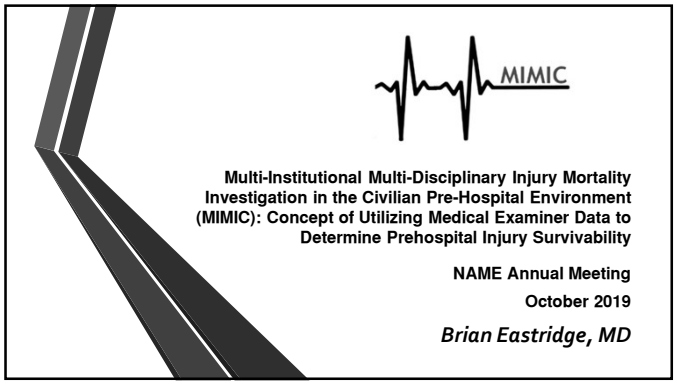

Multi-Institutional Multi-Disciplinary Injury Mortality Investigation in the Civilian Pre-Hospital Environment (MIMIC): Concept of Utilizing Medical Examiner Data to Determine Prehospital Injury Survivability

NAME Annual Meeting

October 2019

Brian Eastridge, MD

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Disclosures

- **Nothing to Disclose**

2

Overview

- **MIMIC Project Overview**
- **Survivability Definitions**
- **Profiler**
- **Preliminary Data**

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MIMIC Project Overview

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DoD Broad Agency Announcement (BAA) Grant

- Department of Defense (BAA $3,979,380)
- PI: Brian Eastridge, MD
  Professor, Department of Surgery
  Division Chief, Trauma and Emergency General Surgery
  Jocelyn and Joe Straus Endowed Chair in Trauma Research
  University of Texas Health Science Center at San Antonio
- Co-PIs: Kurt Nolte, MD
  Professor of Pathology
  University of New Mexico
  Director of Radiology-Pathology Center for Forensic Imaging
  Chief Medical Investigator, Office of the Medical Investigator
  Ellen MacKenzie, PhD
  Dean, Johns Hopkins Bloomberg School of Public Health
  Bloomberg Distinguished Professor

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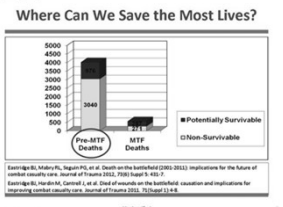
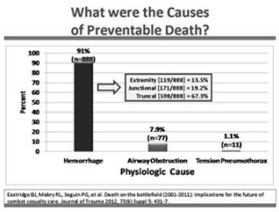
Background/Scientific Rationale Pre-Hospital Mortality Combat





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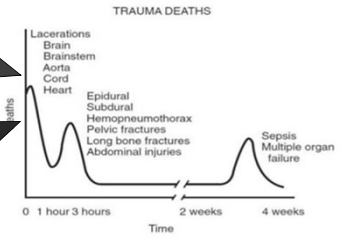
Background/Scientific Rationale Pre-Hospital Mortality Civilian

Poorly defined

NASEM Report Emphasis



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Why is the MIMIC study unique?

- It replicates what other small studies have done.
- Provides a multi-disciplinary review team with granular injury details to determine survivability.
- Allows reviewers to determine survivability.
- Utilizes death data from autopsy reports to determine survivability.
- The MIMIC study is the only study that has examined pre-hospital trauma deaths to determine ways to improve outcomes.

Medrano NW, Villarreal CL, Price MA, et al. Multi-Institutional Multi-Disciplinary Injury Mortality Investigation in the Civilian Pre-hospital Environment (MIMIC). Trauma Surgery and Acute Care Open. 2019.

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Study Hypotheses

- Substantial opportunity to further reduce deaths in pre-hospital setting.
  - Potential liabilities in civilian and military pre-hospital care must be identified and remediated in order to reduce the number of potentially preventable deaths on the battlefield and in the civilian environment.

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MIMIC Objectives

- **Objective #1:** ***Develop a framework and methodology*** for evaluating pre-hospital deaths
- **Objective #2:** Organize and standardize a ***multidisciplinary, multi-institutional network of experts*** to identify the causes of pre-hospital deaths due to trauma and estimate the potential for survivability.
- **Objective #3:** ***Define the causes and pathophysiologic mechanisms of 3,000 pre-hospital deaths***, and estimate the potential for survivability
- **Objective #4:** ***Describe the epidemiology of pre-hospital mortality*** in the context of trauma system development and estimate its impact on society.
- **Objective #5:** ***Develop a blueprint for a sustained effort*** identifying high priority areas for injury prevention, trauma systems performance improvement and research and development.

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System Benefits

Trauma

- Performance improvement
  - Engineering
  - Medical devices / procedures
  - EMS value validation
  - Injury Prevention
  - Collaboration between trauma and ME communities

Medical Examiner

- Funding for advanced radiological imaging
- Improve mechanistic information
- Interaction between trauma and ME communities
- Bridge the gap between ME and TS data sets

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Study Population

- **Inclusion Criteria:**
  1. Pre-hospital deaths (at scene, en route to hospital or DOA defined as no vitals upon arrival at hospital)
  2. Blunt, Penetrating, Thermal, and Suicides are included
- **Exclusion Criteria:**
  1. Non-mechanical causes of death – poisoning, drug overdoses, hangings, drowning (unless associated with trauma)
  2. Decomposed remains only (not fully fleshed with distinguishable organs)

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Forensic Record

Medical Examiner cases may involve any of the following:

- External examination
- Internal examination
- Investigator reports
- Toxicology Report
- Radiographs- CT Reports will be uploaded. Actual images will be uploaded if available and when a case requires adjudication.

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Study Setting
Six Regions in the Country

(Centralized ME systems and utilizing electronic case management system to collect uniform data on all deaths)

1. **State of Connecticut**. Serves a population of 3.6 million. They perform approximately 2,200 autopsy examinations at a single, centralized facility annually.
2. **Johnson County, Iowa.** Serves a population of 142,000. In 2014 JCME accepted jurisdiction of 380 deaths and performed 118 autopsies.
3. **State of Maryland.** Serves a population of approximately 6.0 million residents . They perform 4,220 autopsies at the single, centralized facility annually.
4. **State of New Mexico.** Serves a population of 2.0 million. They perform approximately 2,100 full autopsy examinations annually
5. **State of Oklahoma.** Serves a population of 3.8 million and conducts investigation of roughly 4,000 deaths annually.
6. **The District of Columbia.** Serves a population of 659,000. They perform approximately 1,110 examinations annually.

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Estimates of Number of Injury Deaths

(Blunt, Firearm and Other Sharp Forces)

OCME	2012	2013	2014	Total
Connecticut	684	621	692	1997
Johnson Co, Iowa	133	128	110	371
Maryland	1509	1200*	1200*	3909
Oklahoma	1044	1153	1007	3204
New Mexico	823	778	906	2507
Washington, DC	232	267	254	753
Total	**4,425**	**4,147**	**4,169**	**12,741**

* Estimates

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MIMIC Final Subject Selection

ME Site	Number of Cases
Connecticut	427
Johnson Co, Iowa	47
Maryland	848
Oklahoma	341
New Mexico	1,243
Washington, DC	152
Total	**3,058**

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Case Review Methods

- Steering Committee (Military and Civilian) defined definitions and process
- Expert review panels (~ 80 Military and Civilian reviewers) (6 individuals are on each panel)
  - 4 Surgeons
  - 1 Emergency Medicine/EMS
  - 1 Forensic Reviewer
- Panels will each review a certain number of cases using the **PROFILER** and assign a determination of survivability to each case
- Reviewers will review cases independently. Throughout the course of the study approximately **250 cases** will be reviewed by each team panel.
- Discrepancies in determination of survivability will be identified and non-consensus will be reviewed by an adjudication team

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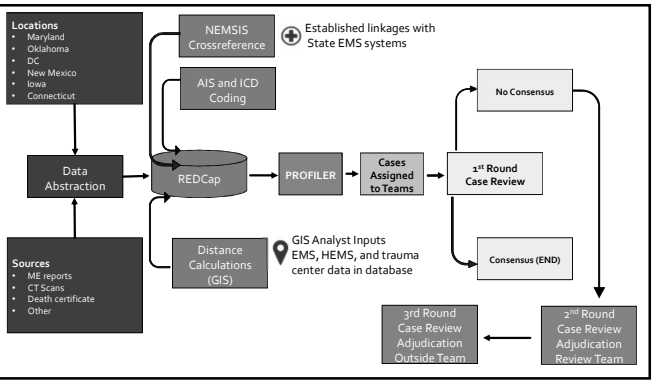

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Survivability Definitions

- **Non-Survivable-** Death as a result of catastrophic anatomic injuries
- **Possibly Survivable -** Anatomic injuries that were severe but medically survivable
- **Definitely Survivable-** Minimal anatomic injuries with a high likelihood of survival
- **Cannot Judge-** information insufficient to make a determination

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Anatomic Survivability

Medically Non-Survivable (MNS)

- Dismemberment / decapitation
- Traumatic Brain evisceration
- Cervical cord transection (above C_3)
- Airway transection within thorax
- Cardiac injury > 2cm
- Uncontained hemorrhage, thoracic aorta
- Uncontained hemorrhage, pulmonary artery
- Hepatic avulsion
- Junctional lower extremity amputations with open pelvis
- Injuries to the deep CNS nuclei, brainstem, or massive brain tissue injury
- Massive Pulmonary Tissue Disruption

Medically Potentially Survivable / Definitely Survivable

- All other

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Profiler

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Profiler

1) **Open medical examiner case in Profiler**
2) **Review case**
   - Medical examiner data (left side of page)
   - Injury cause / circumstance
   - Injury severity
   - First Discovery & Response
   - EMS Care
   - Access to EMS and Trauma Center
3) **Causation and survival determination**
   - Primary cause of death (may choose multiple but must be associated with severe injury)
   - Assuming immediate access to trauma care
   - Actual conditions
   - Opportunities for improvement (free text)

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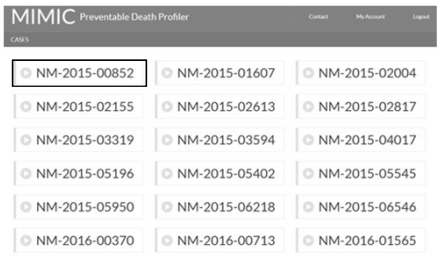
Open Medical Examiner Case in Profiler



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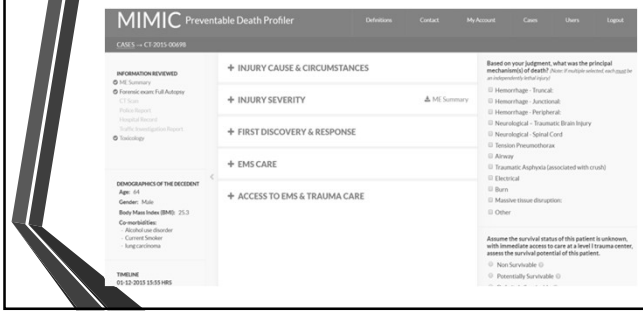
Open Medical Examiner Case in Profiler



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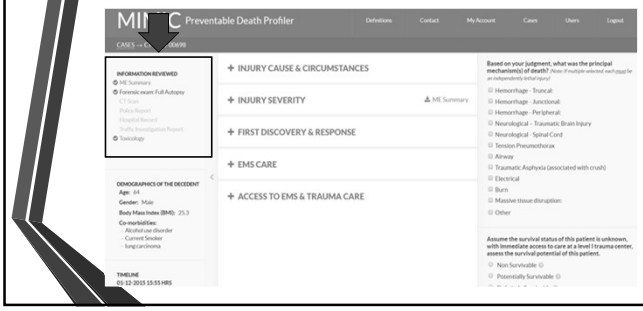
Review Case

Medical Examiner Data



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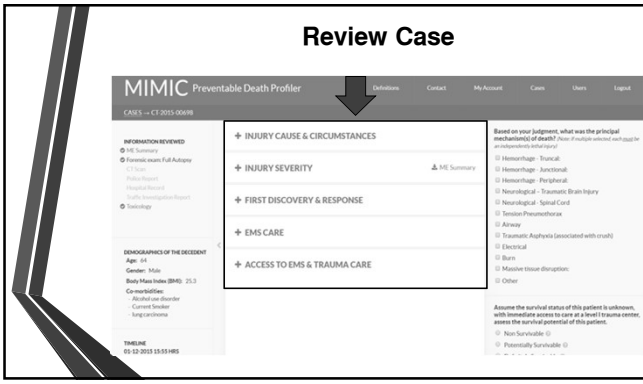
Review Case



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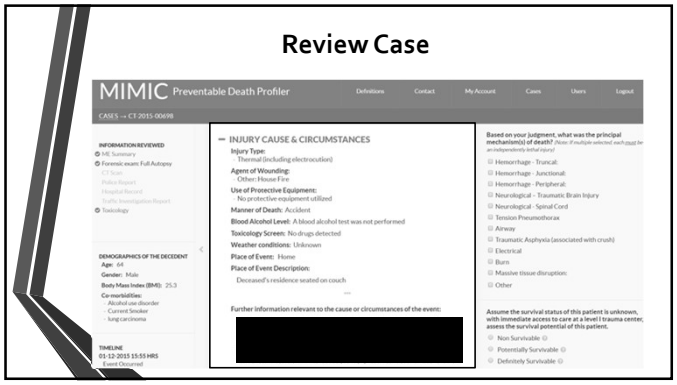
Review Case



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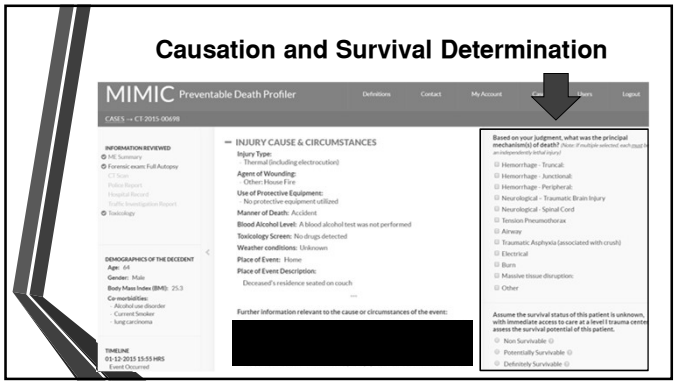
Causation and Survival Determination



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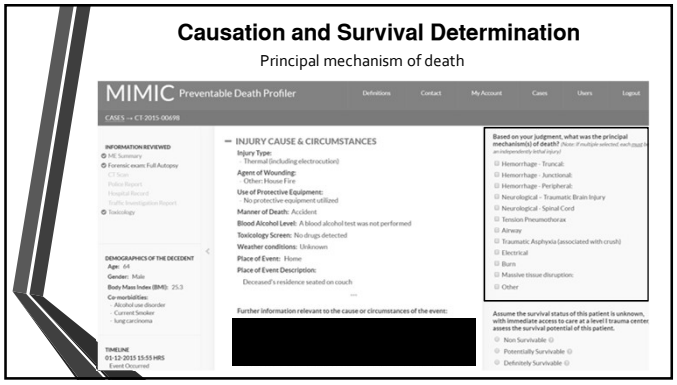
Causation and Survival Determination

Principal mechanism of death



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Causation and Survival Determination

Assuming immediate access to care…rate the likelihood of survival

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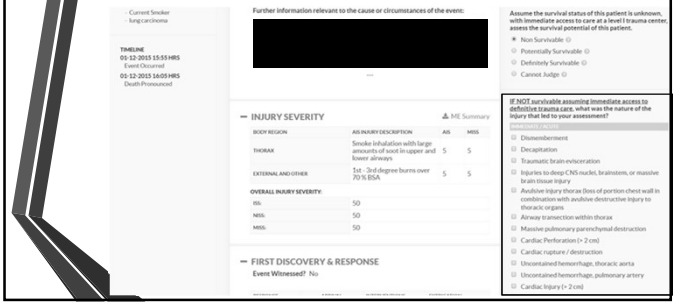
Causation and Survival Determination

If Non Survivable…what led to your assessment?



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Causation and Survival Determination

Given the condition of the actual scenario…rate the likelihood of survival

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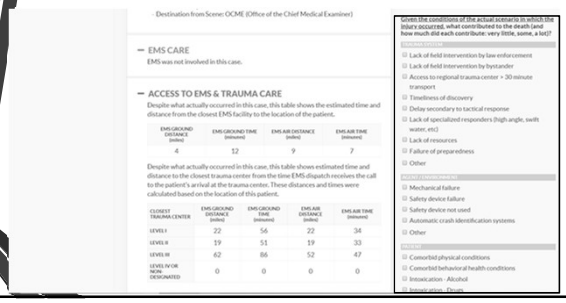
Causation and Survival Determination

What contributed to the death?



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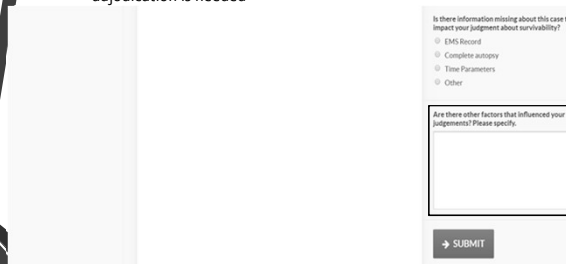
Causation and Survival Determination

- Rationale for how you made your determination; may help if adjudication is needed



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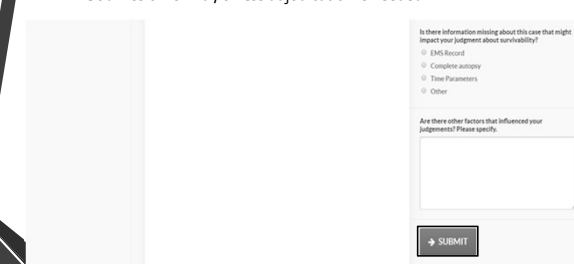
Causation and Survival Determination

- Submission is final, unless adjudication is needed



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Preliminary Data

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Case Reviews

Study Round	Number of Cases Released	Case Completion
Round 1 Status *Began 1-16-2019*	260 Cases Released	240 Cases Completed
Round 2 Status *Began 3-25-2019*	240 Cases Released	240 Cases Completed
Round 3 Status *Began 6-13-2019*	300 Cases Released	150 Cases Completed

- 13 review team panels
- Study will consist of 10 rounds
- Reviewers are reporting being able to complete each case review in about 10-15 minutes

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Questions Used to Determine Consensus

- **Consensus must be reached on both Survivability Questions:**
  - Assume the survival status of this patient is unknown, ***with immediate access to care at a level I trauma center***, assess the survival potential of this patient.
  - Assume the survival status of this patient is unknown, ***given the conditions of the actual scenario*** in which the injury occurred (i.e. discovery, EMS response, access to trauma center, weather etc.), assess the survival potential of this patient.

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Case Consensus Definition

- 5 reviewers are used to determine consensus. The ME/Forensic reviewer is not calculated in consensus as this analysis is kept separate.
- Each variable is independent. So it must be 3 or more reviewers answering the same on one specific category. (For example: 3 agree the case is Potentially Survivable)
  - If one reviewer selects non-survivable and the other 4 select either potentially, definitely survivable, or cannot judge, that case goes to adjudication
  - If two reviewers select cannot judge, but the other three are able to make a determination, the case goes to adjudication

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Case Adjudication

Study Round	Number of Cases That Did Not Reach Initial Consensus	Cases Resolved During Team Adjudication	Cases Still In Team Adjudication	Could Not Reach Consensus, Pushed for Outside Adjudication
Round 1 Status	61 cases	44 cases	3 cases	14 cases
Round 2 Status	49 cases	21 cases	20 cases	8 cases
Round 3 Status	36 cases	9 cases	24 cases	3 cases

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Preliminary Round 1 and Round 2 Data

- Q1: Based on your judgment, what was the principal mechanism(s) of death?

Principal Mechanism(s) of Death	Frequency
Neurological – Traumatic Brain Injury	1342
Hemorrhage – Truncal: Thorax	354
Neurological – Spinal Cord	256
Hemorrhage – Truncal: Abdomen / Pelvis	136
Burn	133
Airway	79
Massive tissue disruption: CNS	67
Asphyxia	65
Massive tissue disruption: Whole Body	59
Massive tissue disruption: Thorax	41
Tension Pneumothorax	32
Hemorrhage – Junctional: Cervical	29
Massive tissue disruption: abdomen	28
hemorrhage - peripheral: upper extremity	21

Note: Cases with multiple causes are counted multiple times. (Round 1 and 2)

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Preliminary Round 1 and Round 2 Data

- Q2: Assume the survival status of this patient is unknown, with immediate access to care at a level I trauma center, assess the survival potential of this patient.

Immediate Access Survivability	Frequency for reviewers reaching consensus	Frequency for medical examiners
	262 (77%)	269 (79%)
	75 (22%)	46 (14%)
	2 (1%)	5 (1%)
	0	19 (6%)

RESEARCH AND DEVELOPMENT OPPORTUNITIES TO INFORM INJURY PREVENTION

Note: Using 339 cases that have reached consensus on survivability assessments for Q2

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Preliminary Round 1 and Round 2 Data

- Q3: Assume the survival status of this patient is unknown, given the conditions of the actual scenario in which the injury occurred (i.e. discovery, EMS response, access to trauma center, weather etc.), assess the survival potential of this patient

Actual Scenario Survivability	Frequency for reviewers reaching consensus	Frequency for medical examiners
	341 (93%)	325 (89%)
	26 (7%)	22 (6%)
	0	0
Cannot Judge	0	20 (5%)

OPPORTUNITIES TO IMPROVE CURRENT TRAUMA SYSTEM

Note: Using 367 cases that have reached consensus on survivability assessments

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Immediate Access Survivability	Frequency for reviewers reaching consensus	Frequency for medical examiners
Non-survivable	262 (77%)	269 (79%)
Potentially Survivable	75 (22%)	46 (14%)
Definitely Survivable	2 (1%)	5 (1%)
Cannot Judge	0	19 (6%)

RESEARCH AND DEVELOPMENT OPPORTUNITIES TO IMPROVE FUTURE TRAUMA SYSTEMS

Actual Scenario Survivability	Frequency for reviewers reaching consensus	Frequency for medical examiners
Non-survivable	341 (93%)	325 (89%)
Potentially Survivable	26 (7%)	22 (6%)
Definitely Survivable	0	0
Cannot Judge	0	20 (5%)

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Preliminary Round 1 and Round 2 Data

- Q4: Which injury prevention programs/devices or interventions might have improved the chances of survival for this individual?

Prevention Program(s)	Frequency
Behavioral health	777
Alcohol / drug	469
Seat belt	149
Airbag	55
Helmet	34
Child Restraint	5
Protective Clothing	5
Personal Flotation Device	4

***Note:** Using records from all reviewers in Round 1 and Round 2.*

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Questions

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Summary

The goal of the research is to identify liabilities in trauma systems and develop mitigation strategies with translation potential for realistic and relevant improvements in trauma systems and medical examiner systems. The research intends to identify ways that the ME and trauma communities can improve linkages to foster in-depth reviews of trauma mortality.

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Future Directions

- Submission of an NIH R-24 award to fund a PEDS-MIMIC project
- Looking for funding opportunities aimed at building the ME system
- Exploring funding opportunities that focus on suicides

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Team Acknowledgment

- Authors: Villarreal CL, Medrano NW, MacKenzie E, Nolte KB, Phillips MJ, Price MA, Eastridge BJ
- MIMIC Steering Committee
- MIMIC Forensic Reviewers
  - Kurt Nolte, Edward Mazuchowski, Roger Mitchell, Stacy Drake, Marcus Nashelsky, David Fowler, Greg Davis, James Gill, Joseph Hunt

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Team Acknowledgment

Study Sites	Medical Examiner	Data Abstractors
New Mexico	Kurt Nolte	Garon Bodor Victoria Chavez Kayla Moorman Susan Catlett Yvette Gonzalez
Maryland	David Fowler	Ling Li Haitaio Bi
Washington, DC	Roger Mitchell	Chikarlo Leak Ameerah Battle
Oklahoma	Eric Pfeifer	Lynda Goldberg-Baedke
Connecticut	James Gill	Michelle Clark Jessica Crowson
Iowa	Marcus Nashelsky	Heather Sanderson

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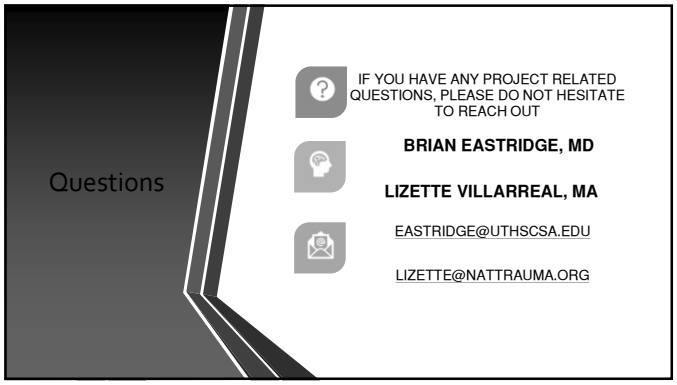
Questions
IF YOU HAVE ANY PROJECT RELATED QUESTIONS, PLEASE DO NOT HESITATE TO REACH OUT
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