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TITLE: Multiinstitutional Multidisciplinary Injury Mortality Investigation in the Civilian Pre-Hospital Environment (MIMIC)

PRINCIPAL INVESTIGATOR: Dr. Brian Eastridge

RECIPIENT:
National Trauma Institute d/b/a Coalition for National Trauma Research, San Antonio, TX

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14. ABSTRACT

The purpose of this project is to focus efforts on a comprehensive review of 3,000 civilian prehospital injury deaths. A multidisciplinary study group will apply the framework and methodology that was developed to identify causes and mechanisms of death and estimate potential survivability. The study will describe the epidemiology of pre-hospital mortality in the context of trauma system development and estimate impact on society. The results will assist in the development of a blueprint for a sustained effort at public health injury mitigation strategies in the pre-hospital environment, identifying high priority areas for injury prevention, trauma systems performance improvement, and opportunities for advancements in research and development.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
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INTRODUCTION:

Advances in care in both trauma centers and trauma systems have substantially reduced death and disability associated with injury. However, there remains a substantial opportunity to further reduce deaths in the 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. The purpose of this proposal is to develop a coordinated, multidisciplinary, multi-institutional effort within the civilian clinical sector to identify and characterize the causes of mortality from trauma in the pre-hospital setting and to identify potential high yield areas for research and development in pre-hospital medical care, injury prevention, and trauma systems. This effort will conduct a review of 3,000 pre-hospital deaths in six areas of the country to develop a more comprehensive understanding of the epidemiology of pre-hospital deaths and their potential survivability with the ultimate goal of identifying liabilities in our current trauma system and improving survival of both civilian and military casualties.

1. KEYWORDS:

Prehospital deaths, survivability, preventable deaths, trauma systems, system improvements

2. ACCOMPLISHMENTS:

What were the major goals of the project?

Objective #1: Develop a framework and methodology for evaluating (i) the causes and pathophysiologic mechanisms of pre-hospital deaths; (ii) the appropriateness of EMS response and care delivered; and (iii) the potential for survivability under both optimal clinical circumstances and within the context of the actual pre-hospital environment.

Major Task 1: Adapt Protocol for Submission and Determination	Months	Completion Date	% Complete
Subtask 1: Prepare Regulatory Documents and Research Protocol for Study	1-3	1/25/2018	100%
Coordinate with Sites for IRB protocol determination as NHR	1-3	2/7/2018	100%
Coordinate with Sites for Military 2nd level IRB review (ORP/HRPO)	1-6	N/A	N/A
Submit amendments, and protocol deviations as needed	As Needed		N/A
Milestone Achieved: Local IRB determination at UTHSCSA	3	01/31/2018	100%

Milestone Achieved: HRPO acknowledgement for all protocols and local IRB determination as NHR through Sites	6	12/28/2016	100%
Major Task 2: Development of the review criteria	Months	Completion Date	% Complete
Subtask1: Develop consensus regarding definitions and rules	1-3	09/13/2017	100%
Subtask 2: Delivery of review criteria, definitions, and procedures to the government for recommendations and approval.	4	09/18/2017	100%
Milestone Achieved: Government recommendations and approval of review criteria, definitions, and procedures	4	10/11/2017	100%
Objective #2: Organize and standardize a multidisciplinary, multi-institutional network of experts who will apply the methodology described above to identify the causes of pre-hospital deaths due to trauma and estimate the potential for survivability. Study Group members will be trained to ensure standardization of assessments within and across panels.			
Major Task 1: Provide training to Study Group members	Months	Completion Date	% Complete
Subtask 1: Hold series of meetings by teleconference	3	01/07/2019	100%
Milestone Achieved: Completed Study Group training	3	01/07/2019	100%
Objective #3: Using the methodology and network of experts described above, define the causes and pathophysiologic mechanisms of 3,000 pre-hospital deaths occurring in 6 regions of the country, and estimate the potential for survivability by mechanism of injury (e.g. blunt versus penetrating), geographic location of the injury (urban, suburban, rural, wilderness), the maturity of the local trauma system, and age of the decedent.			
Major Task 1: Abstract data for all cases and enter into REDCap	Months	Completion Date	% Complete
Subtask 1: Perform AIS Coding	2-24		100%
Major Task 2: Develop Profiler Review	Months	Completion Date	% Complete
Subtask 1: Develop Profiler Review System	8-18	08/23/2018	100%
Subtask 2: Conduct Profiler System Testing	18-23	12/10/2018	100%
Milestone Achieved: Profiler system is used to conduct online reviews	23	1/16/2019	100%
Major Task 3: Perform online mortality reviews	Months	Completion Date	% Complete
Subtask 1: Disseminate cases to review team monthly	24-33		60%
Milestone Achieved: All panel reviews completed and data submitted	33		46%
Objective #4: Describe the epidemiology of pre-hospital mortality in the context of trauma system development and estimate its impact on society. The societal impact of pre-hospital deaths will be measured in terms years of potential life lost and lost productivity. Most important, estimates of potential cost savings will be derived based on the analysis of potential survivability.			
Major Task 1: Data Analysis	Months	Completion Date	% Complete
Subtask 1: Coordinate with Sites & Data Core for monitoring data collection and data quality	4-36		75%
Subtask 2: Perform all analyses according to specifications, share output and finding with all investigators	6-39		20%

Milestone Achieved: Report results from data analysis			0%
Objective #5: Develop a blueprint for a sustained effort at public health injury mitigation strategies in the pre-hospital environment, identifying high priority areas for injury prevention, trauma systems performance improvement as well as opportunities for advancements in research and development.			
Major Task 1: Steering Committee analysis and results dissemination planning	Months	Completion Date	% Complete
Subtask 1: Work with data core and dissemination of findings (abstracts, presentation, publications, DOD, blueprint)	36-42		0%
Milestone Achieved: Dissemination materials produced	42		0%

What was accomplished under these goals?

Obj 1: Develop a framework and methodology for evaluating (i) the causes and pathophysiologic mechanisms of pre-hospital deaths; (ii) the appropriateness of EMS response and care delivered; and (iii) the potential for survivability under both optimal clinical circumstances and within the context of the actual pre-hospital environment.

Major Task 1: Adapt Protocol for Submission and Determination
Progress: Completed in Year 1

Major Task 2: Development of the Review Criteria
Progress: Completed in Year 1

Obj. 2: Organize and standardize a multidisciplinary, multi-institutional network of experts who will apply the methodology

- The current MIMIC review team consists of eighty reviewers from various disciplines including trauma surgery, pediatric trauma surgery, orthopedic surgery, neurosurgery, forensic pathology, prehospital care, EMS, and trauma systems. Representatives from both military and civilian sectors are represented on each review team. All MIMIC reviewers completed a survey via SurveyMonkey. The goal of the survey was to collect demographic and background information from each reviewer to ensure that we created multidisciplinary, multi-institutional, and diverse team compositions. The study team creates 13 team panels. Each panel has 6 team members: four surgeons, one Emergency Medicine/EMS member, and one Forensic member.

Major Task 1: Provide training to Study Group members
Progress: All reviewers completed training through various opportunities in Year 2.

Subtask 1: Hold series of meetings by teleconference

- Study team meets ongoing with reviewers who have questions or need additional training regarding case reviews and adjudication.

Obj. 3: Using the methodology and network of experts, define the causes and pathophysiologic mechanisms of 3,000 pre-hospital deaths.

- Data requests have been submitted to receive NEMSIS data from each of the six states for cases in the MIMIC study that had an EMS intervention.
  -Oklahoma NEMSIS data was received on **17-Jun-2019**
  -Maryland NEMSIS data was received on **15-Sept-2020**
  -Washington DC will be received in April 2021.
  -Connecticut will be received in June 2021.
  -New Mexico request is pending internal review.
  -Iowa request was initially designed, but we were asked to resubmit in the Spring 2020. The case number requested of matching will not impact project if approval is not obtained. Iowa ME office was able to provide very thorough data. EMS data is aimed at providing additional information.

Major Task 1: Abstract data for all cases and enter into REDCap
Progress: All six Medical Examiner sites completed case abstraction in Year 3. GIS coding of all cases was also completed in Year 3. AIS coding, and ICD coding continues to be entered.

Subtask 1: Perform AIS coding

- As of **March 2021,** AIS and ICD coding has been completed for all cases.

Major Task 2: Develop Profiler Review System to Conduct Online Case Reviews
Subtask 1: Develop Profiler Review System

- Development was completed and all Profiler changes were finalized in Year 2

Subtask 2: Conduct Profiler System Testing

- Progress: The development of the Profiler system was completed in Year 2 and has been successfully running. System testing occurs on an ongoing basis. The Profiler development team works closely with the MIMIC study team to ensure that reviewers are able to complete initial case reviews, and online adjudication reviews through a seamless online process. Ongoing edits are incorporated into the Profiler system to improve user experience. The study team is available to present the Profiler review system. Please let us know if you would like us to provide a demo in-person, or via webinar.

Major Task 3: Perform online mortality reviews

Progress: Case reviews are currently in progress by all 13 review team panels. To date, 1,750 cases have been sent out to reviewers to determine survivability. Cases are being launched by panel in a rolling timeline. The dates below indicate when the first panel was released for each round. During the review process, we have included online case adjudication for cases that do not meet initial consensus. At the time of this report, 1,750 cases have been released to panels for review. Out of those cases, 1,363 cases have reached consensus, 54 cases are still under adjudication, 75 cases have been pushed to an outside adjudication team for further review, and 258 cases are still pending initial review.

Subtask 1: Disseminate Cases to review Team Monthly

- Round 1 cases were launched. 16-Jan-2019
- Round 2 cases were launched. 22-March-2019
- Round 3 cases were launched. 13-Jun-2019
- Round 4 cases were launched. 27-Sept-2019
- Round 5 cases were launched. 16-Jan-2020
- Round 6 cases were launched. 27-Jul-2020
- Round 7 cases were launched. 21-Sept-2020
- Round 8 will be launched Spring 2021
- Round 9 will be launched Summer 2021
- Round 10 will be launched Fall 2021

Obj. 4: Describe the epidemiology of pre-hospital mortality in the context of trauma system development and estimate its impact on society. The societal impact of pre-hospital deaths will be measured in terms years of potential life lost and lost productivity. Most important, estimates of potential cost savings will be derived based on the analysis of potential survivability.

Major Task 1: Data Analysis

Progress: Since all cases have now been abstracted, Johns Hopkins University has begun running preliminary data analysis. The study team has also developed data quality strategies that have been implemented to clean up data.

Subtask 1: Coordinate with Sites & Data Core for monitoring data collection and data quality

- Data quality checks are complete.

Subtask 2: Perform all analyses according to specifications, share output and finding with all investigators

- Preliminary data findings have been shared with the MIMIC study group. A publication is being finalized for submission to the Journal of Trauma & Acute Care Surgery.

Obj. 5: Develop a blueprint for a sustained effort at public health injury mitigation strategies in the pre-hospital environment, identifying high priority areas for injury prevention, trauma systems performance improvement as well as opportunities for advancements in research and development.

Major Task 1: Steering Committee analysis and results dissemination planning
Subtask 1: Work with data core and dissemination of findings

- Progress: No progress at the time of this report

What opportunities for training and professional development has the project provided?

Nothing to Report

How were the results disseminated to communities of interest?

Nothing to Report

What do you plan to do during the next reporting period to accomplish the goals?

- Upload additional EMS data for New Mexico, Iowa (NEMSIS data match)
- Continue working on case reviews
- Continue working on case adjudication
- Submit program process methods paper
- Submit GIS paper on NEMSIS data analysis

4. IMPACT:

What was the impact on the development of the principal discipline(s) of the project?

Nothing to Report

What was the impact on other disciplines?

Nothing to Report

What was the impact on technology transfer?

Nothing to Report

What was the impact on society beyond science and technology?

Nothing to Report

5. CHANGES/PROBLEMS:

Changes in approach and reasons for change

Actual or anticipated problems or delays and actions or plans to resolve them

The project has experienced a moderate slow down of case reviews since reviewers have been focused on the COVID-19 crisis. The project team has begun to see more activity from the review team in completing case reviews. The project team continues to work on data cleaning, coding, and publications during this time.

Changes that had a significant impact on expenditures

Nothing to Report

Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents

Significant changes in use or care of human subjects

Not applicable

Significant changes in use or care of vertebrate animals

Not applicable

Significant changes in use of biohazards and/or select agents

Not Applicable

6. PRODUCTS:

- **Publications, conference papers, and presentations**

- C. Lizette Villarreal, MA, Nicolas W. Medrano, MS, Craig M. Remenapp, MS, Zebin Wang, ScM, Ellen J. MacKenzie, PhD, Kurt B. Nolte, MD, Michelle A. Price, PhD, Brian J. Eastridge, MD, MIMIC Study Group. Evaluating Inter-rater Reliability When Determining Pre-hospital Injury Survivability. Poster presentation at the 2020 U.S. Military Health System Research Symposium (posted online).

- Instituting a Multi-disciplinary Review Team to Determine Pre-Hospital Injury Survivability After Traumatic Injury. Notified that abstract was wait listed for 2020 APHA Conference.

- Presentation titled Geographic Information System (GIS) Research in Trauma. Presentation to UT Trauma Think Tank Meeting in San Antonio, Texas. **May-2020** https://storymaps.arcgis.com/stories/00b2884faf5648fe899c3018fb3d5e74

- Nicolas W. Medrano MS, Cynthia L. Villareal MA, Michelle A. Price PhD., Brian J. Eastridge MD, MIMIC Study Group. Statewide system-based geographic approach to trauma care access. Abstract presented as poster presentation to the 2020 AAST conference, September 2020 (virtual conference).

- Nicolas W. Medrano MS, Cynthia L. Villareal MA, Michelle A. Price PhD., Brian J. Eastridge MD, MIMIC Study Group. Statewide system-based geographic approach to trauma care access. Graphic posted online at the ESRI 2020 User Conference (virtual conference).

- C. Lizette Villarreal, MA, Nicolas W. Medrano, MS, Craig M. Remenapp, MS, Zebin Wang, ScM, Ellen J. MacKenzie, PhD, Kurt B. Nolte, MD, Michelle A. Price, PhD, Brian J. Eastridge, MD, MIMIC Study Group. Evaluating Inter-rater Reliability When Determining Pre-hospital Injury Survivability. Presented by Dr. Brian Eastridge at the 2020 Military City USA Trauma Collaborative Research Conference (virtual conference).

- C. Lizette Villarreal, MA, Nicolas W. Medrano, MS, Craig M. Remenapp, MS, Zebin Wang, ScM, Ellen J. MacKenzie, PhD, Kurt B. Nolte, MD, Michelle A. Price, PhD, Brian J. Eastridge, MD, MIMIC Study Group. Examining Differences In Injury Survivability Determinations Between Medical Examiners and Trauma Surgeons Evaluating Pre-hospital Trauma Deaths. Platform presentation at the 2020 National Association of Medical Examiner Conference (virtual conference).

- MIMIC presentation at the “What is CNTR?” webinar hosted by the Coalition for National Trauma Research in November 2020.

Journal publications.

Nothing to report

Books or other non-periodical, one-time publications.

Nothing to report

Other publications, conference papers and presentations.

Nothing to Report

- **Website(s) or other Internet site(s)**

Nothing to Report

- **Technologies or techniques**

Nothing to Report

- **Inventions, patent applications, and/or licenses**

Nothing to Report

- **Other Products**

  - Nothing to Report

7. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

What individuals have worked on the project?

Personnel	***Role***	***Percent Effort***
Brian Eastridge	PI	20%
Amy Flores	Controller	10% Mar-Sep 2020 5% Oct-Dec 2020
Lizette Villarreal	Program Manager	85% Mar 2020 65% Apr-Jun 2020 70% Jul-Aug 2020 50% Sep-Dec 2020 30% Jan-Mar 2021
Michelle Price	Research Director	5% Mar 2020-Mar 2021
Nick Medrano	GIS Analyst	100% Mar-Dec 2020 95% Jan-Mar 2021
Ana Guerrero	Executive Assistant	10% Mar-Dec 2020 5% Jan-Mar 2021

New Mexico Subaward	***Role***	***Percent Effort***
Kurt B. Nolte	PI/Co-I	17%
Johns Hopkins University subaward	***Role***	***Percent Effort***
Ellen Mackenzie	PI/Co-I	14%
Daniel Scharfstein	Lead Statistician	5%
Craig Remenapp	Study Manager	25%
Zebin Wang	Research Assistant	10% Mar 2020-Dec 2020
Elias Weston-Farber	Research Assistant	20%

Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?

Nothing to Report

What other organizations were involved as partners?

The six states below have contributed death data to the project for the total review of 3,000 prehospital death cases.

Organization Name	Location of Organization	Contribution to the Project
Oklahoma Office of the Medical Examiner	901 North Stonewall Oklahoma City, OK 73117	Death data
Washington DC Office of the Medical Examiner	401 E. Street SW Washington, DC 20024	Death data
Maryland Office of the Medical Examiner	900 W. Baltimore Street Baltimore, MD 21223	Death data
New Mexico Office of the Medical Examiner	1101 Camino de Salud NE Albuquerque, NM 87102	Death data
Iowa Office of the Medical Examiner	5244C Roy Carver Pavilion Iowa City, IA 52242	Death data
Connecticut Office of the Medical Examiner	11 Shuttle Road Farmington, CT 06032	Death data

8. SPECIAL REPORTING REQUIREMENTS

COLLABORATIVE AWARDS:

QUAD CHARTS:

Quad Chart Attached

9. APPENDICES:

- Copies of the 8 Products/Reportable Outcomes are attached.

Multi-institutional Multidisciplinary Injury Mortality Investigation in the Civilian Pre-Hospital Environment (MIMIC)

BA150629
W81XWH-17-2-0010

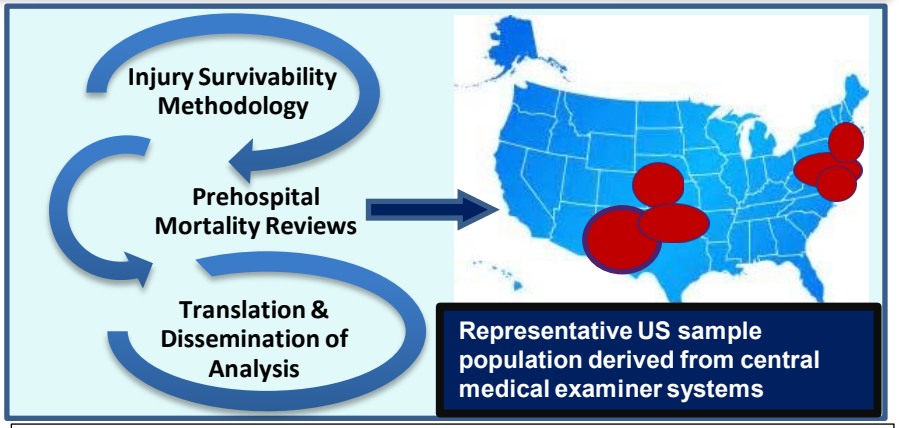
PI: Brian Eastridge **Org:** National Trauma Institute **Award Amount:** $3,979,380

Study/Product Aim(s)

- Develop a framework and methodology for evaluating (i) the causes and pathophysiologic mechanisms of pre-hospital deaths; (ii) the appropriateness of EMS response and care delivered; and (iii) the potential for survivability under both optimal clinical circumstances and within the context of each individual injury event.
- Develop a blueprint for a sustained effort at public health injury mitigation strategies including injury prevention, trauma systems, and acute care.

Approach

The framework and methodology will be established by a multi-institutional network of experts who will apply the methodology in review and analysis of approximately 3,000 pre-hospital death cases at six Medical Examiner sites including those serving urban, rural, and frontier environments.



Accomplishment: Study case reviews by all 13 team panels consisting of eighty reviewers was launched in January 2019. To date, the project is currently completing Round 7 of 10.

Timeline and Cost

Activities CY	17	18	19	20-21
Adapt Protocol for Submission; Develop review criteria				
Provide training to reviewers; Abstract data				
Perform mortality reviews; Data analysis				
Analysis and results dissemination				
Estimated Budget ($K)	**$1,026**	**$1,198**	**$1,225**	**$546**

Updated: (18 April 2021)

Goals/Milestones

CY17 Goal – Methodology determined, reviewers trained, data abstraction and reviews begin
☑ Protocol submitted; methodology determined
CY18 Goals – Virtual Reviews commence
☑ Data abstraction
☑ Reviews in progress
CY19 Goal – Virtual Reviews continue
☑ Data abstraction
☑ Reviews in progress
CY20-21 Goal – Data analysis, result dissemination
☑ Reviews and adjudication in progress
☐ Report results from data analysis and dissemination materials produced

Comments/Challenges/Issues/Concerns

- Review slow down due to COVID-19, but has started to pick back up

Budget Expenditure to Date

- Projected Expenditure: $3,994,076
- Actual Expenditure: $3,449,452 (as of 03-19-21)

Title: Evaluating Inter-rater Reliability When Determining Pre-hospital Injury Survivability

MHSRS 2020
Presenter: Dr. Brian Eastridge
Session: Planning Early for Deployability & Survivability

Authors:
C. Lizette Villarreal, MA[1], Nicolas W. Medrano, MS[1], Craig M. Remenapp, MS[2], Zebin Wang, ScM[2], Ellen J. MacKenzie, PhD[2], Kurt B. Nolte, MD[3], Michelle A. Price, PhD[1], Brian J. Eastridge, MD[4], MIMIC Study Group

1 Coalition for National Trauma Research; San Antonio, Texas
2 Johns Hopkins University Bloomberg School of Public Health; Baltimore, Maryland
3 University of New Mexico School of Medicine; Albuquerque, New Mexico
4 University of Texas Health Science Center at San Antonio; San Antonio, Texas

Background: The Multi-Institutional Multi-Disciplinary Injury Mortality Investigation in the Civilian Pre-Hospital Environment (MIMIC) study developed a multi-disciplinary review team to provide subject matter expertise-based survivability determinations on approximately 3,000 civilian pre-hospital trauma death cases in the United States. The objective of the study is to characterize the causes of mortality from trauma in the pre-hospital setting and identify potential high yield areas for research and development in pre-hospital medical care, injury prevention, and trauma systems. The study sites include New Mexico, Oklahoma, Connecticut, Maryland, District of Columbia, and a region of Iowa. The composite review team was divided into thirteen team panels composed of relevant disciplines including trauma surgery, neurosurgery, orthopedic surgery, forensic pathology, forensic nursing, radiology and emergency medicine. Each panel consists of six members: four surgeons, one emergency medicine physician or EMS provider, and one forensic pathologist reviewer. All panels contain a minimum of two reviewers with military background and experience. *The purpose of this analysis was to determine the inter-rater reliability of survivability judgements for pre-hospital trauma deaths for the MIMIC study.*

Methods: In this preliminary analysis, a total of 1,174 cases were reviewed for potential survivability by review team panels. Data available for survivability determinations include medical examiner autopsy data, imaging reports, field investigator reports, injury codes (Abbreviated Injury Scale/AIS), geospatial data (injury location, EMS location/response time, location/time to nearest trauma center) and EMS data. The study sample includes various injury types such as penetrating, blunt, explosive, and thermal injuries.

The cases were reviewed as excerpts from salient data from individual case files in an online review system known as Profiler. This review system was developed for the MIMIC study as a method for conducting online case reviews. DoD lexicon guidance was utilized to refine trauma terms and definitions in determining survivability. For the MIMIC study, each reviewer made a determination for the potential for survivability under two scenarios 1) **optimal clinical circumstances**: with ***immediate access*** to care at a level I trauma center and 2) **within the context of the scenario**: ***given the conditions*** of the actual scenario in which the injury occurred.

Survivability definitions included 1) Non Survivable: death as a result of catastrophic injuries, 2) Potentially Survivable: anatomic Injuries that were severe but medically survivable, 3) Definitely

Survivable: minimal anatomic injuries with a high likelihood of survival, and 4) Cannot Judge: information insufficient to make a determination. For this study, medically Non Survivable injuries were characterized as follows: dismemberment/decapitation, traumatic brain evisceration, cervical cord transection (above C3), 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 tissue injury, and massive pulmonary tissue disruption.

The survivability determination of five reviewers was then utilized to determine consensus. The survivability determination of the forensic pathologist is not calculated in consensus as this analysis is kept separate. In order to justify consensus, three or more reviewers must answer the same on one specific category. Two caveats to consensus are 1) if one reviewer selects Non Survivable and the other four select either Potentially Survivable, Definitely Survivable, or Cannot Judge, that case goes to adjudication or 2) if two reviewers select Cannot Judge, but the other three are able to make a determination, the case goes to adjudication.

Once all five reviewers have reviewed each case, consensus determination was made. Consensus had to be reached for both survivability scenario questions. Cases that did not reach consensus were pushed out for online adjudication within the team panel. The reviewers used the Profiler system to conduct an online discussion on points to consider, personal experiences, and relevant facts from the case to educate each other in an attempt to reach consensus. These discussions drove reviewers to adjust their responses toward consensus, or if the reviewers could not reach consensus, the case was pushed to an outside adjudication team for further review.

Results: As of April 1, 2020, 1,174 cases have been released to panels for review. Out of those cases, 815 cases have reached consensus, 82 cases are still under adjudication, 42 have been pushed to an outside adjudication team for further review, and 235 cases are still pending initial review. For cases that have reached consensus, 703 (86%) cases reached consensus in the first round, while the remaining 112 (14%) cases required adjudication. Survivability determinations were calculated to assess overall consensus agreement. For cases that reached consensus, when evaluating cases under *optimal clinical circumstances with immediate access*, 82% (n=669) Non Survivable, 16% (n=134) Potentially Survivable, and 1% (n=12) were Definitely Survivable. When evaluating the same set of cases *within the context of the scenario given the conditions of the actual scenario*, 97% (n=787) were Non Survivable, and 3% (n=28) were Potentially Survivable. Survivability was also analyzed based on reviewer type classified as surgeon, emergency medicine, or forensic pathologist reviewer to assess agreement between reviewer type. When reviewing consensus based on *immediate access*, the data showed minimal variability between surgeons and emergency medicine reviewers. A greater level of variability occurred between forensic reviewers and other types of reviewers. Forensic pathologists determined that 81% of the cases were Non Survivable, 13% Potentially Survivable, 2% Definitely Survivable, and 4% Cannot Judge. Emergency Medicine reviewers determined that 75% of cases were Non Survivable, 20% Potentially Survivable, 4% Definitely Survivable, and 1% Cannot Judge. Lastly, Surgeons determined that 72% of the cases were Non Survivable, 23% Potentially Survivable, 3% Definitely Survivable, and 2% Cannot Judge. There was almost no variability between reviewer type when reaching consensus *given the conditions of the actual scenario*. The three leading causes of death for cases determined to be Non Survivable were traumatic brain injury, hemorrhage-truncal thorax, and neurological-spinal cord. The leading causes remained the same when considering both immediate access and given the conditions. Most of the cases that did not reach consensus on the first round were cases where TBI was involved. Based on the assessments of those 112 cases, TBI was the leading cause of death with 23% of the responses.

Conclusion: A uniform structured injury mortality review process is vital to understanding patterns of pre-hospital trauma mortality in order to identify opportunities to improve trauma systems. Creating a diverse team of professionals allows for a broader discussion on potentially survivable deaths. This data demonstrates significant consistency amongst multispecialty reviewers in making prehospital injury survivability determinations. The MIMIC study has developed a coordinated, multi-disciplinary, multi-institutional process to identify and characterize the causes of mortality from trauma in the pre-hospital setting and to identify potential high yield areas for research and development in pre-hospital medical care, injury prevention, trauma systems and public health. Utilizing the expertise of national experts serving as MIMIC team panel reviewers, this study will serve to advance the science and its military impact.

Learning Objectives:

1. Describe the consensus definitions used by review team members, and the process of case adjudication when consensus is not reached on initial review.
2. Discuss the importance of including multidisciplinary experts in survivability determinations and visualize the process in making a survivability determination.
3. Analyze the inter-rater reliability amongst review team members in determining consensus on survivability determinations.

Acknowledgement Statement

The U. S. Army Medical Research Acquisition Activity, 820 Chandler Street, Fort Detrick MD 21702-5014 is the awarding and administering acquisition office. This work was supported by the Office of the Assistant Secretary of Defense for Health Affairs, through the Defense Medical Research and Development Program under Award No. W81XWH-17-2-0010. Opinions, interpretations, conclusions and recommendations are those of the author and are not necessarily endorsed by the Department of Defense.

Cannot insert tables in abstract

Table 1: Survivability Determinations On All Cases that Reached Consensus				
	Non Survivable	**Potentially Survivable**	**Definitely Survivable**	**Cannot Judge**
Assuming Immediate Access	669 (82%)	134 (16%)	12 (1%)	0 (0%)
Assuming actual conditions	787 (97%)	28 (3%)	0 (0%)	0 (0%)

Table 2: Survivability Determinations On All Cases that Reached Consensus By Reviewer Type				
	Non Survivable	**Potentially Survivable**	**Definitely Survivable**	**Cannot Judge**
Forensic Pathologist	493 (81%)	81 (13%)	11 (2%)	22 (4%)
Emergency Medicine/EMS	614 (75%)	162 (20%)	35 (4%)	4 (0%)
Surgeon	2341 (72%)	766 (23%)	90 (3%)	63 (2%)

Table 3: Leading Causes of Death for Cases Determined to be Non Survivable		
Cause of Death	**Optimal clinical Circumstances (Immediate Access)**	**Within the context of the scenario (Given the conditions)**
Neurological - traumatic brain injury	2420	2671
Hemorrhage - truncal: thorax	731	952
Neurological - spinal cord	342	411

Your Abstract Submission Has Been Received

Instituting a multi-disciplinary review team to determine pre-hospital injury survivability after traumatic injury

C. Lizette Villarreal, MA[1], Nicolas W. Medrano, MS[1], Craig Remenapp, MS[2], Ellen MacKenzie, PhD[2], Kurt B. Nolte, MD[3], Michelle A. Price, PhD[1] and **Brian J. Eastridge, MD**[4], (1)National Trauma Institute, San Antonio, TX, (2)Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, (3)Office of the Medical Investigator, Albuquerque, NM, (4)University of Texas Health Science Center San Antonio, San Antonio, TX

Abstract:

Introduction: The Multi-Institutional Multi-Disciplinary Injury Mortality investigation in the Civilian Pre-Hospital Environment (MIMIC) study developed a multi-disciplinary review team process to provide subject matter expertise-based survivability determinations on 3,000 civilian pre-hospital trauma death cases in the United States.
Methods: A 15 question survey was distributed via SurveyMonkey to MIMIC reviewers. The survey collected demographic and professional information on expertise and clinical background. Survey data were used to create thirteen review teams to determine potential survivability.
Results: The MIMIC Investigator Group consists of 74 reviewers. 70% are surgeons, 18% are emergency medicine or EMS providers, and 12% are forensic pathologists including one forensic nurse. Of these, 77% are male, and 23% are female with an average age of 54 years-of-age. Race breakdown indicated a team composition of 88% White, 4% Asian, 3% Black or African American, 1% American Indian or Alaska Native, and 4% did not report. Thirty six percent of review team members have military experience, and of these over 92% of them were part of a medical unit while in the military. 77% have played a role in their state or local trauma/EMS system. The areas of expertise for reviewers varies, 53% consider prehospital/EMS systems, 61% trauma systems, and 74% hospital-based practice.
Conclusion: A uniform structured injury mortality review process is vital to understanding patterns of prehospital trauma mortality in order to identify opportunities to improve trauma systems. Creating a diverse team of professionals allows for a broader discussion on potentially survivable deaths.

Extended Abstract:
Advances in care in both trauma centers and trauma systems have substantially reduced death and disability associated with injury. However, there remains a substantial opportunity to further reduce deaths in the pre-hospital setting. Potential liabilities in civilian pre-hospital care must be identified and remediated in order to reduce the number of potentially preventable deaths on in the civilian environment.

Several gaps exist in understanding the epidemiology of prehospital trauma deaths. This study aims to connect medical examiner data including autopsy reports, emergency medical service data, injury severity codes, ICD codes, and GIS trauma center access by location of trauma centers and EMS ground and air in each study area. The data is summarized and displayed in an online review system known as “Profiler” where each review team is assigned a set of cases to determine potential for survivability and identify liabilities in trauma systems and identify injury prevention strategies that could have been effective.

A multi-disciplinary, multi-institutional network of subject matter experts in the disciplines of trauma surgery, neurosurgery, orthopedic surgery, emergency medicine, radiology, forensic pathology, forensic nursing, trauma systems, and emergency medical services collaborated upon the development of a consensus taxonomy relative to determination of injury survivability. This framework and methodology were developed for evaluating the causes and pathophysiologic mechanisms of 3,000 pre-hospital deaths; the appropriateness of EMS response and care delivered; and the potential for survivability under both optimal clinical circumstances and within the context of each individual injury event.

We aim to educate the public health community:
• Composition of review team panels and the process for reviewing cases.
• Explore the components and utilization of the Profiler system. Profiler is an electronic data tool that displays all relevant information that was specifically developed for reviewers in order to make informed survivability judgements and record their determinations.
• Review survivability determinations that were used to identify strategies to mitigate prehospital injury mortality in the future.

Title:
Instituting a multi-disciplinary review team to determine pre-hospital injury survivability after traumatic injury

Submitter's E-mail Address:
Lizette@nattrauma.org

Preferred Presentation Format:
Oral Preferred

Related Web Page:
https://www.nattrauma.org/research/ (copy&paste to your browser)

Learning Outcome(s):

Define the composition of MIMIC review team panels and the process for reviewing cases.
Describe the components and utilization of the Profiler system. Profiler is an electronic data tool that displays all relevant information that was specifically developed for reviewers in order to make informed survivability judgements and record their determinations.
Define survivability determinations that were used to identify strategies to mitigate prehospital injury mortality in the future.

Consider for award:
N

Keyword(s):
Methodology, Epidemiology

Learning Areas:
Clinical medicine applied in public health
Epidemiology
Public health or related education
Systems thinking models (conceptual and theoretical models), applications related to public health

Health Indicator(s):
Access to Care and Place matters/geographic location (e.g. Exposure to crime, violence, social disorder, zip code counts, infrastructure (physical), broadband)

External Funding:
Project funded by the Department of Defense

First-time presenter at APHA

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Presenter

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University of Texas Health Science Center San Antonio
Department of Surgery/ Division of Trauma
Professor/ Division Chief
San Antonio TX
USA

Qualified on the content I am responsible for because: As a Professor of Surgery and Chief in Trauma Surgery, I have an extensive background in trauma, with specific training and expertise in pre-hospital injury care, damage control resuscitation and surgery, and trauma systems. My research includes investigation into the causes of pre-hospital injury mortality, remote pre-hospital injury outcomes, and non-compressible torso hemorrhage. As PI on several federally funded grants, I successfully administered projects, collaborated with other researchers, and produced peer-reviewed publications.
Any relevant financial relationships? No
Signed on 02/27/2020 by *Brian Eastridge*

Student? No

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APHA Home page

- Presentation titled Geographic Information System (GIS) Research in Trauma. Presentation to UT Trauma Think Tank Meeting in San Antonio, Texas. **May-2020**

  Presentation can be viewed using the following link: https://storymaps.arcgis.com/stories/00b2884faf5648fe899c3018fb3d5e74

Statewide System-Based Geographic Approach to Trauma Care Access

Medrano NW[1], Villarreal CL[1], Price MA[1], Eastridge BE[2], MIMIC Study Group
Coalition for National Trauma Research[1], The University of Texas Health Science Center at San Antonio[2]

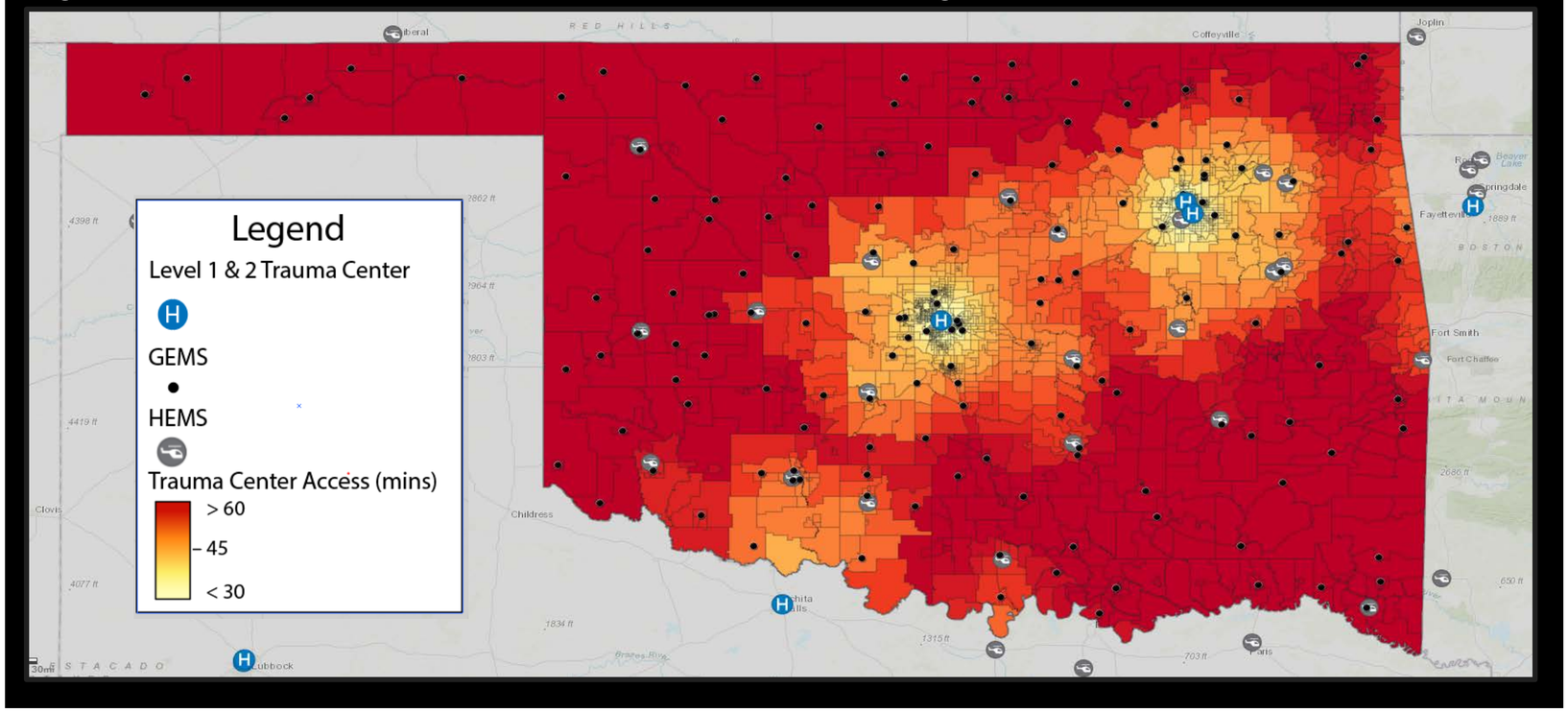
Introduction

The Multi-Institutional Multi-Disciplinary Injury Mortality Investigation in the Civilian Pre-Hospital Environment (MIMIC) study developed a novel geographic information system (GIS) model to estimate total pre-hospital time for emergency medical services (EMS) based upon a specified injury location from forensic records. Our aim was to apply the MIMIC model to statewide populations to estimate trauma center access within the "Golden-Hour" using the *composite pre-hospital interval, from the time the 9-1-1 call was received until arrival at the nearest trauma center.* This includes time taken for the EMS unit to dispatch, response time to the scene, time spent on the scene, and time taken to transport the patient to the nearest trauma center.

Methods

- GIS-based models were built using ArcGIS 10.6 for four states: **Connecticut, Maryland, New Mexico, and Oklahoma**
- These models include ground EMS (GEMS), air EMS (HEMS) and designated level I, II, and III trauma centers for locations within the state and in neighboring state response jurisdictions.
- **Data Locations**: *GEMS locations* were collected from the respective state Departments of Health. *HEMS locations* were obtained from the Atlas and Database of Air Medical Services. *Trauma center locations* were collected from the American Trauma Society Information Exchange Program.
- To calculate ***total pre-hospital ground time***, this trauma system infrastructure was connected to the ArcGIS StreetMap™ Premium traffic network. A previous meta-analysis [1] of pre-hospital care times was added to account for mean dispatch and on-scene times.
- Total pre-hospital air time was calculated using straight-line distance and average cruising speed.
- The model used ***US Census block group population weighted centroids*** to determine the population within 60-minute intervals (Figure 1).

Figure 1: Access to level 1 & 2 trauma centers in Oklahoma using GEMS and HEMS infrastructure



Results

For level 1 & 2 trauma centers, the GEMS model predicted ***Connecticut and Maryland to have the highest coverage rates***, *and* ***New Mexico and Oklahoma to have lower rates of coverage***. When HEMS was integrated with GEMS, all sites had increases in access. Including level 3 trauma centers in analysis showed no increase in accessibility in Connecticut, marginal increases in Maryland and significant increases in accessibility for New Mexico and Oklahoma (Table 1).

Conclusions

This GIS model is the first to analyze trauma center access incorporating the entire pre-hospital interval, utilizing street network traffic data, and the complete trauma system. This approach can be replicated in other states and provides a means to more realistically assess the current state of trauma systems and may aid in future trauma system development.

Table 1. Population accessibility to level trauma centers within 60 minutes.

	Level 1 & 2		Level 1, 2, & 3	
State	GEMS	HEMS	GEMS	HEMS
CT	97.3%	100.0%	97.3%	100.0%
MD	77.8%	96.9%	87.3%	100.0%
NM	40.6%	64.1%	71.4%	87.8%
OK	49.3%	82.6%	74.1%	96.7%

References

Carr BG, Caplan JM, Pryor JP, Branas CC. A Meta-Analysis of Prehospital Care Times for Trauma. Prehospital Emergency Care. 2006;10(2):198-206.

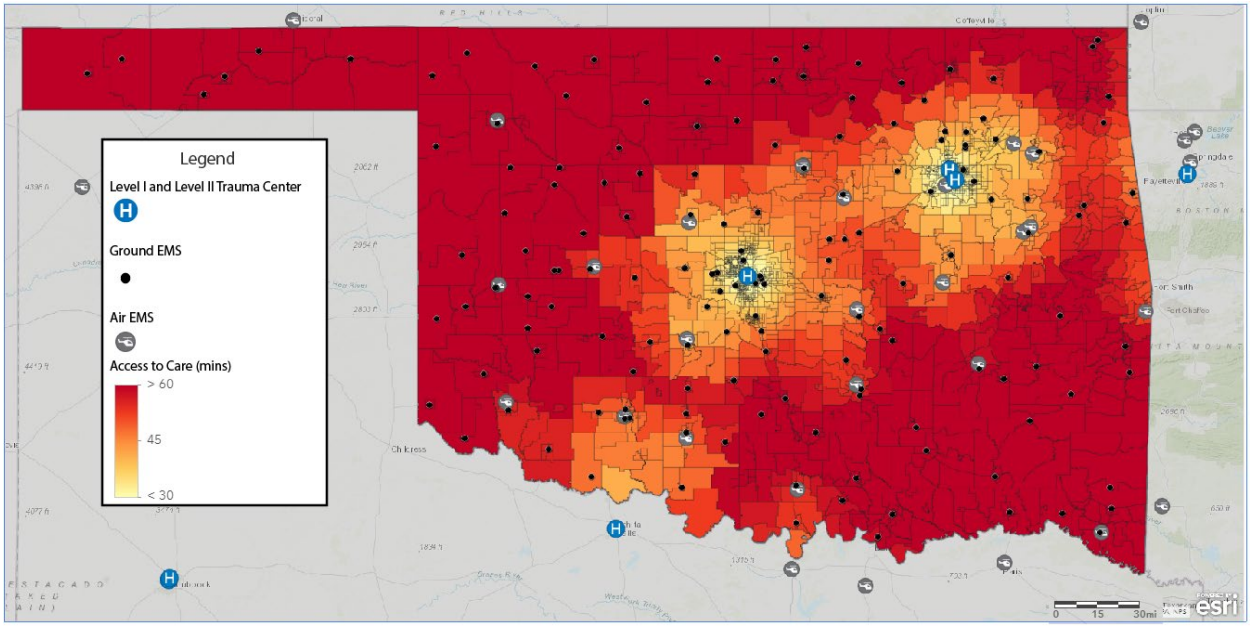
Acknowledgement

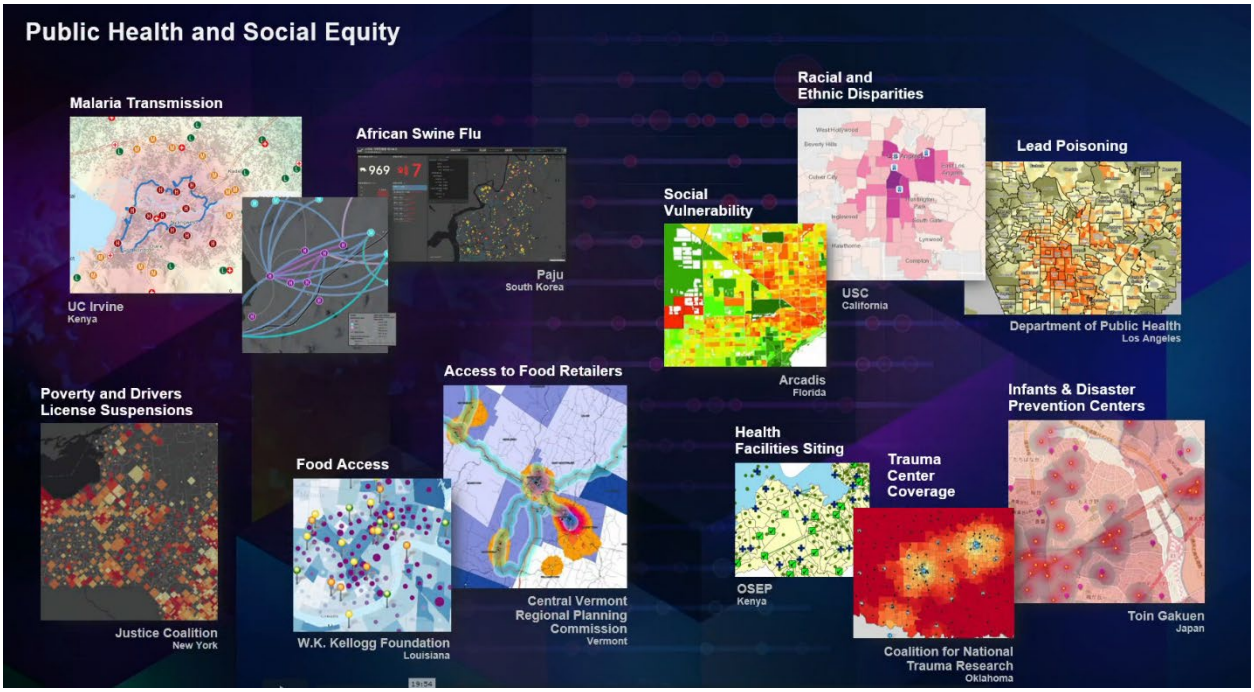
The U. S. Army Medical Research Acquisition Activity, 820 Chandler Street, Fort Detrick MD 21702-5014 is the awarding and administering acquisition office. This work was supported by the Office of the Assistant Secretary of Defense for Health Affairs, through the Defense Medical Research and Development Program under Award No. W81XWH-17-2-0010. Opinions, interpretations, conclusions and recommendations are those of the author and are not necessarily endorsed by the Department of Defense.

ESRI 2020 User Conference

Map shared during plenary session

This statewide system-based approach to trauma care access utilized known level I and II trauma center, ground EMS, and air EMS locations to estimate Oklahoma population access to trauma care. Total pre-hospital time was comprised of four time intervals – activation, response, on-scene, and transport – and was calculated using the Network Analyst and StreetMap Premium dataset. Population centroids by Census Block Group were used to determine overall population access within the "golden-hour," the hour following a traumatic injury during which medical treatment to prevent irreversible internal damage and optimize the chance of survival is most effective. Results show 49.3% and 82.6% of the Oklahoma population have access within one hour utilizing ground and air EMS, respectively. This analysis identified geographic areas lacking immediate access and may aid in trauma system planning. The analysis was completed for three other states (CT, MD, NM) who are participating in the Multi-Institutional Multi-Disciplinary Injury Mortality Investigation in the Civilian Pre-Hospital Environment (MIMIC) study.





Preliminary Analysis of the Multi-institutional Multidisciplinary Injury Mortality Investigation in the Civilian Pre-Hospital Environment (MIMIC)

Military City USA Collaborative Trauma Research Conference
August 26,2020

Brian Eastridge, MD, FACS

Professor, Department of Surgery

Division Chief, Trauma and Emergency General Surgery

Jocelyn and Joe Straus Endowed Chair in Trauma Research

UT Health San Antonio

Disclosures

Grant Support

Office of the Assistant Secretary of Defense for Health Affairs

Defense Medical Research and Development Program

Award No. W81XWH-17-2-0010

Disclaimer

The opinions or assertions contained herein are the private views of the author and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense.

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Background

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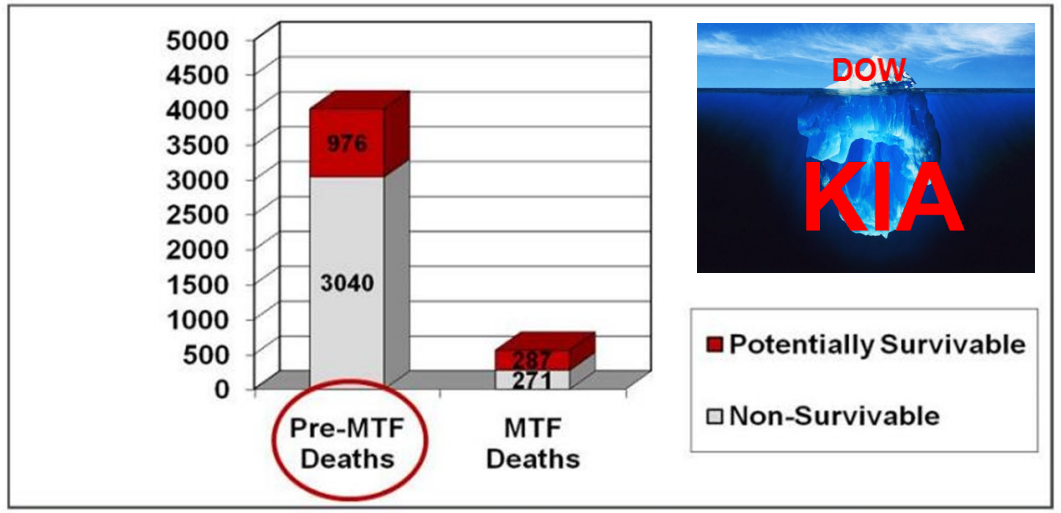
Background/Scientific Rationale
PreHospital Battlefield Mortality

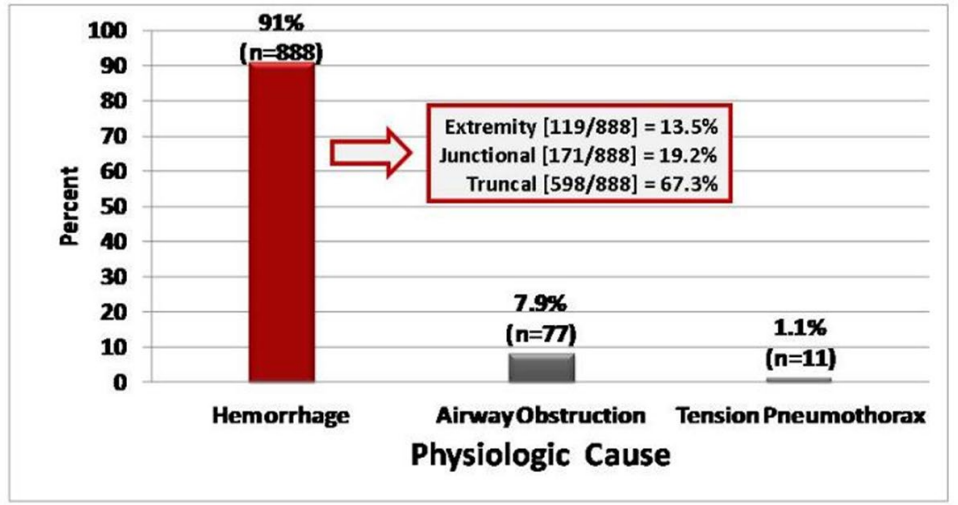
Where Can We Save the Most Lives?



Eastridge BJ, Mabry RL, Seguin PG, et al. Death on the battlefield (2001-2011): implications for the future of combat casualty care. Journal of Trauma 2012, 73(6) Suppl 5: 431-7.

Eastridge BJ, Hardin M, Cantrell J, et al. Died of wounds on the battlefield: causation and implications for improving combat casualty care. Journal of Trauma 2011. 71(Suppl 1):4-8.

What were the Causes of Preventable Death?



Eastridge BJ, Mabry RL, Seguin PG, et al. Death on the battlefield (2001-2011): implications for the future of combat casualty care. Journal of Trauma 2012, 73(6) Suppl 5: 431-7.

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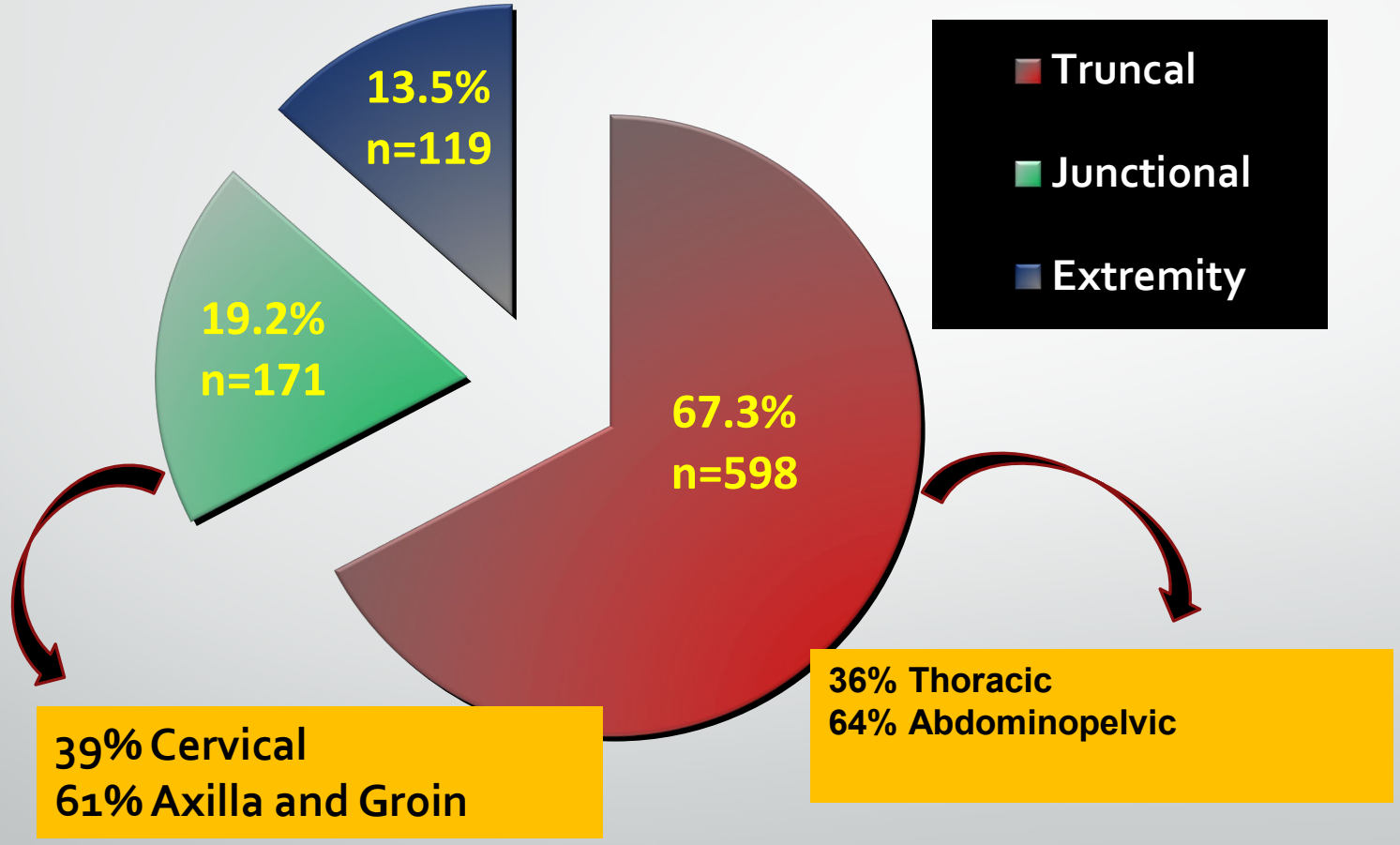
Anatomic / Physiologic Mechanism of Death



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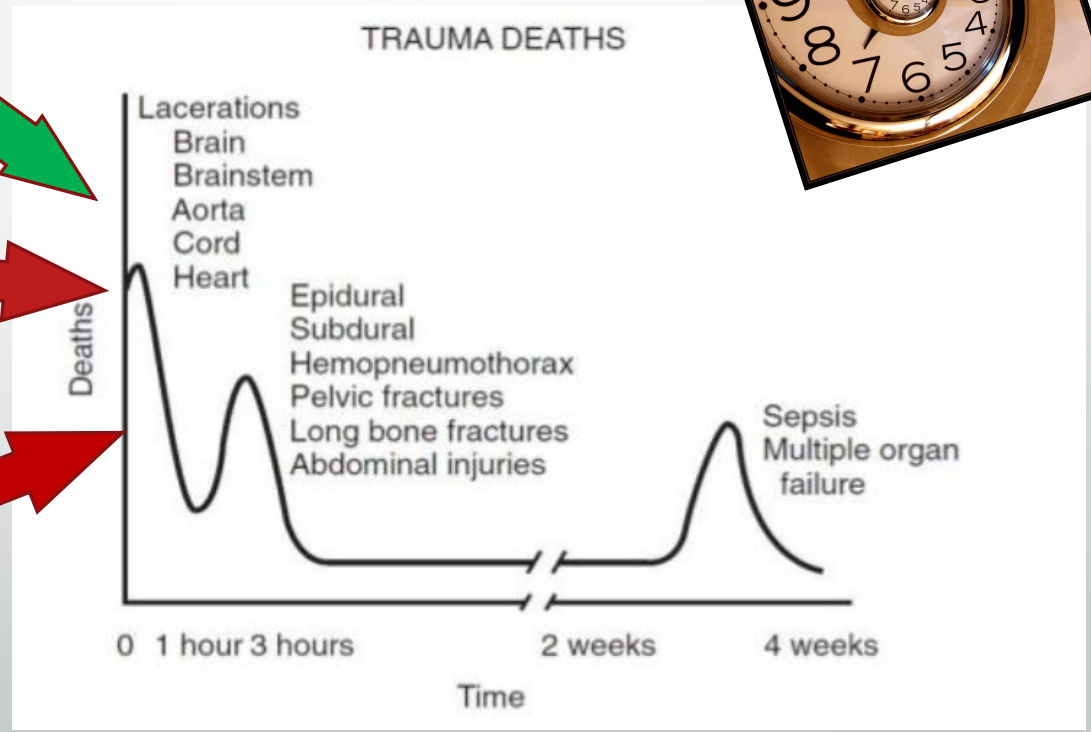
Eastridge BJ, Mabry RL, Seguin PG, et al. Death on the battlefield (2001-2011): implications for the future of combat casualty care. Journal of Trauma, 2012.

Background/Scientific Rationale Pre-Hospital Civilian Mortality

Impact Not Well Quantitated

Potential Survivability Poorly Defined

NASEM Report Emphasis



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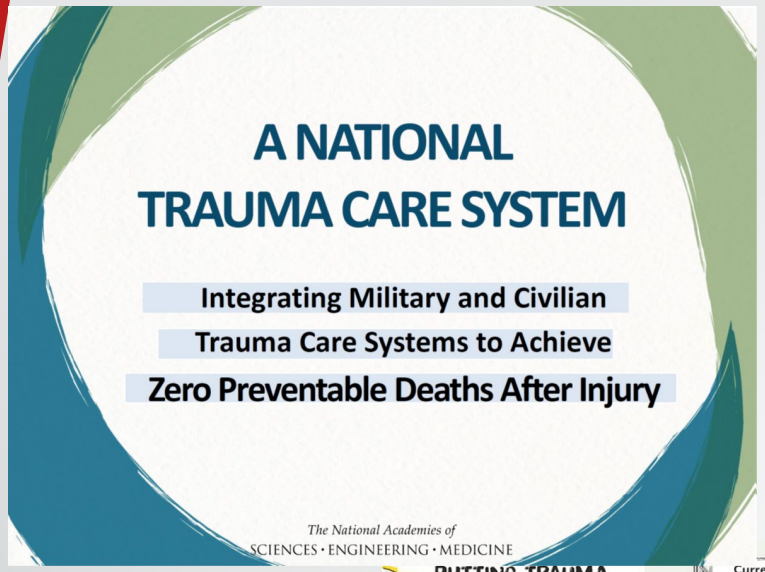

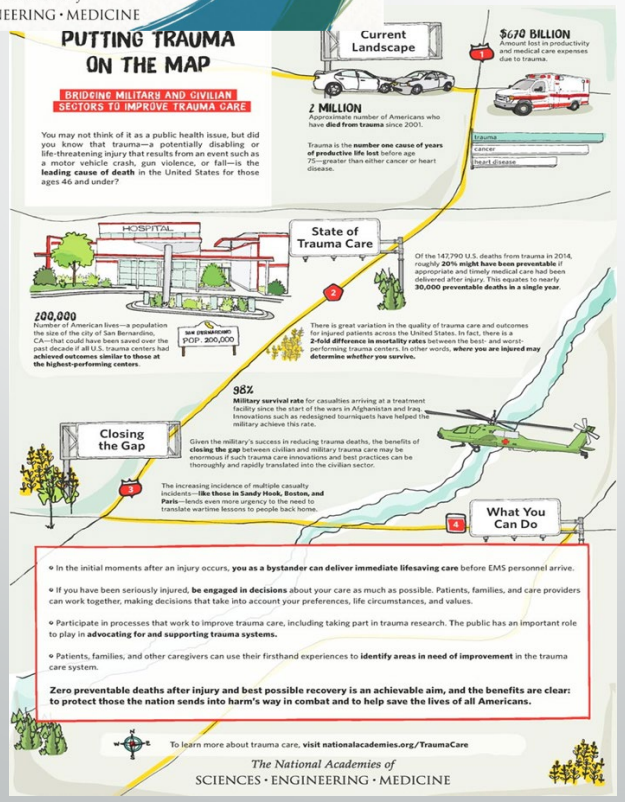

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Potentially survivable injuries US civilian population

147,790 x 0.276 = 40,790

Getting Beyond Estimates

Objective Establishment of the Impact on Society

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Methods

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Multiinstitutional Multidisciplinary Injury Mortality Investigation in Civilian PreHospital Environment

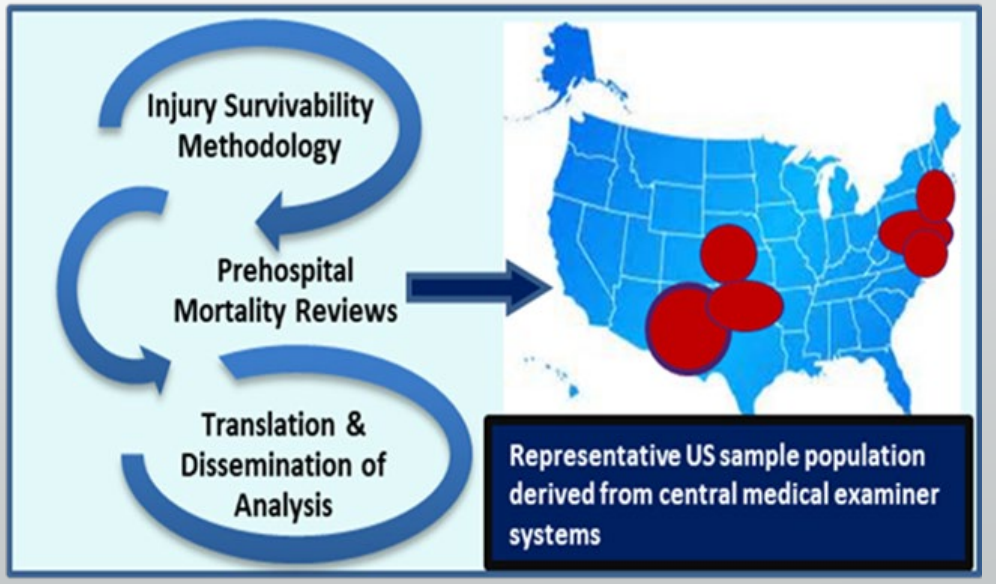
PI:Eastridge
Co-I: Nolte, MacKenzie

Funded by USAMRMC
(Department of Defense)

MIMIC

Purpose of this proposal is to develop a coordinated, multidisciplinary, multi-institutional effort within the civilian clinical sector to identify and characterize the causes of pre-mortality from trauma

Identify potential high yield areas for research and development in pre-hospital medical care, injury prevention, and trauma systems.



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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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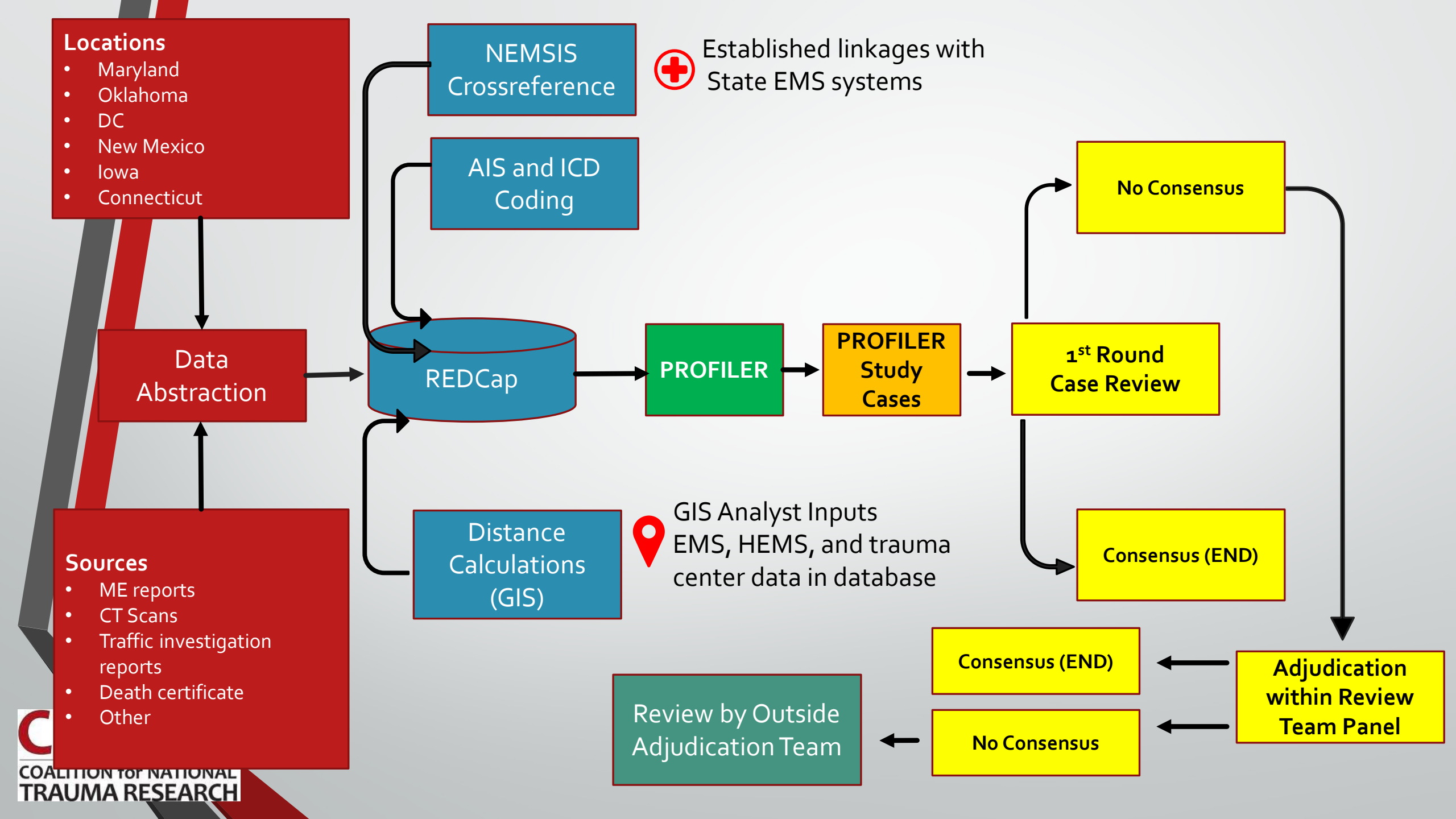
Locations
Maryland
Oklahoma
DC
New Mexico
Iowa
Connecticut
NEMSIS Crossreference
Established linkages with State EMS systems
AIS and ICD Coding
Data Abstraction
REDCap
PROFILER
PROFILER Study Cases
1st Round Case Review
No Consensus
Consensus (END)
Sources
ME reports
CT Scans
Traffic investigation reports
Death certificate
Other
Distance Calculations (GIS)
GIS Analyst Inputs
EMS, HEMS, and trauma center data in database
Adjudication within Review Team Panel
Consensus (END)
No Consensus
Review by Outside Adjudication Team
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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 C3)
- 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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Results

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Preliminary Round 1 and Round 2 Data

Principal Mechanism(s) of Death	Frequency
Massive tissue disruption	146
Neurological – Traumatic Brain Injury	1342
Neurological - Spinal Cord	246
Hemorrhage - Truncal	393
Hemorrhage - Junctional	44
Hemorrhage - Peripheral	38
Airway	79
Traumatic Asphyxia	59
Tension Pneumothorax	32
Burn	133
Electrical	1
Other	84
Unknown	51

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Preliminary Round 1 and Round 2 Data (All Patients)

Immediate Access	Immediate Access (All)	Actual Scenario (All)
Survivable	318 (79.5%)	380 (95.0%)
Potentially Survivable	78 (19.5%)	20 (5.0%)
Definitely Survivable	4 (1.0%)	0 (0.0%)
Cannot Judge	0 (0.0%)	0 (0.0%)

RESEARCH AND DEVELOPMENT OPPORTUNITIES TO INFORM INJURY PREVENTION

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Preliminary Round 1 and Round 2 Data (All Patients)

Immediate Access Survivability	Immediate Access (All)	Actual Scenario (All)
Non-survivable	318 (79.5%)	380 (95.0%)
P… S…	78 (19.5%)	20 (5.0%)
Definitely Survivable	4 (1.0%)	0 (0.0%)
Cannot Judge	0 (0.0%)	0 (0.0%)

OPPORTUNITIES TO IMPROVE CURRENT TRAUMA SYSTEM

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Preliminary Round
(All Pa

RESEARCH AND DEVELOPMENT OPPORTUNITIES TO IMPROVE FUTURE TRAUMA SYSTEMS

Immediate Access Survivability	Immediate Access (All)	Actual Scenario (All)
Non-survivable	318 (79.5%)	380 (95.0%)
Potentially Survivable	78 (19.5%)	20 (5.0%)
Definitely Survivable	4 (1.0%)	0 (0.0%)
Cannot Judge	0 (0.0%)	0 (0.0%)

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Preliminary Round 1 and Round 2 Data (Excluding Suicide)

Immediate Access Survivability	Immediate Access (Excluding Suicide)	Actual Scenario (Excluding Suicide)
Non-survivable	150 (67.9%)	202 (91.4%)
Potentially Survivable	68 (30.8%)	19 (8.6%)
Definitely Survivable	3 (1.4%)	0 (0.0%)
Cannot Judge	0 (0.0%)	0 (0.0%)

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Preliminary Round 1 and Round 2 Data (Excluding Suicide)

Immediate Access Survivability	Immediate Access (Excluding Suicide)	Actual Scenario (Excluding Suicide)
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Definitely Survivable	3 (1.4%)	0 (0.0%)
Cannot Judge	0 (0.0%)	0 (0.0%)

POTENTIALLY PREVENTABLE DEATHS

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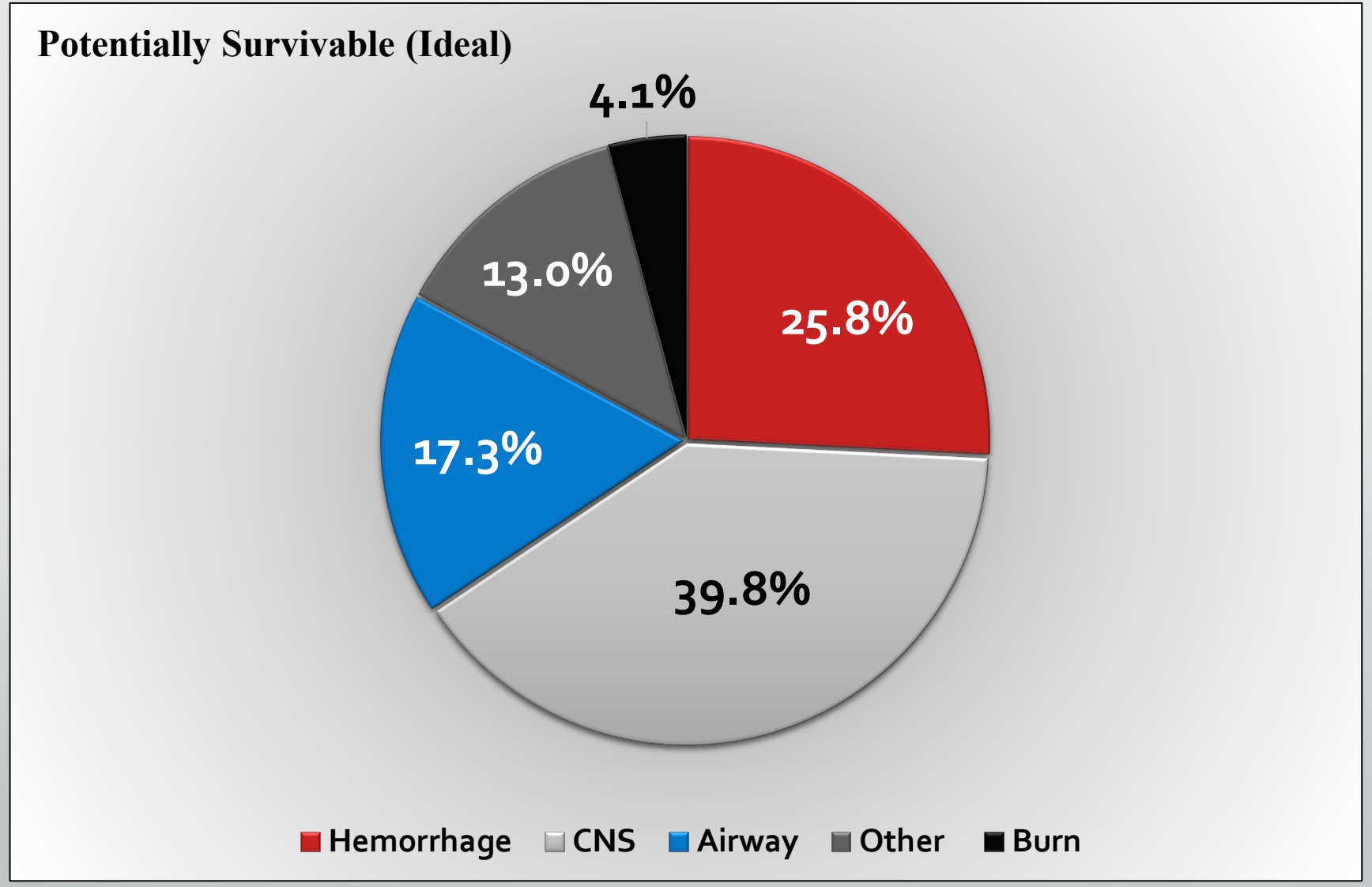
Mechanism of Death (All)
Ideal Circumstance



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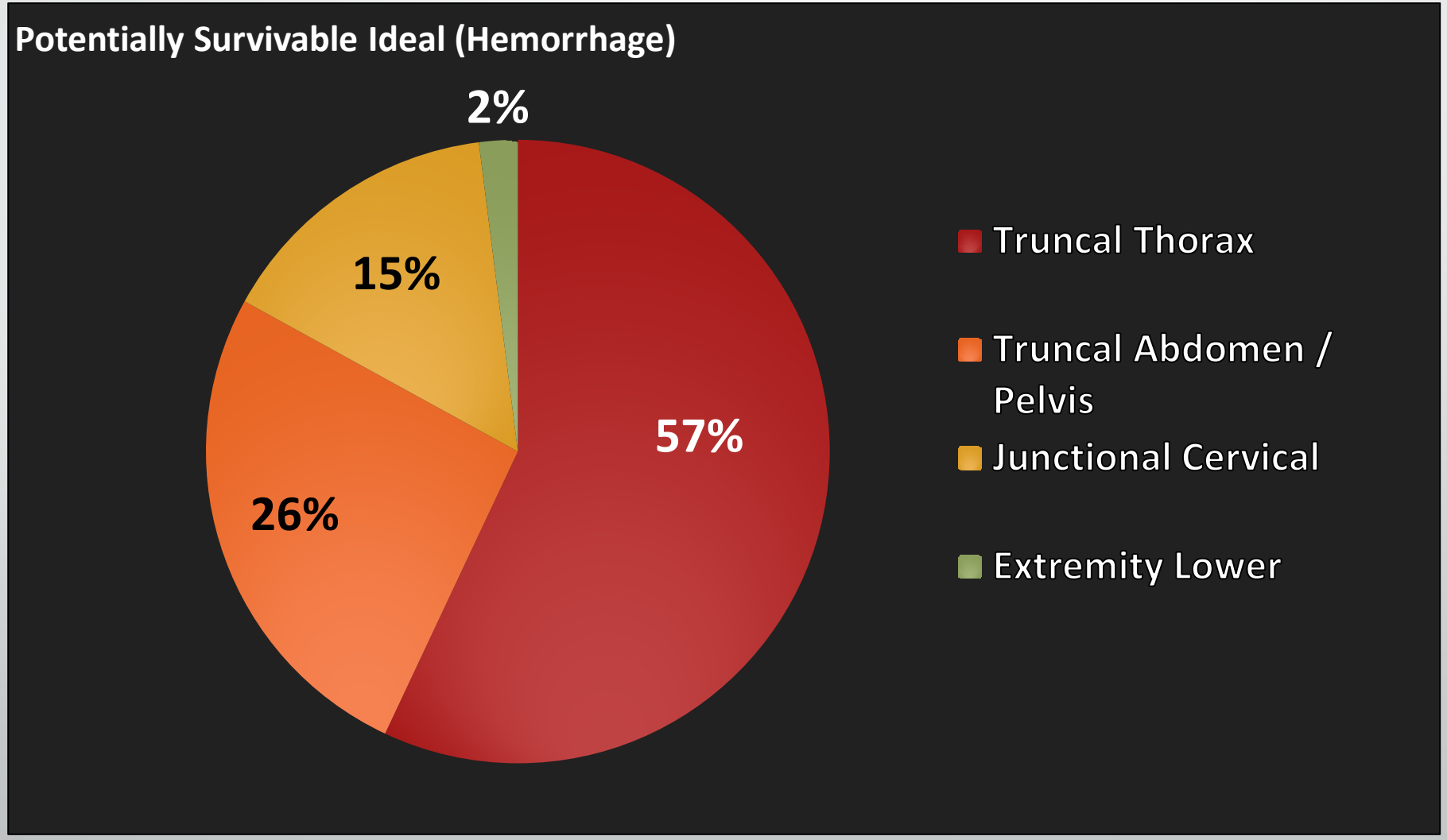
Potentially Survivable (Hemorrhage Focus) Ideal Circumstance



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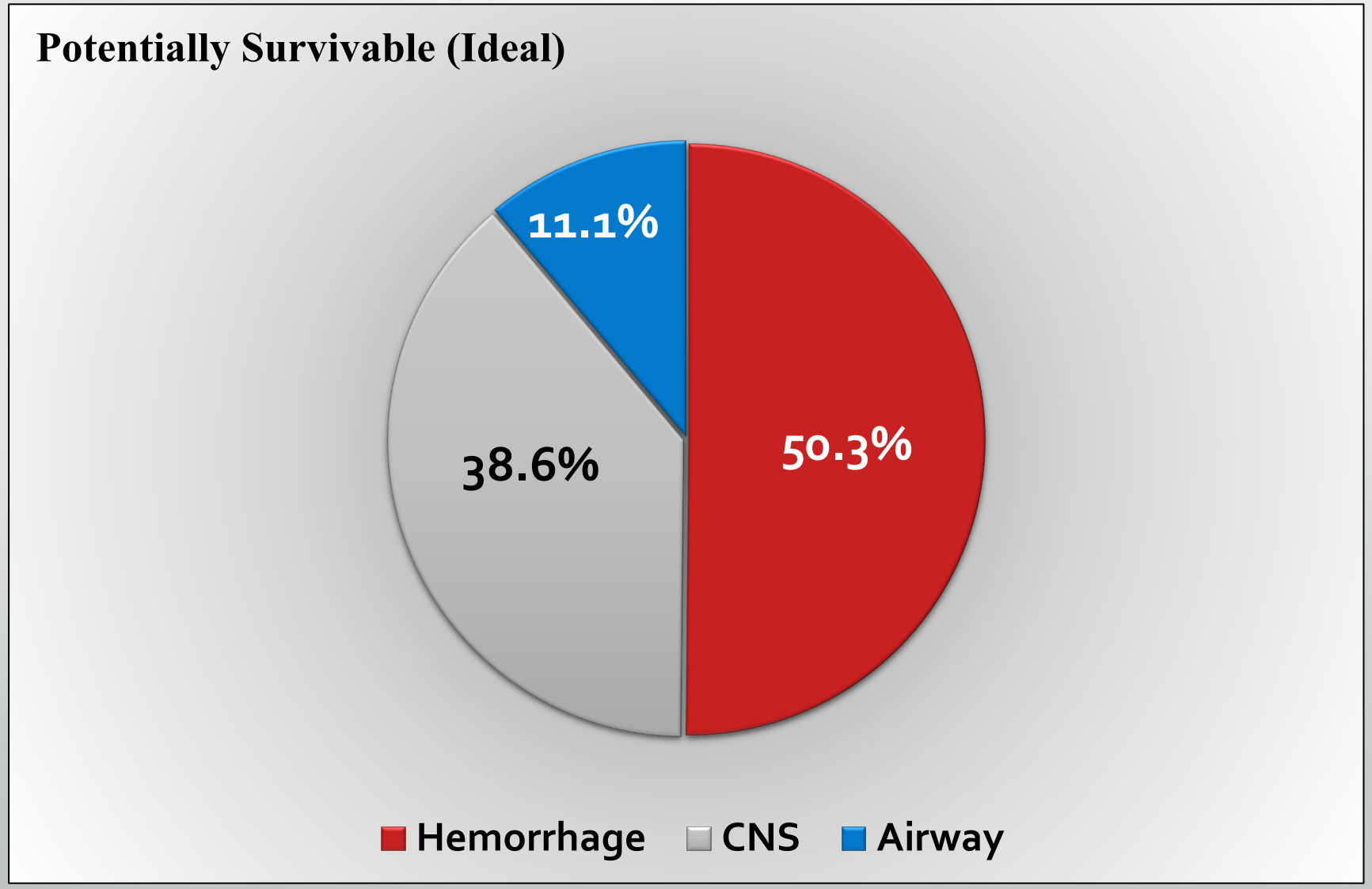
Mechanism of Death (All)
Actual Circumstance



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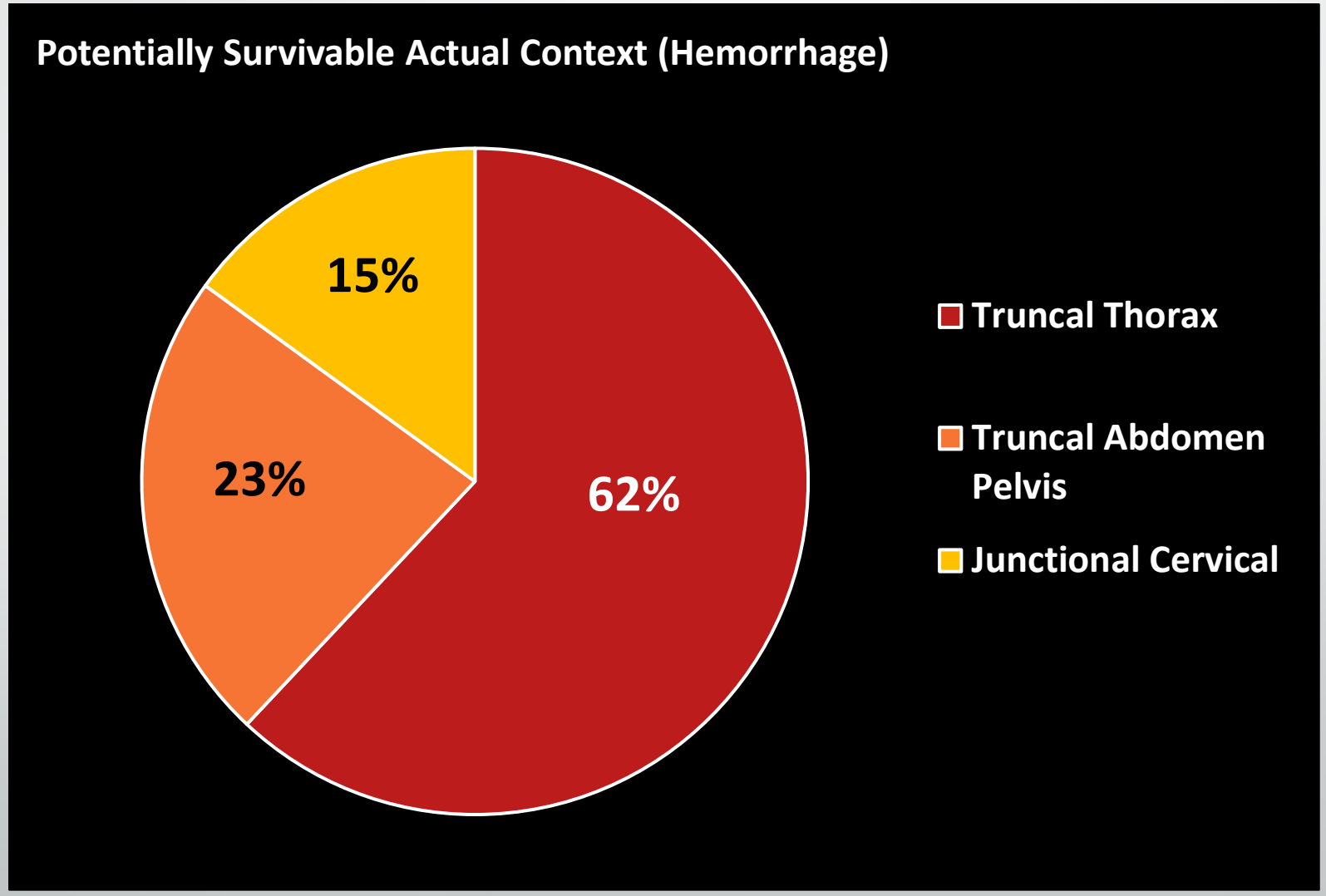
Potentially Survivable (Hemorrhage Focus) Actual Circumstance



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Preliminary Round 1 and Round 2 Data

Injury prevention programs/devices or interventions might have improved the chances of survival

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

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Limitations

- Potential sources of bias
  - Observer bias
  - Misclassification bias
  - Bias relative to consensus rule amongst expert panels
- Heterogeneity medical examiner system processes
- Survivability determinations based upon anatomic injury metrics
  - No consideration additive effects of multiple injuries, age, comorbidities
- Generalizability

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MIMIC Interrater Reliability Analysis

- Mortality reviews
  - 86.8 % consensus
    - 75.5 % primary review
    - 12.2 % secondary online adjudication

Table 1: Survivability Determinations On All Cases that Reached Consensus

	Non Survivable	Potentially Survivable	Definitely Survivable	Cannot Judge
Assuming Immediate Access	669 (82%)	134 (16%)	12 (1%)	0 (0%)
Assuming actual conditions	787 (97%)	28 (3%)	0 (0%)	0 (0%)

Table 2: Survivability Determinations On All Cases that Reached Consensus By Reviewer Type

	Non Survivable	Potentially Survivable	Definitely Survivable	Cannot Judge
Forensic Pathologist	493 (81%)	81 (13%)	11 (2%)	22 (4%)
Emergency Medicine/EMS	614 (75%)	162 (20%)	35 (4%)	4 (0%)
Surgeon	2341 (72%)	766 (23%)	90 (3%)	63 (2%)

Conclusions

- Current assessment provides objective evidence to support a more comprehensive understanding of pre-hospital injury mortality
- Research highlights specific targets for future focus of R&D to improve the pre-hospital management and outcomes of the injured patient
- May be useful in the development and implementation of mitigation strategies for therapy and injury prevention to improve trauma systems

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Examining Differences In Injury Survivability Determinations Between Medical Examiners and Trauma Surgeons Evaluating Pre-hospital Trauma Death

National Association of Medical Examiners Virtual Meeting 2020

BRIAN EASTRIDGE, MD, FACS

PROFESSOR, DEPARTMENT OF SURGERY

DIVISION CHIEF, TRAUMA AND EMERGENCY GENERAL SURGERY

JOCELYN AND JOE STRAUS ENDOWED CHAIR IN TRAUMA RESEARCH

UT HEALTH SAN ANTONIO

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Disclosures

Grant Support

Office of the Assistant Secretary of Defense for Health Affairs

Defense Medical Research and Development Program

Award No. W81XWH-17-2-0010

Disclaimer

The opinions or assertions contained herein are the private views of the author and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense.

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Background

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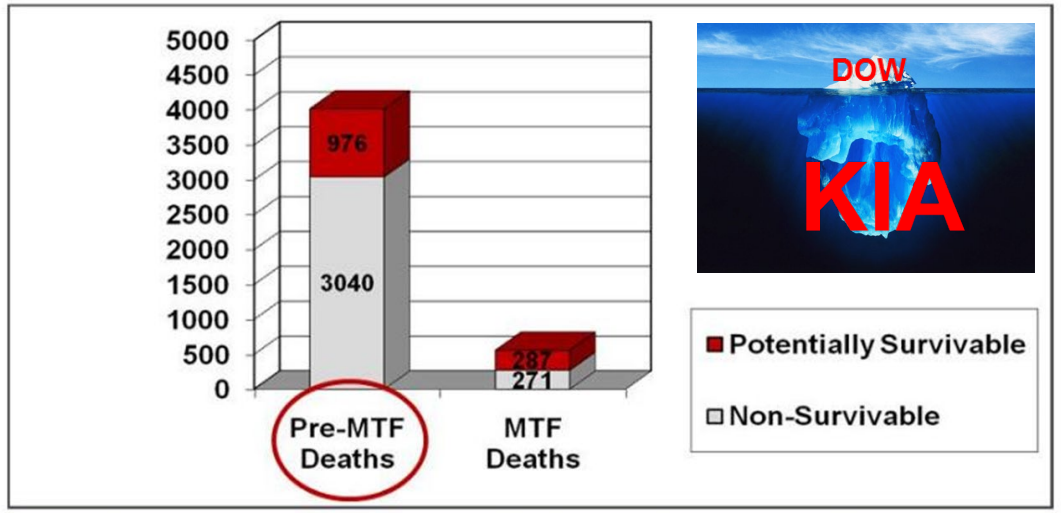
Background/Scientific Rationale
PreHospital Battlefield Mortality

Where Can We Save the Most Lives?

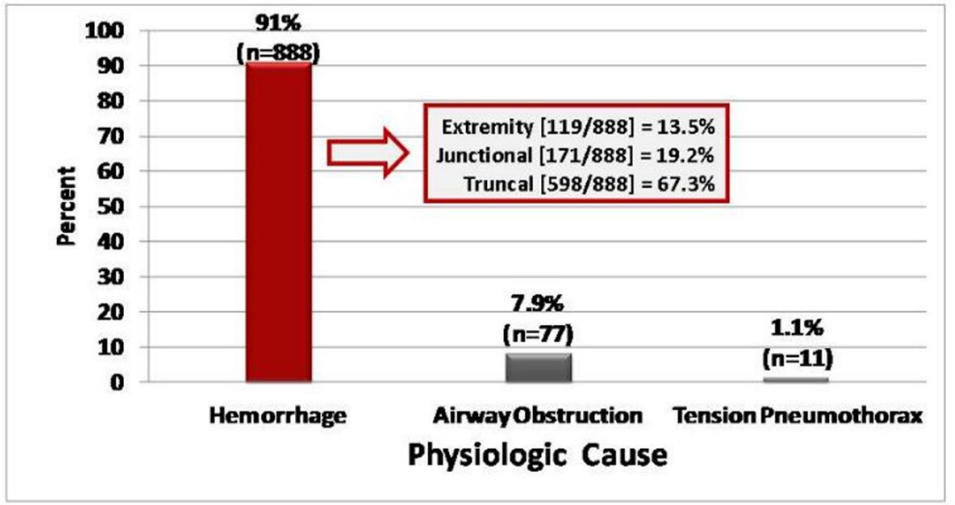


Eastridge BJ, Mabry RL, Seguin PG, et al. Death on the battlefield (2001-2011): implications for the future of combat casualty care. Journal of Trauma 2012, 73(6) Suppl 5: 431-7.

Eastridge BJ, Hardin M, Cantrell J, et al. Died of wounds on the battlefield: causation and implications for improving combat casualty care. Journal of Trauma 2011. 71(Suppl 1):4-8.

Unclassified 5

What were the Causes of Preventable Death?



Eastridge BJ, Mabry RL, Seguin PG, et al. Death on the battlefield (2001-2011): implications for the future of combat casualty care. Journal of Trauma 2012, 73(6) Suppl 5: 431-7.

Unclassified 6

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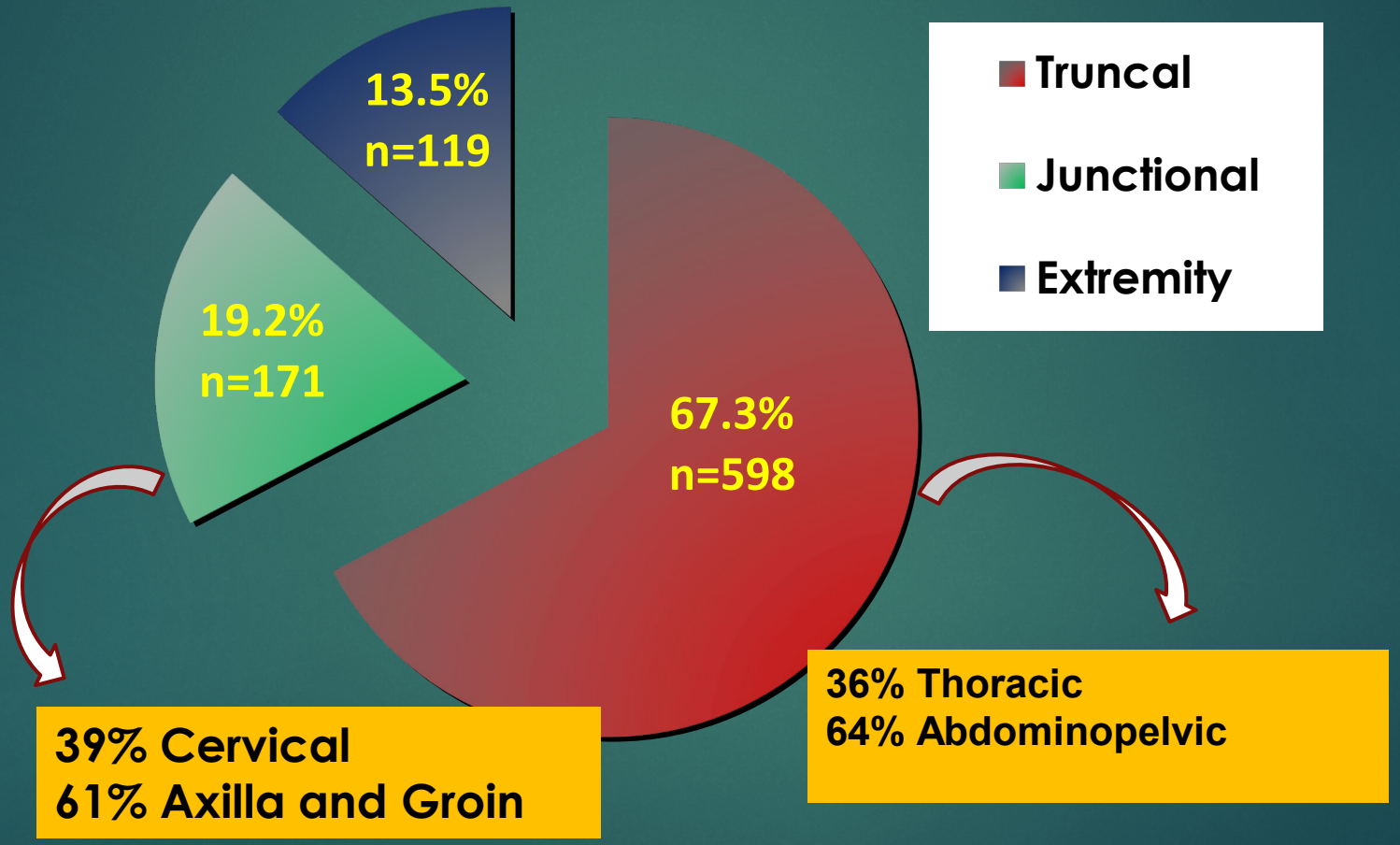
Anatomic / Physiologic Mechanism of Death



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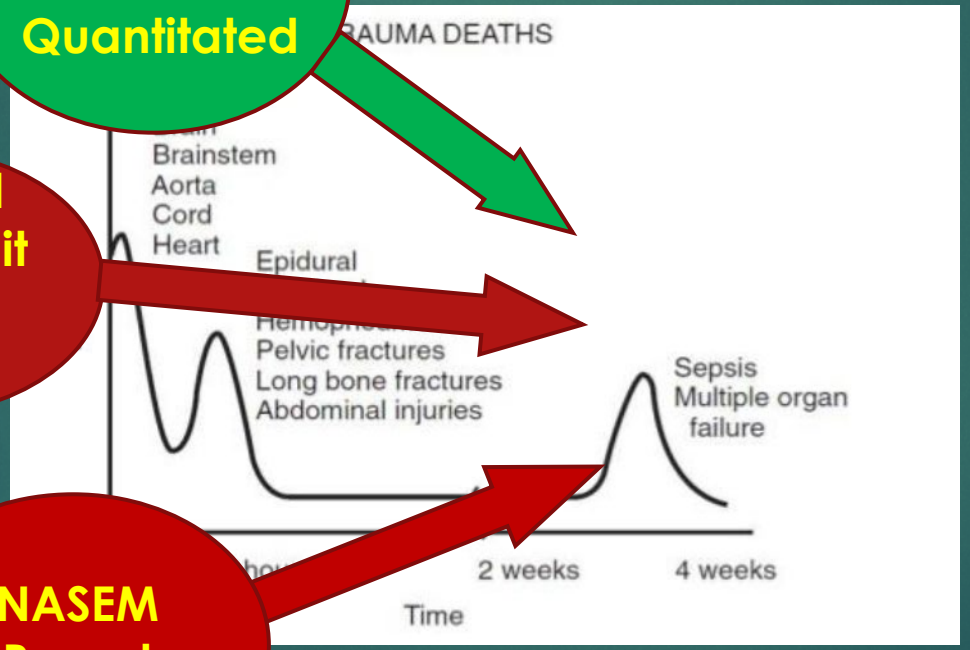
Eastridge BJ, Mabry RL, Seguin PG, et al. Death on the battlefield (2001-2011): implications for the future of combat casualty care. Journal of Trauma, 2012.

Background/Scientific Rationale Pre-Hospital Civilian Mortality

Impact Not Well Quantitated

Potential Survivability Poorly Defined

NASEM Report Emphasis



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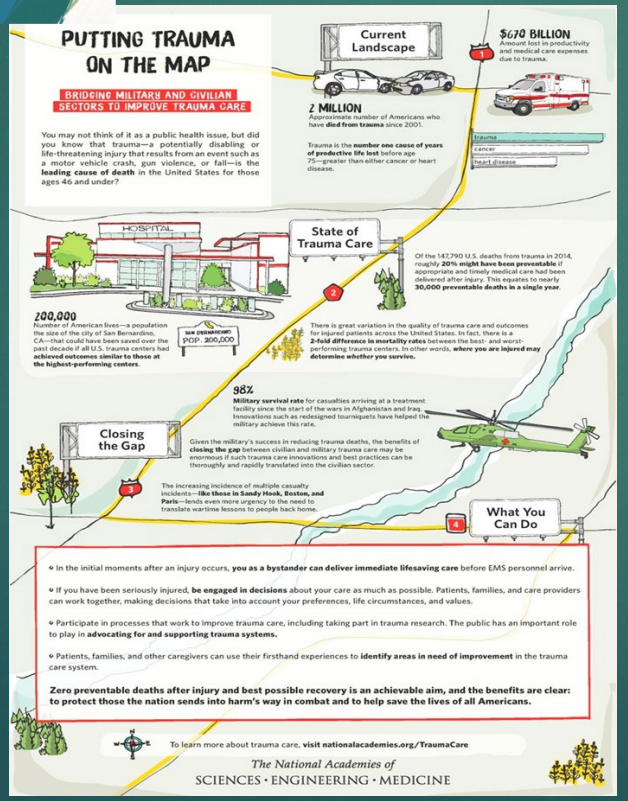

Potentially survivable injuries US civilian population

147,790 x 0.276 = 40,790

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Getting Beyond Estimates

Objective Establishment of the Impact on Society

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Methods

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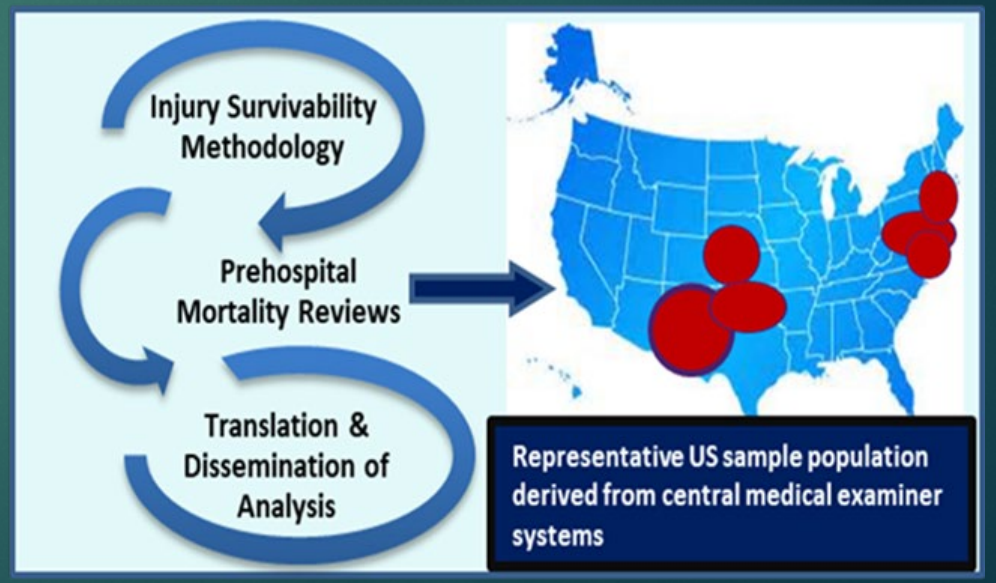
Multiinstitutional Multidisciplinary Injury Mortality Investigation in Civilian PreHospital Environment

PI:Eastridge
Co-I: Nolte, MacKenzie

MIMIC

Purpose of this proposal is to develop a coordinated, multidisciplinary, multi-institutional effort within the civilian clinical sector to identify and characterize the causes of pre-mortality from trauma

Identify potential high yield areas for research and development in pre-hospital medical care, injury prevention, and trauma systems.



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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

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MIMIC Data Sources

- Autopsy data
- ME imaging reports
- Field investigator report
- EMS data (if EMS engaged)
- Injury codes (Abbreviated Injury Scale/AIS)
- Geospatial data
  - Injury location
  - EMS location/response time
  - Location/time to nearest trauma center by level trauma center

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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 C3)
- 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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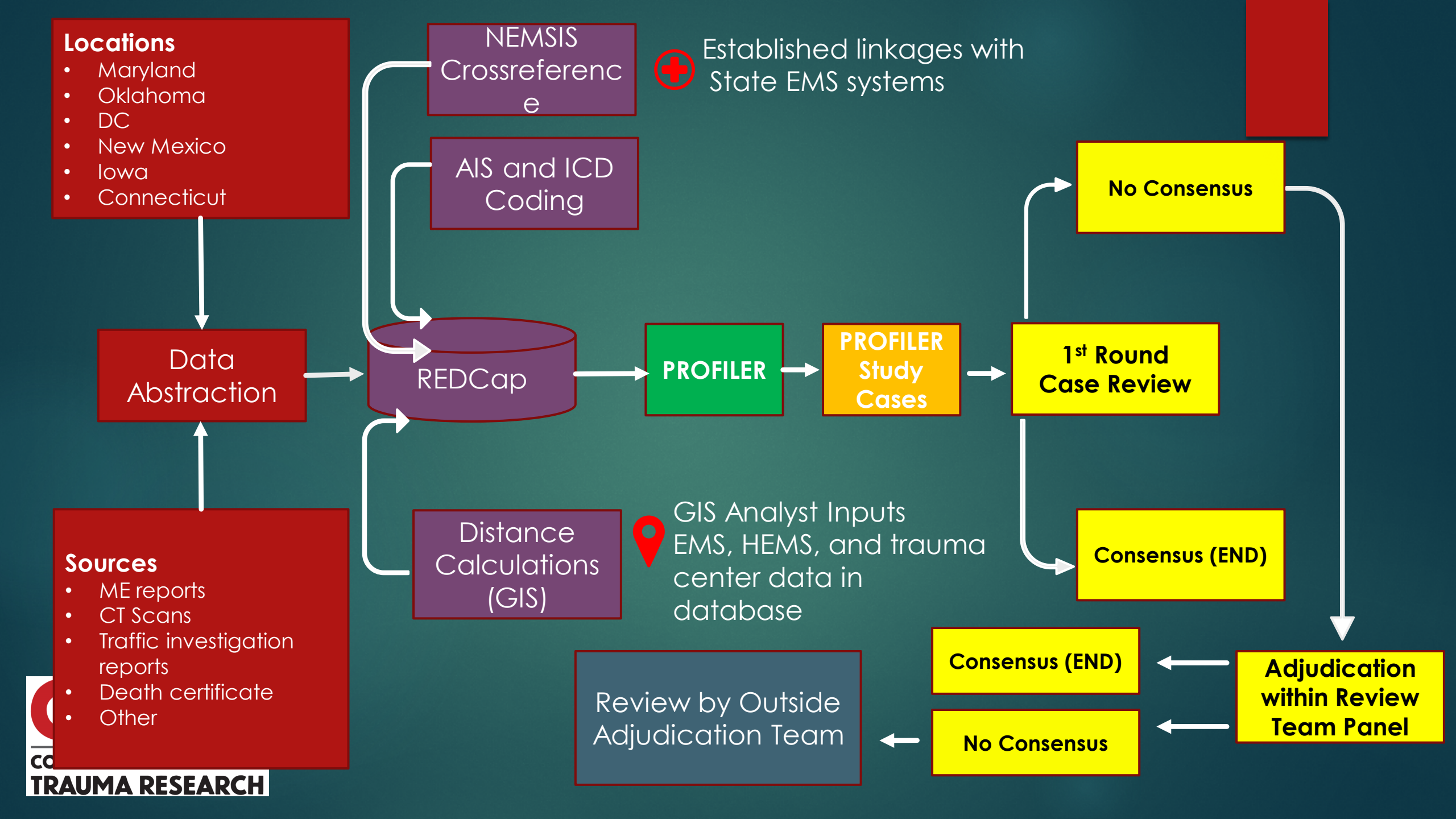
Locations
Maryland
Oklahoma
DC
New Mexico
Iowa
Connecticut
NEMSIS Crossreference
Established linkages with State EMS systems
AIS and ICD Coding
Data Abstraction
REDCap
PROFILER
PROFILER Study Cases
1st Round Case Review
No Consensus
Consensus (END)
Sources
ME reports
CT Scans
Traffic investigation reports
Death certificate
Other
Distance Calculations (GIS)
GIS Analyst Inputs EMS, HEMS, and trauma center data in database
Review by Outside Adjudication Team
Consensus (END)
No Consensus
Adjudication within Review Team Panel
TRAUMA RESEARCH

Results

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Preliminary Data

Principal Mechanism(s) of Death	Frequency
Massive tissue disruption	146
Neurological – Traumatic Brain Injury	1342
Neurological - Spinal Cord	246
Hemorrhage - Truncal	393
Hemorrhage - Junctional	44
Hemorrhage - Peripheral	38
Airway	79
Traumatic Asphyxia	59
Tension Pneumothorax	32
Burn	133
Electrical	1
Other	84
Unknown	51

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Preliminary Data (All Patients)

Survivability	Immediate Access (All)	Actual Scenario (All)
Probably Survivable	318 (79.5%)	380 (95.0%)
Potentially Survivable	78 (19.5%)	20 (5.0%)
Definitely Survivable	4 (1.0%)	0 (0.0%)
Cannot Judge	0 (0.0%)	0 (0.0%)

RESEARCH AND DEVELOPMENT OPPORTUNITIES TO INFORM INJURY PREVENTION

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Preliminary Round 1 and Round 2 Data (All Patients)

Survivability	Immediate Access (All)	Actual Scenario (All)
Non-survivable	318 (79.5%)	380 (95.0%)
[illegible]	78 (19.5%)	20 (5.0%)
Definitely Survivable	4 (1.0%)	0 (0.0%)
Cannot Judge	0 (0.0%)	0 (0.0%)

OPPORTUNITIES TO IMPROVE CURRENT TRAUMA SYSTEM

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Preliminary Round 1 and
(All Patients)

RESEARCH AND DEVELOPMENT OPPORTUNITIES TO IMPROVE FUTURE TRAUMA SYSTEMS

Survivability	Immediate Access (All)	Actual Scenario (All)
Non-survivable	318 (79.5%)	380 (95.0%)
Potentially Survivable	78 (19.5%)	20 (5.0%)
Definitely Survivable	4 (1.0%)	0 (0.0%)
Cannot Judge	0 (0.0%)	0 (0.0%)

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Preliminary Round 1 and Round 2 Data (Excluding Suicide)

Survivability	Immediate Access (Excluding Suicide)	Actual Scenario (Excluding Suicide)
Non-survivable	150 (67.9%)	202 (91.4%)
Potentially Survivable	68 (30.8%)	19 (8.6%)
Definitely Survivable	3 (1.4%)	0 (0.0%)
Cannot Judge	0 (0.0%)	0 (0.0%)

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Preliminary Round 1 and Round 2 Data (Excluding Suicide)

Survivability	Immediate Access (Excluding Suicide)	Actual Scenario (Excluding Suicide)
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POTENTIALLY PREVENTABLE DEATHS

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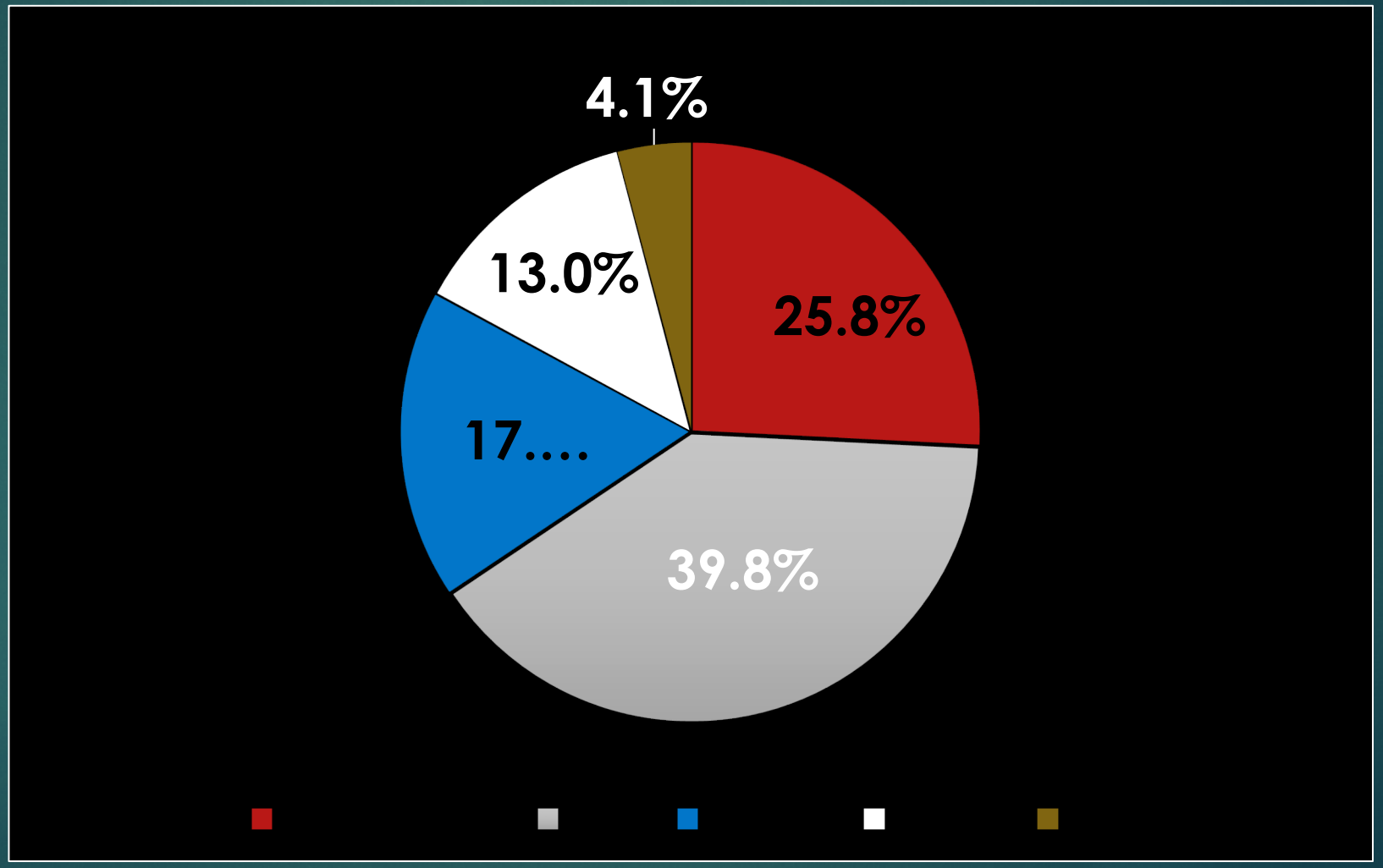
Mechanism of Death (All)
Ideal Circumstance



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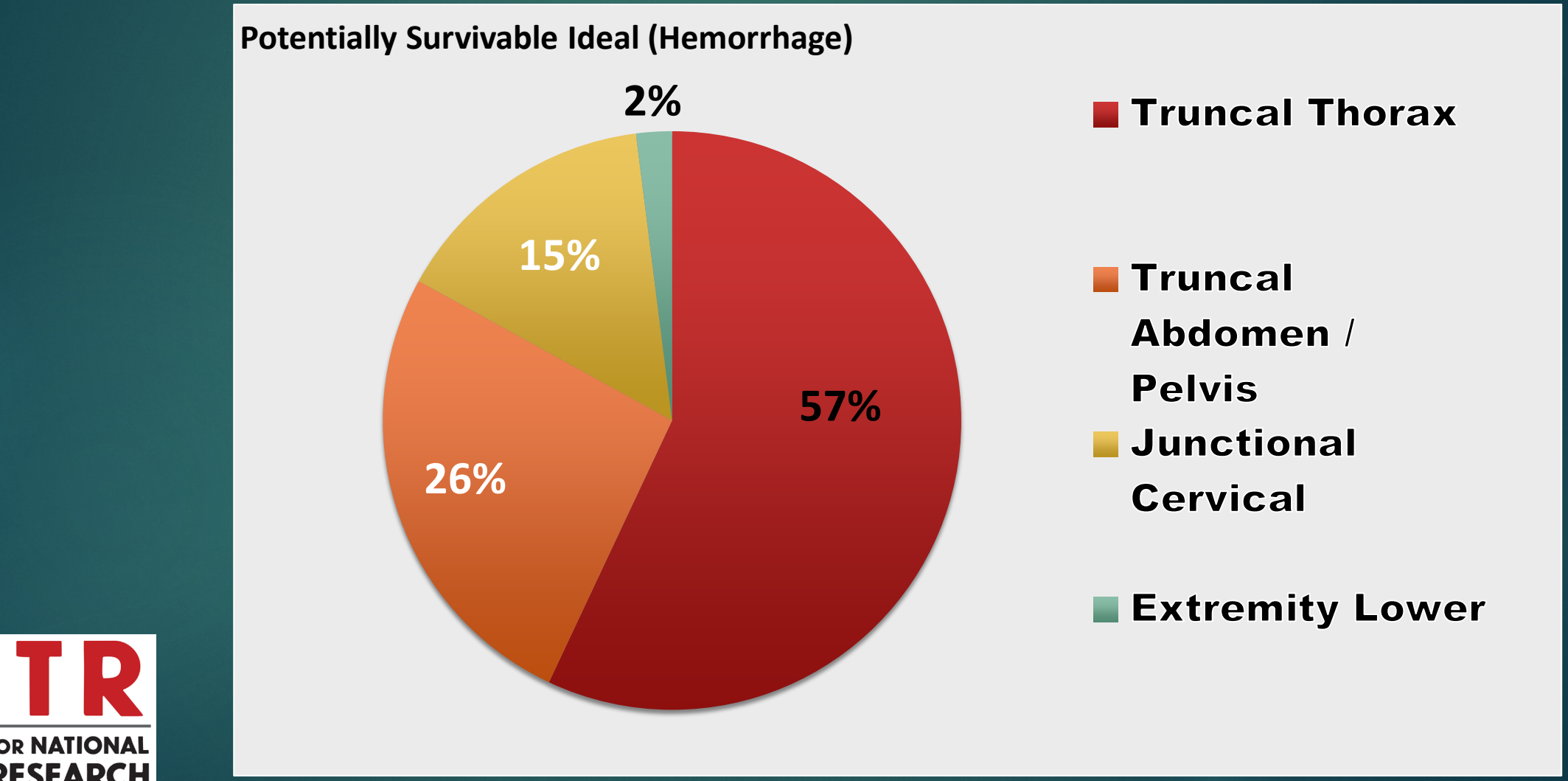
Potentially Survivable (Hemorrhage Focus) Ideal Circumstance



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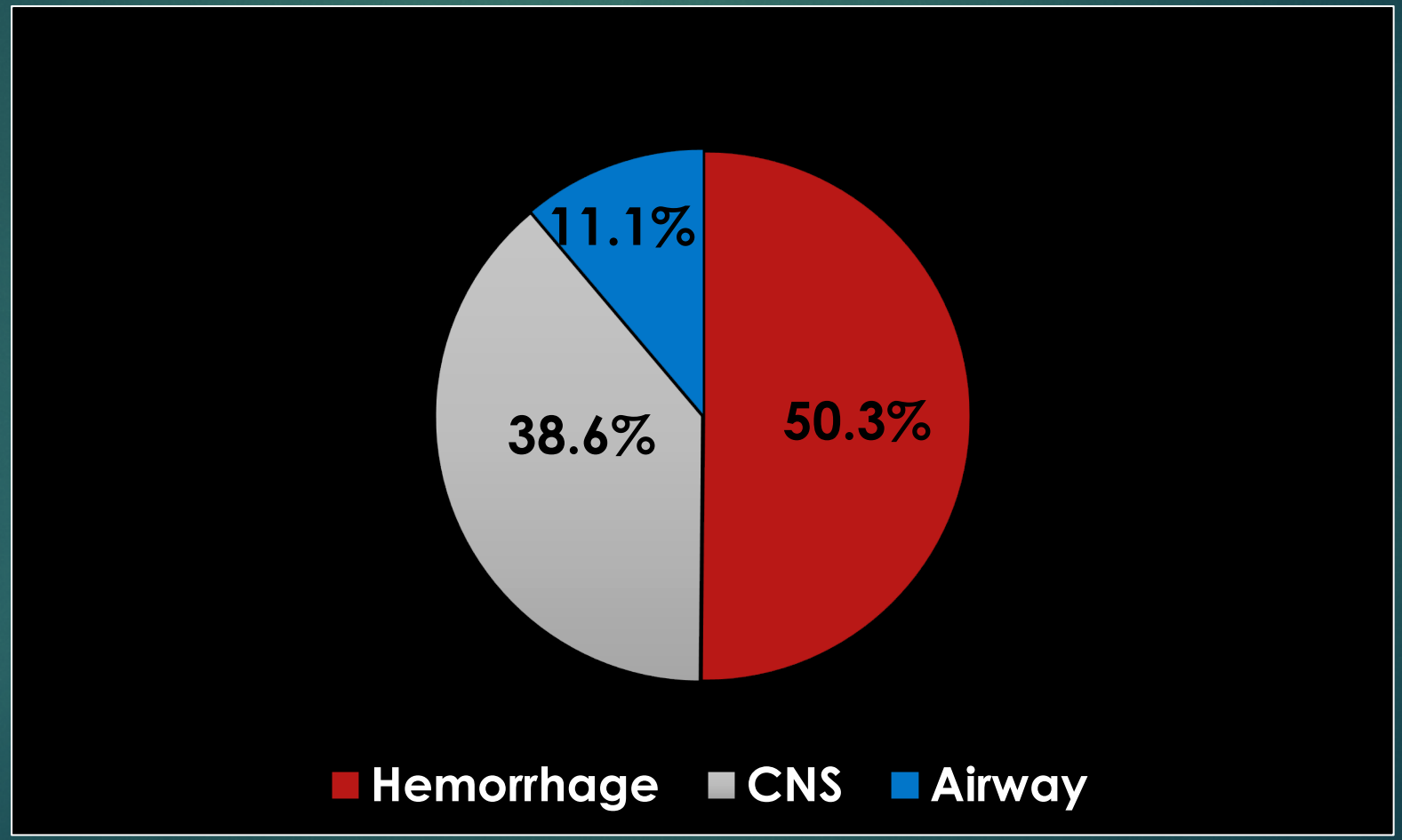
Mechanism of Death (All)
Actual Circumstance



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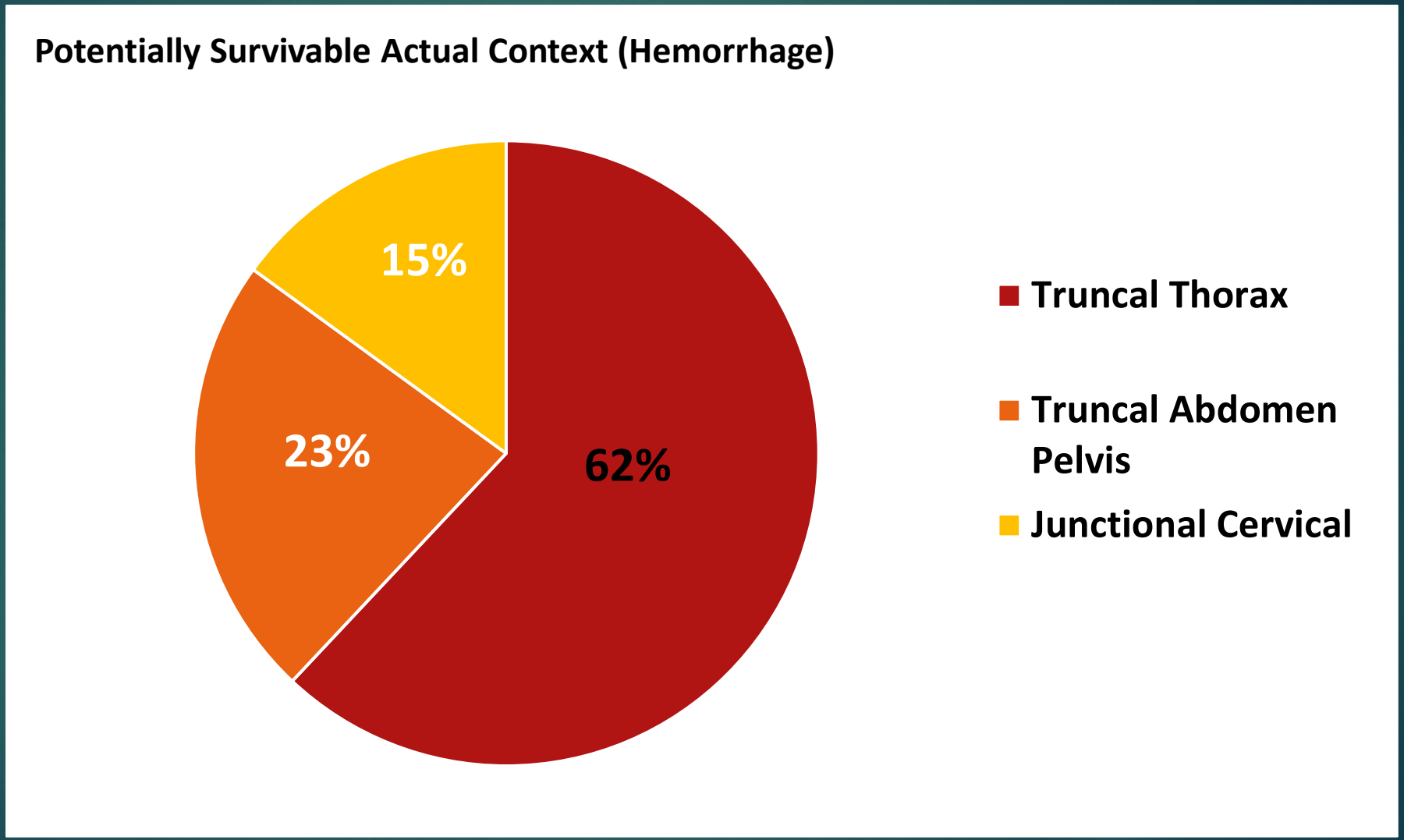
Potentially Survivable (Hemorrhage Focus) Actual Circumstance



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Preliminary Round 1 and Round 2 Data

Injury prevention programs/devices or interventions might have improved the chances of survival

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

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Consensus Determinations of Survivability

- MIMIC interrater reliability analysis
  - Mortality reviews
    - 86.8 % consensus
      - 75.5 % primary review
      - 12.2 % secondary online adjudication

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Survivability Determinations On All Cases that Reached Consensus

Survivability Consensus				
	Non Survivable	Potentially Survivable	Definitely Survivable	Cannot Judge
Immediate Access	669 (82%)	134 (16%)	12 (1%)	0 (0%)
Actual Conditions	787 (97%)	28 (3%)	0 (0%)	0 (0%)

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Survivability Determinations On All Cases that Reached Consensus By Reviewer Type

Consensus by Reviewer Specialty				
	Non Survivable	Potentially Survivable	Definitely Survivable	Cannot Judge
Forensic Pathologist / Medical Examiner	493 (81%)*	81 (13%)*	11 (2%)	22 (4%)
Emergency Medicine/EMS	614 (75%)	162 (20%)	35 (4%)	4 (0%)
Surgeon	2341 (72%)	766 (23%)	90 (3%)	63 (2%)

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* $P < 0.05$

Mechanism of Death Discordance Medical Examiners vs Surgeon / EM

- Truncal hemorrhage within the thorax
- Traumatic brain injury
- Traumatic asphyxia

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Limitations

- Potential sources of bias
  - Observer bias
  - Misclassification bias
  - Bias relative to consensus rule amongst expert panels
- Heterogeneity medical examiner system processes
- Survivability determinations based upon anatomic injury metrics
  - No consideration additive effects of multiple injuries, age, comorbidities
- Generalizability

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Conclusions

- Creating a diverse team of professionals allows for a broader discussion of potentially survivable injury deaths
- Differential assessments of injury survivability between forensic pathologists / medical examiners and surgeons / EM clinicians indicates a need for further efforts to increase agreement and consistency between these two communities
- Further research is needed to identify opportunities to improve collaboration between medical examiners and trauma surgeons to improve medical examiner and trauma systems.

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Conclusions

- Current assessment provides objective evidence to support a more comprehensive understanding of pre-hospital injury mortality
- Research highlights specific targets for future focus of R&D to improve the pre-hospital management and outcomes of the injured patient

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Collaborators

- C. Lizette Villarreal, MA
- Nicolas W. Medrano, MS
- Craig M. Remenapp, MS
- Zebin Wang, ScM
- Ellen J. MacKenzie, PhD
- Kurt B. Nolte, MD
- Michelle A. Price, PhD
- Brian J. Eastridge, MD
- MIMIC Study Group

- 1 Coalition for National Trauma Research; San Antonio, Texas
- 2 Johns Hopkins University Bloomberg School of Public Health; Baltimore, Maryland
- 3 University of New Mexico School of Medicine; Albuquerque, New Mexico
- 4 University of Texas Health Science Center at San Antonio; San Antonio, Texas

- Medical Examiner Systems

  Connecticut

  District of Columbia

  Iowa (Johnson County)

  Maryland

  New Mexico

  Oklahoima

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Multi-Institutional Multidisciplinary Injury Mortality Investigation in the Civilian Pre-Hospital Environment (MIMIC)

Brian Eastridge, MD, FACS

COL, MC, USAR

Division Chief, Trauma and Emergency General Surgery

Professor, Clinical Jocelyn and Joe Straus Endowed Chair in Trauma Research

Department of Surgery, UT Health San Antonio

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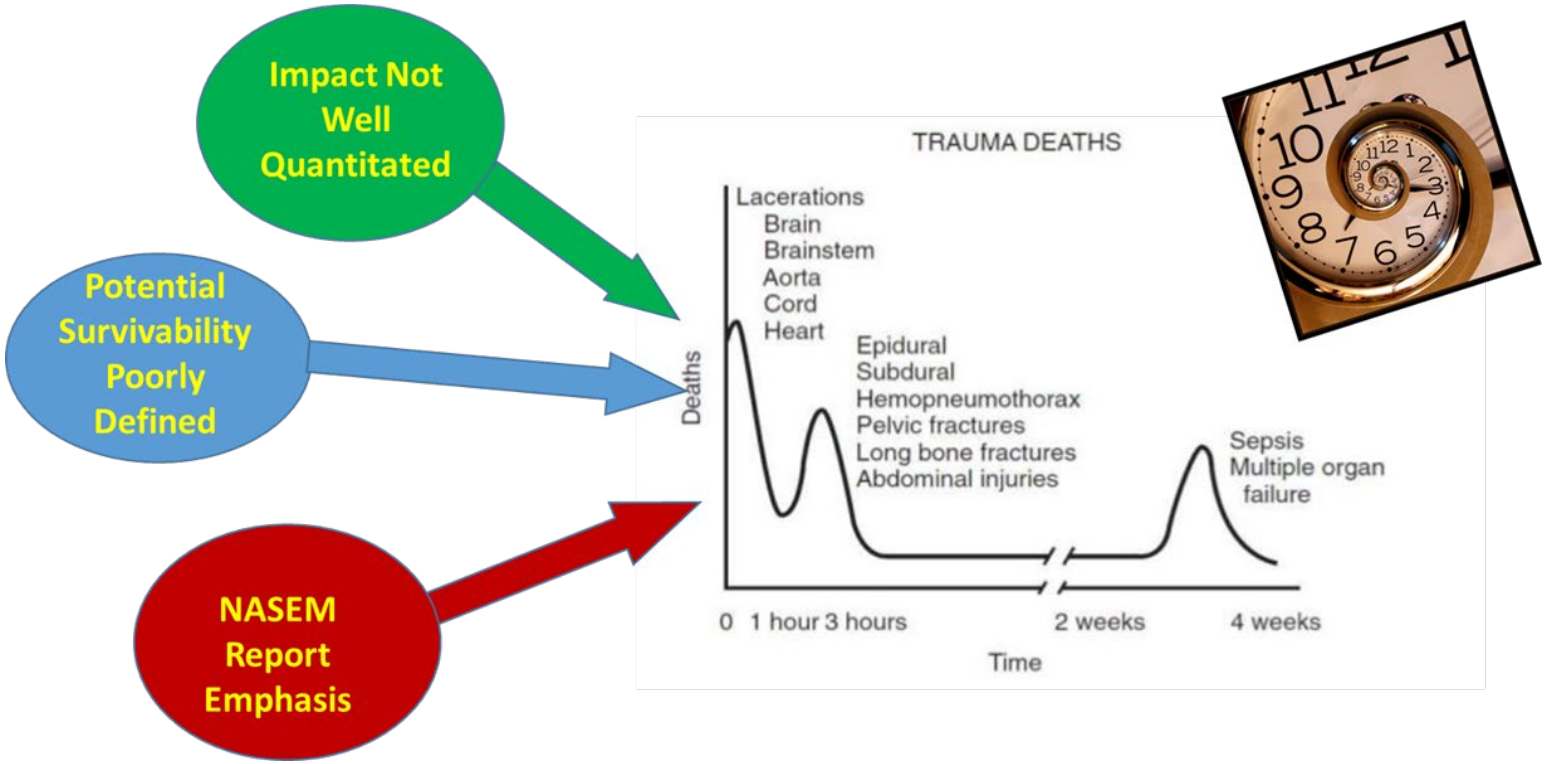
Background and Scientific Rationale



Goal of Research :
Get beyond estimates of prehospital injury mortality in order to establish the objective impact on public health

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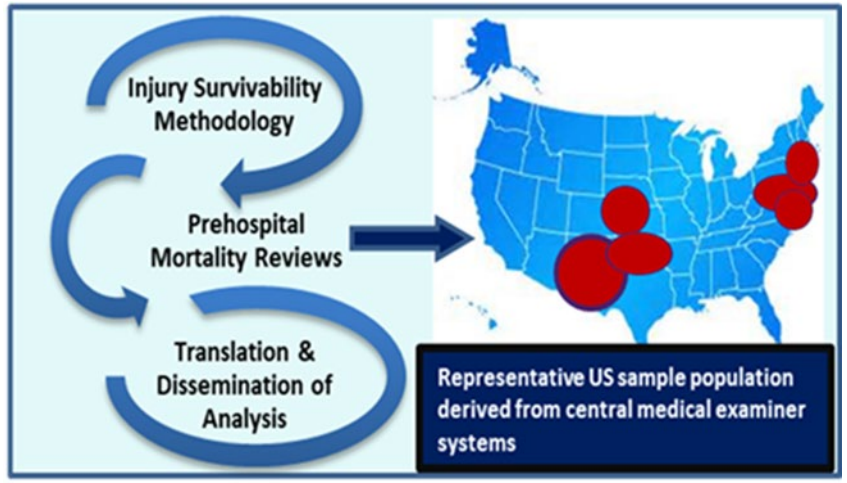
MIMIC Multi-Institutional Multidisciplinary Injury Mortality Investigation in the Civilian Pre-Hospital Environment

(PI: Brian Eastridge, MD)

- Review 3,000 pre-hospital deaths in six areas of the country
- Develop a more comprehensive understanding of the epidemiology of pre-hospital deaths, identify liabilities in the current trauma system, and improve survival
- Create a framework and methodology for evaluating the causes and pathophysiologic mechanisms of pre-hospital deaths, the appropriateness of EMS response and care delivered, and the potential for survivability under optimal clinical circumstances and within the context of each individual injury event



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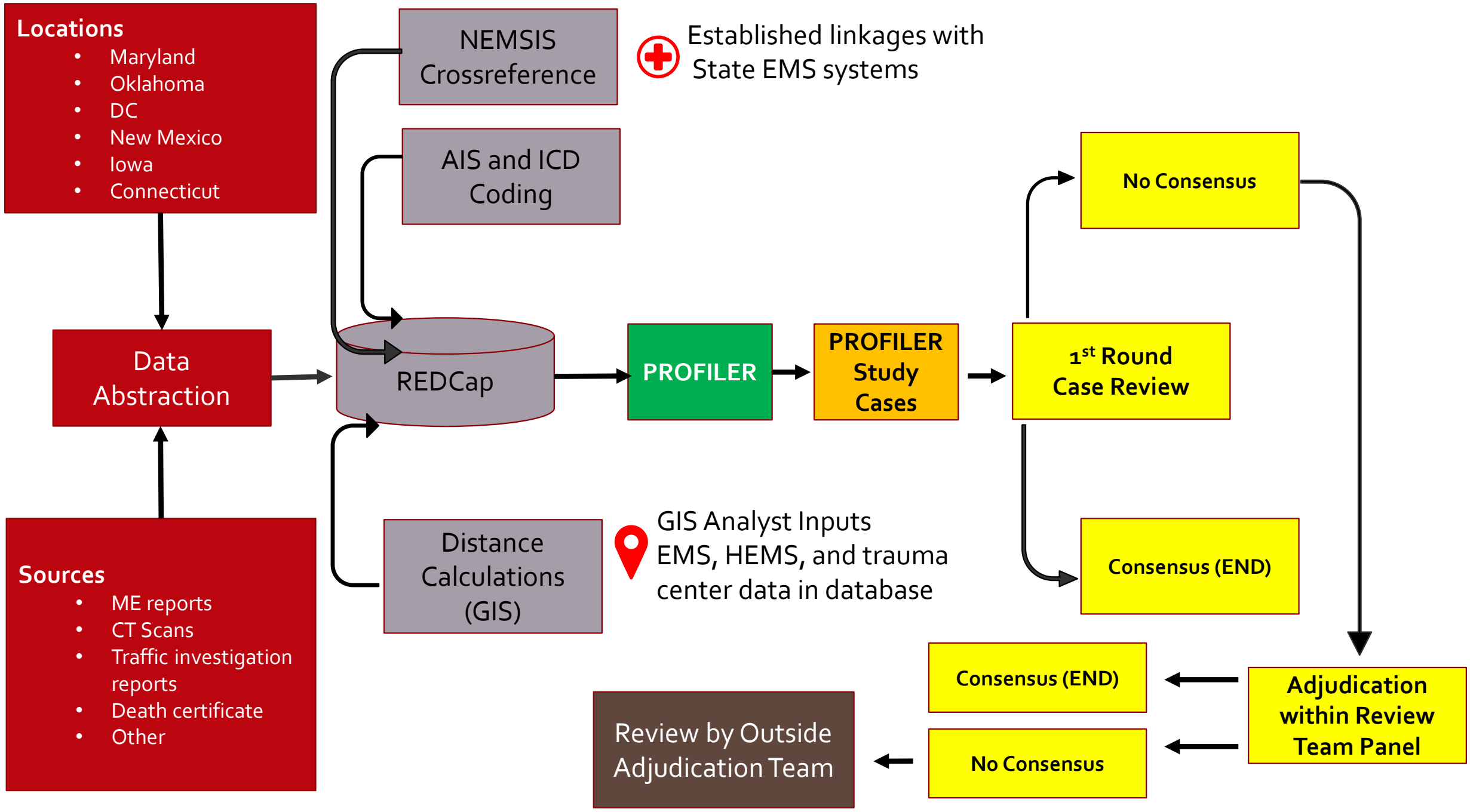
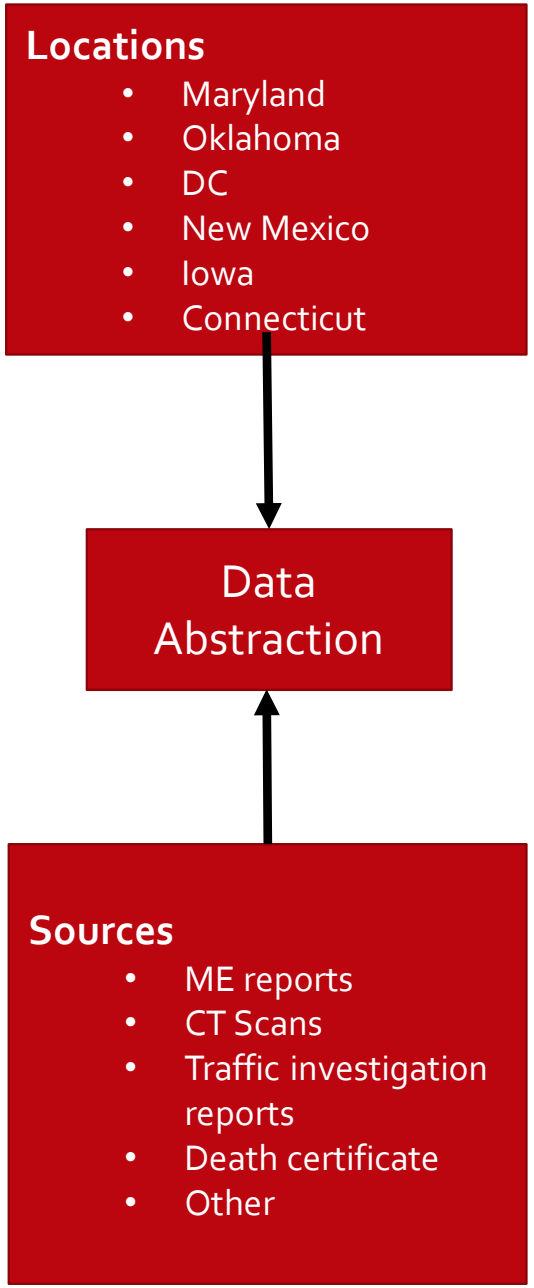
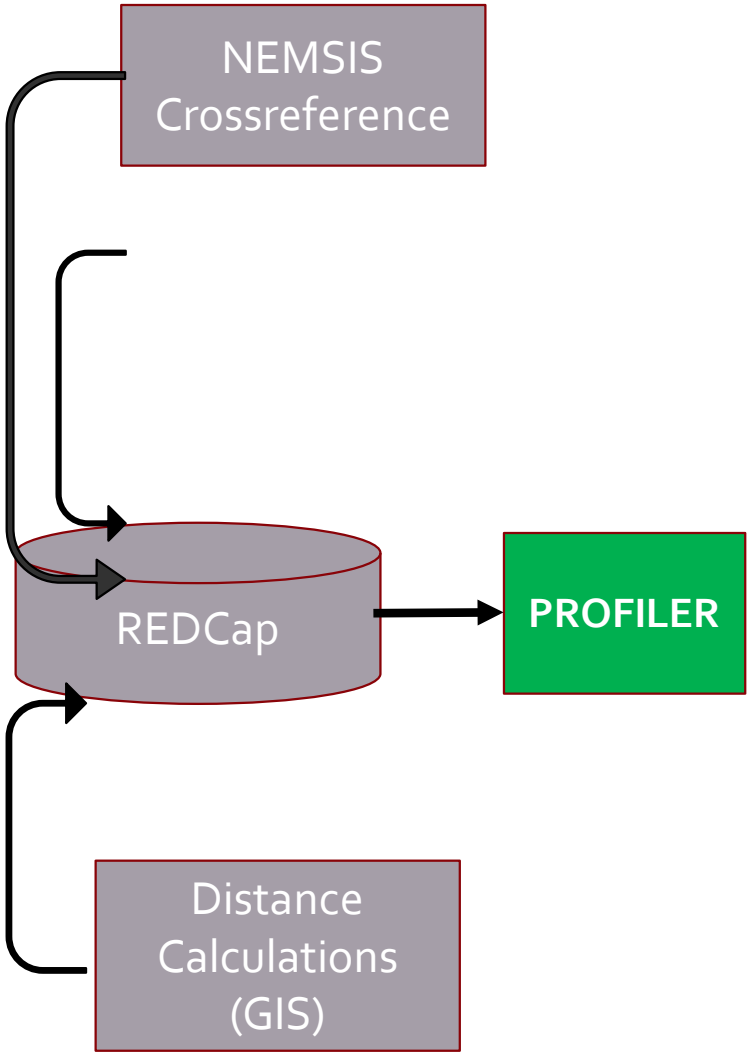

Locations
Maryland
Oklahoma
DC
New Mexico
Iowa
Connecticut
NEMSIS Crossreference
Established linkages with State EMS systems
AIS and ICD Coding
Data Abstraction
REDCap
PROFILER
PROFILER Study Cases
No Consensus
1st Round Case Review
Consensus (END)
Sources
ME reports
CT Scans
Traffic investigation reports
Death certificate
Other
Distance Calculations (GIS)
GIS Analyst Inputs
EMS, HEMS, and trauma center data in database
Adjudication within Review Team Panel
Consensus (END)
No Consensus
Review by Outside Adjudication Team



CNTR Involvement

- Interface with granting agency (Department of Defense)
- Coordination with investigators and Steering Committee
- Budget development and administration
- Subaward contracting with Medical Examiner (ME) sites
- IRB liaison
- REDCap database development
- Development of study data dictionary
- Training of ME sites to ensure data accuracy
- Conduct QA checks on data



CNTR Data Coordination

- Geospatial mapping expertise by a **GIS Analyst**
- GIS Analyst created an **access to care database** utilizing ground and air EMS locations
- Relationship development and data use agreements with NEMSIS and state EMS data managers
- Establish linkages (EMS records to ME record)

CNTR Program Management

- Coordination of development of electronic tool "Profiler" with JHU
- Development and management of 14 multidisciplinary review teams
  - ~80 subject matter experts in trauma, neurosurgery, orthopedics, emergency medicine, EMS, and forensic pathology
- Track case reviews: 10 rounds=3,000 cases
- Manage adjudication process
- Meeting logistics and travel support
- Presentation and publication support