Bridging the Gap

How Forensic Pathology Informs Trauma Care

CT OCME Trauma Collaborations

&

Subtle but Deadly Trauma

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The "Retrospective Lens"

Bridging Clinical & Pathological Goals

rovides a critical feedback loop for

mediate life-saving, pathologists provide

njury mechanisms, validating successes

n pitfalls.

Clinical Perspectives vs. Forensic Focus

Clinical Trauma Focus

Primary Goal: Resuscitation and hemorrhage control.

Diagnosis: Based on physical exam, imaging (FAST/CT), and physiological response.

Outcome: Focused on survival and immediate stabilization.

Forensic Pathology Focus

Primary Goal: Reconstruction and causation.

Diagnosis: Based on gross dissection, histology, and ancillary testing.

Outcome: Defining precise mechanism of injury, cause of death and manner of death.

The Missed Injury Audit

39%

Clinical Discrepancy Rate

26%

Potentially Fatal Injuries Missed

Lessons from the Morgue

Some traumatic injuries are not identified during the initial primary or secondary surveys.

Forensic audits act as a quality improvement tool, identifying systematic gaps in trauma activation and diagnostic protocols.

Commonly Missed Traumatic Injuries

Anatomical Region	Clinically Missed Injury	Forensic Implication
Thorax	Rib Fractures (Occult)	Contributing to respiratory failure/pneumonia.
Abdomen	Liver/Spleen Lacerations	Secondary hemorrhage post-stabilization.
Head	Cerebral Edema / Diffuse Axonal	Clarifying neurological death in low-GCS cases.
Vascular	Retroperitoneal Bleed	Unexplained hypotension despite FAST-negative exam.

The Value-Added Forensic Autopsy

Performance Improvement (PI)

Forensic pathologists are "experts in the pathology of trauma," providing a unique form of preventative medicine through post-mortem auditing.

- Participating in clinical M&M conferences.
- Strengthening trauma registry data.
- Refining public health surveillance.

Forensic Pathologists and Clinical Trauma Reviews

Performance Improvement, Public Health, and a Concise Autopsy Documentation Guide

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Improvement of Forensic Pathology Trauma Practice

External Examination, Internal Examination, Report Writing

Mapping the Surface and Skeleton

Vascular Branch Specificity

Grading Visceral Injuries

Quantification of Hemorrhage

Ballistic Trajectory Vectors

Medical Intervention Verification

The Terminology & Coding Disconnect

Pathology Descriptions

Pathologists focus on **Cause and Manner** of **Death**, using descriptive terms (e.g., "extensive hemorrhage") that don't always map to coding systems.

Clinical Needs (AIS/ISS)

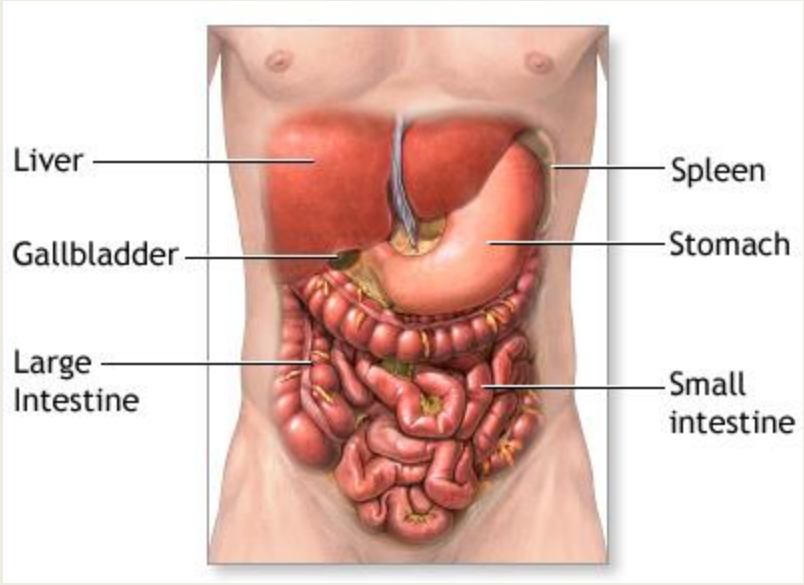
Trauma registrars require specific anatomical details—branch-specific vascular injuries and organ-specific injury depth—to accurately calculate injury severity.

"Pathologists familiar with AIS scoring can improve the usefulness of autopsy descriptions to trauma clinicians ...by providing sufficient detail to make AIS coding feasible"

Visceral Injuries

Key Descriptive Requirements

- **Laceration Depth:** Differentiate between serosal (partial) vs. full-thickness tears.
- **Specific Segments:** Identify duodenum vs. jejunum; cecum vs. sigmoid.
- **Peritoneal Contents:** Presence of bile, fecal matter, or gastric contents to assess delay in care.



Vascular Injuries

Vascular System	Pathology documentation needs	Why it matters (AIS Coding)
Major Arteries	Identify by name (e.g., Internal Carotid vs. Common).	Significant difference in ISS weighting.
Thoracic Aorta	Describe location (Ascending vs. Descending).	Captures mechanism of deceleration.
Branches	Specify branch (e.g., Superior Mesenteric vs. Generic).	Refines hemorrhagic shock assessment.

The Often Overlooked Injuries

Pelvic Findings

Describe pelvic fractures in terms of **stability** and associated soft tissue hemorrhage.

Retroperitoneum

Specify the **Zone** (I, II, or III) of hematoma to assist surgeons in retrospective surgical review.

Axial Skeleton

Specific vertebral levels for fractures; crucial for determining neuro-deficit potential.

Impact on Injury Severity Scoring

12%

Increase in mean ISS when autopsy data is integrated

The ISS Calculation

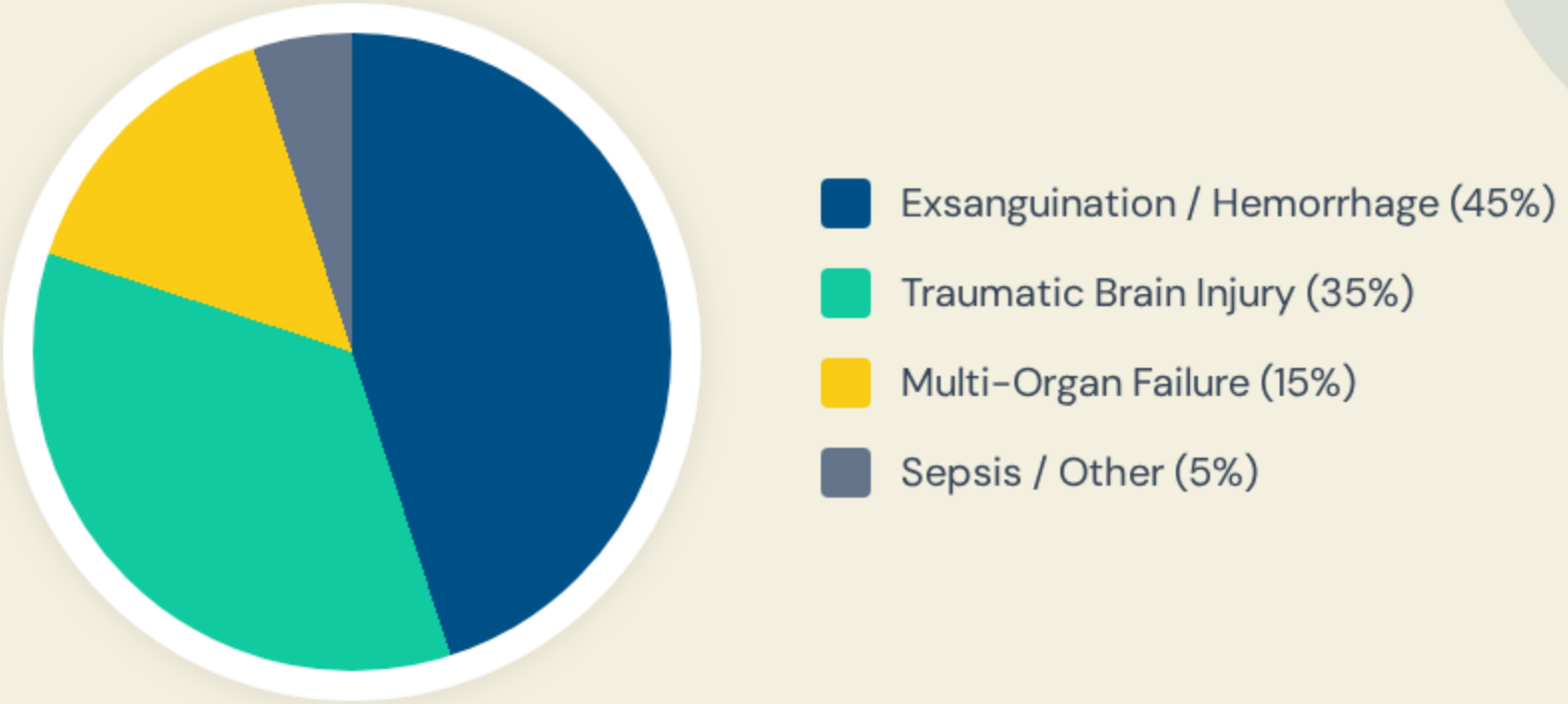
Accurate forensic data prevents "under-scoring" trauma center performance by revealing the true anatomical burden of injury.

$$ISS = AIS_1^2 + AIS_2^2 + AIS_3^2$$

Implementing the Feedback Loop

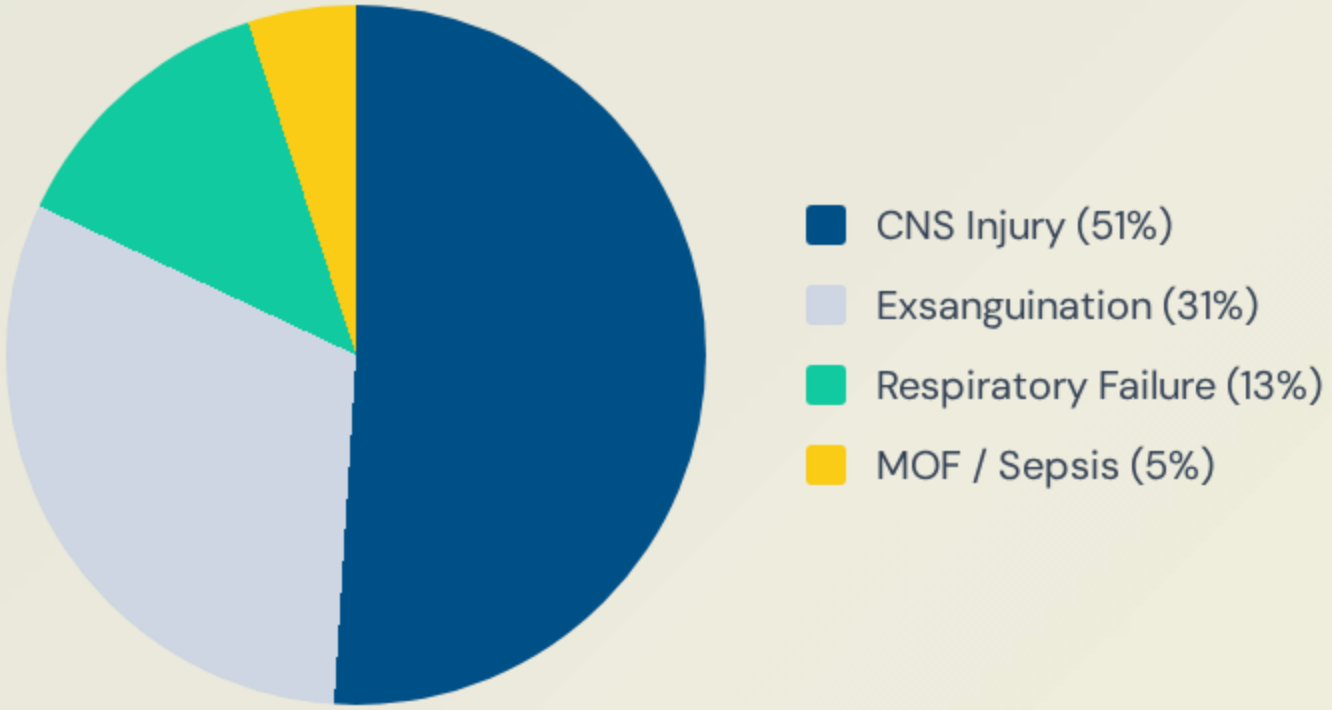
Review	Refine	Educate	Prevent
Forensic presence at monthly M&M/PI meetings.	Updating AIS coding based on autopsy reports.	Using real-case pathology to train residents/EMTs.	Informing public health on injury trends.

Mechanisms of Traumatic Fatality



Aggregated autopsy data highlighting the primary drivers of trauma-related mortality.

Mechanisms of Traumatic Fatality



Source: Szyper-Kravitz et al. (2020)

The DoD MIMIC Project

Multi-Institutional Multi-Disciplinary Injury Mortality Investigation

Components, Methodology, and Research Results

The Mission

Translating Military Battlefield Mortality Reviews to Civilian Trauma Systems

Component I: The Multidisciplinary Panel

Trauma Surgeons

Provide clinical perspective on operative potential and accessibility of injuries.

Forensic Pathologists

Define precise anatomical damage and physiological causes of death via gross and microscopic review.

EMS & EM Physicians

Analyze prehospital time-to-care and the feasibility of field interventions.

Component II: Data Foundations

Forensic Evidence

- Full Autopsy Reports & Toxicology
- Post-Mortem CT (PMCT) Scanning
- Detailed Wound Trajectory Mapping

Prehospital Clinical Data

- EMS Run Sheets & Field Notes
- GIS-based GPS Scene Locations
- Estimated Prehospital Distance/Time

The Connecticut Contribution

1,997

Cases from CT OCME

A High-Fidelity Dataset

Connecticut was a primary contributor to this study

- centralized state-wide Medical Examiner system.
- consistent procedures and EMS systems
- 2012–2014, CT provided the project's second largest data cohort, representing blunt, firearm, and sharp force fatalities.

This centralized data allowed for the highest fidelity of clinical-forensic correlation in the national study.

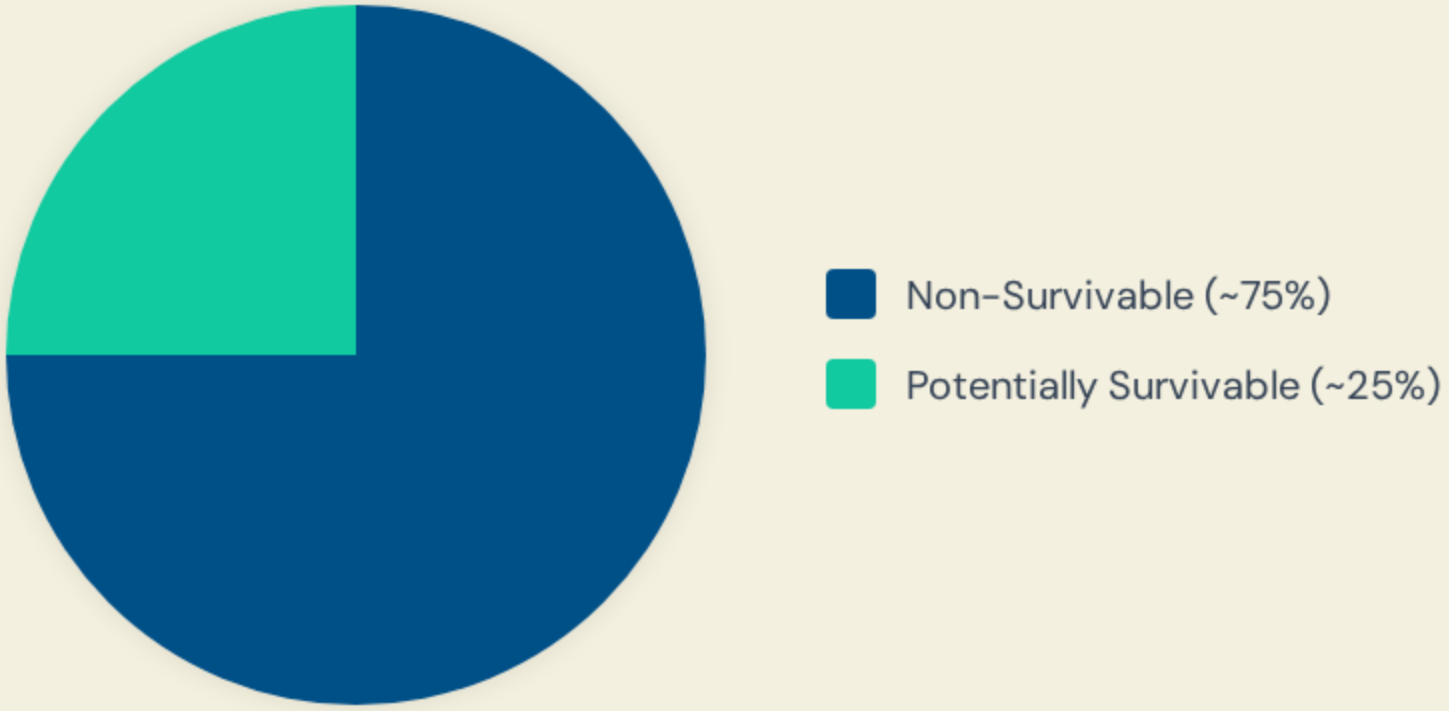
Methodology: Survivability Classification

- **Non-Survivable:** Injuries fatal regardless of intervention (e.g., decapitation, total aortic transection).
- **Potentially Survivable:** Patients with injuries that could be managed with *advanced* prehospital care (e.g., junctional hemorrhage, tension PTX).
- **Survivable:** Minimal injury burden where death resulted from system failure or prolonged transport times.

Military and Civilian (MIMIC) Outcomes

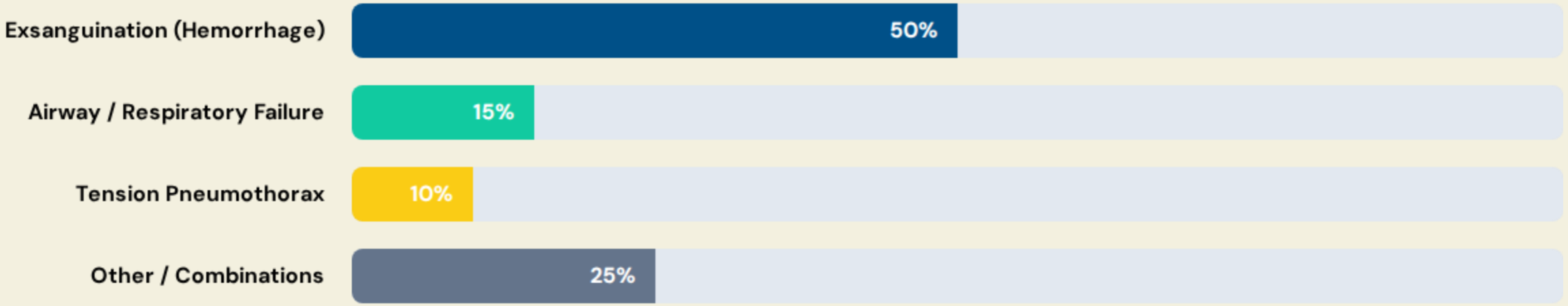
Category	Military Outcomes (Eastridge 2012)	Civilian Outcomes (Medrano 2019/2024)
Total Deaths Reviewed	~4,500 military fatalities	~3,000 civilian fatalities
Potential Survivability	24.3%	~25%
Primary Lethal Factor	Penetrating / Blast (Hemorrhage)	Blunt / MVC (Hemorrhage & CNS)
Top Intervention	Tourniquets / Blood	Blood / Airway / Optimized Transport

Results: Potential for Survivability

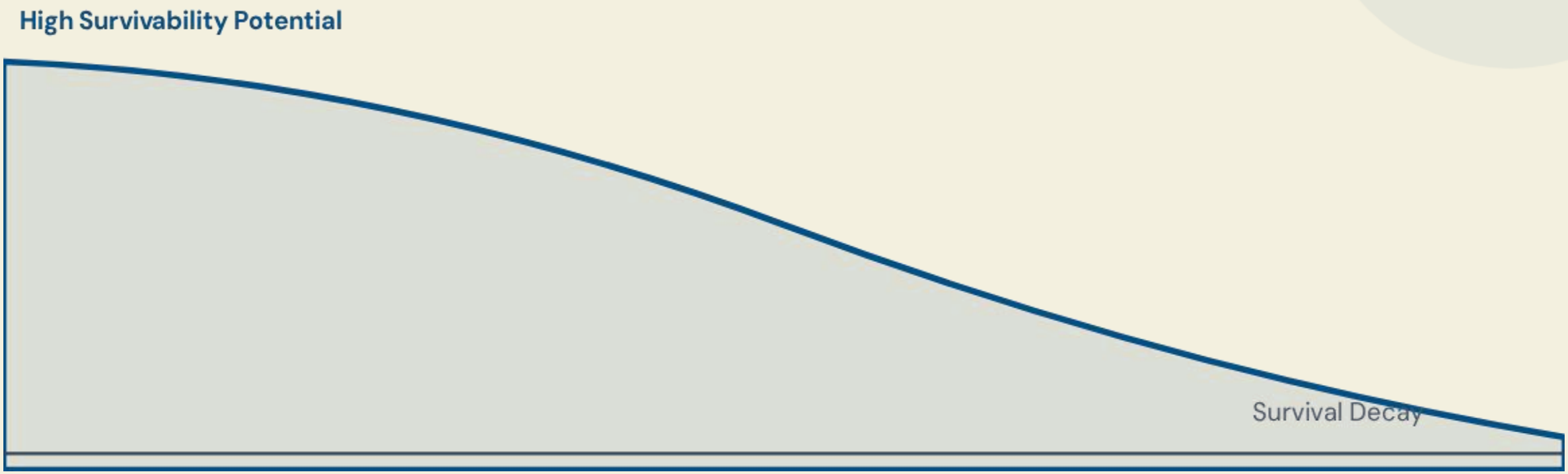


1 in 4 prehospital civilian deaths may be potentially survivable with optimized field care.

Results: Causes (Mechanisms) of Preventable Death



Results: GIS & The "Golden Hour" Decay



MIMIC mapping in CT demonstrated that transport distance is a direct modifier of "Potential for Survivability," especially in penetrating junctional hemorrhage.

Clinical Lessons from MIMIC for the Trauma Team

Stakeholder	Actionable Takeaway from MIMIC Results
Paramedics	Focus on aggressive junctional hemorrhage control and early needle decompression.
ER Physicians	Assume "occult" internal bleeding in negative FAST patients with high-risk MOI.
Trauma Surgeons	Integrate autopsy findings into M&M to identify missed vascular injuries.
Hosp. Admin	Support regionalization of trauma care based on GIS time-decay data.

The Integrated Clinical – Forensic Feedback Loop

Pre-Hospital	Resuscitation	Intervention	Post-Mortem	Quality Improvement
MOI reporting & evidence preservation.	Identifying patterns in the trauma bay.	Surgical exploration guided by wounds and ballistics.	Verification of clinical findings. Expansion of descriptions and unexpected findings.	Refining trauma system protocols. Integration of Autopsy Information into Case Reviews

How You can Inform and Support the Forensic Pathologist

Evidence Preservation and Solid Communication

- **Avoid Cutting Through Defects:** Never cut through bullet holes or knife entry sites in clothing.
- **In-Situ Preservation:** Leave endotracheal tubes, IV lines, and chest tubes in place if the patient is declared DOA.
- **Hands-Off "Evidence":** Bag the hands of gunshot or assault victims to preserve gunpowder residue or DNA.
- **Documentation:** Precise description of wounds prior to surgical debridement or alteration. Alert the Medical Examiner to any ballistic evidence found on the body or recovered during surgery.
- **Communication:** Thorough communication to OCME on the identification, the family notification, the extent of medical treatment provided, and any important tidbits (family opposed to autopsy, patient will be a donor)

Reading the Body: Patterned Injuries and Subtlety

Seatbelt Sign

Linear abrasions across the torso; high index of suspicion for mesenteric tear or bowel rupture.

Bumper Fractures

Lower extremity fractures indicating pedestrian impact height, predicting pelvic and spinal involvement.

Steering Wheel Imprints

Cardiac contusion and sternal fractures; warning for blunt aortic injury (BAI).
Shrapnel injury

The Subtle but Deadly – Lessons from Autopsy Surprises

Penetrating Injuries

Air Rifle

Nail Gun

Ice Pick

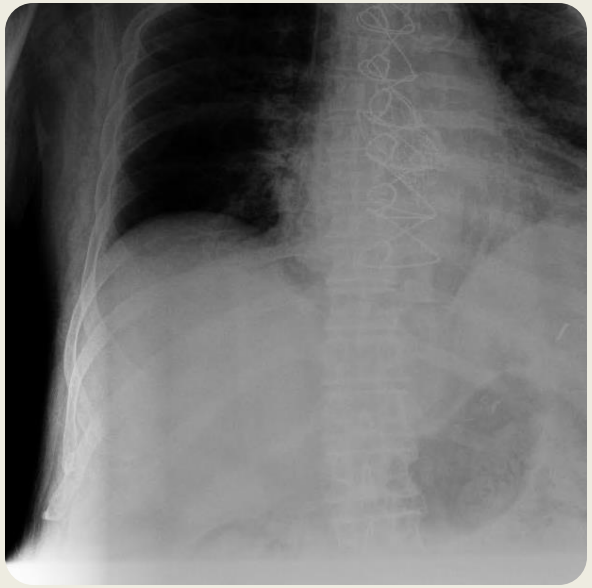
Sharp Force Venous

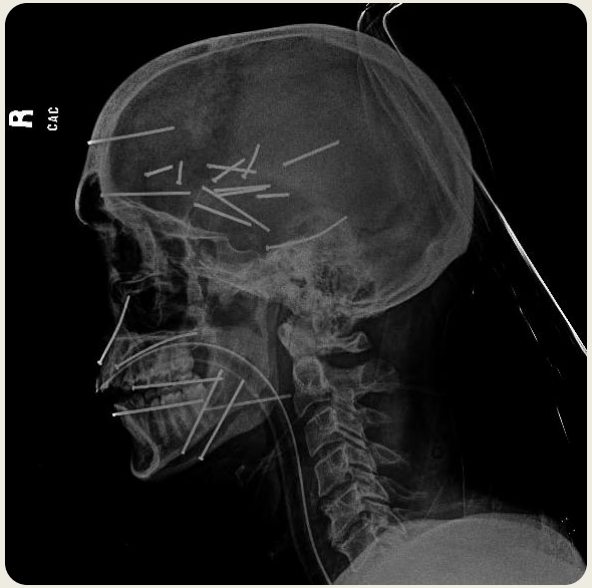
Suicides and Homicides

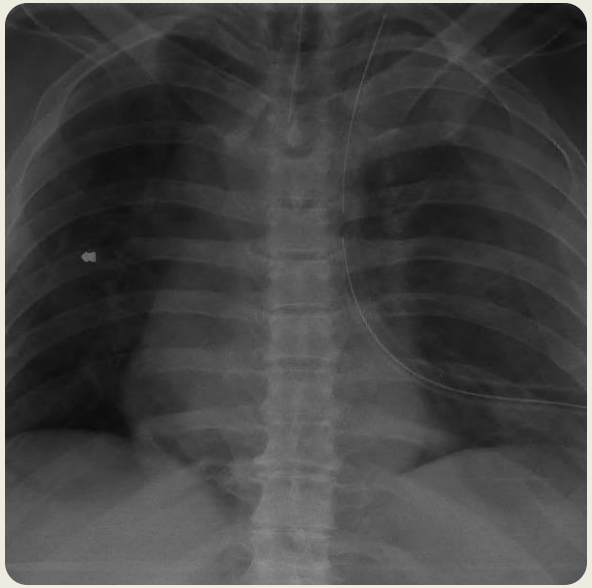
Multiple

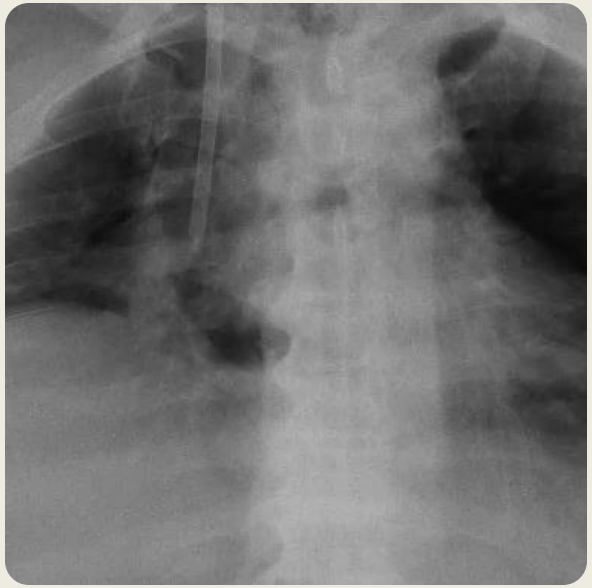
Wrong Place Wrong Time

Air Embolus

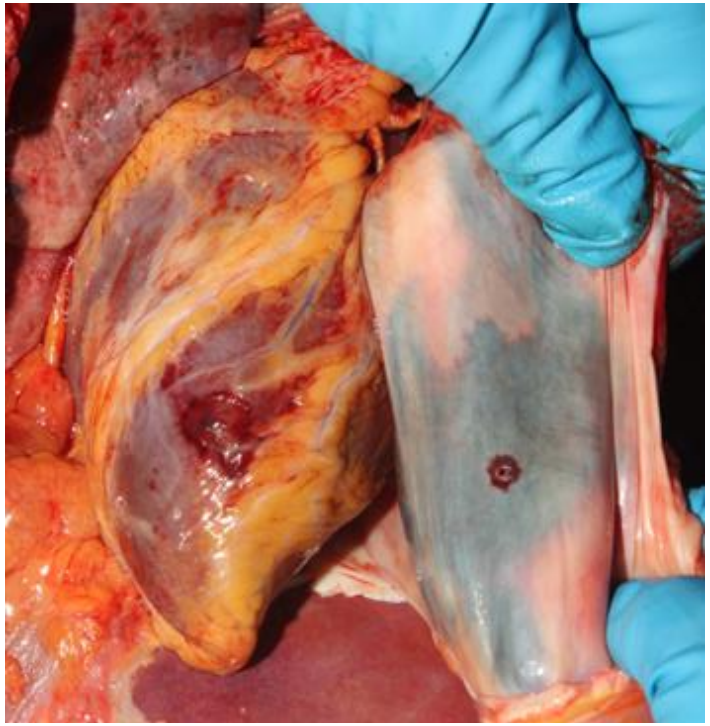


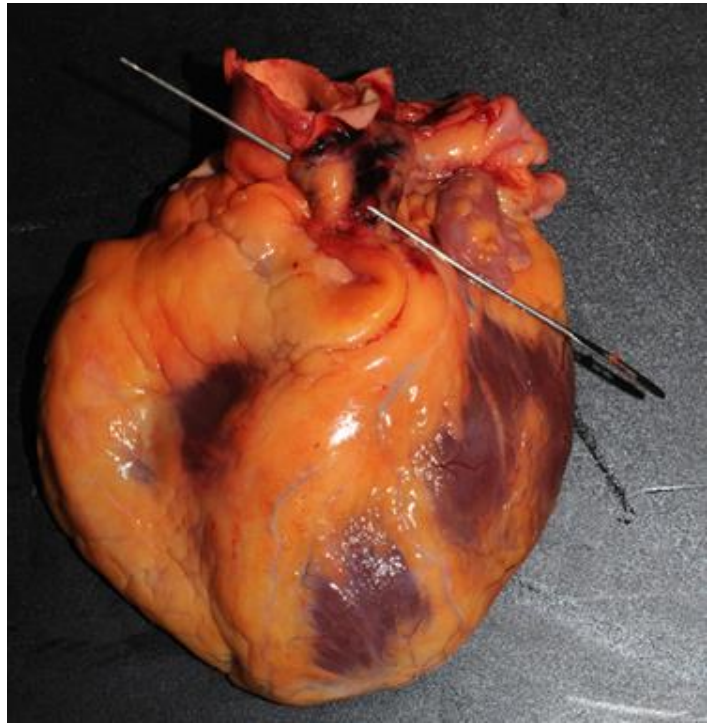


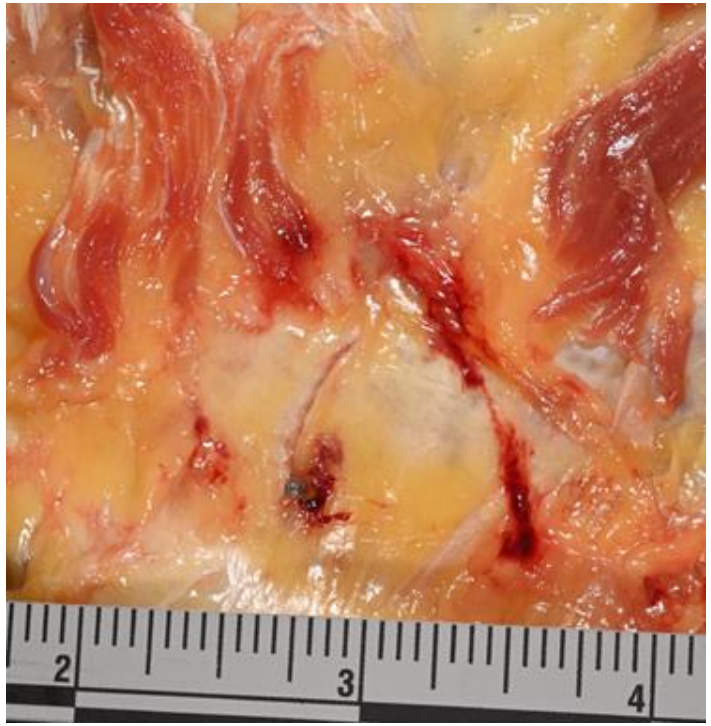




Postmortem Xray







- Ice Pic, Air Rifle and Nail Gun Track

The Subtle but Deadly – Lessons from Autopsy Surprises

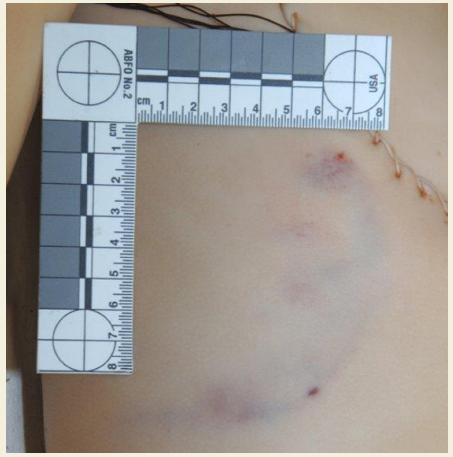
Miscellaneous

Fire

Death Before / Death During

Livestock

Clinical Suspicion



Pedestrians

Heavy clothing

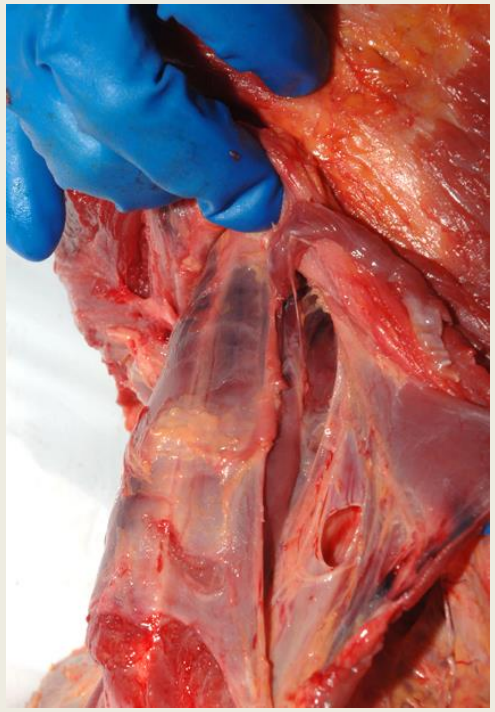
Don’t under appreciate thin atrophic skin of lower extremities (avulsion pockets)

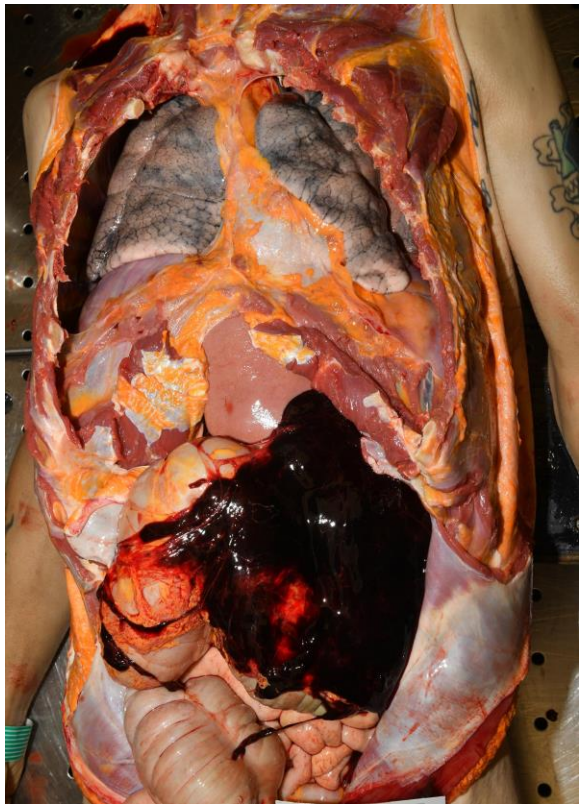
Strangulation

Death with discordant postmortem changes; other subtleties

Strangulation

- Death with discordant postmortem changes
- Irregular cutaneous marks
- Facial and Mucosal Petechiae



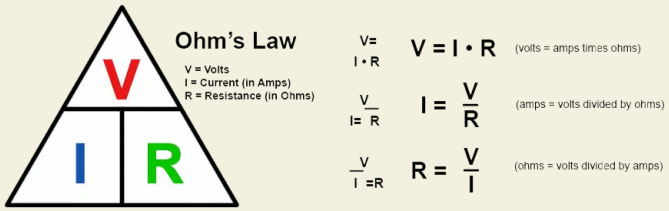


Unsuspected Blunt Trauma

- 40 YO M found down in parking lot known for drug use. EMS transport incardiac arrest. Pronounced in ED after CPR.

The Subtle but Deadly – Lessons from Autopsy Surprises

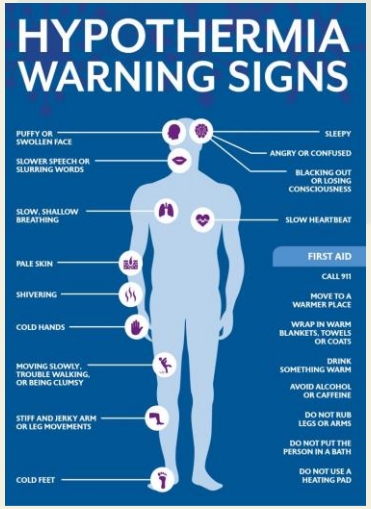
Environmental



Electrocution

Lightning

Envenomation



Hypothermia

Minor to Marked

Index of Suspicion

Occupation, Season

Season

The Dead Teach the Living…So the Living May Survive the Next Trauma

With Dedicated Statewide Mortality Review

- Survivability can be Studied
- Interventions can be Explored
- Public Health and Safety can Improve

Summary and Take Aways

- Clinical Pathological Relationships are Imperative
- Medical Examiners are Eager Partners in Trauma Care
- Collaboration and Bidirectional Feedback in Subtle Cases

Questions?

"Collaborations between trauma teams and forensic pathologists benefit each other and help communicate autopsy findings in a more clinically useful way to stakeholders to further benefit the living."

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