23 (21.7)
Respiratory failure	19 (17.9)
Cardiac arrest/failure	14 (13.2)
Neurologic death	12 (11.3)
Sepsis or infection	8 (7.6)

Table 3 Categorization of avoidable errors by TPIC discussions

Avoidable errors as identified by TPIC before formal classification using JC taxonomy (n 5 142)	n (% incidence)
Questionable treatment	21 (14.8%)
Delay of appropriate treatment	18 (12.7%)
Incorrect treatment	18 (12.7%)
Omission of essential procedure	14 (9.9%)
Inappropriate documentation	11 (7.8%)
Delayed diagnosis because of incorrect interpretation of vital signs	8 (5.6%)
Inaccurate diagnosis	6 (4.2%)
Preventable pulmonary embolism	5 (3.5%)
Inappropriate use of damage control techniques	4 (2.8%)
Self-extubation or extubation out of protocol	4 (2.8%)
Admission to an inappropriate hospital location	4 (2.8%)
Aspiration during placement of nasogastric tube	3 (2.2%)
Lack of transfusion products because of unavailability	3 (2.2%)
Complications of an appropriate treatment	3 (2.2%)
Cause of death unknown or unexpected	3 (2.2%)
Lack of monitoring	2 (1.4%)
Airway occluded by mucus plug	2 (1.4%)
Femoral access resuscitation in the setting of active abdominal bleeding	2 (1.4%)
Esophageal intubation	2 (1.4%)
Emergency room triage error	2 (1.4%)
Radiologic misinterpretation	1 (.7%)
Medication reaction	1 (.7%)
Inordinate prehospital delay	1 (.7%)
Ventilator malfunction	1 (.7%)
Inaccurate medical history report	1 (.7%)
Iatrogenic pneumothorax	1 (.7%)
Communication error	1 (.7%)
Total	142

JC 5 Joint Commission; TPIC 5 Trauma Performance Improvement Conference.

nonidentification of asystole and death in a patient who should have been on telemetry, delayed diagnosis of abdominal bleeding despite tachycardia and anemia).

By far, most error *causes* were human (139 cases), the majority of which identified a knowledge deficiency (61 cases), inappropriate venous thromboembolic prophylaxis resulting in a fatal pulmonary embolism (Table 6). System causes were rare (9 cases) involving primarily equipment unavailability (4 cases), a missing ventilator connector during a procedure resulting in hypoxia without alarm and subsequent death).

Table 4 Error type classification of 142 avoidable errors in 106 cases of preventable or potentially preventable deaths as classified by the Joint Commission

Joint Commission taxonomy: error type

Communication	
Questionable advice or interpretation	20
Questionable documentation	12
Inaccurate and incomplete information	4
Questionable disclosure process	1
Management	
Questionable tracking or follow-up	23
Questionable use of resources	17
Questionable delegation	4
Questionable referral or consultation	2
Clinical performance	
Diagnosis (preintervention)	
Inaccurate diagnosis	28
Correct diagnosis, questionable intervention	18
Intervention	
Procedure not indicated	22
Correct procedure, but untimely	20
Omission of essential procedure	20
Correct procedure, with complication	10
Correct procedure, incorrectly performed	6
Procedure contraindicated	1
Prognosis (postintervention)	
Inaccurate prognosis	7

Note: Errors may span multiple categories and as such sum totals do not equal 142. Categories not involving a single case are omitted.

Several (142) mitigation or *preventive* strategies were implemented after identification of errors in preventable and potentially preventable deaths. The vast majority of

Table 5 Error domain of 142 avoidable errors found in 106 preventable or potentially preventable deaths as classified by the Joint Commission

Joint Commission taxonomy: error domain

Setting	
Emergency department	59
Intensive care unit	42
Surgical ward	19
Operating room	17
Prehospital care	5
Staff	
Physician	122
Physician 1 nurse	12
Nurse	5
Other	3
Target	
Therapeutic only	104
Diagnosis only	26
Therapeutic 1 diagnosis	9
Other	3

Note: Domain parameters identified in certain errors overlapped and as such certain errors were classified in more than one category. Categories not involving a single case are omitted.

Table 6 Error cause of 142 avoidable errors found in 106 preventable or potentially preventable deaths as classified by the Joint Commission

Joint Commission taxonomy: error cause

Human causes	
Knowledge-based (insufficient time, incomplete knowledge)	61
Rule-based (failure of recall of stored instructions)	39
Skill-based (failure in execution of stored instructions)	39
System causes	
organizational	
Protocols/processes	1
technical/facilities	
Equipment/material availability	4
Equipment/material malfunction	3
Equipment/material obsolescence	1

Note: Cause parameters identified in certain errors overlapped and as such certain errors were classified in more than one category. Categories not involving a single case are omitted.

improvements involved correcting ineffective communication (66 cases), improving alarm systems to detect abnormal vital signs as soon as possible, instituting guidelines requiring charted medical orders before departure from the ED, routine review of documentation to assure the correct accomplishment of tasks, or that wound packing remains in situ for > 72 hours), followed by eliminating wrong procedures (17 cases), instituting a 2-step nasogastric tube insertion technique to avoid tracheal placement, protocolized direct laryngoscopy in transferred patients for timely identification of esophageal intubations) and improving the safety of high-alert medications (30 cases) (Table 7).

Comments

Depending on definitions used in published reports, the incidence of preventable death in trauma ranges from 2% to 29%.^{4,15,23,24} Determining preventability of death depends on the identification of avoidable errors in the management of injured patients during their hospital care and sometimes also their prehospital care. In a 9-year review, we found a 7% incidence of preventable and potentially preventable deaths in our urban academic trauma center. We classified 142 avoidable errors identified in these cases using the JC taxonomy to allow a better comparison with the experience of other trauma centers. Deaths resulted primarily from multiorgan dysfunction, hemorrhage, and failure in airway management and primarily involved the clinical performance of physicians in the early ED resuscitative phase. Avoidable errors were overwhelmingly human and resulted primarily in universal mitigation strategies.

More than one decade has passed since The Institute of Medicine published the report "To Err is Human: Building a

Table 7 Error prevention/mitigation derived from 142 avoidable errors found in 106 preventable or potentially preventable deaths as classified by the Joint Commission

Joint Commission taxonomy: error prevention/mitigation	
Universal	
Improving the effectiveness of caregiver communication	66
Reducing the risk of healthcare-acquired infections	6
Improving effectiveness of clinical alarm systems	2
Selective	
Eliminating wrong procedures	17
Eliminating wrong procedure surgery	14
Eliminate wrong-site surgery	6
Indicated	
Improving the safety of high-alert medications	30
Improving the safety of using infusion pumps	1

Note: Prevention parameters identified in certain errors were assigned to more than 1 mitigation strategy. Conversely, several similar errors were addressed with the same prevention strategy. As such, the number of errors of a given type in the preceding tables does not match the number of strategies of the same type under Table 6. Categories not involving a single case are omitted.

Safer Health System.” This sentinel document exposed the alarming absence of routine and standardized reporting of the errors that occur with abundant frequency in health care.

With growing scrutiny from regulatory bodies, reliable reporting of avoidable errors in management has become increasingly necessary as the 1st step to improve the quality of health care. Although trauma PI efforts have existed for decades, there remains no uniformity in reporting death

preventability among trauma centers and even greater variability exists in classifying and reporting avoidable errors. Unfortunately, this lack of standard language in error categorization makes difficult comparisons between different centers and challenging the setting of benchmark goals. This study is one of a few to use the JC scheme to organize avoidable errors in preventable trauma deaths, classifying each into the 5 nodes required by the taxonomy.

Definitions of trauma death preventability vary between institutions, some using a TRISS survival probability threshold ($\geq 50\%$ or $\geq 75\%$) where deaths in patients with greater survival are considered preventable or potentially preventable. However, this alone may not identify all cases otherwise identified by peer review panels that yield more reproducible results.^{22,35,36} Similar to our center, most

mature trauma centers today employ consensus by multidisciplinary peer case review panels as the standard method to determine preventability of trauma deaths. Peer review panels most often use the 3 guiding criteria described by Mackenzie³⁴ in their deliberations in addition to American College of Surgeons’ Committee on Trauma audit filters.³³

Other recent studies in large cohorts of trauma admissions have demonstrated varying rates of preventable deaths. Gruen et al³² in a 9-year study used TRISS survival probability ($\geq 50\%$) in combination with mortality and morbidity (M

1 M) conferences to determine death preventability and found a 2.5% rate of cases where errors were likely to have contributed to death. In a different 1-year state-wide trauma outcome study, the reported rate of preventable mortality was 7%, but 11% when only including patients surviving to hospital admission.⁸ In a large 7-year study of 2,081 trauma patient deaths admitted to Los Angeles County - University of Southern California, Teixeira et al¹⁵ found a 2.4% rate of preventable deaths using peer case review. Ivatury et al²² who studied 19,000 trauma admissions over a 5-year period in an urban Virginia trauma center found a preventable death rate of 9.9%. Outside the United States, in studies from Amsterdam³⁰ and South Wales, Australia,²⁴ preventable mortality rates were 29% and 22%, respectively, although patients dead on arrival were excluded. In this study, using peer case review, the combined preventable and potentially preventable death rate was 7.4%, which closely resembles the Virginia study. These wide variations in trauma death preventability may indeed relate to dissimilarities in the quality of care provided at different trauma centers, but may also reflect variations in the definition of avoidable errors in the absence of a standardized classification scheme. While all studies used error classification systems that have common elements, only 2 of these studies^{22,32} to date have employed

the JC standards endorsed by the National Quality Forum.¹⁸ The most common cause of death we encountered was organ failure (28%) followed by hemorrhage (21%) and airway management issues (18%). Teixeira et al¹⁵ reported a greater contribution of hemorrhage (40%) than organ dysfunction (27%) and only a minority (6%) of errors involving airway or respiratory issues. Others also reported hemorrhage as the predominant cause of death, but also found neurologic causes to be responsible for 30% of cases.³⁰ Taken together, the 4 most commonly reported causes of preventable/potentially preventable trauma deaths are hemorrhage, organ failure, airway failure, and neurologic demise.

The classification of error *types* (the processes that failed or were faulty) is highly variable among published reports and the JC taxonomy specifically differentiates communication from management errors (improper delegation, referral, or follow-up) and further distinguishes the latter from clinical performance errors. Performance errors are subdivided in relation to the intervention (procedure, surgery) as preintervention (diagnosis) and postintervention (prognosis). Many studies that use their own classification systems combine management and performance errors, often without further breaking down error type. Ivatury et al²² and Gruen et al³² used the JC classification system, but subclassified error type differently, the latter group separating them into diagnosis, treatment, and prevention errors. As in our study, Ivatury found that the majority of error types were in patient management (resuscitation or

OR/ICU care), which we rather classified as clinical performance (intervention) error types. Other studies have also identified treatment or delay in treatment as predominant error types, although rate comparisons are difficult because of the lack of consistency in subclassification schemes.^{15,24} Interestingly, communication errors that were not infrequently found by both Ivatury and Gruen were not part of error type classification in most other large and small studies.^{8,15,24,32} The JC considers communication as a principal error type and reports that greater than 80% of serious or sentinel medical errors involve miscommunication between caregivers, particularly when patients are transferred or handed-off.³⁷ Trauma care is multidisciplinary and involves frequent provider handoffs making communication and miscommunication particularly relevant to error occurrence. Missed injuries or delays in diagnosis have been extensively studied in trauma and were common error types reported by this and most other studies, here classified as inaccurate diagnosis/clinical performance error types using JC taxonomy.^{15,30,32}

Error domain, commonly referred to as the management phase (resuscitative, definitive, or rehabilitative), and often including hospital location (ED, OR, ward) and provider type is classified by the JC into setting (phase), staff (physician, nurse), and target (therapeutic, diagnostic). We found that the domain of most avoidable errors was in the resuscitative (ED) phase and in the ICU, least often occurring in the OR. These results are consistent with other studies identifying the OR and ICU as 2nd or 3rd to the emergency room regardless of classification scheme.^{15,22,24,32} Sanddal et al.,⁸ in the only study closely scrutinizing the prehospital phase, described how the pre-hospital domain accounted for almost 40% of avoidable errors in a statewide (mostly rural) analysis. As in our study, Ivatury found the provider most commonly to be the physician, but other accounts did not distinguish the type of providers specifically^{15,30,32} in their classification schemes.

Error causes (factors or agents) are separated into system (process/structure) and human causes, where system errors are remote from the direct control of the physician (orientation/training, staffing levels, physical environment, organization). Human errors are further subdivided into their relation to skills (execution), rules (input), or knowledge (insufficient familiarity).¹⁸ Gruen et al.,³² who based their classification on the JC taxonomy, classified errors differently into *input*, *intention*, and *execution* causes and found a majority to be related to intention. Again, comparisons in error cause between this and other studies are difficult without standard terminology. Other studies used their own classification of error causes and although human causes were more prevalent, these were not further subcategorized.^{15,30} Our study also demonstrated that human errors predominate (13-fold) and are primarily related to knowledge deficits, although system-related errors do also occur.

The 5th node (prevention/mitigation strategies) of the JC taxonomy is the least often addressed category in locally

derived classification schemes. This node is further classified into universal (directed at entire population), selective (directed at different subpopulations), or targeted (directed only at specific subpopulations).¹⁸ Interestingly, the only 2 other published studies that used JC taxonomy in trauma deaths either did not use this node²² or created their own, more specific subcategories³² of prevention strategies. Although not specifically categorized, several other studies discussed prevention strategies, describing the establishing of guidelines and the training for providers.^{15,30} We found that universal measures targeted at general trauma patient populations were twice as frequently enacted as those directed at selective subgroups of patients and primarily involved improving communication between caregivers.

While this study is among the larger series reported and uses a standardized classification scheme, it only evaluates 106 cases and as such has limitations. While our TPIC case review discussions identified trauma deaths that were judged as preventable or potentially preventable, the classification of errors using JC taxonomy was conducted after the fact by one of the authors reviewing each case file (S.M.V.) and as such this may have been the subject of interpretation bias. We did not use external panels to corroborate determinations by the TPICs, although this may improve identification of avoidable errors.^{16,38} Nonetheless, such independent review is resource and time consuming and impracticable for the vast majority of trauma centers. Also, our method of searching for preventable deaths may have missed certain cases as it was conducted through self-reporting by the trauma team or the presence of the coordinator at the morning report. Yet, one of our PI coordinators was present at all weekly morning reports and their search for identifiable errors remained constant during the study period. Additionally, this study is limited to only those errors deemed to have contributed to mortality, the highest level of impact by JC criteria. As such, it does not address the medical errors which occurred leading to serious nonfatal consequences or in near-misses. Finally, although this report has only evaluated errors in preventable and potentially preventable deaths, it has not explored avoidable errors that occurred in nonpreventable mortalities. Despite this, it is likely that increasing familiarity with the JC taxonomy will likely yield opportunities for improvement in all trauma deaths and even in complications/near-misses reviewed using this framework. Outside the JC taxonomy, no other universal classification of avoidable errors in trauma exists. To date, the lack of a standard language among studies makes it difficult to compare the results and apply findings across different centers. As expressed in the American Surgical Association presidential address by H.C. Polk, “quality, safety and transparency are key to minimizing surgical errors.”³⁹ Using a comprehensive common classification of avoidable errors allows a decentralized approach of patient safety reporting using a common language and framework that will facilitate an eventual coding structure to reconcile data collected by different institutions.¹⁸

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Nonsurgical Admissions With Traumatic Injury: Medical Patients Are Trauma Patients Too

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ABSTRACT

Nontrauma service (NTS) admissions are an increasing problem as ground-level falls in elderly patients become more common. The admission and evaluation of trauma patients to nontrauma services in trauma centers seeking American College of Surgeons (ACS) verification, must follow the ACS mandates for performance improvement requiring some method of evaluating this population when admitted to services other than trauma, orthopedics, and neurosurgery. The purpose of this study and performance improvement project was to improve our process for the definition and evaluation of trauma patients who were being admitted to nontrauma services. We designed an algorithm to evaluate appropriateness of NTS admission and evaluated outcomes for NTS admissions utilizing that algorithm.

We created a scoring algorithm and evaluated appropriateness of NTS admission over 2 years in a community-teaching ACS Level II trauma center. We

reviewed trauma registry data using χ^2 and Fisher exact tests to determine differences in outcome for NTS versus trauma service (TS) admissions.

From December 2014 to December 2016, NTS admission rate fell from maximum of 28% to 4% stabilizing between 8% and 10%. Mortality and overall complication rate between NTS and TS were similar ($p = .40$ and $.66$, respectively), but length of stay was lower for TS admissions ($p < .0001$).

A scoring system of algorithm can be used to determine appropriateness of NTS admissions, and validity of the tool can be confirmed using registry-based outcome data for TS versus NTS admissions.

Key Words

Algorithm, Mortality and complication rates, Nontrauma service admissions, Performance improvement, Rationale for admission to nonsurgical service

BACKGROUND

The ACS Committee on Trauma's "Resources for Optimal Care of the Injured Patient" (ACS, 2014) includes evaluation of the rate of nontrauma service (NTS) admissions among the required performance improvement and patient safety (PIPS) measures. Trauma services (TSs) are defined as surgical services including General, Orthopedic, and Neurosurgery, and if the rate of admission to NTSs exceeds 10%, trauma programs must be "subjected to individual case review." The optimal resource document allows exclusion of those who have had consultation by trauma or other surgical service, have same height falls (ground level), or mechanisms including drowning, poisoning, and hanging or an Injury Severity score (ISS) of less than 9 (ACS, 2014), but for practical purposes, some level of review is necessary to determine whether these criteria have been met.

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The rationale for this metric as a measure of trauma center quality is to ensure the active involvement of surgeons in the evaluation and care of trauma patients. Because trauma patients older than 75 years are increasing and the most frequent mechanism of injury reported to the National Trauma Data Bank (NTDB) is falls with ISS of 1–8 (ACS, 2016), this metric and its evaluation by PIPS programs have become even more relevant.

Despite data demonstrating an increase in minimally injured elderly trauma patients (Kozar et al., 2015), information regarding admission service and/or outcomes by service is generally lacking. In addition to demographic changes, trauma centers are increasingly staffed by full-time TSs that admit a significant proportion of all trauma patients (Bugaev, Arabian, & Rabinovici, 2013) as opposed to the specialty services, Orthopedics and Neurosurgery. These data indicate that admission patterns for single system injury have changed in the direction of TS admission. Additional studies have described the use of geriatric fracture and fragility services that (Kozar et al., 2015; Prestmo et al., 2015) may or may not involve substantial input from surgical services.

Given the considerations noted previously, it is not surprising that many trauma centers have NTS admission rates exceeding 10% and PIPS programs expend

considerable time and energy to review process and outcome of care for these patients. We sought to determine whether an objective scoring system might improve our ability to assess appropriateness of admission to NTS and whether admission to those services was associated with any adverse outcome compared with TS admission.

METHODS

In accordance with institutional and health system guidelines, IRB approval for this study was obtained. This project was carried out in a community Level II trauma center utilizing a core group of 6 trauma surgeons staffing full-time TS. Orthopedic and Neurosurgery do not routinely admit patients in our hospital; single-system injuries were admitted either to the TS or to the hospitalist medical service. Our trauma center previously utilized an administrative data set to identify all trauma patient admissions regardless of admitting service, and those admitted to NTS were flagged for review by the trauma medical director (TMD) and performance improvement coordinator (PIC).

In accordance with the Optimal Resource guide (ACS, 2014), we tracked specific metrics regarding surgical service consultation and then evaluated appropriateness of NTS admission on a case-by-case basis. These evaluations occurred on a weekly basis, tended to be time consuming, and in our view were somewhat arbitrary. In providing feedback to colleagues who were responsible for triage and admission service determination, we could not provide consistent objective criteria that could be used before the fact in determining the need for TS admission.

As a response to these concerns, we developed a tool (Table 1) to objectify the evaluation of NTS admissions that incorporated two of the metrics identified in the Optimal Resource guide (same height falls, ISS of ≤9) but expanded beyond that by adding variables we felt reflected acuity/severity of injury and potential need for TS admissions. By definition, these criteria are somewhat

arbitrary and reflect the overall philosophy of our trauma program. For example, the decision to include intensive care unit admission and surgical procedure as criteria reflects our belief that such patients have potentially higher potential for complications and problems related to their injury at any level of preexisting disease. Conversely, we felt that age and comorbidities (>65, 3 or more major comorbidities) might be common in patients whose severity of injury was a less significant problem than their preexisting medical conditions. We felt that patients with low ISS, advanced age, and comorbidity who did not require operation or admission to the intensive care unit might be better served by admission to an NTS. We intentionally excluded isolated hip fractures from ground-level falls because these have traditionally been admitted to our medical service. Hip fractures from other mechanisms and all fractures of the femur in the elderly were included. The trauma program Performance Improvement Coordinator (PIC) was able to employ the tool independently to rate appropriateness of admission and determine an adjusted NTS admission rate. The PIC determinations were “over-read” by the Trauma Medical Director (TMD) on a monthly basis.

The evaluation score provides a maximum of 7 points; all patients with 7 points were considered as definitely appropriate for NTS admission. Patients with 4 or 5 points were subject to review and determination; patients with fewer than 4 points were considered inappropriate for NTS admission.

The tool was implemented and the rate of NTS admissions as well as the outcomes for NTS versus surgical service admissions was tracked concurrently. In addition, we measured outcomes (mortality and major complications), length of stay, and disposition differences between trauma and NTS admissions to determine whether there were differences based upon admitting service.

RESULTS

The peak unadjusted rate for NTS admissions in our trauma center was 28% in December of 2014. The evaluation scoring system was implemented in January of 2015 and adjusted NTS admissions fell to 4% by November of 2015 (Figure 1). Episodic increase in NTS admissions above the 10% threshold was observed in fluctuating time periods, was not consistently sustained, and returned to subthreshold levels within 2 months. There were no significant differences in outcome including mortality and major complications or resource utilization for TS versus NTS admissions; these results are displayed in Table 2.

DISCUSSION

The discussion of TS versus NTS admission should begin with clear understanding of whom or what constitutes

TABLE 1 Tool for the Evaluation of Nontrauma Service Admissions	
Algorithm/Criteria	Points
Age >65 years	1
3 or more comorbidities	1
ISS < 10	1
MOI GLF	1
No ICU admission	1
No need for surgical intervention	1
No blood products	1
Note. MOI GLF = mechanism of injury, ground level fall; ICU = intensive care unit; ISS = Injury Severity score.	

**Southside Hospital
Trauma Department
% NTS Admissions / Total Trauma Admissions**

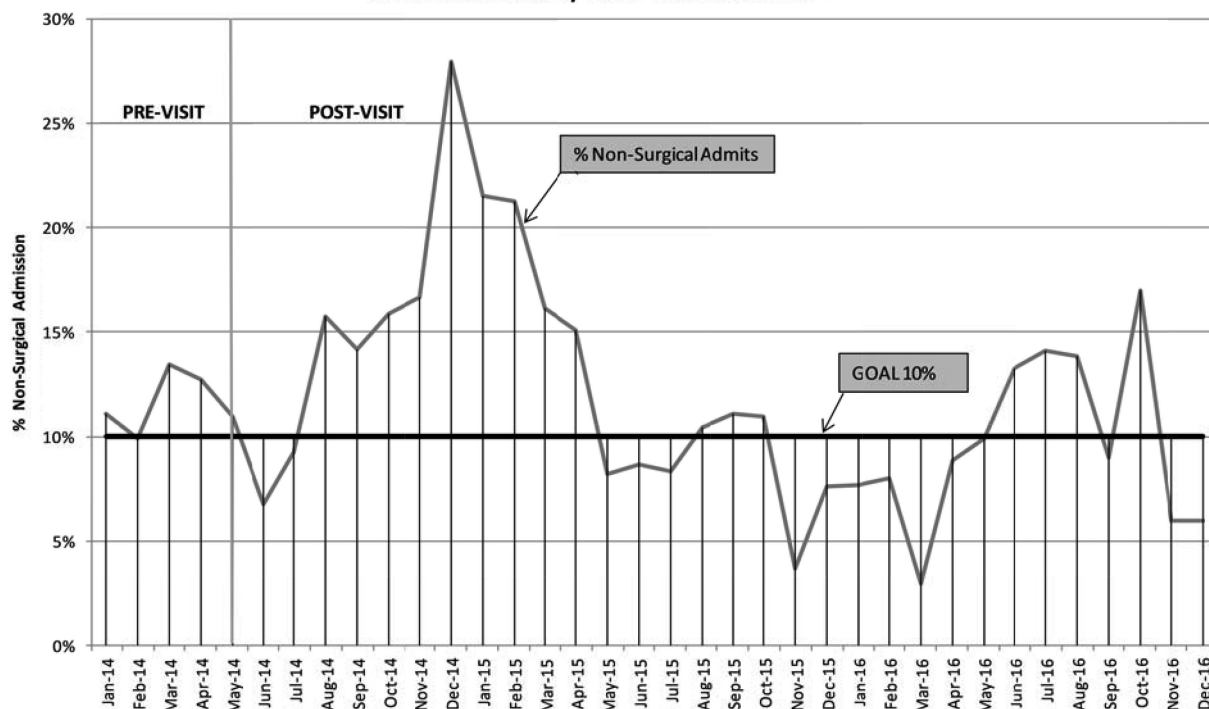


Figure 1. Nontrauma service admission rates. NTS = nontrauma service.

a trauma patient. These definitions have changed over time but are now standardized for the purposes of ACS trauma center verification. Patients meeting the NTDB inclusion criteria who are admitted to the trauma center are defined as trauma patients. Exclusions are isolated hip fracture from same surface fall, drowning, hanging, and poisoning. Patients with minor mechanism and single system injury with low severity will meet inclusion criteria if admitted to the hospital. This includes many patients who would be discharged and therefore not counted were it not for the contribution of comorbidities, frailty, and functional dependence all of which are

independent predictors of poor outcome (Joseph et al., 2016; Kozar et al., 2015).

Given these considerations, the evaluation of NTS admission rates presupposes that admission to NTS may be associated with process or outcomes that are less desirable than would be achieved following TS admission. A theoretic basis for this assumption relates to potential for delay in diagnosis or treatment of injuries and/or failure to recognize injury-specific complications. For patients whose reason for admission is a major injury mechanism, a significant single system injury, or multiple injuries, the assumption seems valid. For patients in whom the

TABLE 2 Outcomes for Trauma Versus Nontrauma Service Admissions

Variables	Admission Type			
	Trauma	NTS	N	p
Mortality	2.1%	1.2%	2,862	.4002 ^a
Complications	6.1%	5.5%	2,859	.668 ^b
LOS (days)	5.1	6.2	2,861	<.0001 ^c

Note. LOS = length of stay; NTS = nontrauma service.

^aFisher exact test.

^b χ^2 test.

^cNonparametric Wilcoxon test.

principal reason for admission is evaluation and management of decompensated comorbidities, or complications related to frailty, these assumptions may not be valid.

We are aware of a single previous study that reported an algorithm or tool intended to discriminate between appropriate medical versus surgical admitting services for trauma patients (Salottolo et al., 2009). In this retrospective study, patients who met algorithmic criteria for NTS admission were identified both before and after such a service existed. The “before” group was admitted to a TS, subspecialist service, or medical service; the after group primarily to a hospitalist service (“TMED”). No differences in any outcomes were identified though there was a slight trend toward a reduction in aggregate complications for patients in the second time period admitted to the NTS.

Our data show that there are no significant differences between mortality in patients admitted to TS versus NTS though there is a slight trend toward increased mortality in the TS group. We compared a group preselected by our own criteria as having lower injury burden but higher age and comorbidity burden (NTS) with *all* patients admitted to the TS, so there may be inherent differences in these populations related to injury severity or mechanism of injury (penetrating vs. blunt). Nonetheless, our “burden of proof” with respect to NTS admissions requires that we demonstrate that outcomes are no worse for patients admitted to NTS. We did observe differences in length of stay (LOS) that are significant and again may reflect inherent, uncontrolled differences between the two groups versus differences in the process of care on TS versus NTS. We are currently attempting to identify whether such differences exist by analyzing specific process measures between these services such as numbers of consultants called, test ordering, and utilization of rehabilitative services.

Our scoring system allows us to provide some of the same discrimination between admission groups as was reported in the study by Salottolo et al. (2009). In addition, the use of concurrent and registry-based retrospective review allows us to measure outcomes between the two groups as required by the Optimal Resource guide. However, it does have weaknesses. Although a score of 7 seems to be a good predictor of appropriate NTS admission, the system does not allow discrimination of which variables are most predictive of the need for TS admission. An analysis using multiple logistic regression is currently under way in an effort to address this question. The methodology of our scoring system excludes isolated hip fracture from ground-level falls essentially assigning these as “appropriate” NTS admissions when there might be some (intensive care unit, blood products) who would have benefited from surgical admission with medical consultation.

Despite these limitations, the NTS score may provide trauma programs an opportunity to establish baseline

objective criteria (with or without modification) that will facilitate discussions with other providers and allow for more efficient evaluation of NTS admission rates. It is reasonable to assume that there will be some anticipated reduction in the rate of NTS admissions with implementation of this tool as was shown by Salottolo et al. (2009), but with the changing demographics of trauma care, it seems likely that NTS admission rates will continue to meet or exceed the 10% threshold in many trauma centers.

KEY POINTS

- The changing demographics of trauma care will require trauma performance coordinators and program directors in ACS-verified trauma centers to evaluate large number of patients who are admitted to nontrauma services (NTS) in order to establish that care is appropriate.
- As an alternative to case-based reviews for all such patients, a scoring system or algorithm was developed that defined a group of patients considered as reasonable or appropriate for admission to NTS.
- Validity of the scoring system in defining appropriateness of NTSD admission was tested by comparing outcomes for the two patient populations. Mortality and complication rates did not differ though length of stay was shorter for the TS group.

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Trauma Performance Improvement and Patient Safety Committee

Fostering an Effective Team

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ABSTRACT

Trauma programs that are verified by the American College of Surgeons are required to have a multidisciplinary committee that examines trauma-related patient care operations. To facilitate a potentially large number of issues relevant to patient care, the Trauma Performance Improvement and Patient Safety Committee can apply team principles to promote success. A literature review concerning effective teams was conducted. Eleven principles were identified as essential for developing an effective committee that can properly respond to and resolve performance issues in complex trauma care. This article describes and applies these 11 principles to the Trauma Performance Improvement and Patient Safety Committee.

Key Words

Patient safety, Performance improvement, Teams, Trauma

Trauma programs that are verified by the American College of Surgeons are required to have a multidisciplinary committee that examines trauma-related patient care operations.¹ The Trauma Performance Improvement and Patient Safety (TPIPS) Committee is often the same staff as the multidisciplinary trauma team but operating with a different function: assessment, rather than provision, of patient care. Clinical practitioners who serve on the committee, however, are not usually trained in committee or organizational development work, but rather in teamwork, in which a group of individuals works together toward a common goal. Teamwork is recognized as an essential component to ensure the most favorable outcomes in patient safety² and is increasingly encouraged to achieve optimal performance.³

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To facilitate a potentially large number of issues relevant to patient care, the TPIPS Committee may be more successful operating under the guidelines of teamwork. Thus, the purpose of this article is to examine the elements of effective teams and discuss these elements as each relates to the TPIPS Committee.

A systematic literature review was conducted and revealed a paucity in the literature concerning best practices and functionality of health care committees. Because the TPIPS Committee may have a more functional understanding as a team, the best practices and functionality of teams were explored. Key words used in the search included “teams,” “health care,” “effective,” “teamwork,” “principles,” and “team building.” This search expanded beyond health care organizations to capture essential components necessary for any team success. Eleven essential principles were identified appropriate for application to an effective and successful TPIPS Committee. These principles included appropriate team, clearly defined goals, clearly defined process, clearly defined parameters, structured communication, common language, and shared understanding, power/authority for decision making and implementation, champion, shared norms and accountability, skilled facilitation, understanding of systems theory, and self-evaluation. These essential components are discussed here as applied to the TPIPS Committee.

The American College of Surgeons Committee on Trauma Performance Improvement and Patient Safety prescribes requirements and definitions that trauma centers must follow to remain accredited. The combination of the American College of Surgeons Committee on Trauma requirements met by well-developed teams, following well-defined processes, can lead to the achievement of patient safety and continual improvement of performance (see Figure 1). At minimum, these components are necessary to demonstrate a clearly defined TPIPS program and avoid deficiency ratings during reverification assessment.

PRINCIPLE 1: APPROPRIATE TEAM

Teams should consist of members with skills and attitudes that represent multiple disciplines and represent the appropriate authority.⁴ Attendance should be limited

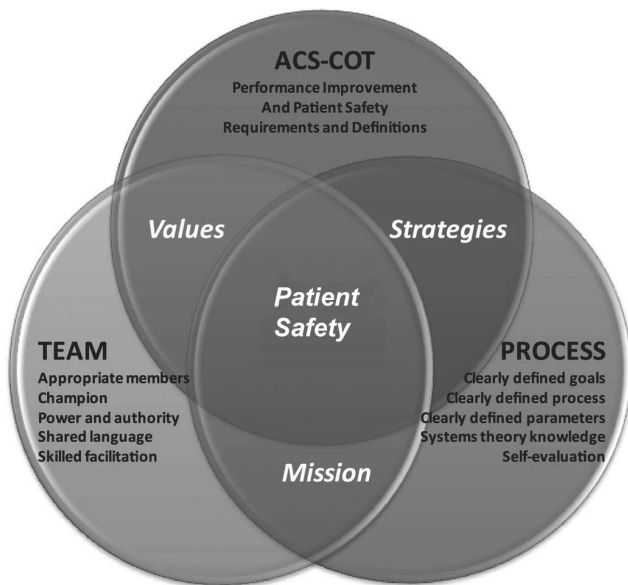


Figure 1. Venn diagram representing relationships between American College of Surgeons Committee on Trauma (ACS-COT), trauma teams, and process.

to those who are clearly involved and participating for maximum success.⁵ Clear roles and expectations for each member should be defined to ensure that the appropriate individuals are assigned to the appropriate task.⁶ Furthermore, it is necessary to make certain that all members understand their roles and are aware of obligations expected of them to complete team goals.

Application to TPIPS Committee

The complexity of the safety and performance issues requires knowledge beyond a single profession to identify and implement solutions. A multidisciplinary team with appropriate representation by skilled decision makers should be created. This includes trauma registry personnel, trauma nurses, physician assistants, residents, trauma surgeons, and collaborative partners as necessary (eg, emergency physicians). The most critical members of the TPIPS Committee are the registrar, coordinator, and medical director or surgeon who provides oversight.¹ The Table suggests role assignment and potential time frame for completion of specific individual and group tasks. Providing role responsibilities and an expected time frame promotes a shared understanding of the individual's function within the team and creates accountability.

PRINCIPLE 2: CLEARLY DEFINED GOALS

Clearly defined team goals ensure that members understand the function and purpose of the team as well as provide that all members have clearly defined roles.⁷⁻⁹ According to Scholtes,¹⁰ team members work at their most optimal level when all members understand the overall purpose and specific goals. Furthermore, the team should

have defined metrics for achieving the established goals.⁴ Without clearly defined goals, every team resource is going to be underleveraged. Unless teammates fully understand the team objectives, they will inevitably work at cross-purposes.¹¹

Application to TPIPS Committee

The overall goal of TPIPS Committee is to identify, monitor, evaluate, and correct, if necessary, problems that arise in the operations of quality patient care at the provider, system, and facility levels.¹ Patient safety and performance problems are to be identified, as required by the American College of Surgeons¹² and determined by institutional observations, and problem resolution should be demonstrated. The American College of Surgeons has listed complications and conditions that it expects all verified trauma centers to identify and develop processes to prevent their occurrences. In addition, institutional observations should identify additional safety and improvement objectives. These objectives serve as clear goals for TPIPS teams to identify, quantify, resolve, and, if possible, prevent. Clearly defining prevention as a TPIPS goal promotes a proactive perspective when reviewing trends. Rather than resolving problems individually, action plans can be developed to prevent recurring issues.

The lack of clearly defined goals in a TPIPS program may subject the trauma program to reverification deficiencies such as the following: "trauma center does not demonstrate a clearly defined TPIPS program for the trauma population" (16.1); "there is no process to address trauma program operational issues" (16.15); "the process does not demonstrate problem resolution" (16.18); or "when a consistent problem or inappropriate variation is identified, corrective actions are not taken and documented" (16.26).¹

PRINCIPLE 3: CLEARLY DEFINED PROCESS

A clearly defined process is essential to streamline processes and prompt goal resolution^{10,13} and may be best communicated visually as a process map.¹⁴ A clearly defined process should be relatively simple and have clearly defined starting and ending points¹⁰ and lead to standardization of processes. When team processes become uniform and consistent, team goals are easier to meet and decision-making time is preserved. Decision making and task assignment become clear and consistent to all members.

Application to TPIPS Committee

A systematic process that standardizes problem resolution methodology and is provided visually will lead to a greater understanding by TPIPS team members (especially when team members may rotate on and off of the committee). Figure 2 is an example of a schematic for a TPIPS process. This schematic (which would be specific to each facility) identifies how information enters into,

TABLE Suggested Task Assignment Matrix for TPIPS

TASK	Trauma Registrar(s)	Administrative Assistant	Trauma Program Manager	Trauma Pediatric Coordinator	Trauma Outreach and Education	Trauma Surgeon(s)	ED Physician	Residents	Trauma Physician Assistants	Trauma Nurses	Risk Management	Other Departments ^a	Other Departmental TPIPS	Mortality and Morbidity Review	Trauma Program Director	Trauma Medical Director	Trauma Executive Committee	Surgery Executive Committee	Medical Executive Committee	Board of Trustees
Attend rounds for real-time complication monitoring	A		A	A	A	D		D	D	D					A					
Enters trauma data in registry	D																			
Monitors complications in registry	D																			
Monitors HNS			W																	
Records HNS in registry	B																			
Organization of cases needing TPIPS review	W	B	W																	
Sets TPIPS agenda			B																	
Pulls charts (for initial review)						N		N	N	N		N								
Chairs TPIPS meeting			B																	
Presents cases to the TPIPS committee	B																			
Attends TPIPS meeting	B	B	B	B	B	B	B	B	B	B	B	N	N		B	N				
Assign cases to be reviewed			B			B														
Investigates cases (context specific)						N		N	N	N		N								
Records TPIPS meeting minutes		B																		
Pulls charts (for additional review)						N		N	N	N		N								
Determines initial standard of care						B														
Forwards cases to external sources			N																	
Prepares information/data for escalation (if necessary)			N																	
Independent review of patient care determination (trauma issue only)																N				

(Continues)

TABLE Suggested Task Assignment Matrix for TPIPS (Continued)

TASK	Trauma Registrar(s)	Administrative Assistant	Trauma Program Manager	Trauma Pediatric Coordinator	Trauma Outreach and Education	Trauma Surgeon(s)	ED Physician	Residents	Trauma Physician Assistants	Trauma Nurses	Risk Management	Other Departments	Other Departmental TPIPS	Mortality and Morbidity Review	Trauma Program Director	Trauma Medical Director	Trauma Executive Committee	Surgery Executive Committee	Medical Executive Committee	Board of Trustees
Independent review of patient care determination (outside trauma department)													N			N				
Reviews cases of mortality			M			M						N	N	M		M				
Review cases for standard-of-care clarification												N	N							
Review cases for standard of care possible requiring punitive action																	M			
Review cases for possible physician disciplinary action																		M		
Review cases for external standard-of-care decisions																				M
Reviews external standard-of-care decisions TPIPS	B	B	B	B	B	B	B	B	B	B	B	N	N		B	N				
Records external standard-of-care decision	B																			
Determines closing of case (loop closure)						B														
Records loop closure in registry	B																			
Reports issues in trauma review meeting			W																	
Reports to Quality and Patient Safety Committee			Q																	

Abbreviations: A, as available; B, bimonthly; D, daily; ED, emergency department; HNS, health care notification system; M, monthly; N, as needed; Q, quarterly; TPIPS, Trauma Performance Improvement and Patient Safety; W, weekly.

*ED, orthopedics, radiology, or any other department involved in care of trauma patient.

Trauma Performance Improvement and Patient Safety
Patient Care Review Process
Adult and Pediatric

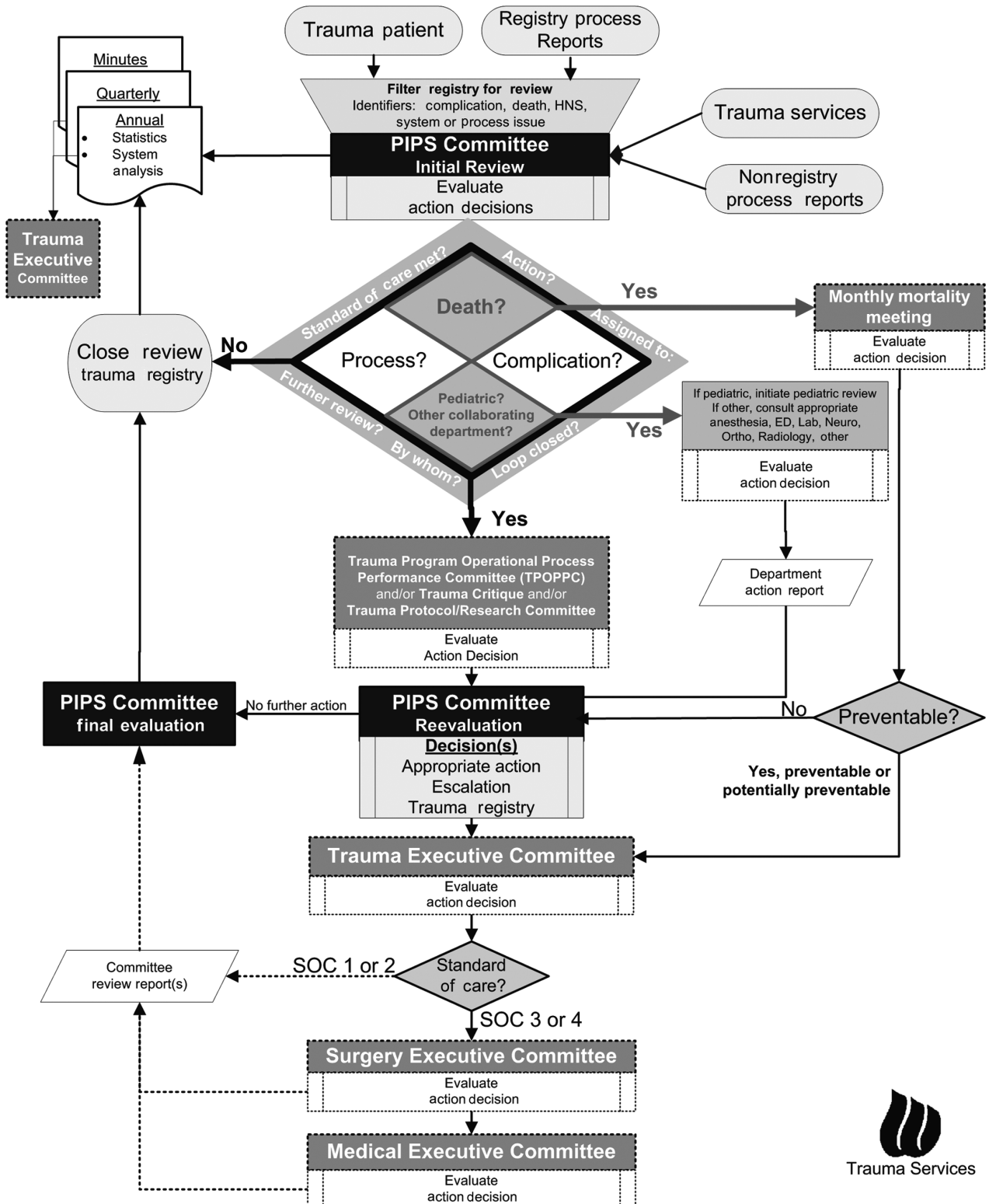


Figure 2. Schematic for the Trauma Performance Improvement and Patient Safety (TPIPS) process. SOC indicates standard of care; ED, emergency department.

proceeds within, and exits out from the committee, which affords automated processes (such as escalation to Mortality Committee in the event of a patient death). This protocol for the patient care review process allows for consistent case review methodology and ensures that all team members are aware of progress. Referral to specific departments is often necessary to gather further information. Peer review is likewise referred to the appropriate executive committee, with the results reported back to the TPIPS Committee.

Having a clearly defined process can help the TPIPS program avoid review deficiencies such as the following: “trauma center does not demonstrate clearly defined TPIPS program for the trauma population” (16.1); “unreliable methods to identify opportunities for improvement” (16.2); “lack of referral to appropriate peer review” (16.13), “identification” (16.17), and “documentation of problems or corrective actions” (16.7); “demonstration of problem resolution” (16.18); and “inadequate documentation of dissemination of information from trauma peer review” (16.23).¹

PRINCIPLE 4: CLEARLY DEFINED PARAMETERS

Clearly defined parameters refer to the team knowing and understanding the boundaries of team goals.¹⁰ Clear boundaries need to be developed and the team needs to work within these parameters to ensure that the team is attaining its goals.^{9,13} If clear parameters are not developed, the team may enter into matters in which the team has no authority.

Application to TPIPS Committee

Mutual agreement is necessary to make a final case determination. Referrals to executive committees are necessary if (1) a determination cannot be agreed upon within the TPIPS Committee, (2) a potentially severe violation of standard of care occurred, or (3) if peer review is involved.

The first objective should be to clarify what defines a trauma patient. This clarification may require reinforcement with emergency department and trauma personnel due to the complicated nature of trauma.¹⁵⁻¹⁸ A schematic can be developed that clearly identifies the boundaries of the TPIPS Committee (see Figure 2). Items that are presented to the committee, which requires resolution outside the parameters of the TPIPS Committee, need to have an appropriate process to which they are transferred and then monitored for resolution. In addition, all peer-review issues should be referred to the appropriate executive committee, with the final results reported back to the TPIPS Committee. Appropriate parameters can increase compliance with criteria, especially in “multidisciplinary review of problem trends” (16.13); “multidisciplinary peer review with representatives from other appropriate

service lines” (16.19); and “process to address trauma program operational issues” (16.15).¹

PRINCIPLE 5: STRUCTURED COMMUNICATION, COMMON LANGUAGE, AND SHARED UNDERSTANDING

Structured communication with a common language that develops shared understanding is important to team success and encourages a shared “mindset” that facilitates collaborative coordination.⁵ Appropriate and/or standardized communication, or the exchange of information, is a necessary tenet of shared language and understanding.¹⁹ Just as structured communication has been identified as essential in the performance of major trauma resuscitation to reduce the complexity of group dynamics and control consequences of mistakes,²⁰ it is also essential for the evaluation of trauma operations.

Application to TPIPS Committee

Communication that affords direction and/or resolution of each case is vital. Identified issues are classified as systematic, institutional, or individual in origin. Determination of standards of care should be assigned to each case on the basis of accepted definitions from objective versus subjective information.²¹ Deaths should be appropriately categorized in nomenclature as “mortality with opportunity for improvement” (potentially preventable), “unanticipated mortality with opportunity for improvement” (preventable), or “mortality without opportunity for improvement” (nonpreventable).^{1,21} During the actual TPIPS meetings, the use of specific and standardized language that describes the process, decisions, and outcomes will reduce confusion and reinforce organizational functioning of the meetings. Furthermore, information and decisions made in the core committee should be communicated to the entire trauma staff. Criteria deficiencies that have been noted are “failure to systematically categorize deaths” (16.25) and “lack of dissemination information outside TPIPS core members” (16.22).¹

PRINCIPLE 6: POWER/AUTHORITY

Teams must have the power and authority necessary to develop and implement effective processes as well as enforce decisions.⁷ If there is not sufficient power to put recommended changes into effect, the purpose of the team will not be fulfilled and goals will be unmet.

Application to TPIPS Committee

The TPIPS Committee should have the authority to make determinations of minor standard-of-care deviations and to promote remediation in providers and initiate changes in system and facility deficiencies. The committee serves to ensure problem resolution and loop closure for any identified deficiency. Moreover, TPIPS committees

should be given authority to move unresolved issues up the hierarchy to promote appropriate and timely conclusion. High-level standard-of-care deficiencies of health care providers or complex facility and system deficiencies should be forwarded to the Trauma Executive Committee (or appropriate equivalence). Failure to ensure appropriate authority can lead to a deficiency ratings such as “lack of empowerment to address issues involving multiple disciplines” (16.8); “comprehensive evaluation of all trauma care” (16.9); “authority or administrative support to lead program” (16.10); “authority to set qualifications for trauma service members” (16.11); and “recommend changes for trauma panel based on performance reviews” (16.12).¹

PRINCIPLE 7: CHAMPION

Champions, or opinion leaders, who are recognized among their peers support and advocate the team purpose.²² This helps ensure that the team strives to advance goals within appropriate parameters.

Application to TPIPS Committee

TPIPS team members need to be champions for improvement in their particular field of representation. This is instrumental in fostering quick adoption of recommended changes. Connections to champions in related departments allow for quick dissemination of ideas either in or out of the TPIPS process.

PRINCIPLE 8: SHARED NORMS AND ACCOUNTABILITY

Shared norms are necessary to ensure that tasks are completed and appropriate conduct is displayed.⁷ Shared norms not only set the culture for group members but also convey the central values. Appropriate behaviors allow expression of values and ideas to build trust and establish interdependence while facilitating progress toward problem resolution.

Application to TPIPS Committee

Accepted norms for outcomes are determined by the institution, the medical literature, or government agency standards. This provides a framework that allows for consistent monitoring and activity for resolution of identified issues. Committee members discuss from their perspective expertise and contribute ideas equally. Representatives of the various disciplines should be expected to attend the meetings, complete their assigned tasks, and report back to the committee with defined time frames. Failure to comply with accepted norms such as meeting attendance can lead to reported deficiencies such as “attendance by the trauma medical director and specialty representatives is less than 50%” (16.20) and “general surgeon attendance at trauma peer review is less than 50%” (16.21).¹

PRINCIPLE 9: SKILLED FACILITATION

Skilled facilitation is critical for the team to meet its goals and accomplish its tasks. Facilitation provides structure and establishes a context to motivate individuals to action.²³ Without skilled facilitation, team members may be unaware of important decisions or fail to support the committee in task completion. The role of the facilitator is to designate and implement relevant roles, rules, procedures, and techniques to establish outcomes.²³

Application to TPIPS Committee

Facilitation of language and process is especially vital at the initial stages. As processes involving case stratification, appropriate investigation, standard-of-care determination, and problem resolution are understood, the team will essentially facilitate itself on the basis of the common language and the clearly defined roles. Appropriate and skilled facilitation will ensure progress toward goals and deter process deficiencies such as “not being able to address trauma program operational issues” (16.15) and “failure to demonstrate problem resolution” (16.18).¹

PRINCIPLE 10: UNDERSTANDING OF SYSTEMS THEORY

To be successful within an organization, teams need to have an understanding of systems theory. Systems theory maintains that an action or decision that is made in one branch of the overall organization can and will affect other branches.⁵ Patient care is not provided in a vacuum and is subject to a continuous chain of events within the hospital. It must be understood that significant process changes may affect the organization as a whole.

Application to TPIPS Committee

A nontrauma departmental change will occasionally affect (positively or negatively) the trauma service process. This may result in the need for outside input in the TPIPS review process from external departments. Likewise, process changes within the trauma service may result in disruption outside the trauma department. Collaboration and good communication are important to prevent error and maintain optimal patient safety. Working with the understanding of systems theory can promote solutions that synergize multidisciplinary perspectives and thus avoid deficiencies such as “lack of multidisciplinary peer review with representatives from other appropriate service lines” (16.19).¹

PRINCIPLE 11: SELF-EVALUATION

Continual evaluation ensures clear processes and completion of objectives. This may be the most important and difficult activity of a team.¹⁰ Process problems cannot be addressed if not identified and evaluated; thus, goal achievement may not be measurable. A team that

monitors its performance can generate plans for continual improvement.⁴

Application to TPIPS Committee

Monitoring of an admitted patient diagnosis is performed as close to real-time as possible to ensure that trauma patients are not missed from review. Monitoring for identified complications¹ should be performed and placed in a priority classification. Some complications are considered important enough to require in-depth review on every occurrence; others are trended for periodic review to ensure that benchmarks are met. All American College of Surgeons listed complications should undergo annual review (quarterly rotation) at the Trauma Executive Committee. Likewise, a yearly report of all TPIPS activity should be reported to an executive trauma committee. Furthermore, the TPIPS Committee should not only be limited to the evaluation of patient care operations but also committed to evaluation of the performance improvement and patient safety process itself. An ongoing self-diagnosis of problem resolution performance involves the application of analysis and corrective strategies to process itself.

CONCLUSION

To ensure optimal care, teamwork is essential beyond direct patient care only and should be developed within committees concerned with patient safety and performance improvement. Application of these 11 principles can streamline and demystify processes and foster interorganizational cooperation. Process innovation is necessary for developing an effective performance improvement and patient safety committee that can properly respond to and resolve performance issues in complex trauma care.

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