The Role of Data in Trauma Systems

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Disclosures
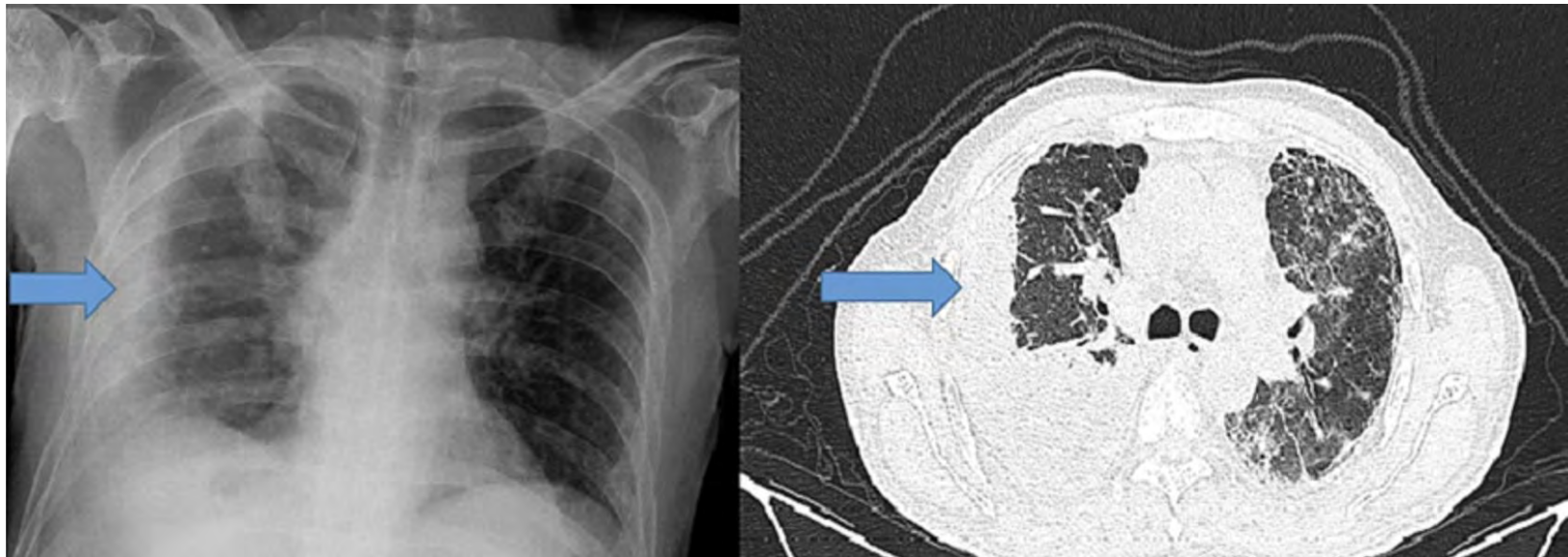
- AIMedica (consultant)

The Role of Data in Trauma Systems

Agenda

1. Introduction-why data matters
2. Why trauma systems matter
3. The role of data in trauma system performance
4. The future of the technology
5. Conclusions

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Why Data Matters

Delayed Hemothorax

- <u>Definition</u>: Hemothorax developing >48 hours after an initially negative CT, or "minimal/trace" hemothorax (not clearly visible on CXR)

- **Trauma Registry Data**→ All older adults with rib fractures admitted to two Level I trauma centers who had a CT scan on admission

- **Delayed hemothorax in 12**

  - 64% had NO evidence of blood on initial CT

  - 57% were NOT on blood thinners

  - Majority (67%) not discovered on initial hospital visit

  - All required intervention

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Delayed Hemothorax

- Current practice

  - Repeat CXR in all older adults with rib fractures

  - Rate is **MUCH HIGHER** (currently assessing rates)

    --Study population were only those with CTs

  - Eliminated retained blood and empyemas by early identification and management
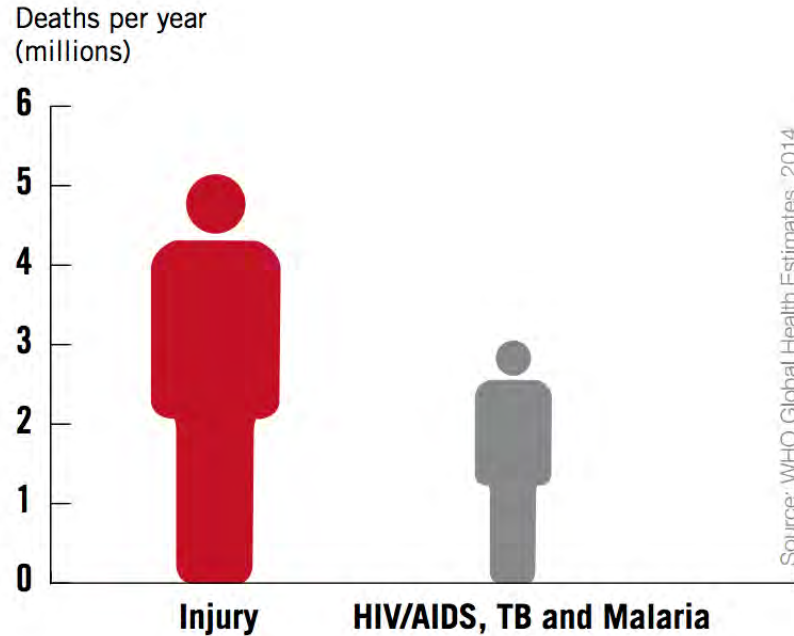
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How did data help?

- Fragmented care hid problem
- Confirmation bias led to mis-diagnosis
- Plausible alternative explanations
- Hospital administrative data only can "see" what the physician saw

The trauma registry allowed us to both <u>identify an unknown problem</u> and address it to <u>save lives</u>

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Before we talk about data, let's start with the *why*. Why do trauma systems deserve investment?

The Burden of Injury Exceeds Many other Common Diseases Worldwide

Deaths per year (millions)

Injury — HIV/AIDS, TB and Malaria

Source: WHO Global Health Estimates, 2014

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Total Death Counts per Year

Unintentional Injury 83.3k
Suicide 23.4k
Malignant Neoplasms 17.4k
Homicide 16.9k
Heart Disease 16.1k
Liver Disease 6.7k
Diabetes Mellitus 4.0k
Cerebrovascular 3.0k
Congenital Anomalies 2.2k
Influenza & Pneumonia 1.8k
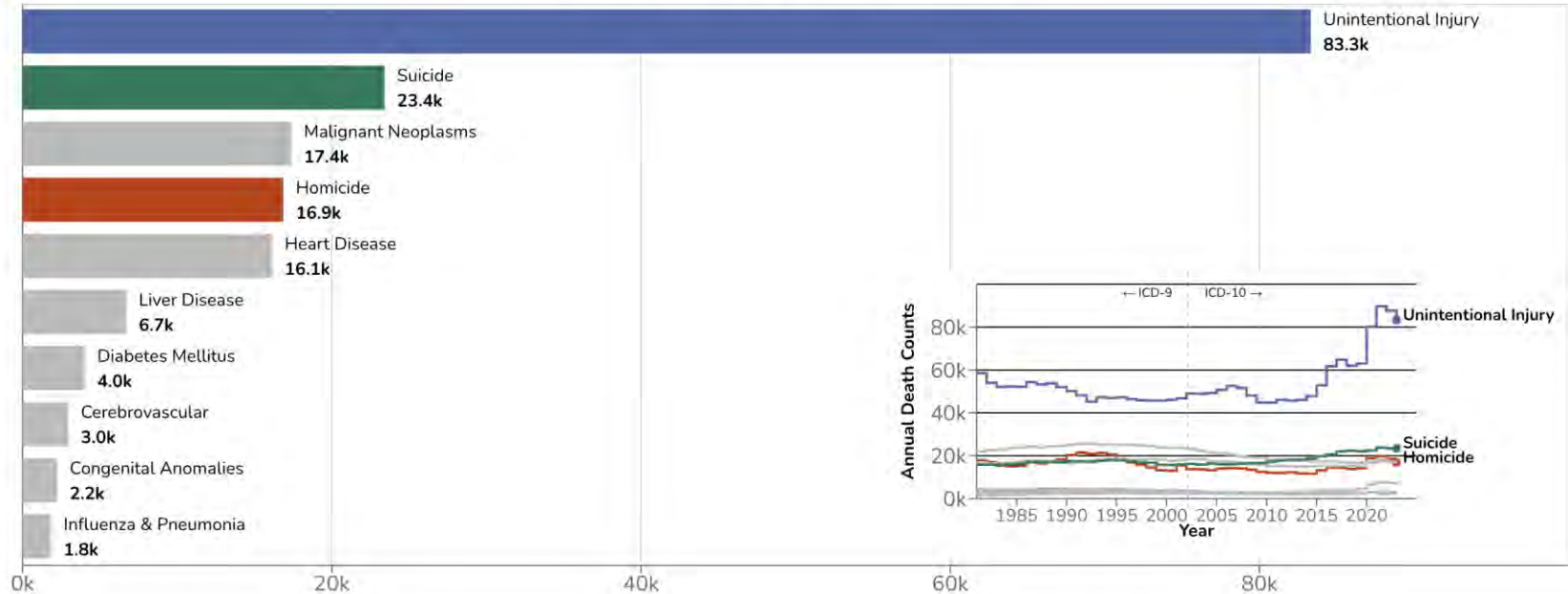
Leading Cause of Death for Americans <45

https://wisqars.cdc.gov/animated-leading-causes/

Estimated Costs of Injury (2019)

$4.2 trillion, with greater than half in adults 25-64

Peterson, MMWR Morb Mortal Wkly Rep 2021;70

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How Does Investing in Data and Trauma Systems Make a Difference?

Trauma Centers→

25% Reduction in Mortality after Injury

The NEW ENGLAND JOURNAL of MEDICINE

SPECIAL ARTICLE

A National Evaluation of the Effect of Trauma-Center Care on Mortality

Ellen J. MacKenzie, Ph.D., Frederick P. Rivara, M.D., M.P.H.,
Gregory J. Jurkovich, M.D., Avery B. Nathens, M.D., Ph.D.,
Katherine P. Frey, M.P.H., Brian L. Egleston, M.P.P., David S. Salkever, Ph.D.,
and Daniel O. Scharfstein, Sc.D.

MacKenzie et al., A national evaluation of the effect of trauma-center care on mortality. N Engl J Med. 2006

Maturation Curve for Trauma Centers

- Process is long-term effort
- From initiation of a trauma center, benefits may not appear for 10 years
- Requires continued investment

Nathens AB, Jurkovich GJ, Cummings P, Rivara FP, Maier RV. The Effect of Organized Systems of Trauma Care on Motor Vehicle Crash Mortality. *JAMA.*

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The ROI on Investing in Trauma Systems-AK

Does the Institution of a Statewide Trauma System Reduce Preventable Mortality and Yield a Positive Return on Investment for Taxpayers?

CrossMark

Todd Maxson, MD, FACS, Charles D Mabry, MD, FACS, Michael J Sutherland, MD, FACS, Ronald D Robertson, MD, FACS, James O Booker, MD, FACS, Terry Collins, RN, Horace J Spencer, MS, Charles F Rinker, MD, FACS, Teri L Sanddal, BS, Nels D Sanddal, PhD, REMT

- Arkansas began to annually fund its trauma system at $20M in 2009
- Looked at impact from 2013-2014
- Preventable mortality 30%➔16%
- Economic impact $186M annually, **9-fold ROI**

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The ROI on Investing in Trauma Systems-GA

- Georgia reduced its trauma mortality rate from 16% above the national average to 6% below the national average from 2003 to 2020

- *Saved $4.3 billion in lifetime personal income*

- *Saved $508 million in lifetime tax revenue*

Groce HE, et al. Trauma Surg Acute Care Open 2025
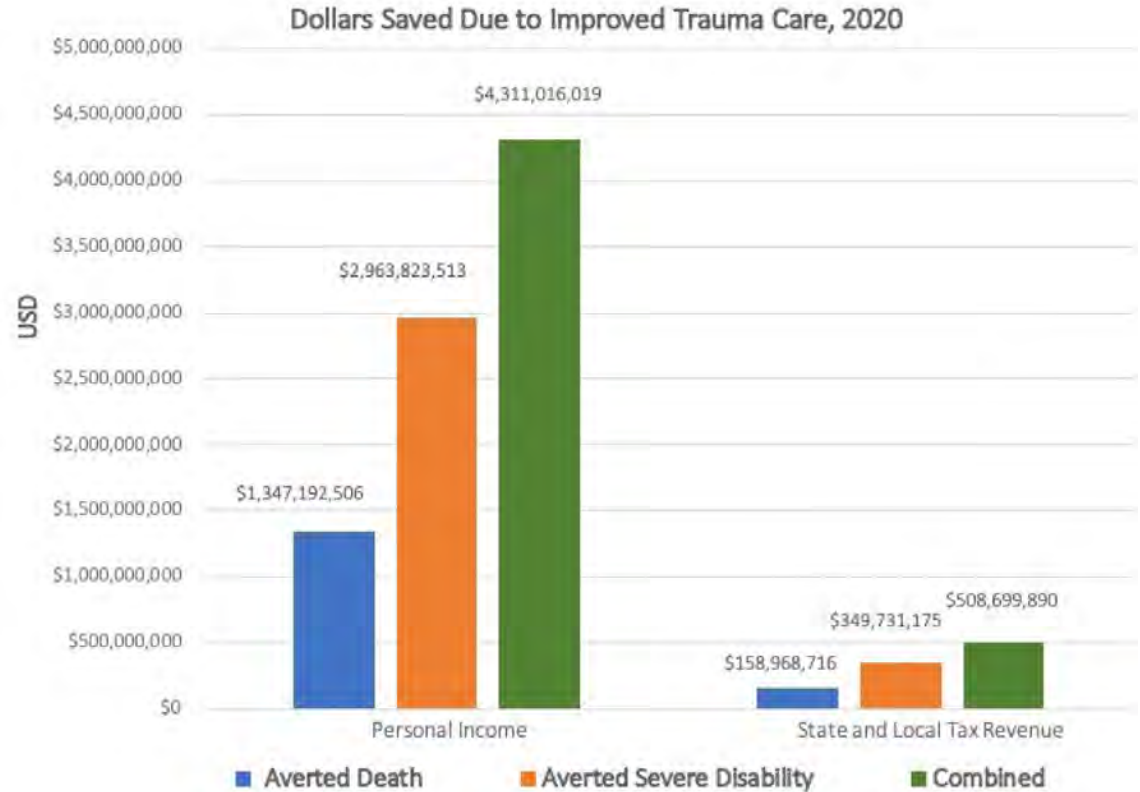
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The ROI on Investing in Trauma Systems- GA

Dollars Saved Due to Improved Trauma Care, 2020

Personal Income:
- Averted Death: $1,347,192,506
- Averted Severe Disability: $2,963,823,513
- Combined: $4,311,016,019

State and Local Tax Revenue:
- Averted Death: $158,968,716
- Averted Severe Disability: $349,731,175
- Combined: $508,699,890

Legend: Averted Death | Averted Severe Disability | Combined

Groce HE, et al. Trauma Surg Acute Care Open 2025

The "Charcoal Book"

Formula for Trauma Center Success

- The COT first published criteria for the resources and personnel needed in 1976.

- Since 1987, the VRC Program has **verified** trauma centers that meet the standards— the presence of **the resources, structures, and processes**— outlined in *Resources for Optimal Care of the Injured Patient*.
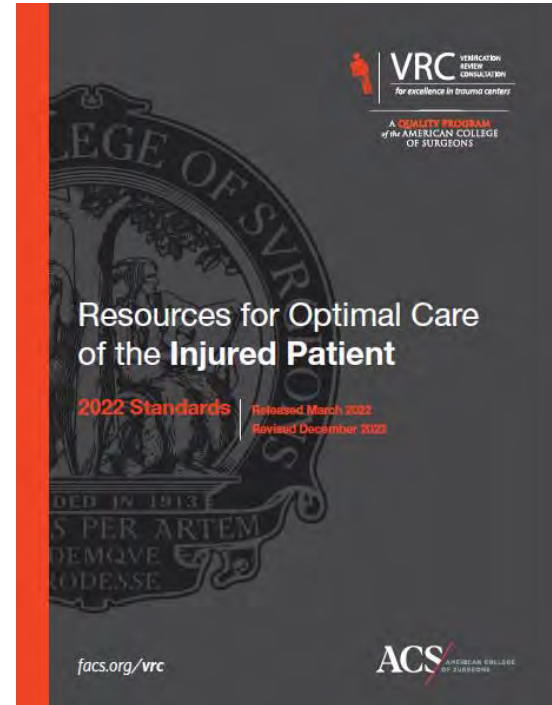
Trauma *System* Essential Elements

Trauma Systems Consultation Guide

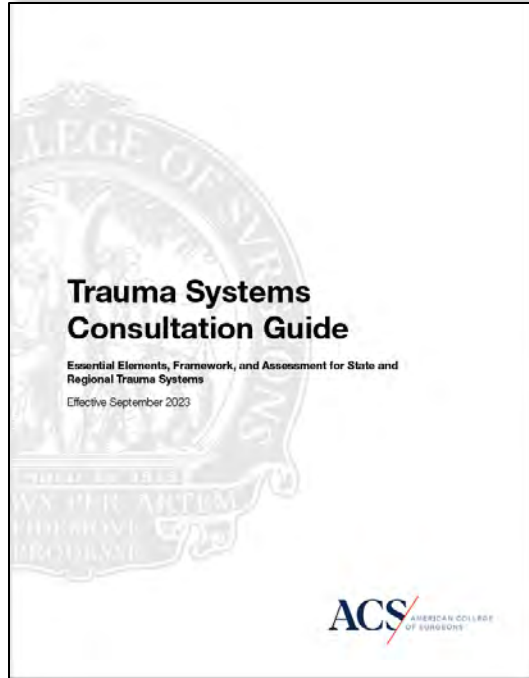Essential Elements, Framework, and Assessment for State and Regional Trauma Systems

Effective September 2023

- Statutory Authority
- Multidisciplinary Advisory Group
- Trauma System Plan
- Needs-Based Designation
- Funding
- Confidentiality and Discoverability
- Data Collection
- System-wide Performance Improvement
- Disaster Preparedness
- Military Integration

The Donabedian Foundational Model

Quality can be measured as Structure-Process-Outcome

Must consider the continuum of care
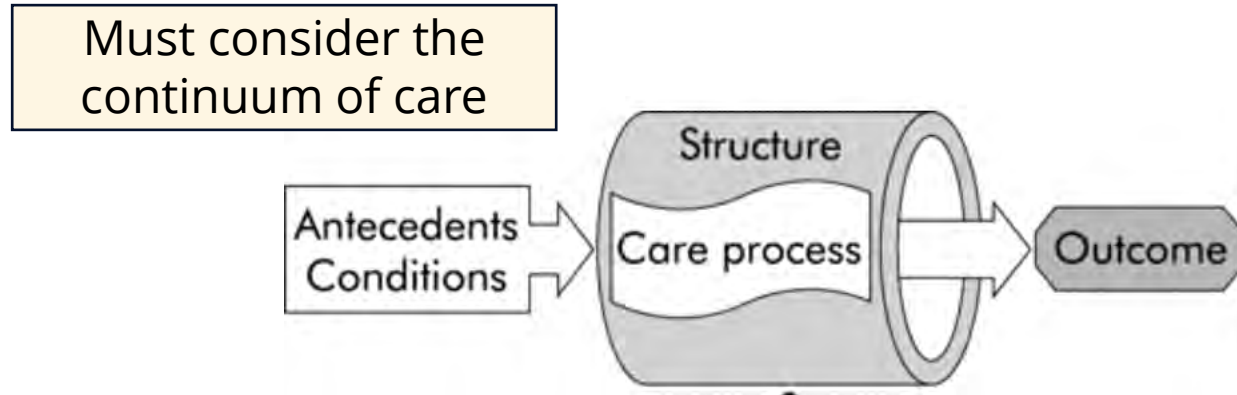
- Need information on all components
- Focus in on a single patient or group of patients

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The lifecycle of improving care

In a learning health care system, research influences practice and practice influences research.

EVALUATE — Collect data and analyze results to show what works and what doesn't.

ADJUST — Use evidence to influence continual improvement.

DISSEMINATE — Share results to improve care for everyone.

INTERNAL AND EXTERNAL SCAN — Identify problems and potentially innovative solutions.

DESIGN — Design care and evaluation based on evidence generated here and elsewhere.

IMPLEMENT — Apply plan in pilot and control settings.

Internal

External

Role of Benchmarking

TQIP
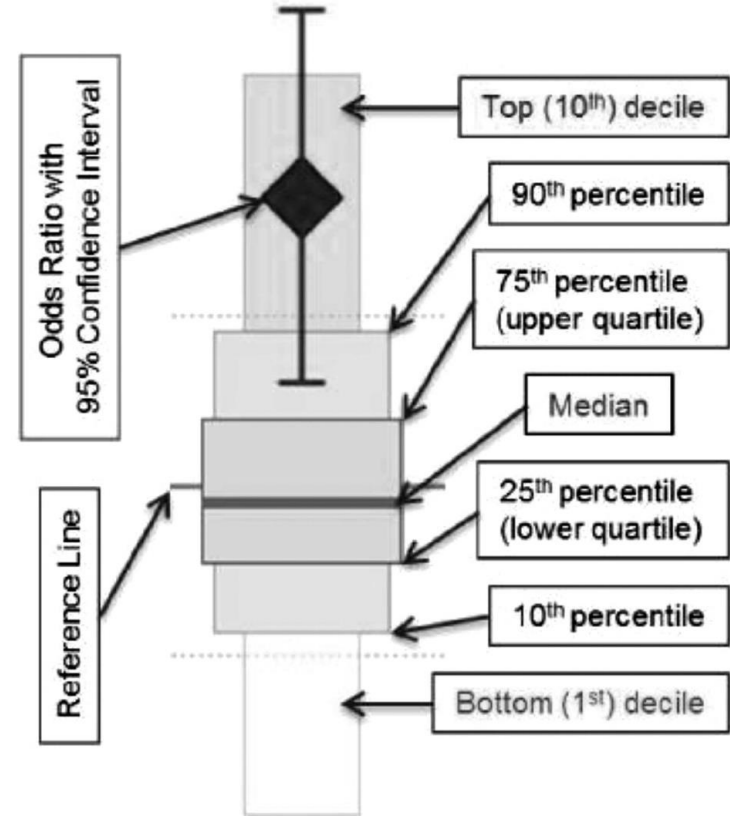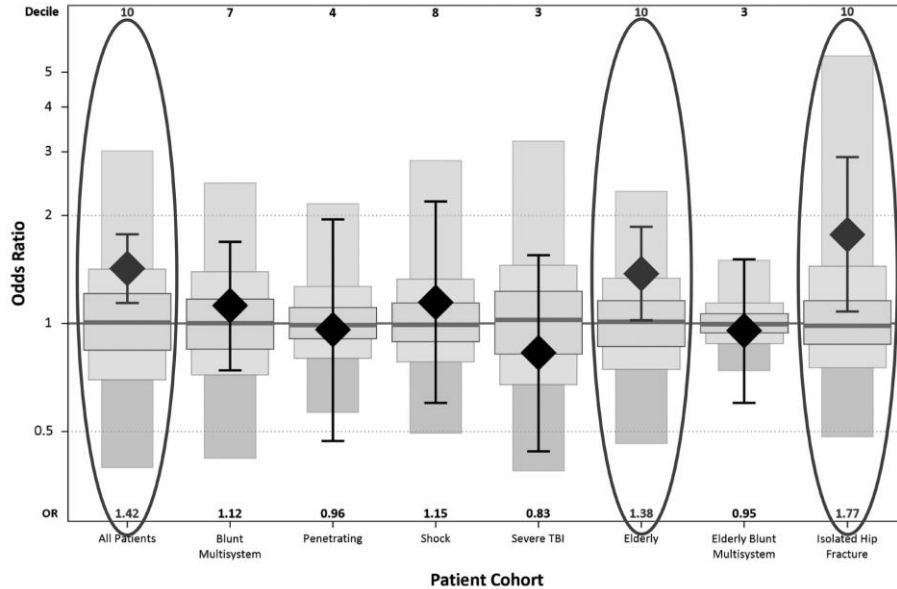
Blackmore A, Journal of Trauma Nursing, 2019

Principles in Practice

Case Example

A 29-year-old soldier sustained a gunshot wound to the head while on patrol. At the point of injury, he was unresponsive and bleeding excessively. He also exhibited decorticate posture—bent arms, clenched fists, and legs held out straight—indicating severe damage to the brain.

Upon arrival at a Role 3 military treatment facility, he underwent a hemicraniectomy, a neurosurgical operation designed to relieve building intracranial pressure as the brain swells.

He was stabilized, sent to a US military facility in Germany, and eventually transferred back to the US.

The patient survived his injuries and, despite some remaining difficulties with attention span and memory, was able to ***recover functional independence***

National Academies of Sciences, Engineering, and Medicine. 2016.
A national trauma care system

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Advancements in Survival

- Analysis of all US military casualties 2001 through 2017

- Survival among the most critically injured casualties increased 3-fold

- 3 key interventions (tourniquets, transfusions, and prehospital transport) were associated with 44% of the mortality reduction.

Howard JT et al., JAMA Surg. 2019
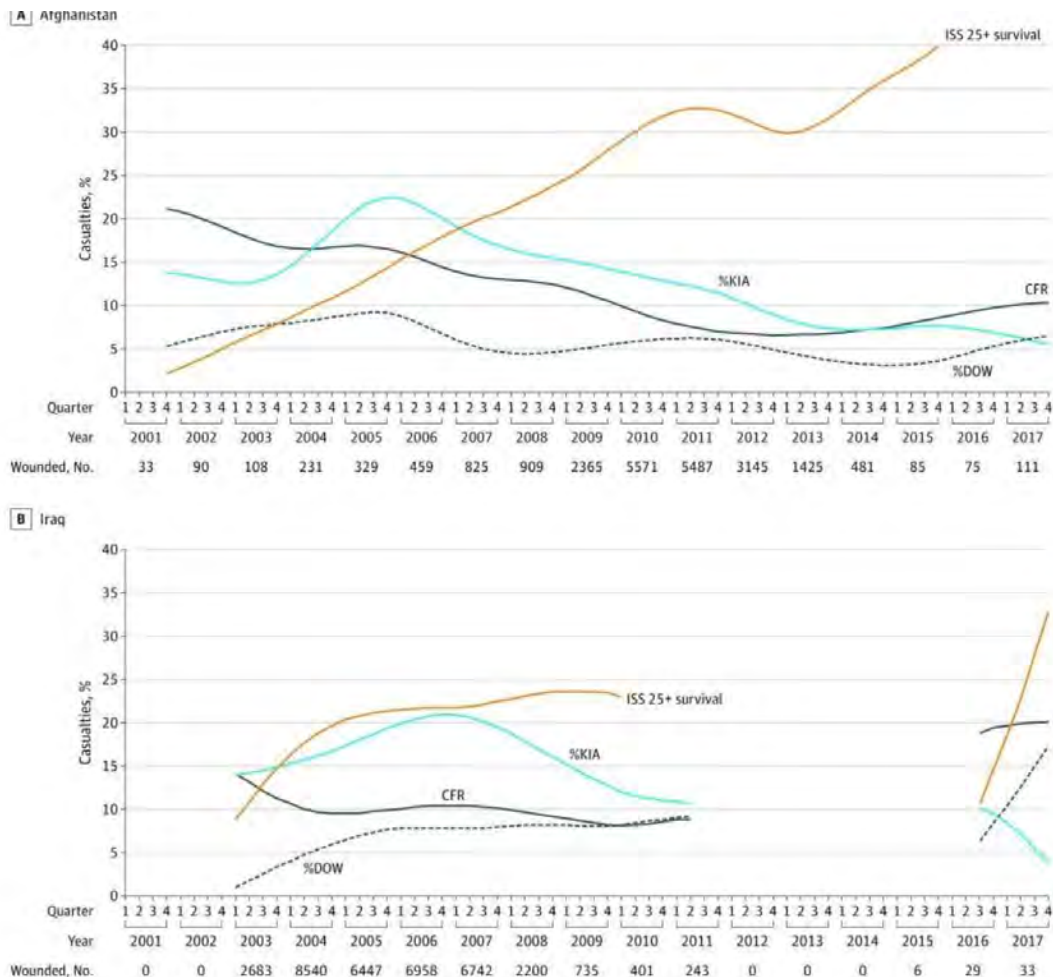
The "Secret Sauce"

American College of Surgeons COT Meeting, March 2025

"This is the secret sauce of the JTS: delivery of trauma care, input that data into a registry, analyze the data, and then through process improvement, develop best practices. It's pretty simple."

-Jeffrey A. Bailey, MD, FACS,retired US Army colonel

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Joint Trauma System Model

12 Core Functions of the CTS & the JTS Operational Pyramid
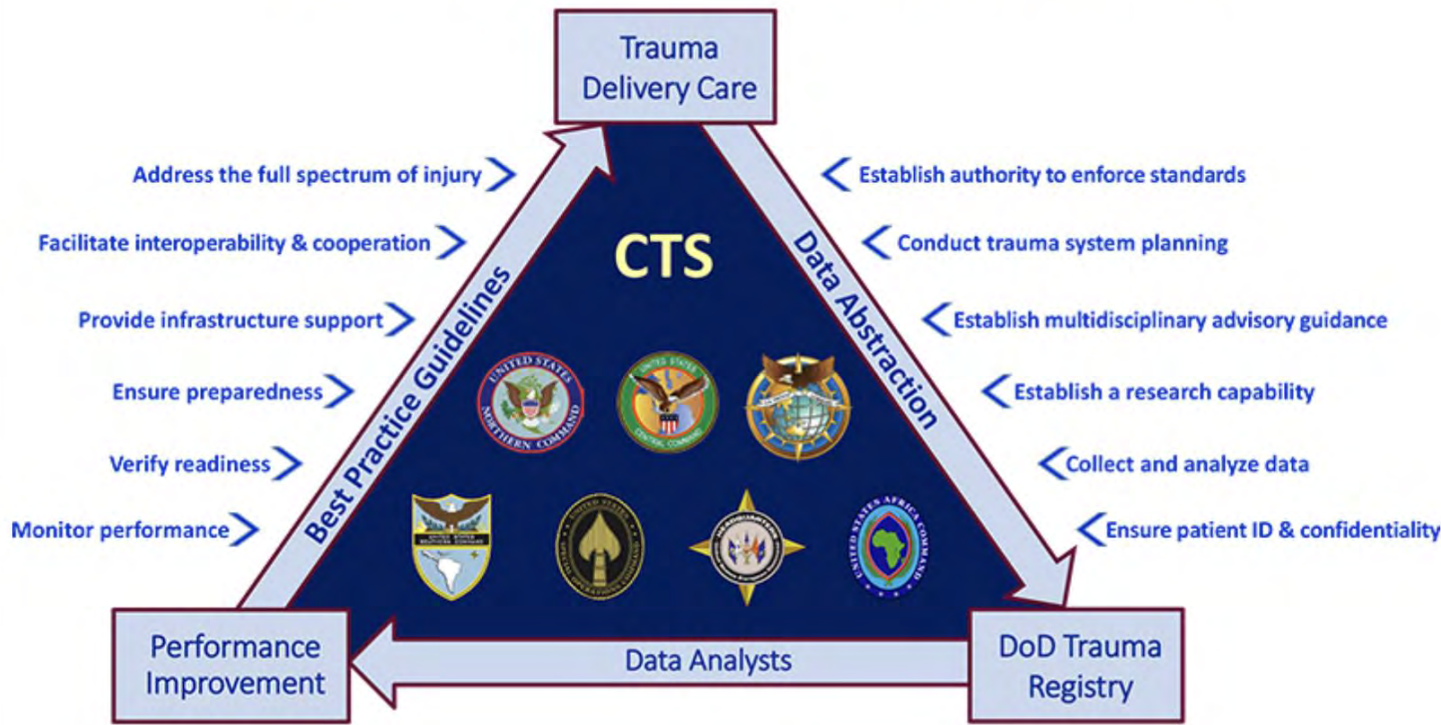
Let's talk data

The Universe of Data

Medical Records	Registry	Administrative Data
• Very detailed • Laborious	• Detailed • Flexible	• ICD Codes • Convenient

Administrative (Billing) Data

Many companies serving in this role

- Organizations support many hospital-based initiatives, not just quality

- Rely on administrative data

- OK for large signals in data

NOT adequate for <u>clinical</u> insights

Administrative vs. Registry

Missing patients, injuries, details

- Procedures missing 9-40% of the time
- Almost ½ (40%) of trauma patients have an associated trauma-specific DRG
- Under-reporting of individual injuries
- Mechanism of injury rarely collected

Wynn A, J Trauma. 2001
Hunt JP, J Trauma. 2000
Hackworth J, Injury. 2017

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Registry Data

	NTDB	NEMSIS	JTS DoDTR and JTS PHTR
Owner	ACS COT	NHTSA	JTS
Time frame	In-hospital only	Prehospital only	Prehospital (Role 1); prehospital and inter-facility transport; hospital (Roles 2, 3, and 4)
Can data be collected electronically/ imported from existing patient care records?	Yes for some elements, no for others	Yes	Yes, has this capability, but is limited by TMDS expeditionary framework
How much coverage by percentage of patients?	Moderate (all ACS COT trauma centers); in 2015, 746 hospitals submitted data to the NTDB: 237 Level I, 259 Level II, 189 Level III or IV centers, 36 Level I or II pediatric-only centers (ACS, 2015)	Near complete (includes an estimated 87 percent of all 911-activated EMS responses occurring in the United States)	100 percent for those admitted to a Role 3 facility that met inclusion criteria of DOA, DOW, transfer, admit of ICD-9 code 800-995 when JTTS teams were in combat theater; near complete for OCONUS combat and noncombat casualties; nominal for CONUS noncombat casualties

National Academies of Sciences, Engineering, and Medicine. 2016. A national trauma care system

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Registry Data

| What are the coverage gaps? | Only trauma centers; covers a small percentage of Level III/IV trauma centers and does not cover non-trauma center hospitals; only index hospitalization—does not capture readmissions and long-term outcomes; does not include patients seen and discharged from emergency department; does not link data for transfers (cannot tell it is the same patient who left a Level III center and arrived at a Level I center); no prehospital deaths | Does not adequately capture interfacility transfers, critical care transfers, and air medical care; covers only patients transported by EMS; no data on patients transported by "self" transport mode or police vehicle | 2012: mandate for Role 2 data, retrospective entry occurring now

2012: initiated Trauma Infectious Disease Outcome Study (TIDOS) module

2013: started including prehospital (Role 1) data

2013: initiated military orthopedic trauma registry (MOTR) module

2015: started including rehabilitation facility (VA) data

2015: initiated acoustic module |
|---|---|---|---|

National Academies of Sciences, Engineering, and Medicine. 2016. A national trauma care system

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Using Benchmarks

QUALITY IMPROVEMENT

Using the Trauma Quality Improvement Program Metrics Data to Enhance Clinical Practice

Abigail R. Blackmore, MSN, RN ■ Jan Leonard, MSPH ■ Robert Madayag, MD ■ Pamela W. Bourg, PhD, RN, TCRN, FAEN

ABSTRACT

The American College of Surgeons Trauma Quality Improvement Program (TQIP) provides trauma centers with hospital-specific performance data and the ability to compare their performance data with that of similar hospitals nationwide. Utilizing the TQIP *data and drill down feature* can lead to changes in clinical practice and improved care. The purpose of this article is to provide a guide that demonstrates how using the TQIP hospital-specific data can improve outcomes. We recommend 4 separate categories by which data and reports should be evaluated: processes of care, quality of care, data coding, and data mapping. We discuss these categories using 4 targeted examples. Utilizing our guidelines, trauma programs participating in the TQIP should be able to (1) identify trends and focus on outliers in their institutional data, (2) create processes and implement practice improvements, and (3) evaluate the results of their corrective action plan. This topic may be of special interest to those involved in the management of programs or systems-level policies as reduction in costs and improving quality are program drivers.

Key Words

ACS TQIP, Benchmarking, Quality Improvement

benchmarking. These measures provide a scientific basis in which participating centers can enact changes to clinical practice ("Level I & II TQIP," n.d.).

The TQIP reports mortality and complications for all TQIP patients. As of the Fall 2017 TQIP benchmark report, the TQIP reported on the following 10 cohorts of patients: (1) blunt multisystem injuries, (2) elderly patients, (3) elderly patients with blunt multisystem injuries, (4) elderly patients with isolated hip fractures (IHFs), (5) fractures, (6) hemorrhagic shock, (7) penetrating injuries, (8) severe traumatic brain injuries, (9) shock, and (10) splenic injuries (Table 1). For each of these cohorts, statistical models are used to create risk-adjusted estimates for outcomes and complications.

The purpose of this article is to provide a guide to trauma programs that demonstrates how using the TQIP hospital-specific data and benchmarking to national data can improve outcomes. We discuss data provided by the TQIP and how to identify trends and outliers in the data, create individualized solutions and corrective action plans, and reevaluate the data to assess the impact of the corrective action plan. We review this process using examples from our institution that highlight 4 categories by which data and reports should be evaluated: processes of care (i.e., time to operating room [OR]), quality of

Blackmore A, Journal of Trauma Nursing, 2019

- Share examples of how they were able to use reporting tools to improve care and troubleshoot issues

Blackmore A, Journal of Trauma Nursing, 2019

TABLE 2	ACS TQIP Data Drill Down Steps
Step 1	Open up ACS data platform at https://www.acsdataplatform.com/platform/trauma/facility/9289/uploader
Step 2	Go to the left-sided menu and click on "Operational Reports" under the Analytics header
Step 3	Select TQP Explorer
Step 4	Select which report you would like to review (NTDS/TQIP)
Step 5	Select parameters: Reporting Year and Reporting Period
Step 6	Apply parameters
Step 7	View summary by *Cohort* on the left-sided drop-down[a]
Step 8	Scroll through Patient Summary screen to identify high outliers
Step 9	Click on high outlier box in red; this will bring up a listing of patients in the detail box below
Step 10	Right click within the detail box and export these data to an Excel spreadsheet. These are the patients who require a deeper investigation to determine complication fallouts.

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Research and Funding

Barriers

Condition	% of total funding > % of total burden
HIV/AIDS	+16.9%
Cancer	+11.1%
Drug abuse	+2.4%
Dental and oral disease	+2.0%
Diabetes mellitus	+1.7%
Sexually transmitted diseases	+1.5%
Tuberculosis	+1.2%
Kidney disease	+1.1%
Alcohol abuse	+0.6%
Parkinson disease	+0.5%
Multiple Sclerosis	+0.4%
Perinatal conditions	+0.3%
Epilepsy	+0.3%
Schizophrenia	+0.1%
Peptic Ulcer	+0.0%
Otitis Media	-0.1%
Asthma	-0.5%
Cirrhosis	-0.5%
Dementia	-0.6%
Arthritis	-1.0%
Pneumonia	-1.2%
Migraine	-1.3%
Stroke	-2.7%
Depression	-3.8%
COPD	-5.8%
Ischemic heart disease	-11.0%
Injuries	-11.8%

% of total funding = % of total burden

Difference in % of total NIH funding and % of total burden of disease

-20.0%   0.0%   20.0%

The Future

Barriers Limiting AI

Its coming but there is a governor on the gas pedal...

- Culture

- Legal

- Building the right data sets
  - Registries were built for humans
  - Registry variables constrained

- Requires more than off-the-shelf AI

- Will require provider-engineer relationships (which currently do not exist)

- **NOT interoperability with EHRs (anymore)**

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Information Blocking

EHRs can no longer block programs from connecting

- The 2016 21st Century Cures Act (Cures Act) made data sharing the expected norm

- It authorized the Secretary of Health and Human Services (HHS) to identify "reasonable and necessary activities that do not constitute information blocking."

- Addressed two different "knowledge" standards

  - EHRs—the law applies the standard of whether they know that a practice is likely to interfere with the access, exchange, or use of EHI.

  - Healthcare providers--the laws applies the standard of whether they know that the practice is *unreasonable* and is likely to interfere with the access, exchange, or use of EHI

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ONC 2020 Cures Act Final Rule

Formalized the law

Established information blocking exceptions to implement the law

- Specifies a standardized core clinical data class set (by adopting the United States Core Data for Interoperability ("USCDI") standard)
- Established 8 exceptions to data blocking
- For patients
  - Called on the industry to adopt standardized interfaces to allow individuals to securely and easily access structured information using smartphone applications.
  - Includes a provision requiring that patients can electronically access all of their electronic health information (EHI) at no cost

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Near-Term Possibilities Relevant to Trauma Data

Automated Registry Extraction

- Technology has arrived

- 2-3 Companie in the marketplace
  - Some connect directly to the HER
  - Others process reports

- When connected to the EHR, real-time reporting and queries possible

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Example of Future Capabilities: Data/Evidence to Guidelines

Long lifecycle and **significant effort to produce** guidelines from data and evidence

Human Intervention

01 Search for Relevant Data /Background Research
-Literature
-Existing guidelines
6 Months

02 Synthesis of Research
6 Months

03 Draft Clinical Guidance
6 Months

04 Approval, revision cycles
6 Months

AI-Supported Function (days)

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Conceptual Framework

Research Papers / APIs

Data References

AI Analysis
Evidence Synthesis

Knowledge Linking   Knowledge Conflicts

Guidelines and Inferencing

Building Guidelines

Guard Rails , Citations, References

Verification and Hallucinations

Multiple AI Agents

Knowledge Graphs

Human Feedback
SMECH (SME
COllaboration hub)

Feedback

01 Search for Relevant Data /Background Research -Literature -Existing guidelines — 6 Months

02 Synthesis of Research — 6 Months

03 Draft Clinical Guidance — 6 Months

AI-Supported Function (days)

Creative Bits AI
AI Business Solutions

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Prediction...

One year

- Many centers using programs to automatically extract data

- More real-time reporting used to improve care

- Application of AI agents to small parts of the quality improvement cycles

- With new ability comes new mindsets-expanded and new ways to use data to improve care

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Summary

- Data saves lives

- Data saves money

- The future is here and how we use information will change rapidly, but..

It is important that we prioritize and invest in building these systems to ensure we continue to improve the care we deliver

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Questions?

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