AWARD NUMBER: W81XWH-17-2-0010

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
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REPORT DATE: APRIL 2022

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PREPARED FOR: U.S. Army Medical Research and Development Command
Fort Detrick, Maryland 21702-5012

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

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W81XWH-17-2-0010

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

National Trauma Institute
9901 IH 10, Suite 730
San Antonio, TX 78230-2258

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Medical Research and Development Command
Fort Detrick, Maryland 21702-5012

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12. DISTRIBUTION / AVAILABILITY STATEMENT
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13. SUPPLEMENTARY NOTES

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 NONE LISTED

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			USAMRDC
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Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

TABLE OF CONTENTS

INTRODUCTION: Narrative that briefly (one paragraph) describes the subject, purpose and scope of the research.

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:** Provide a brief list of keywords (limit to 20 words).

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

2. **ACCOMPLISHMENTS:** The PI is reminded that the recipient organization is required to obtain prior written approval from the awarding agency grants official whenever there are significant changes in the project or its direction.

What were the major goals of the project?
List the major goals of the project as stated in the approved SOW. If the application listed milestones/target dates for important activities or phases of the project, identify these dates and show actual completion dates or the percentage of completion.

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		80%
Milestone Achieved: All panel reviews completed and data submitted	33		75%
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		90%
Subtask 2: Perform all analyses according to specifications, share output and finding with all investigators	6-39		60%

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?

For this reporting period describe: 1) major activities; 2) specific objectives; 3) significant results or key outcomes, including major findings, developments, or conclusions (both positive and negative); and/or 4) other achievements. Include a discussion of stated goals not met. Description shall include pertinent data and graphs in sufficient detail to explain any significant results achieved. A succinct description of the methodology used shall be provided. As the project progresses to completion, the emphasis in reporting in this section should shift from reporting activities to reporting accomplishments.

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 data was received on **05-Aug-2021**
  -New Mexico data was received on **31-Mar-2022**
  -Connecticut was unable to retrieve their data due to a data corruption loss in their state. The study team was able to work with the ME team in the state to confirm inclusion criteria was met and additional information was included for all records. The absence of EMS data for Connecticut data will not negatively impact the project. Connecticut ME office was able to provide very thorough data. EMS data is aimed at providing additional information.
  -Iowa request was initially denied but was resubmitted. We are currently awaiting a decision. The case number requested of matching will not impact the 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 has been completed.

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, 2,285 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, 2,285 cases have been released to panels for review. Out of those cases, 2,043 cases have reached consensus, 64 cases are still under adjudication, 106 cases have been pushed to an outside adjudication team for further review, and 82 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 cases were launched. 18-May-2021
- Round 9 cases were launched 31-Aug-2021
- Round 10 will be launched in May 2022

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. The study team is drafting the main manuscript to be submitted to JAMA.

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?

If the project was not intended to provide training and professional development opportunities or there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe opportunities for training and professional development provided to anyone who worked on the project or anyone who was involved in the activities supported by the project. "Training" activities are those in which individuals with advanced professional skills and experience assist others in attaining greater proficiency. Training activities may include, for example, courses or one-on-one work with a mentor. "Professional development" activities result in increased knowledge or skill in one's area of expertise and may include workshops, conferences, seminars, study groups, and individual study. Include participation in conferences, workshops, and seminars not listed under major activities.

Nothing to Report

How were the results disseminated to communities of interest?
If there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe how the results were disseminated to communities of interest. Include any outreach activities that were undertaken to reach members of communities who are not usually aware of these project activities, for the purpose of enhancing public understanding and increasing interest in learning and careers in science, technology, and the humanities.

Nothing to Report

If this is the final report, state "Nothing to Report." Describe briefly what you plan to do during the next reporting period to accomplish the goals and objectives.

- Upload additional EMS data for New Mexico, and Iowa
- Continue working on case reviews
- Begin case adjudication with outside review panel
- Submit program process methods paper

4. **IMPACT:** Describe distinctive contributions, major accomplishments, innovations, successes, or any change in practice or behavior that has come about as a result of the project relative to:

What was the impact on the development of the principal discipline(s) of the project?
If there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe how findings, results, techniques that were developed or extended, or other products from the project made an impact or are likely to make an impact on the base of knowledge, theory, and research in the principal disciplinary field(s) of the project. Summarize using language that an intelligent lay audience can understand (Scientific American style).

Nothing to Report

What was the impact on other disciplines?
If there is nothing significant to report during this reporting period, state "Nothing to Report." Describe how the findings, results, or techniques that were developed or improved, or other products from the project made an impact or are likely to make an impact on other disciplines.

Nothing to Report

What was the impact on technology transfer?

If there is nothing significant to report during this reporting period, state "Nothing to Report."

Nothing to Report

What was the impact on society beyond science and technology?
If there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe how results from the project made an impact, or are likely to make an impact, beyond the bounds of science, engineering, and the academic world on areas such as:

- *improving public knowledge, attitudes, skills, and abilities;*
- *changing behavior, practices, decision making, policies (including regulatory policies), or social actions; or*
- *improving social, economic, civic, or environmental conditions.*

Nothing to Report

5. **CHANGES/PROBLEMS:** The PD/PI is reminded that the recipient organization is required to obtain prior written approval from the awarding agency grants official whenever there are significant changes in the project or its direction. If not previously reported in writing, provide the following additional information or state, "Nothing to Report," if applicable:

Changes in approach and reasons for change *Describe any changes in approach during the reporting period and reasons for these changes. Remember that significant changes in objectives and scope require prior approval of the agency.*

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

Describe problems or delays encountered during the reporting period and actions or plans to resolve them.

The project experienced a major slowdown of case reviews since reviewers have been focused on the COVID-19 crisis. The project team has begun to see a huge uptick in activity from the review team in completing case reviews and will complete the final round of reviews. After a long delay from the New Mexico Department of Health, we were able to finalize a data use agreement and begin receiving NEMSIS data. The project team continues to work on data cleaning, coding, and publications during this time.

Changes that had a significant impact on expenditures

Describe changes during the reporting period that may have had a significant impact on expenditures, for example, delays in hiring staff or favorable developments that enable meeting objectives at less cost than anticipated.

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: List any products resulting from the project during the reporting period. If there is nothing to report under a particular item, state "Nothing to Report."

- **Publications, conference papers, and presentations**
  Report only the major publication(s) resulting from the work under this award.

- Eastridge, BE. Multi-institutional Multidisciplinary Injury Mortality Investigation in the Civilian Pre-Hospital Environment (MIMIC). UT Health San Antonio Research Week, Department of Surgery Podium Presentation. April 8, 2021. https://lsom.uthscsa.edu/office-research/research-day-2021/
- Multi-institutional Multi-disciplinary Injury Mortality Investigation in Civilian Prehospital Environment (MIMIC): Focus on Improving Prehospital Trauma Survival. American Trauma Society webinar presentation. September 22, 2021.
- Eastridge BJ. Civilian Prehospital Trauma Mortality. Presentation at the National Association of Emergency Medical Technicians (NAEMT) World Trauma Symposium in Atlanta, GA, October 5, 2021.
- Eastridge BJ. Multi-institutional Multidisciplinary Injury Mortality Investigation in Civilian Prehospital Environment (MIMIC): Trauma system Implications Civilian Prehospital Mortality. Presentation at the American College of Surgeons Committee on Trauma in Chicago, Il October 15, 2021
- Eastridge BJ. Multi-institutional Multidisciplinary Injury Mortality Investigation in Civilian Prehospital Environment (MIMIC): Establishing Societal Impact and Remediation Strategies. Presentation at the 2021 Military City USA Trauma Collaborative Research Conference, October 21, 2021.
- Eastridge BJ. Multi-Institutional Multidisciplinary Injury Mortality Investigation in Civilian Prehospital Environment (MIMIC): Establishing Societal Impact and Remediation Strategies. Presentation at the UT Health Think Tank Meeting, November 12, 2021.
- Nicolas W. Medrano, Cynthia Lizette Villarreal, N. Clay Mann, Michelle A. Price, Kurt B Nolte, Ellen J. MacKenzie, Pam Bixby, Brian J. Eastridge & for the MIMIC Study Group (2022) Activation and on-scene intervals for severe trauma EMS interventions: An analysis of the NEMSIS database, Prehospital Emergency Care, DOI: 10.1080/10903127.2022.2053615

Journal publications. *List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Identify for each publication: Author(s); title; journal; volume: year; page numbers; status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).*

- Nicolas W. Medrano, Cynthia Lizette Villarreal, N. Clay Mann, Michelle A. Price, Kurt B Nolte, Ellen J. MacKenzie, Pam Bixby, Brian J. Eastridge & for the MIMIC Study Group (2022) Activation and on-scene intervals for severe trauma EMS interventions: An analysis of the NEMSIS database, Prehospital Emergency Care, DOI: 10.1080/10903127.2022.2053615

Books or other non-periodical, one-time publications. *Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like. Identify for each one-time publication: author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (e.g., book, thesis or dissertation); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).*

Nothing to report

Other publications, conference papers and presentations. *Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication as noted above. List presentations made during the last year (international, national, local societies, military meetings, etc.). Use an asterisk (*) if presentation produced a manuscript.*

Nothing to Report

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

List the URL for any Internet site(s) that disseminates the results of the research activities. A short description of each site should be provided. It is not necessary to include the publications already specified above in this section.

Nothing to Report

- **Technologies or techniques**

Identify technologies or techniques that resulted from the research activities. Describe the technologies or techniques were shared.

Nothing to Report

- **Inventions, patent applications, and/or licenses**
  Identify inventions, patent applications with date, and/or licenses that have resulted from the research. Submission of this information as part of an interim research performance progress report is not a substitute for any other invention reporting required under the terms and conditions of an award.

Nothing to Report

- **Other Products**
  Identify any other reportable outcomes that were developed under this project. Reportable outcomes are defined as a research result that is or relates to a product, scientific advance, or research tool that makes a meaningful contribution toward the understanding, prevention, diagnosis, prognosis, treatment and /or rehabilitation of a disease, injury or condition, or to improve the quality of life. Examples include:

• Nothing to Report

7. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

What individuals have worked on the project?
Provide the following information for: (1) PDs/PIs; and (2) each person who has worked at least one person month per year on the project during the reporting period, regardless of the source of compensation (a person month equals approximately 160 hours of effort). If information is unchanged from a previous submission, provide the name only and indicate "no change".

Personnel	***Role***	***Percent Effort***
Brian Eastridge	PI	20%
Amy Flores	Controller	5% Sept 2021-Mar 2022
Lizette Villarreal	Program Manager	30% Mar 2021-Mar 2022
Michelle Price	Research Director	5% Mar 2021-Mar 2022
Nick Medrano	GIS Analyst	95% Mar 2021-Aug 2021 100% Sept 2021-Mar 2022
Ana Guerrero	Executive Assistant	5% Mar 2021-Mar 2022
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	5%
Daniel Scharfstein	Lead Statistician	2%

Craig Remenapp	Study Manager	60%
Elias Weston-Farber	Research Assistant	5%
Aidan McDermott	Data Analyst	10%

Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?
If there is nothing significant to report during this reporting period, state "Nothing to Report."

If the active support has changed for the PD/PI(s) or senior/key personnel, then describe what the change has been. Changes may occur, for example, if a previously active grant has closed and/or if a previously pending grant is now active. Annotate this information so it is clear what has changed from the previous submission. Submission of other support information is not necessary for pending changes or for changes in the level of effort for active support reported previously. The awarding agency may require prior written approval if a change in active other support significantly impacts the effort on the project that is the subject of the project report.

Nothing to Report

What other organizations were involved as partners?
If there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe partner organizations – academic institutions, other nonprofits, industrial or commercial firms, state or local governments, schools or school systems, or other organizations (foreign or domestic) – that were involved with the project. Partner organizations may have provided financial or in-kind support, supplied facilities or equipment, collaborated in the research, exchanged personnel, or otherwise contributed.

Provide the following information for each partnership:
Organization Name:
Location of Organization: (if foreign location list country)
Partner's contribution to the project (identify one or more)

- *Financial support;*
- *In-kind support (e.g., partner makes software, computers, equipment, etc., available to project staff);*
- *Facilities (e.g., project staff use the partner's facilities for project activities);*
- *Collaboration (e.g., partner's staff work with project staff on the project);*
- *Personnel exchanges (e.g., project staff and/or partner's staff use each other's facilities, work at each other's site); and*
- *Other.*

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: For collaborative awards, independent reports are required from BOTH the Initiating Principal Investigator (PI) and the Collaborating/Partnering PI. A duplicative report is acceptable; however, tasks shall be clearly marked with the responsible PI and research site. A report shall be submitted to **https://ers.amedd.army.mil** for each unique award.

QUAD CHARTS: If applicable, the Quad Chart (available on https://www.usamraa.army.mil) should be updated and submitted with attachments.

Quad Chart Attached

9. APPENDICES:

Attach all appendices that contain information that supplements, clarifies or supports the text. Examples include original copies of journal articles, reprints of manuscripts and abstracts, a curriculum vitae, patent applications, study questionnaires, and surveys, etc.

- Copies of the 7 Products/Reportable Outcomes are attached.

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

BA150629
W81XWH-17-2-0010

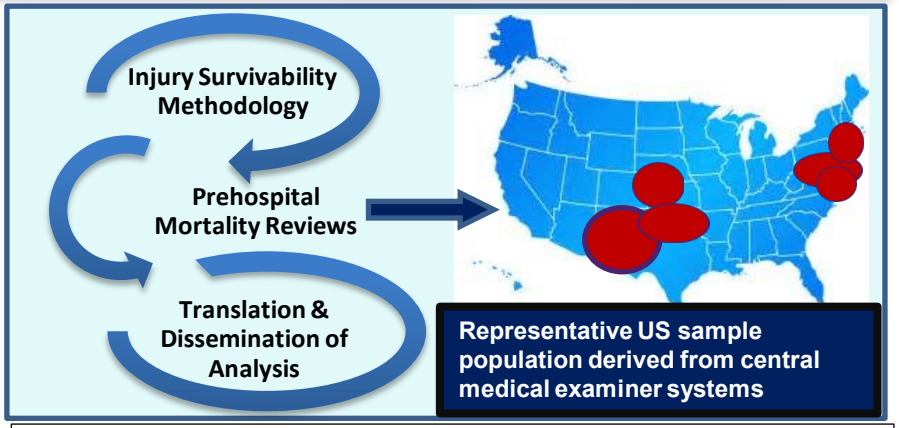
PI: Brian Eastridge **Org:** National Trauma Institute **Award Amount:** $3,979,380

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	20-23
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 2022)

Goals/Milestones

CY17 Goal – Methodology determined, reviewers trained, data abstraction and reviews begin
☑ Protocol submitted; methodology determined
CY18, CY19, CY20, CY21 Goals – Virtual Reviews commence
☑ Data abstraction
☑ Reviews in progress
CY22 –CY23 Goal – Data analysis, result dissemination
☑Reviews and adjudication in progress
☐Report results from data analysis and dissemination materials produced

Comments/Challenges/Issues/Concerns

- Final case reviews being completed and data analysis

Budget Expenditure to Date

- Projected Expenditure: $3,994,076
- Actual Expenditure: $3,717,778 (as of 03-19-22)

Multi-institutional Multi-disciplinary Injury Mortality Investigation in Civilian Prehospital Environment (MIMIC): Focus on Improving Prehospital Trauma Survival

American Trauma Society
22 September 2021

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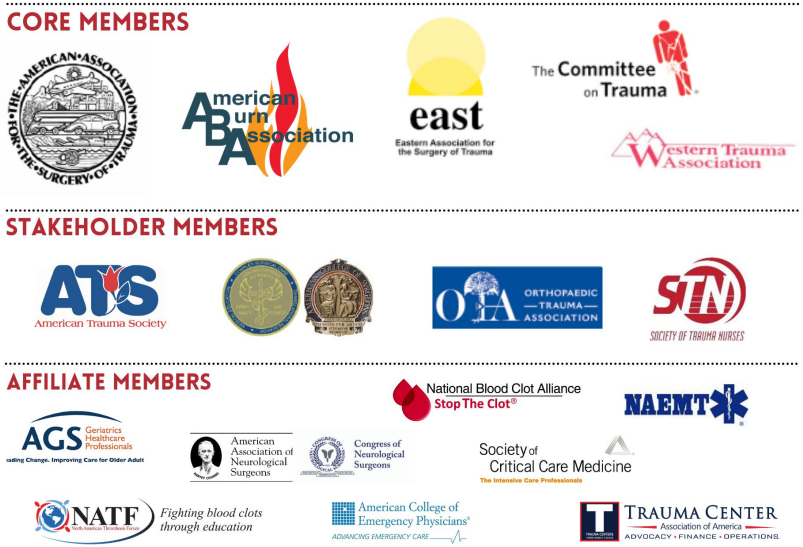
Acknowledgements

CNTR
COALITION FOR NATIONAL TRAUMA RESEARCH



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Disclaimer

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Objectives

- Establish the epidemiology of potentially survivable injury and preventable deaths after injury in adults and children
- Utilize epidemiological data on trauma injury and death to highlight research and innovation gaps in early post injury hemostasis and resuscitation

Scope of the Problem

All Cause Death

10 Leading Causes of Death, United States
2017, All Races, Both Sexes

	Age Groups										
Rank	<1	1-4	5-9	10-14	15-24	25-34	35-44	45-54	55-64	65+	All Ages
1	Congenital Anomalies 4,580	Unintentional Injury 1,267	Unintentional Injury 718	Unintentional Injury 860	Unintentional Injury 13,441	Unintentional Injury 25,669	Unintentional Injury 22,828	Malignant Neoplasms 39,266	Malignant Neoplasms 114,810	Heart Disease 519,052	Heart Disease 647,457
2	Short Gestation 3,749	Congenital Anomalies 424	Malignant Neoplasms 418	Suicide 517	Suicide 6,252	Suicide 7,948	Malignant Neoplasms 10,900	Heart Disease 32,658	Heart Disease 80,102	Malignant Neoplasms 427,896	Malignant Neoplasms 599,108
3	Maternal Pregnancy Comp. 1,432	Malignant Neoplasms 325	Congenital Anomalies 188	Malignant Neoplasms 437	Homicide 4,905	Homicide 5,488	Heart Disease 10,401	Unintentional Injury 24,461	Unintentional Injury 23,408	Chronic Low. Respiratory Disease 136,139	Unintentional Injury 169,936
4	SIDS 1,363	Homicide 303	Homicide 154	Congenital Anomalies 191	Malignant Neoplasms 1,374	Heart Disease 3,681	Suicide 7,335	Suicide 8,561	Chronic Low. Respiratory Disease 18,667	Cerebro-vascular 125,653	Chronic Low. Respiratory Disease 160,201
5	Unintentional Injury 1,317	Heart Disease 127	Heart Disease 75	Homicide 178	Heart Disease 913	Malignant Neoplasms 3,616	Homicide 3,351	Liver Disease 8,312	Diabetes Mellitus 14,904	Alzheimer's Disease 120,107	Cerebro-vascular 146,383
6	Placenta Cord Membranes 843	Influenza & Pneumonia 104	Influenza & Pneumonia 62	Heart Disease 104	Congenital Anomalies 355	Liver Disease 918	Liver Disease 3,000	Diabetes Mellitus 6,409	Liver Disease 13,737	Diabetes Mellitus 59,020	Alzheimer's Disease 121,404
7	Bacterial Sepsis 592	Cerebro-vascular 66	Chronic Low. Respiratory Disease 59	Chronic Low. Respiratory Disease 75	Diabetes Mellitus 248	Diabetes Mellitus 823	Diabetes Mellitus 2,118	Cerebro-vascular 5,198	Cerebro-vascular 12,708	Unintentional Injury 55,951	Diabetes Mellitus 83,564
8	Circulatory System Disease 449	Septicemia 48	Cerebro-vascular 41	Cerebro-vascular 56	Influenza & Pneumonia 190	Cerebro-vascular 593	Cerebro-vascular 1,811	Chronic Low. Respiratory Disease 3,975	Suicide 7,982	Influenza & Pneumonia 46,862	Influenza & Pneumonia 55,672
9	Respiratory Distress 440	N 44	33	51	Disease 188	513	804	2,441	5,838	Nephritis 41,670	Nephritis 50,633
10	Neonatal Hemorrhage 379	Perinatal Period 42	Benign Neoplasms 31	Benign Neoplasms 31	Complicated Pregnancy 168	Complicated Pregnancy 512	HIV 831	Homicide 2,275	Nephritis 5,671	Parkinson's Disease 31,177	Suicide 47,173

WISQARS™ Produced By: National Center for Injury Prevention and Control, Centers for Disease Control and Prevention
Data Source: National Center for Health Statistics (NCHS), National Vital Statistics System

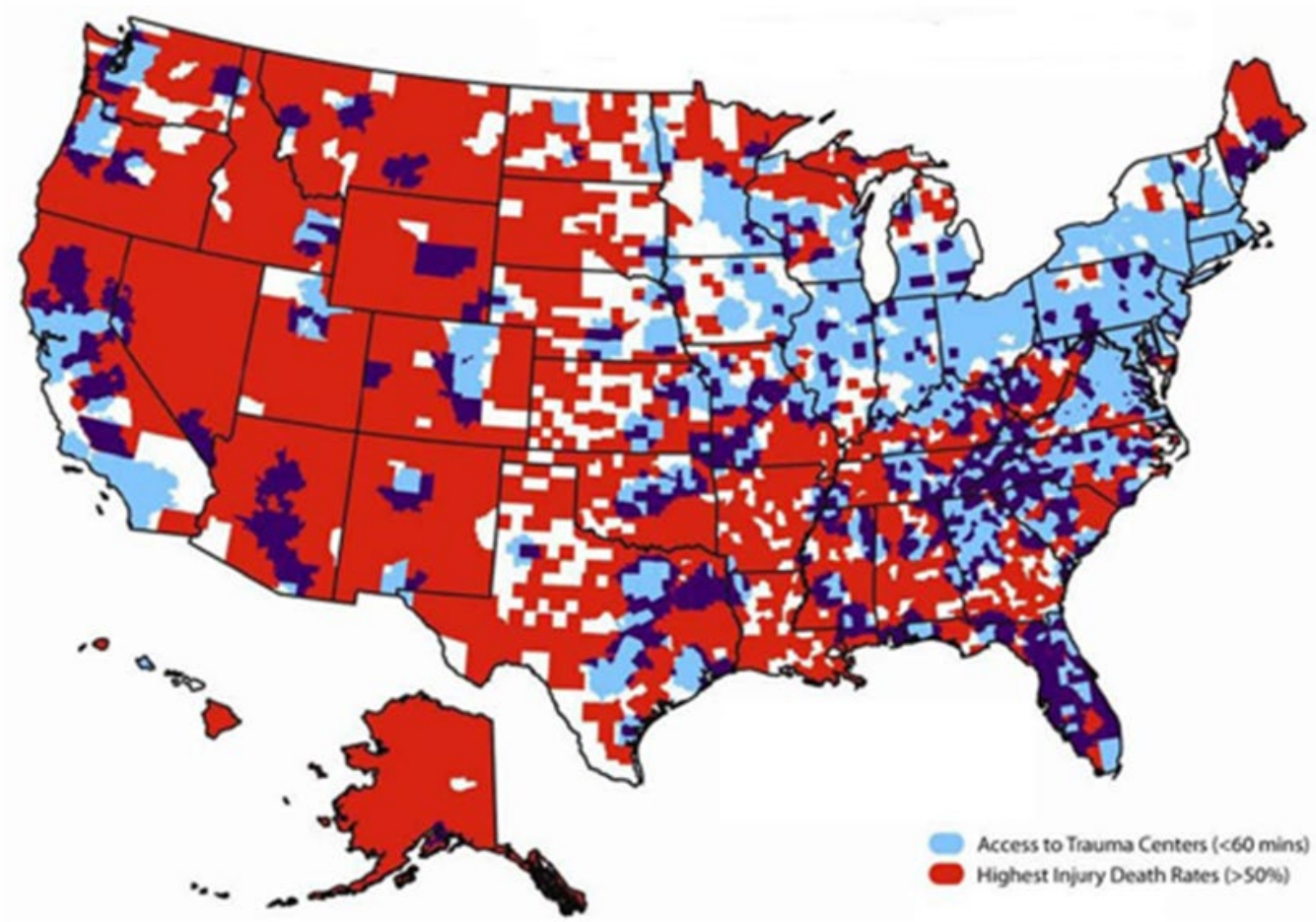


FIGURE 2-3 Lack of access to an appropriate level of trauma care is associated with higher trauma patient mortality.

SOURCE: Map provided by Charles Branas, Ph.D., Professor of Epidemiology, University of Pennsylvania, 2016.

110

 # people in United States

who will

DIE today

from potentially survivable injury

before reaching medical care

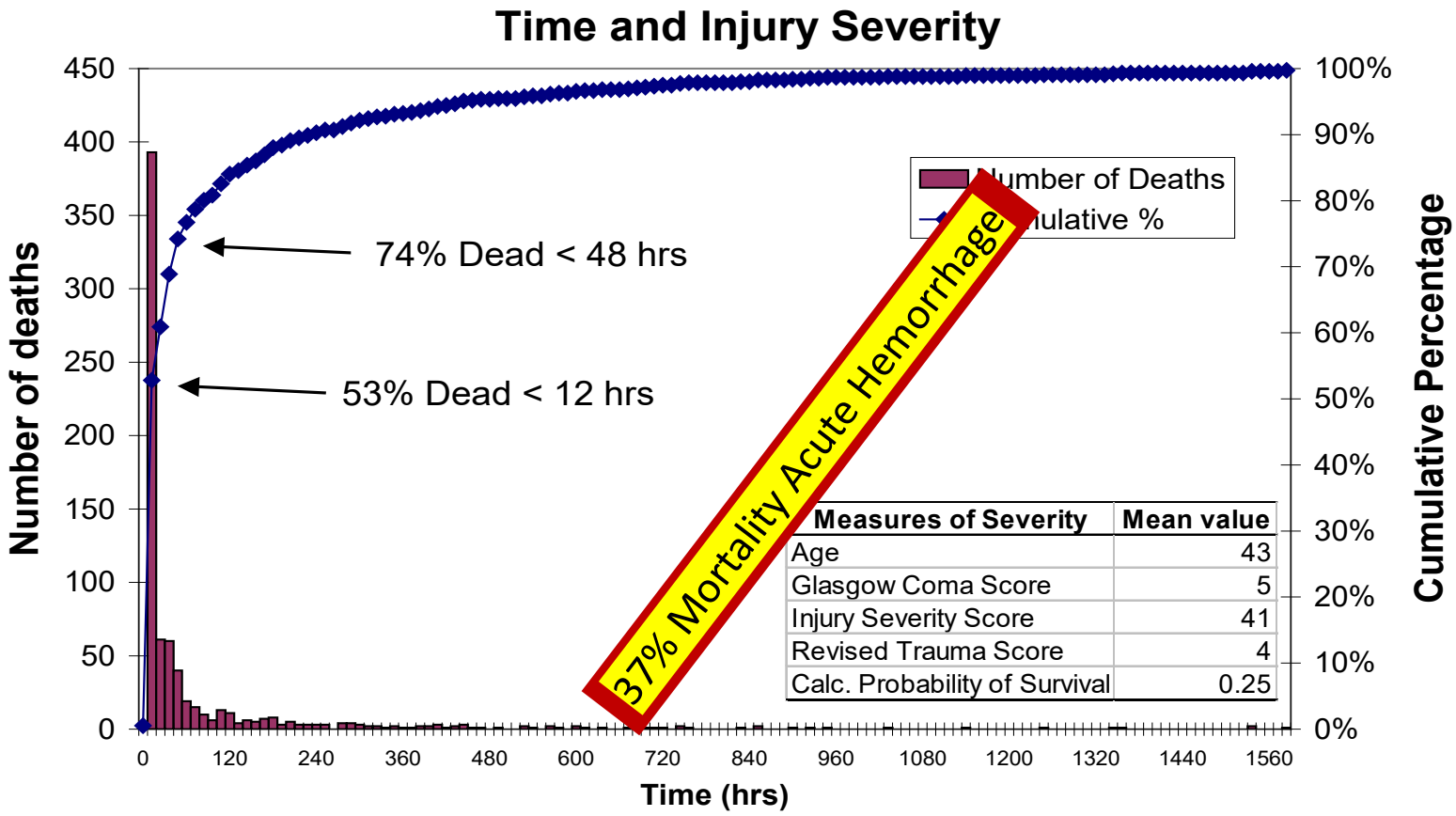
Perspective

In one year, that number will equal the number of people it takes to fill Camden Yards in Baltimore

Background

Civilian Hospital Injury Mortality

Trauma Center Mortality



Stewart: Analysis of 753 deaths in a Level I Trauma Center. J Trauma 2003.

Death Classification

Classification	N	Percent
Not Therapeutically Preventable	701	93.1%
Possibly Preventable	32	4.2%
Preventable	20	2.7%

Eliminating ALL errors, curing MOF, sepsis, DVT/PE, and secondary brain injury would theoretically reduce the number of deaths by 6.9%

Combat Hospital Injury Mortality

Died of Wounds Analysis

DOW Analysis

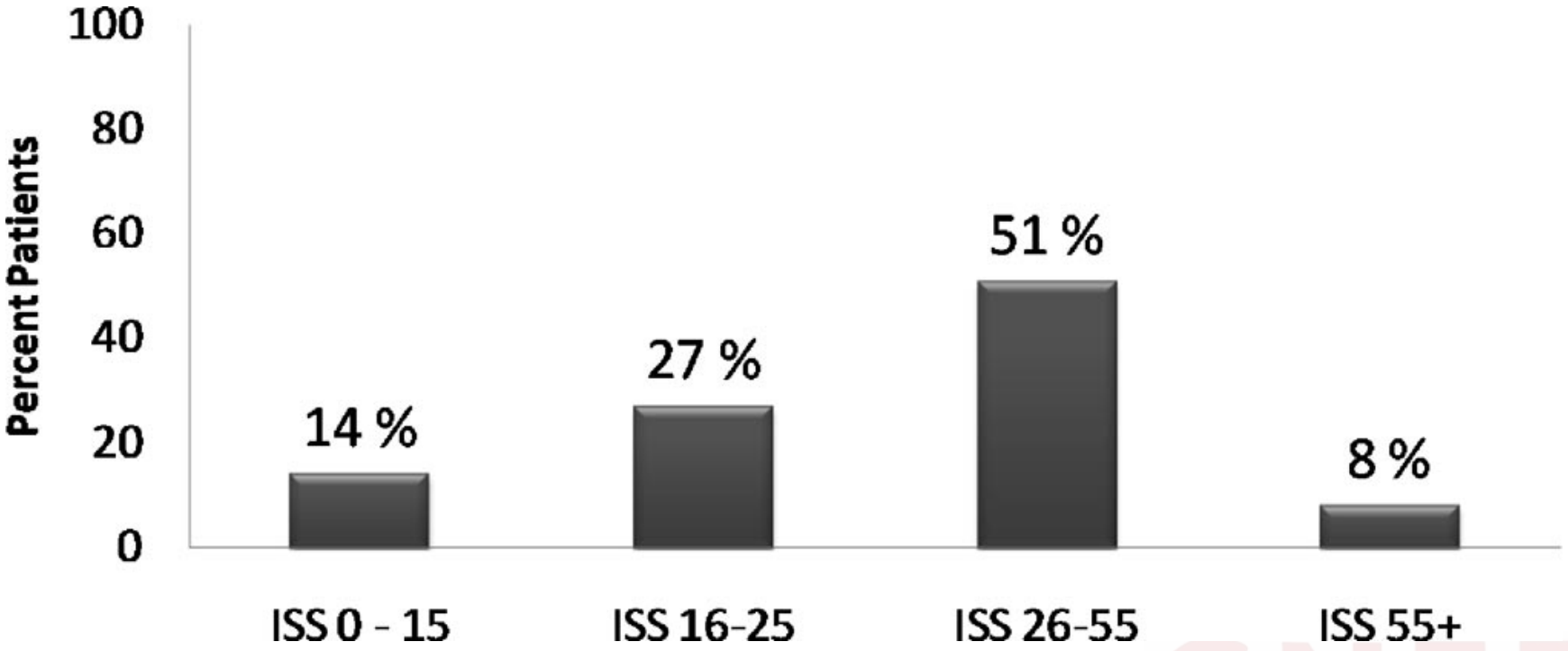
- Review died of wounds (DOW)deaths n=558
- Data sources
  - DoD Trauma Registry
  - Armed Forces Medical Examiner System (AFMES)
- Variables
  - Demographics
  - Mechanism and cause
  - Injury severity
- Expert panel trauma surgeons, emergency physician, neurosurgeon, and forensic pathologist graded deaths as non survivable or potentially survivable.

- Goal: Identify areas for improved training, medical care, material, research and development

DOW Analysis

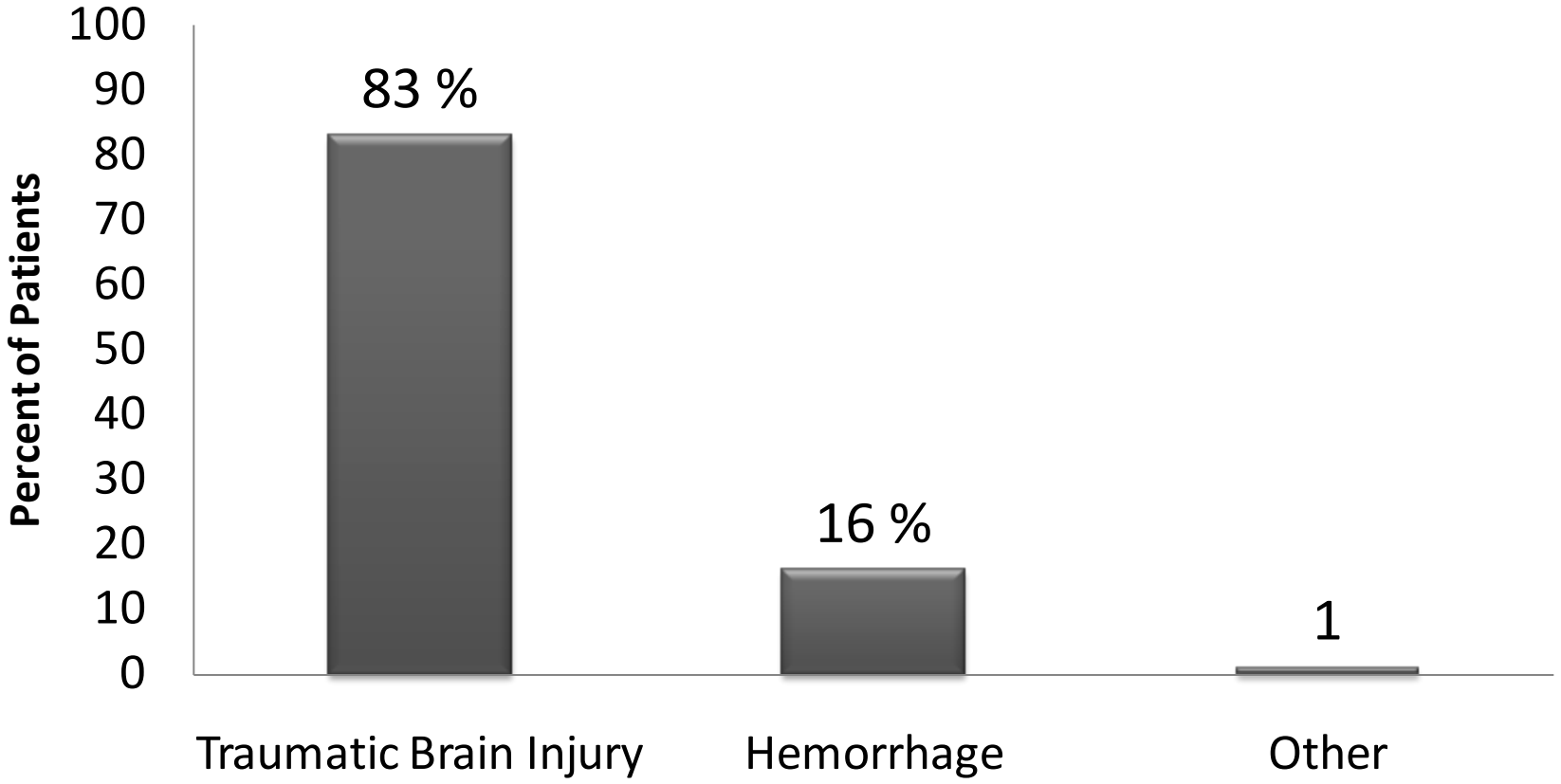
- DOW rate 4.6%
- Non-Survivable = 271 (48.6%)
- Potentially Survivable = 287 (51.4%)
- 51% presented in extremis with CPR on admission

DOW ISS



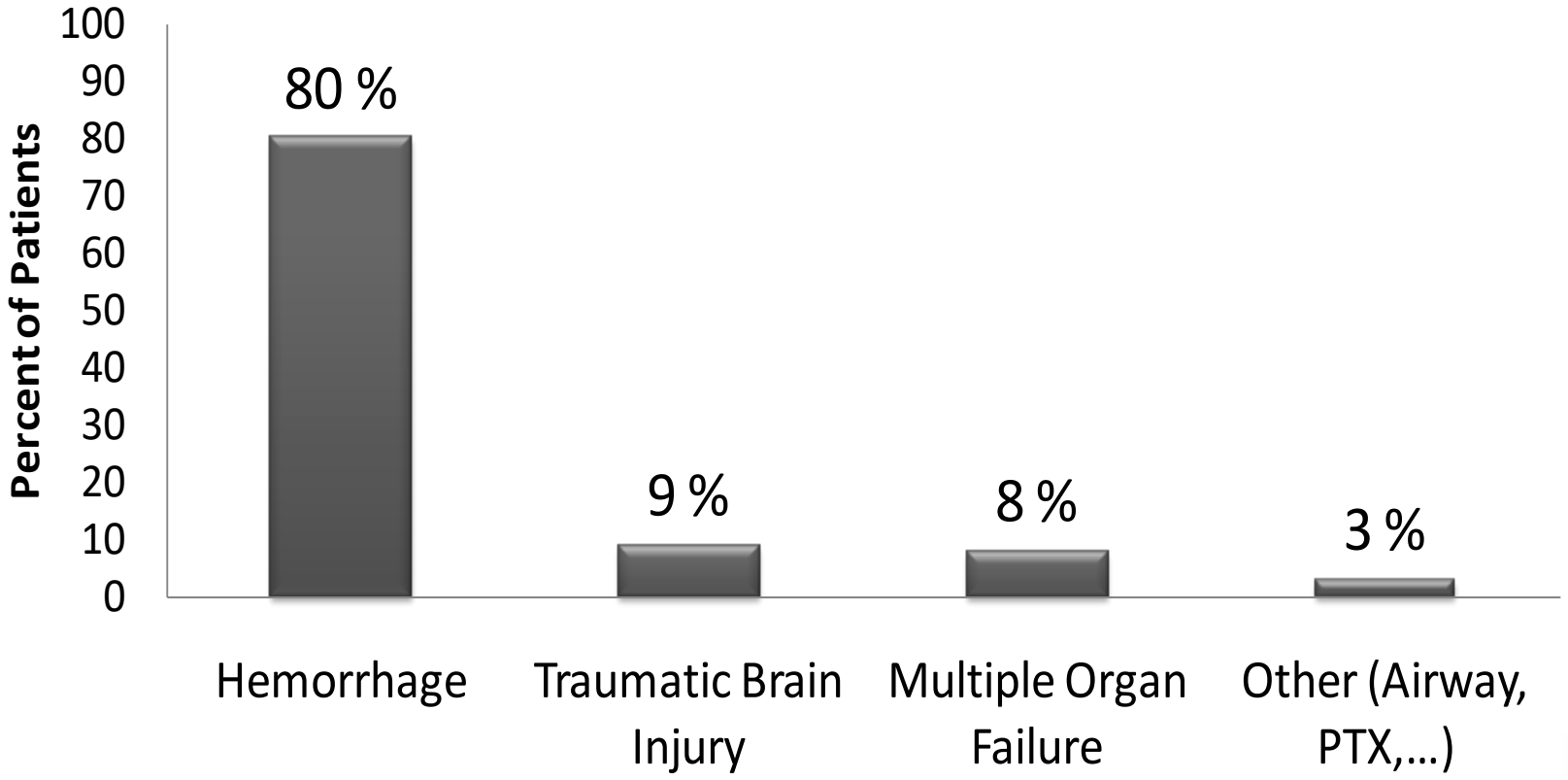
Eastridge et al: Died of Wounds on the Battlefield. J Trauma 2011

DOW
Non-Survivable Etiology



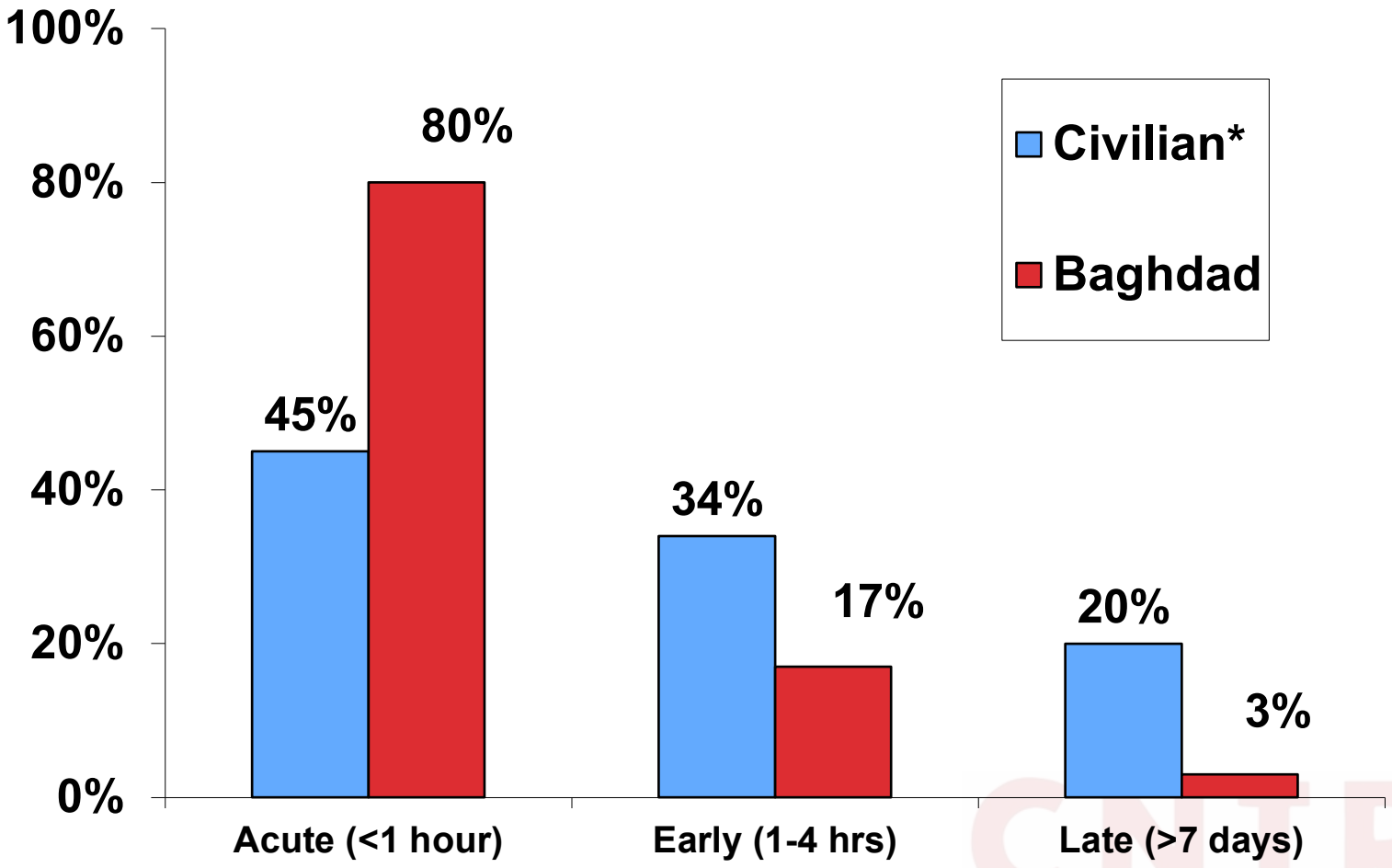
Eastridge et al: Died of Wounds on the Battlefield. J Trauma 2011

DOW
Potentially Survivable Etiology



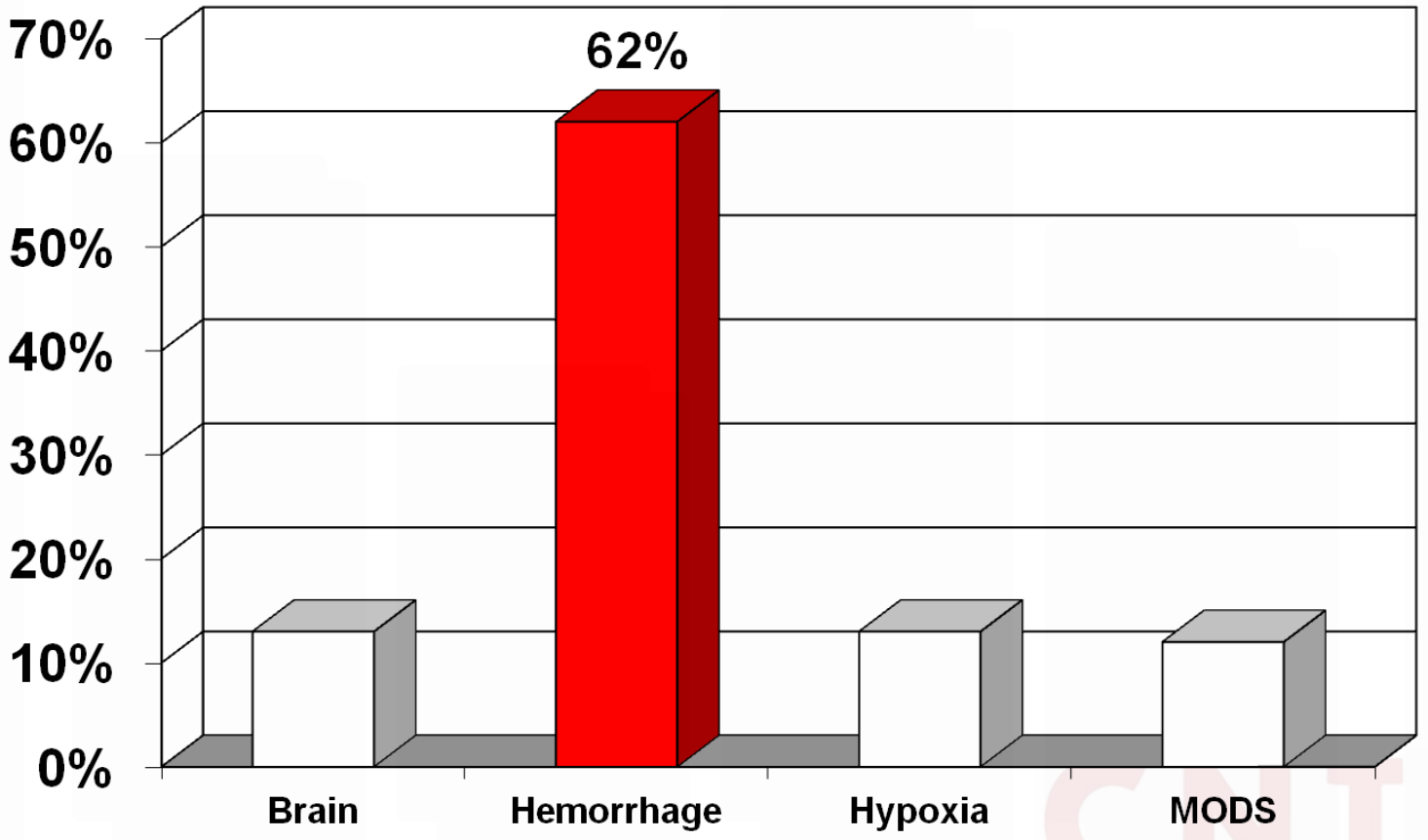
Eastridge et al: Died of Wounds on the Battlefield. J Trauma 2011

Timing of In-hospital Trauma Death



Martin et al., J Trauma 2009

Combat Hospital Death



Martin et al., J Trauma 2009

The Therapeutic Turnip

"I fear there is very little blood to be squeezed from the therapeutic turnip"

- Trauma centers
- Trauma systems
- Dedicated performance improvement activities
- Technological advances
- GME focus on training

Jonathan Rhoads, M.D.

William T. Fitts Lecture

American Association for the Surgery of Trauma, 1995

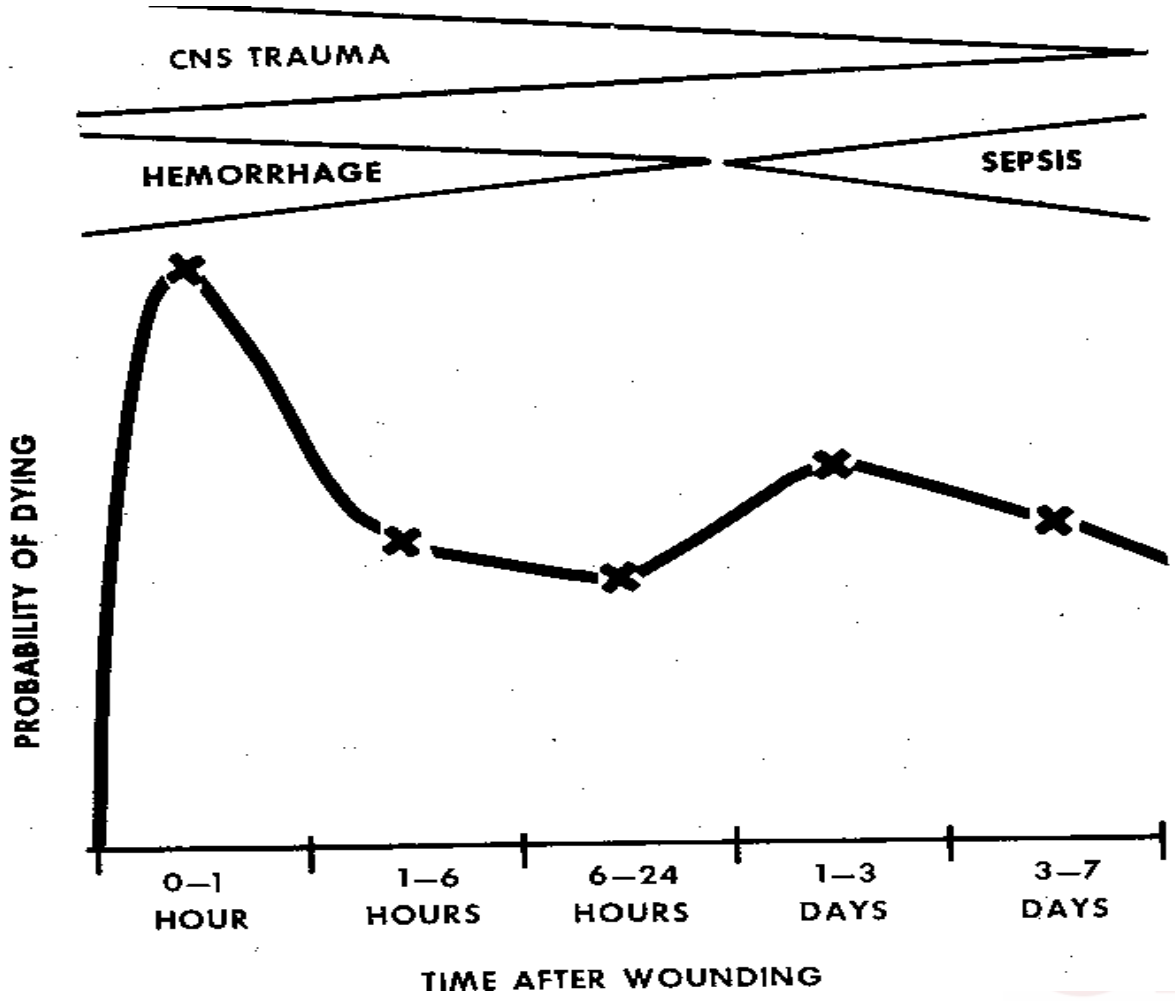
Genesis of the Research Question

How do we determine of survivability of those that never reach hospital care?

- Much bigger population
- More opportunities to effect outcomes

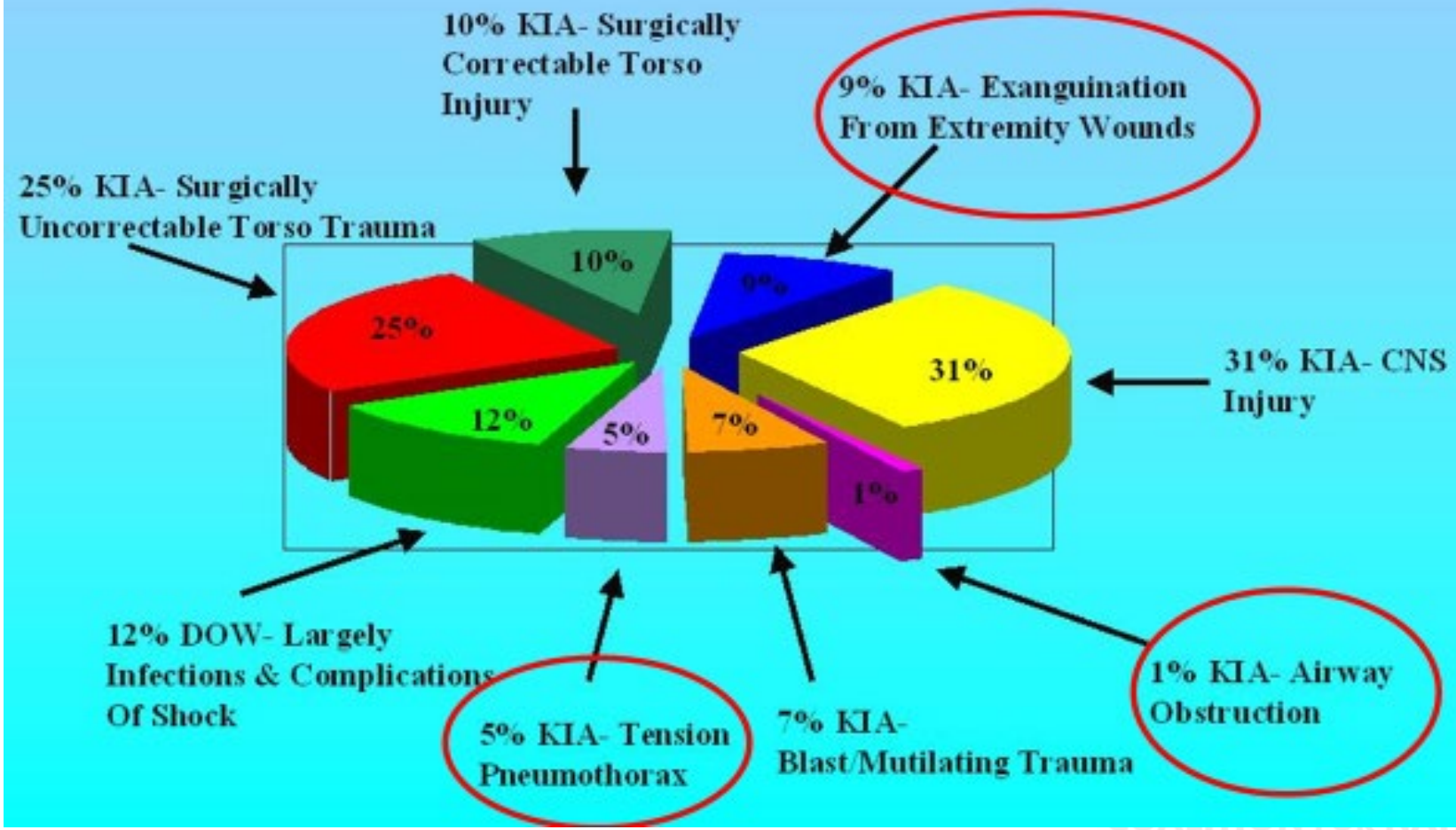
Battlefield Prehospital Mortality Mechanism and Causation

Empiric Probability Combat Death



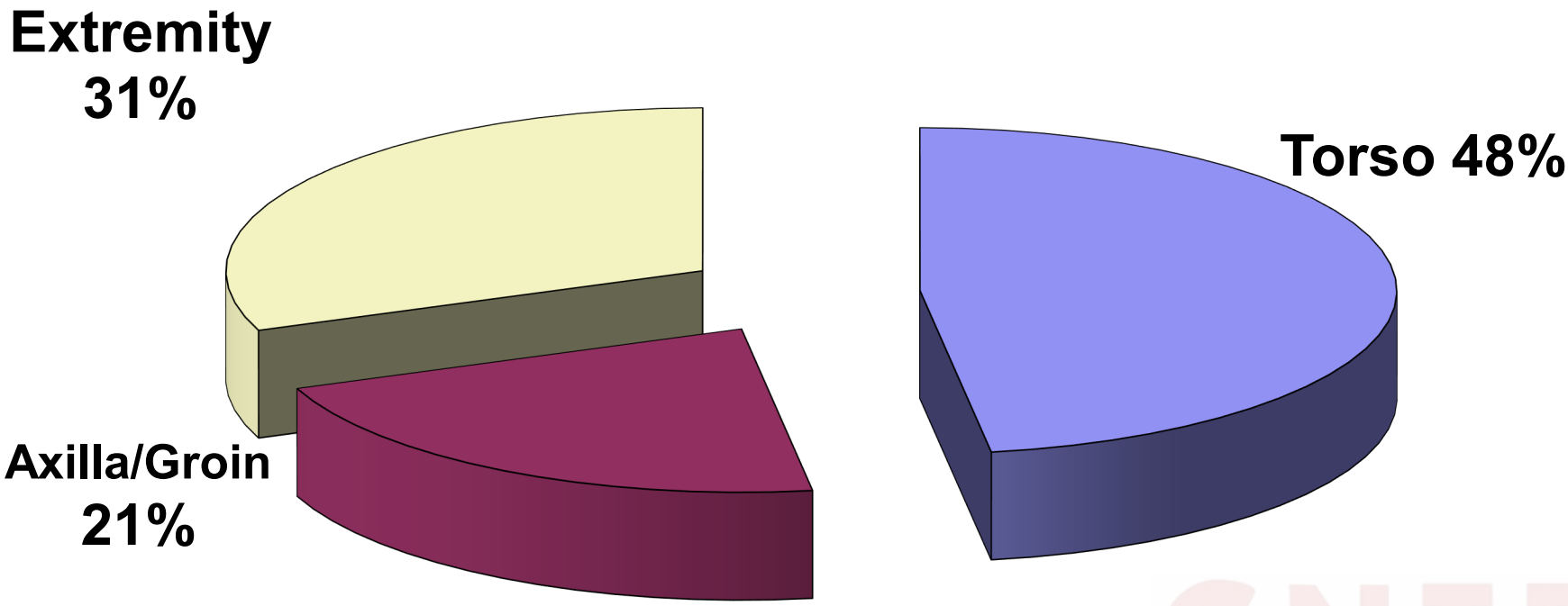
Bellamy, J Trauma, 1984

How People Die In Ground Combat (From COL Ron Bellamy)



Potentially Survivable Hemorrhagic Deaths on the Battlefield

Of PS deaths, 79% secondary to hemorrhage



Nearly 50% of deaths not amenable to field control

Injury Severity and Causes of Death From Operation Iraqi Freedom and Operation Enduring Freedom: 2003–2004 Versus 2006

Joseph F. Kelly, MD, Amber E. Ritenour, MD, Daniel F. McLaughlin, MD, Karen A. Bagg, MS, Amy N. Apodaca, MS, Craig T. Mallak, MD, Lisa Pearse, MD, Mary M. Lawnick, RN, BSN, Howard R. Champion, MD, Charles E. Wade, PhD, and COL John B. Holcomb, MC

- OEF / OIF analysis combat deaths
- 2003-04 (n = 486) vs. 2006 (n = 496)
  - KIA 75%
  - DOW 25%
- 24% deaths deemed potentially survivable
- Hemorrhage most prevalent cause of death in those with PS injuries (87% and 83%)

*Kelly et al. *J Trauma* 2008

Killed in Action Analysis

Battlefield Death Analysis

- Review battlefield deaths (n=4,596)
- Data sources
  - DoD Trauma Registry
  - Armed Forces Medical Examiner System (AFMES)
- Variables
  - Demographics
  - Mechanism and cause
  - Injury severity
- Expert panel trauma surgeons, emergency physician, neurosurgeon, and forensic pathologist graded deaths as non survivable or potentially survivable.
- Assumption of immediate access to resuscitative / operative care
- Goal: Broadly identify areas for improved training, medical care, material, research and development

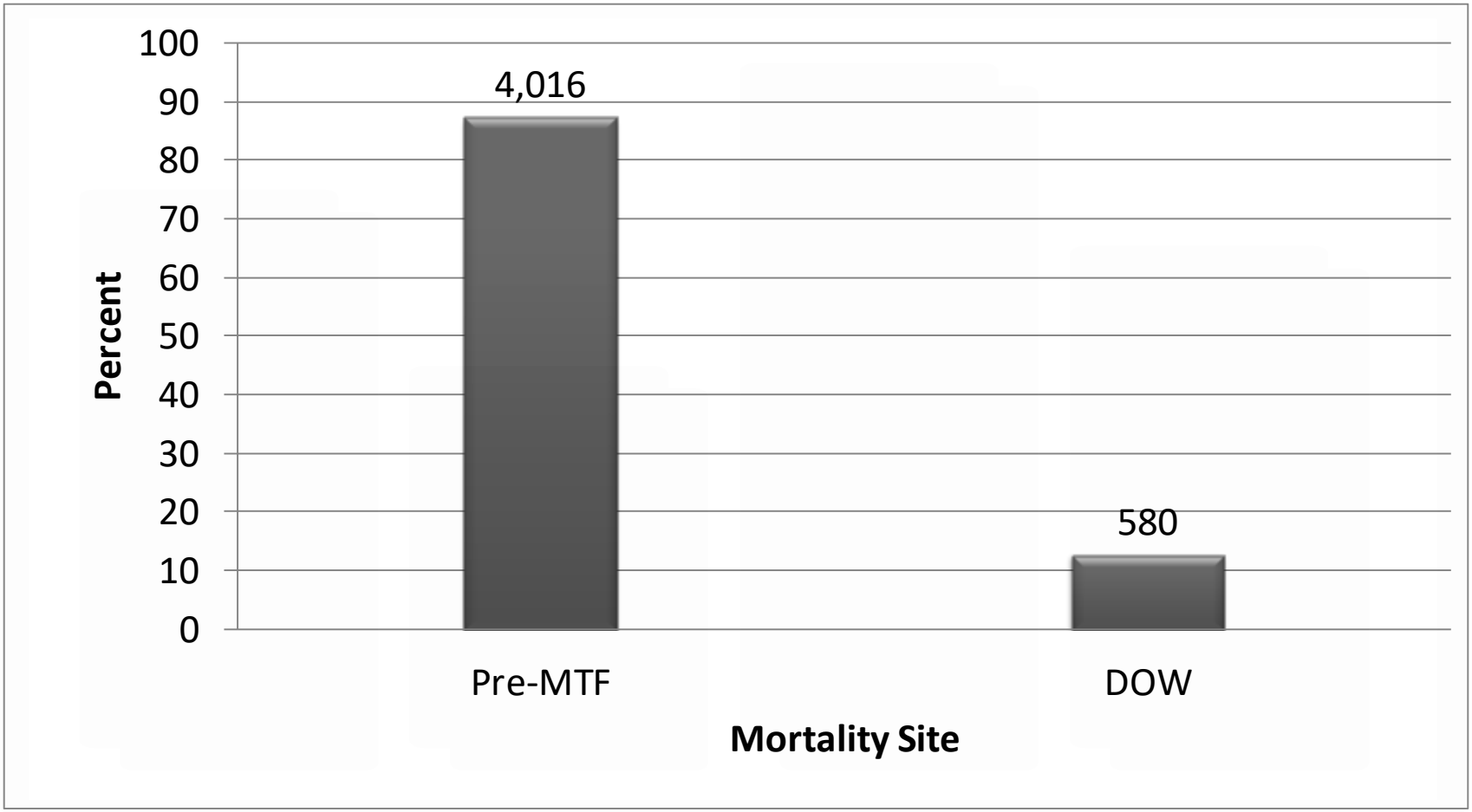
KIA Analysis

- Nonsurvivable
  - Dismemberment
  - Traumatic brain injury
  - Cervical cord transection (above C3)
  - Airway transection within thorax
  - Cardiac injury (>1/2”), thoracic aorta injury, pulmonary artery
  - Hepatic avulsion
  - Junctional lower extremity amputations with open pelvis with soft tissue loss

KIA Analysis

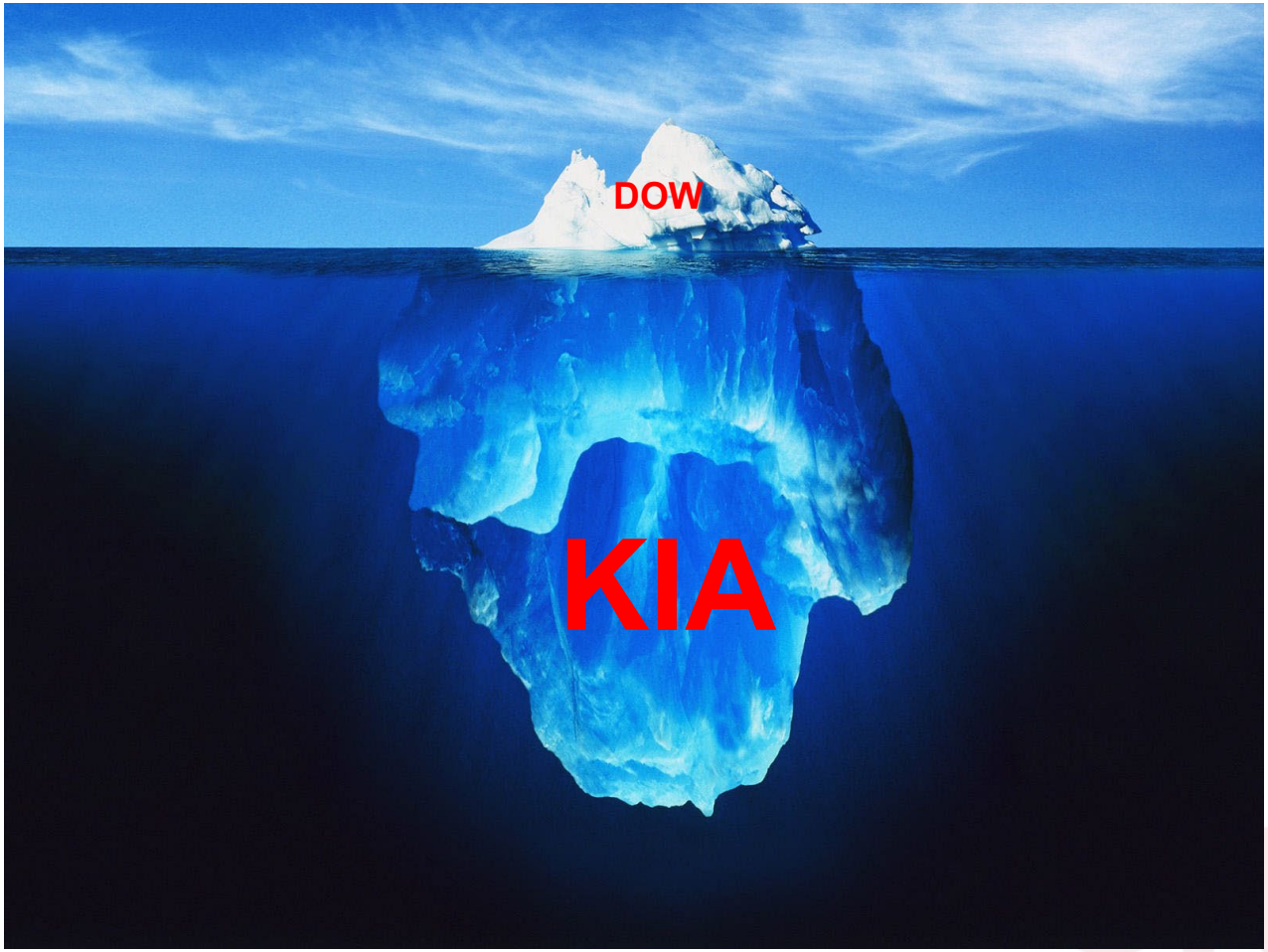
- Potentially survivable
  - All other injuries

Where Battlefield Casualties Die n=4,596

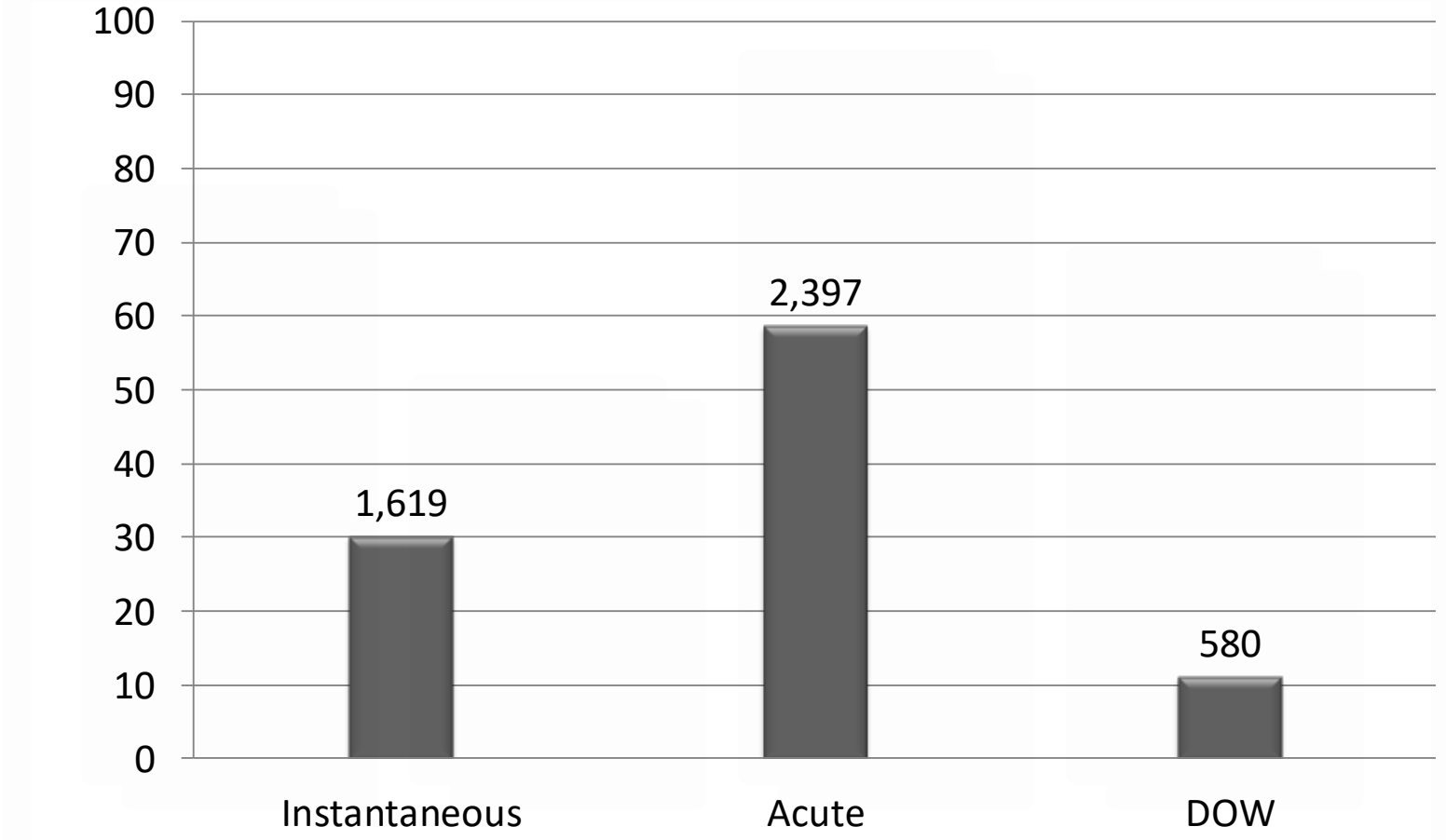


Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Putting it in Perspective

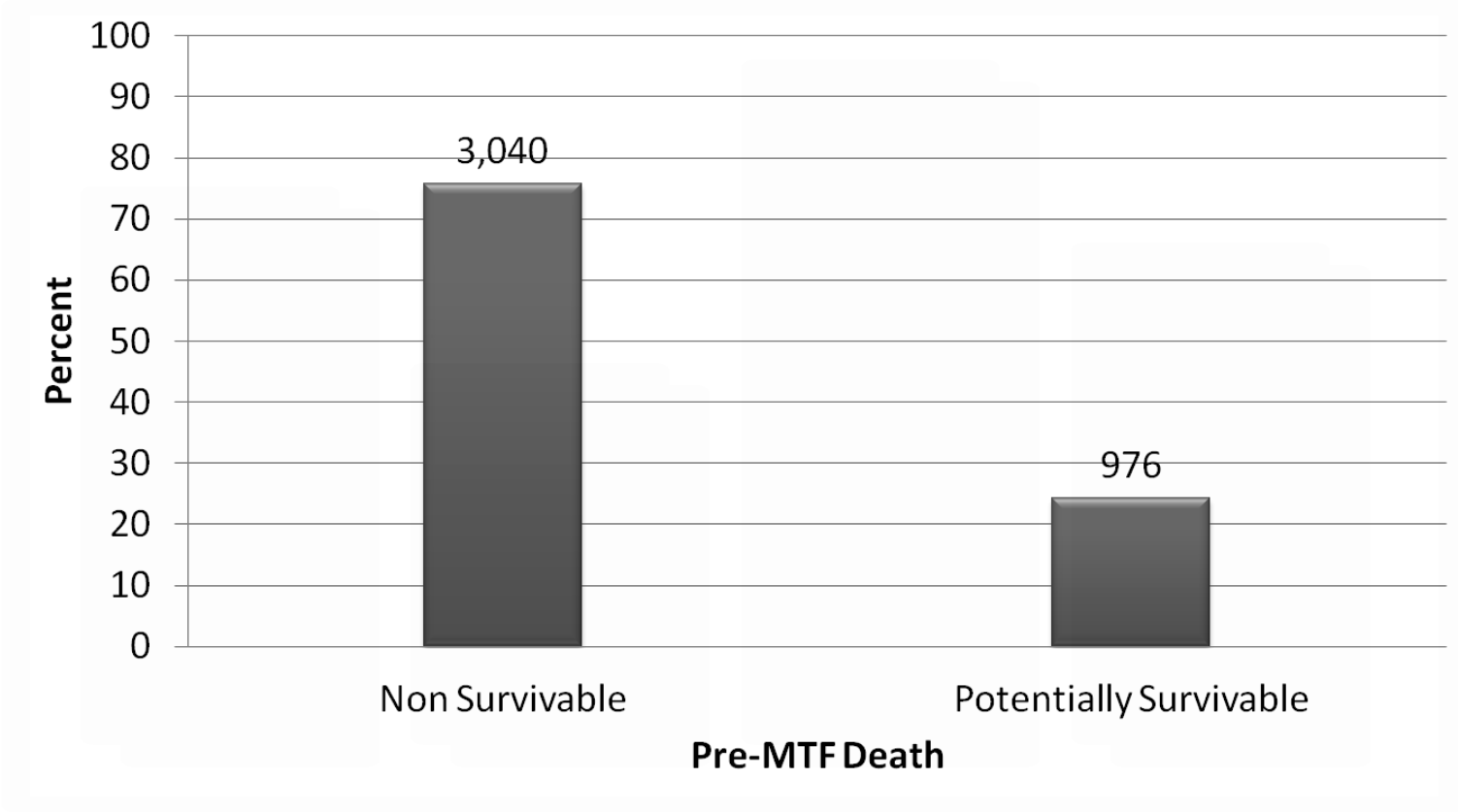


Distribution of Battlefield Death n=4,596



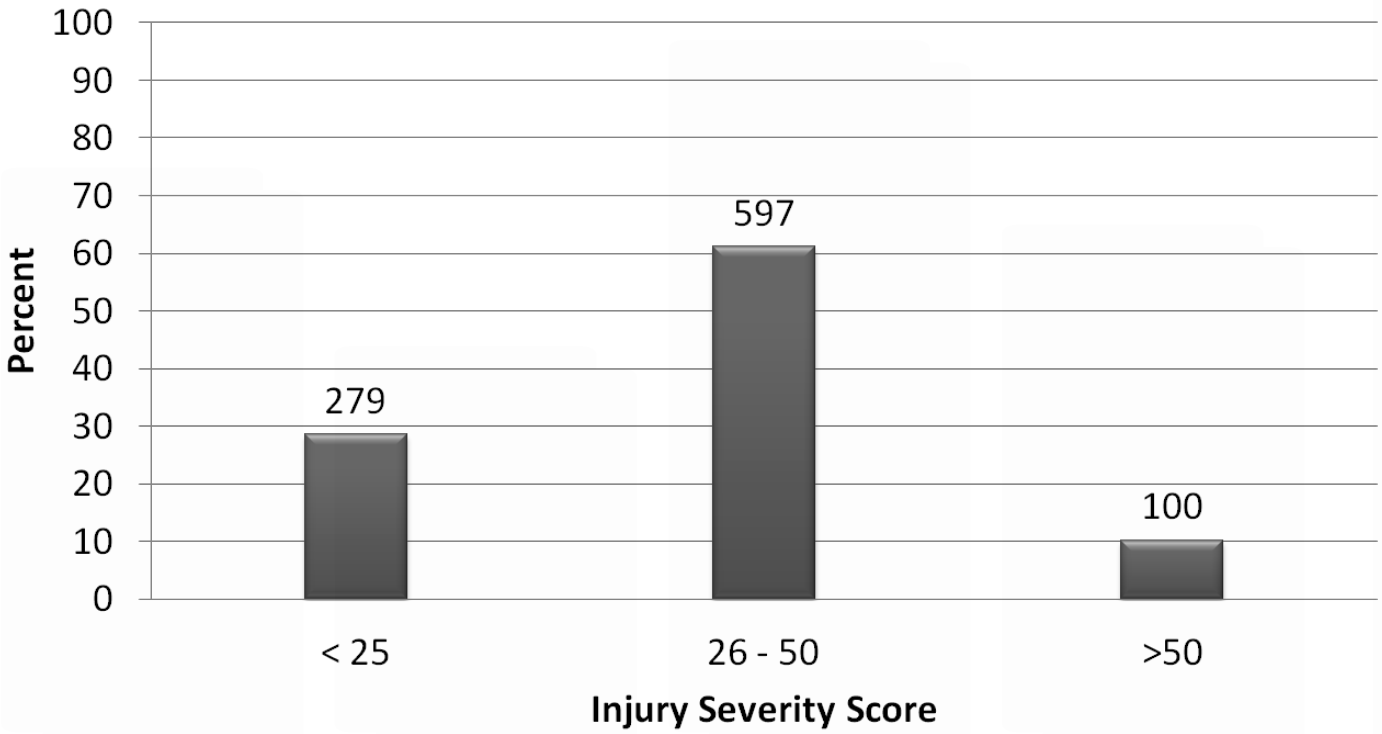
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Battlefield Pre-Hospital Death Analysis n=4,016 (DOW excluded)



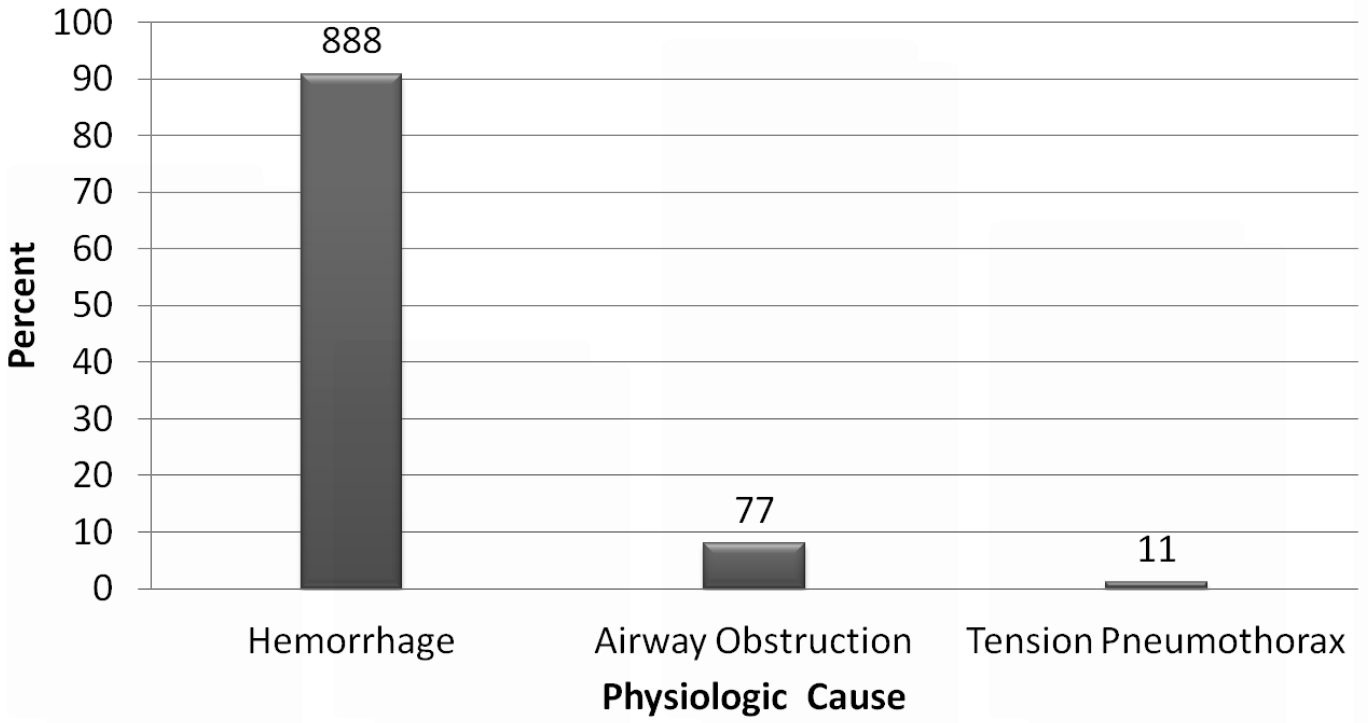
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Potentially Survivable Pre-MTF Death Analysis (n=976)



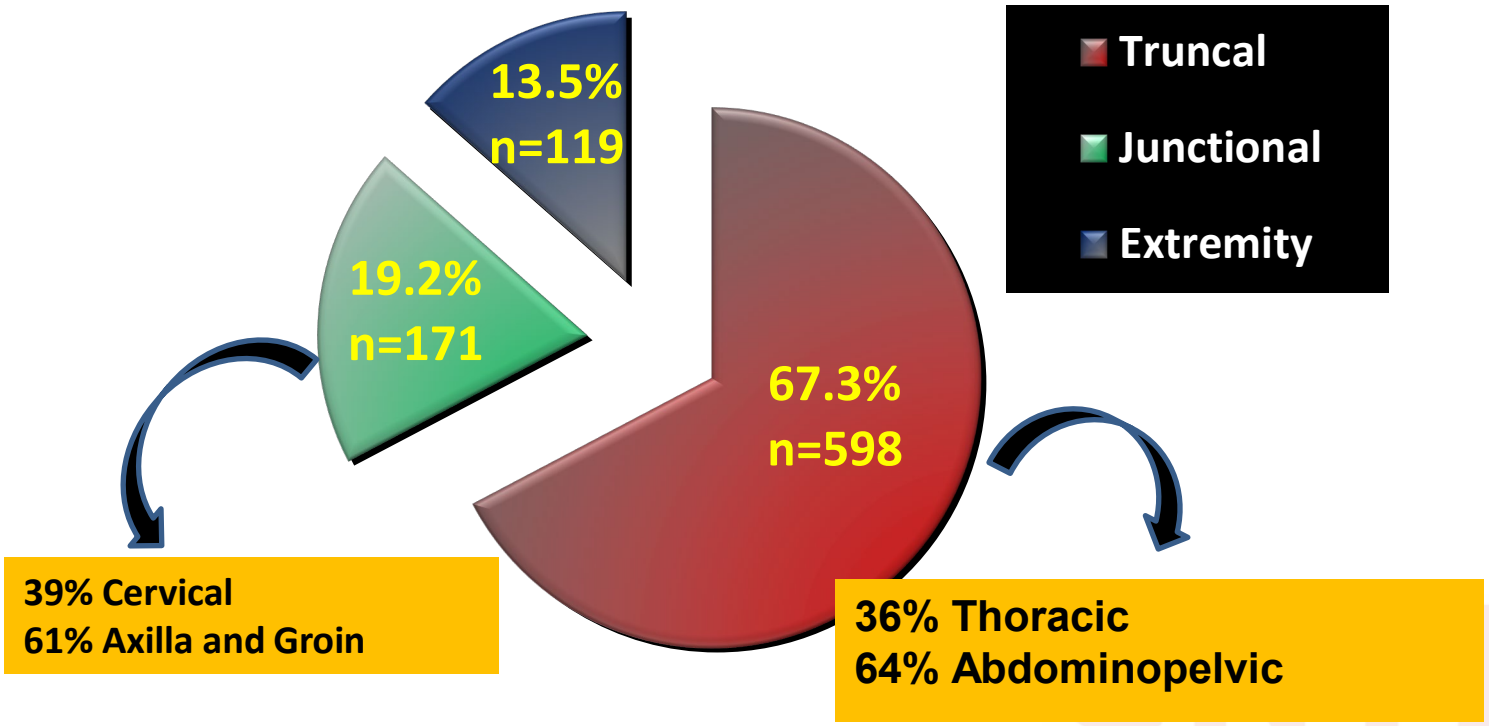
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Battlefield Acute Lethality Potentially Survivable n=976



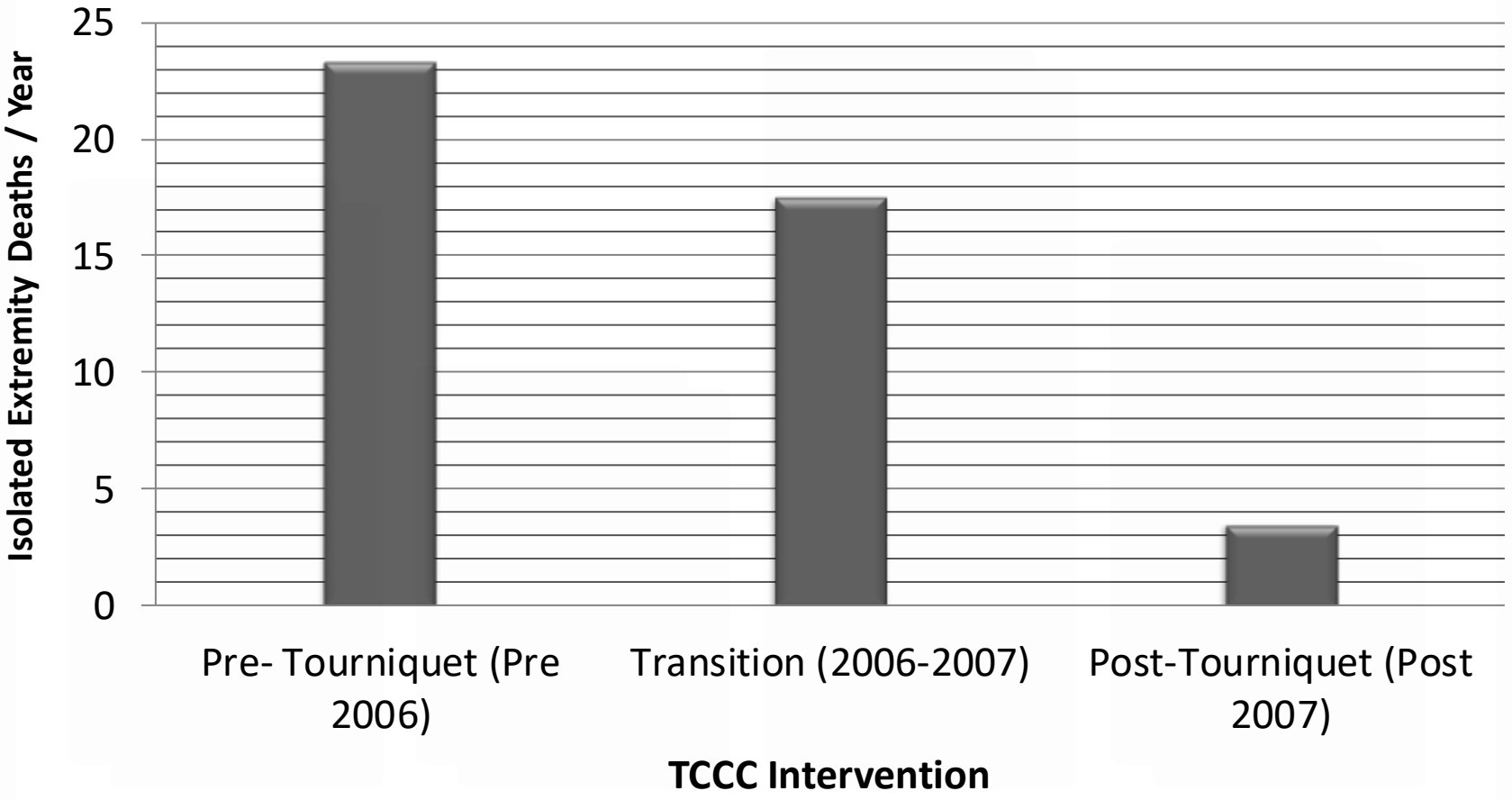
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Anatomic / Physiologic Cause of 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. In press.

Can We Have An Impact?



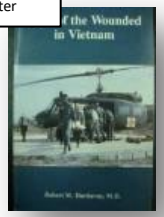
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

History of Battlefield Medical Innovation

OEF / OIF
- **Military trauma system (JTS / DoDTR)**
- **Damage control resuscitation**
- **Tactical Combat Casualty Care**
- **Tourniquet**
- **Understanding of preventable death**
- **Combat casualty care research**

Desert Shield/Storm
- Burn team augmentation of evacuation hospitals to provide theater-wide burn care
- Intercontinental aeromedical transport of burn patients

Vietnam
- Improved use of helicopters
- Improved laboratory support
- Portable radiology equipment
- Mechanical ventilators in theater



Korean Conflict
- Improved fluid resuscitation
- Forward availability of definitive surgery
- Helicopters for patient evac/transport
- Primary repair/grafts for vascular injury

World War II
- Whole blood/plasma a
- Specialty-specific surgical groups
- Antibiotics
- Fixed wing aero-medical evacuation

World War I
- IV fluids
- Blood transfusions
- Motorized ambulances
- Topical antisepsis

Summary

- **Most battlefield casualties (87.3 %) die on the battlefield**
- **Majority of battlefield deaths (75.7%) are non-survivable**
  - **Mitigation strategy: prevention**
- **Hemorrhage is the major mechanism of death in (90.9 %) of potentially survivable combat injuries**
  - **Mitigation strategy: hemorrhage control**
    - **Tourniquets**
    - **Junctional hemorrhage control**
    - **Intracorporeal hemostasis**
      - **Freeze dried plasma**
      - **TXA**
      - **Novel therapeutics**
    - **Damage control to point of injury**
    - **Extending the survival time window from POI to MTF**

Research Value

Death on the battlefield (2001–2011): implications for the future of combat casualty care

BJ Eastridge, RL Mabry, P Seguin… - Journal of trauma and …, 2012 - journals.lww.com

BACKGROUND Critical evaluation of all aspects of combat casualty care, including mortality, with a special focus on the incidence and causes of potentially preventable deaths among US combat fatalities, is central to identifying gaps in knowledge, training, equipment …

Cited by 1514

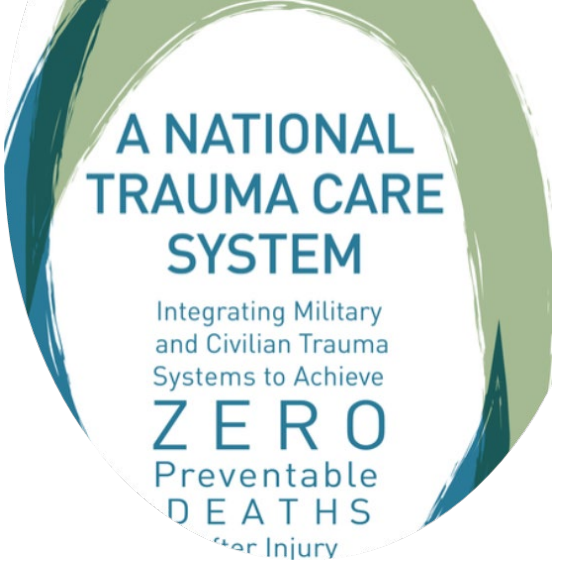
Conclusion

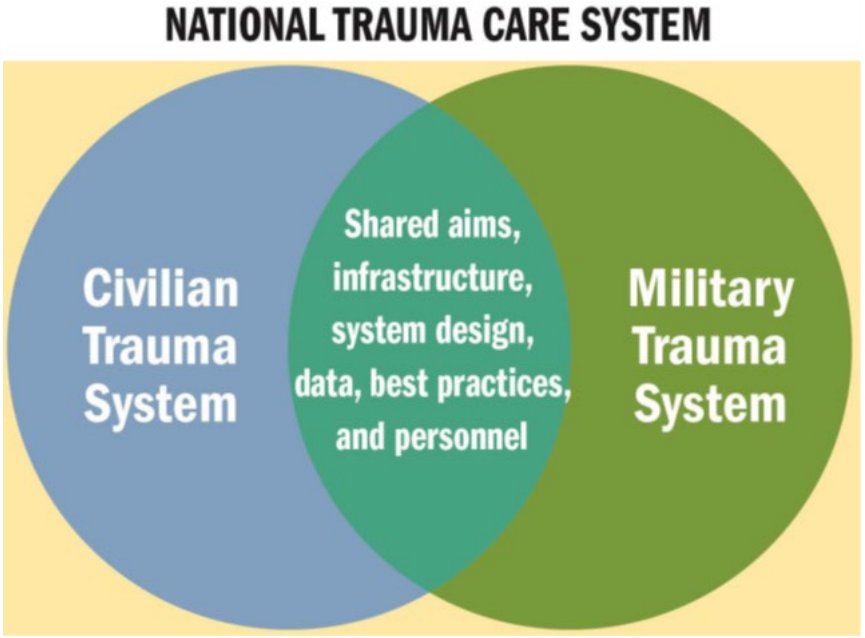
- Value of understanding battlefield mortality in military context
  - Joint Trauma System
    - Strategic decision making
  - Tactical Combat Casualty Care improvements
  - Reprioritized combat casualty care research and development activities
  - Command / leadership emphasis

Translation of Combat Casualty Care Lessons to Civilian Injury Management

- Death secondary to injury major problem for civilians and troops
- Most deaths in occur pre-hospital environment
- Many die from potentially survivable injury

National Trauma System Vision



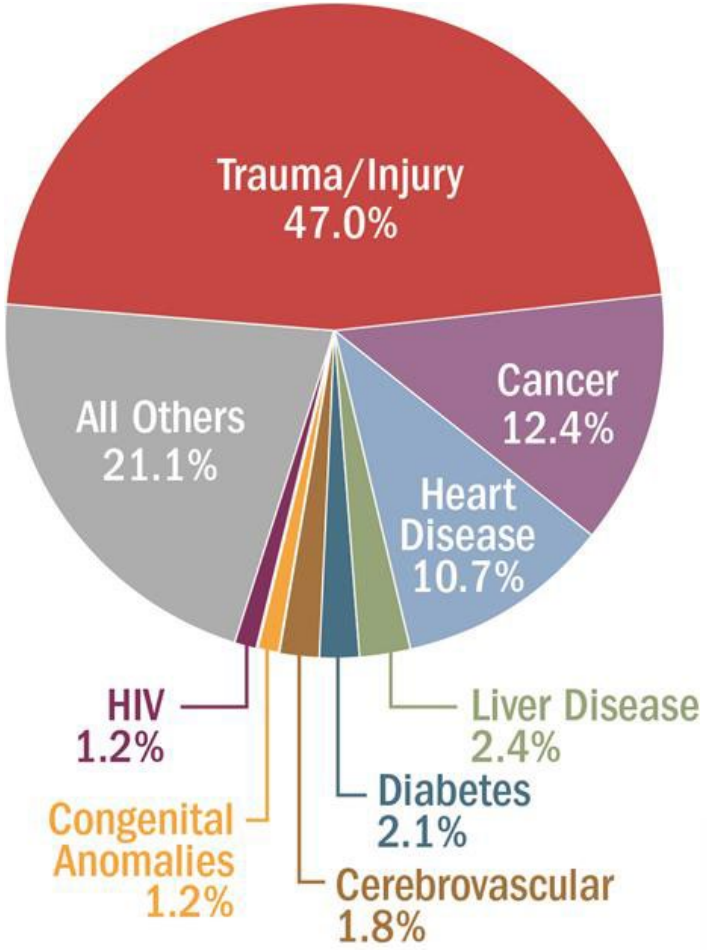


A unified effort is needed to ensure the delivery of optimal trauma care to save the lives of Americans injured within the United States and on the battlefield.

Trauma System
Scope of the Problem

- **Potentially survivable injuries US military operations**
  - **1,273 / 4,574 (27.6%)**

- **Potentially survivable injuries US civilian population 2014**
  - **147,790 x 0.276 = 40,790**



110

 # people in United States

who will

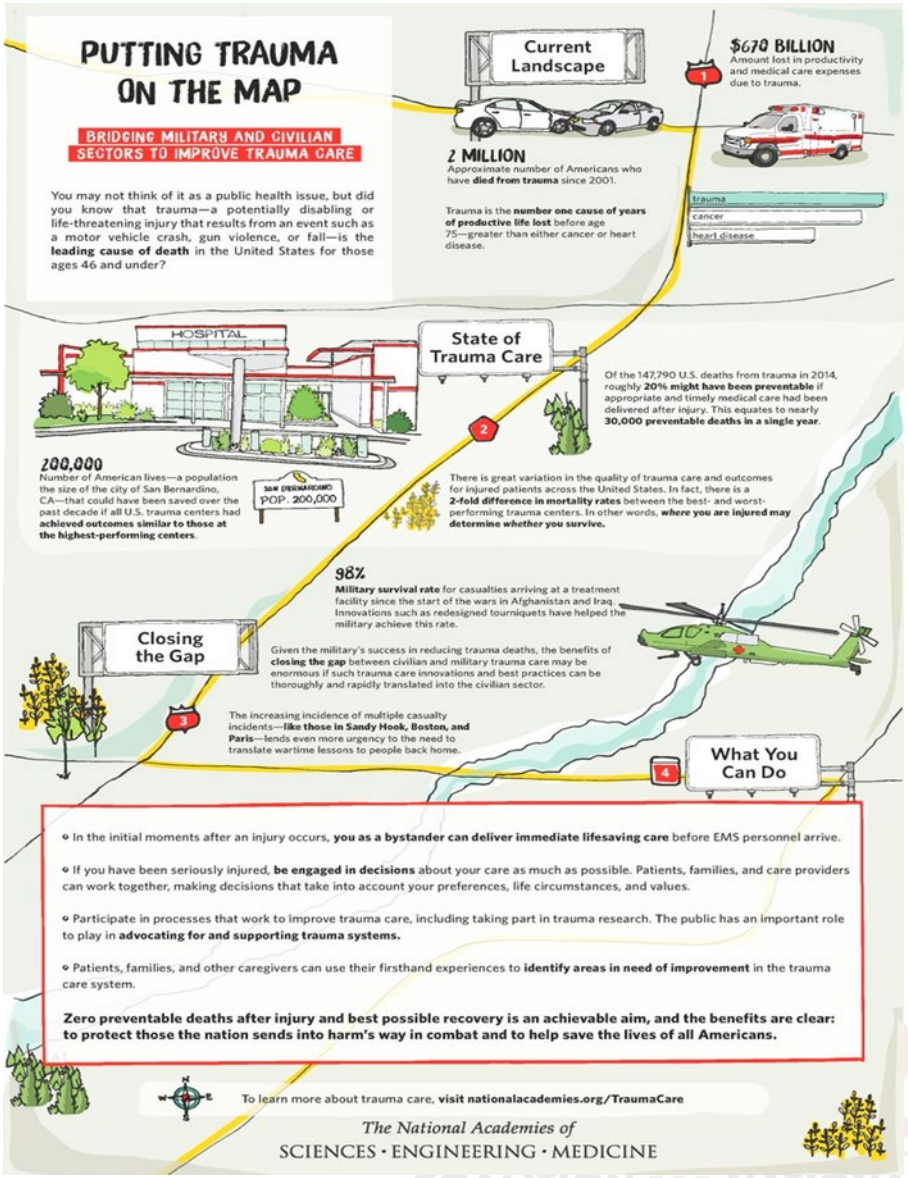
DIE today

from potentially survivable injury

before reaching medical care

Research Needed to Get Beyond Estimates

Objective Establishment of the Impact on Society



NASEM Zero Preventable Death

Specific Recommendations for Medical Examiner system Integration

Gap:

Linkages are incomplete or entirely missing among prehospital care; hospital-based acute care; rehabilitation; and medical examiner data.

“A critical but often neglected source of data—particularly in civilian systems—is autopsy reports on trauma deaths, which could be used to determine the preventability of fatalities based on a common, accepted lexicon.”

Recommendation 5:

The Secretary of Health and Human Services and the Secretary of Defense, together with their governmental, private, and academic partners, should work jointly to ensure that military and civilian trauma systems collect and share common data spanning the entire continuum of care

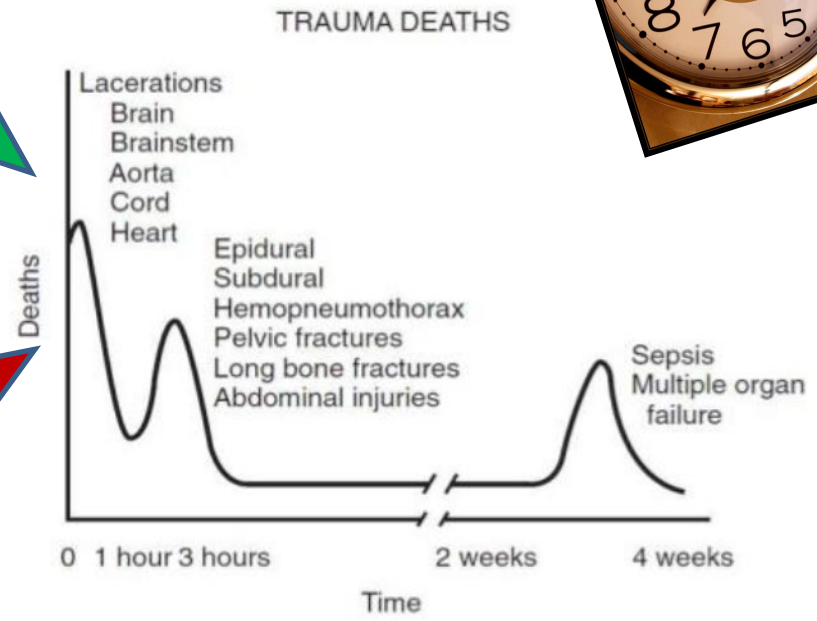
Civilian Prehospital Injury Mortality

Background/Scientific Rationale Pre-Hospital Mortality Civilian

Impact Not Well Quantitated

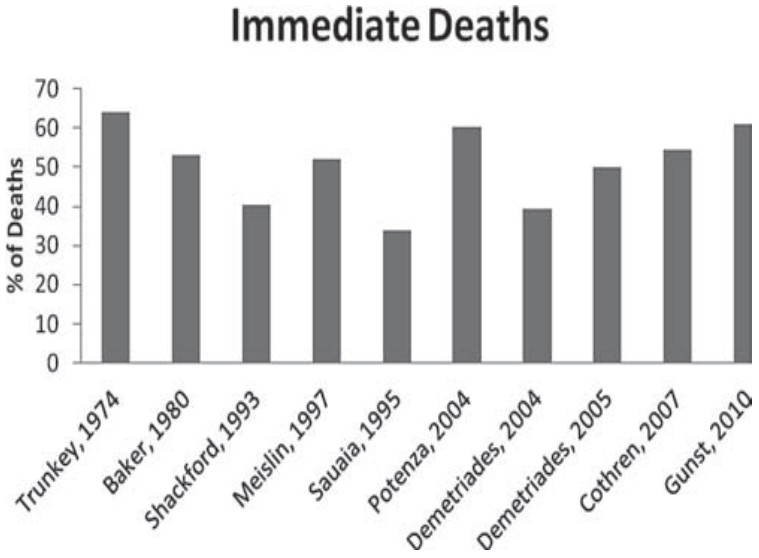
Potential Survivability Poorly Defined

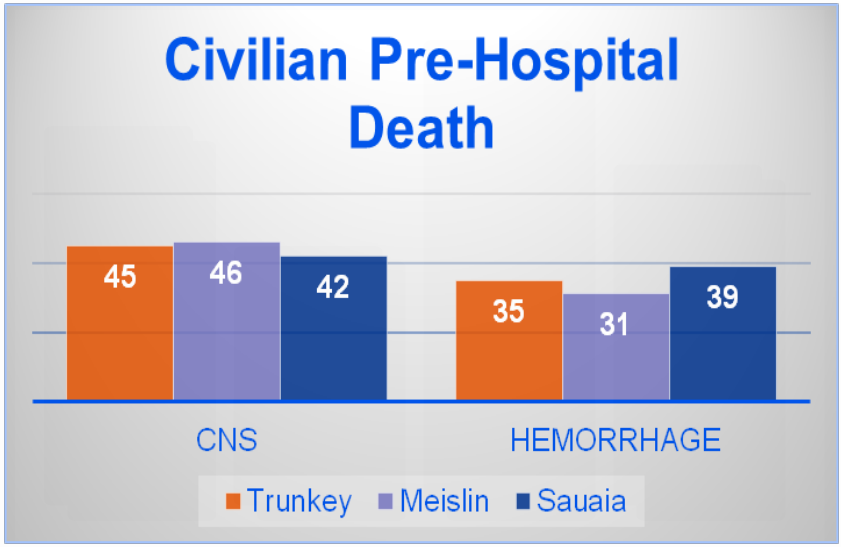
NASEM Report Emphasis



Case Fatality Rate (CFR) ~ 4.1% /
2-5 % Hospital Mortality Potentially Preventable

Civilian Injury Death Pre-Hospital





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Trunkey DD, Lim RC. Analysis of 425 consecutive trauma fatalities: anautopsy study. *J Am Coll Emerg Phys* 1974;3(6):368–371.

Goal and Strategy

Develop a framework and methodology for evaluating the causes and pathophysiologic mechanisms of pre-hospital deaths

Describe the epidemiology of all pre-hospital injury deaths for defined populations

- Age: 0-14; 15-24; 25-54; 55-74; 75 and older
- Type: Blunt vs. Penetrating vs. Other Sharp Forces
- Geography: Urban/Suburban; Rural/Wilderness
- Major focus of pathophysiology associated with death

Develop blueprint for a sustained effort at public health injury mitigation strategies in the pre-hospital environment

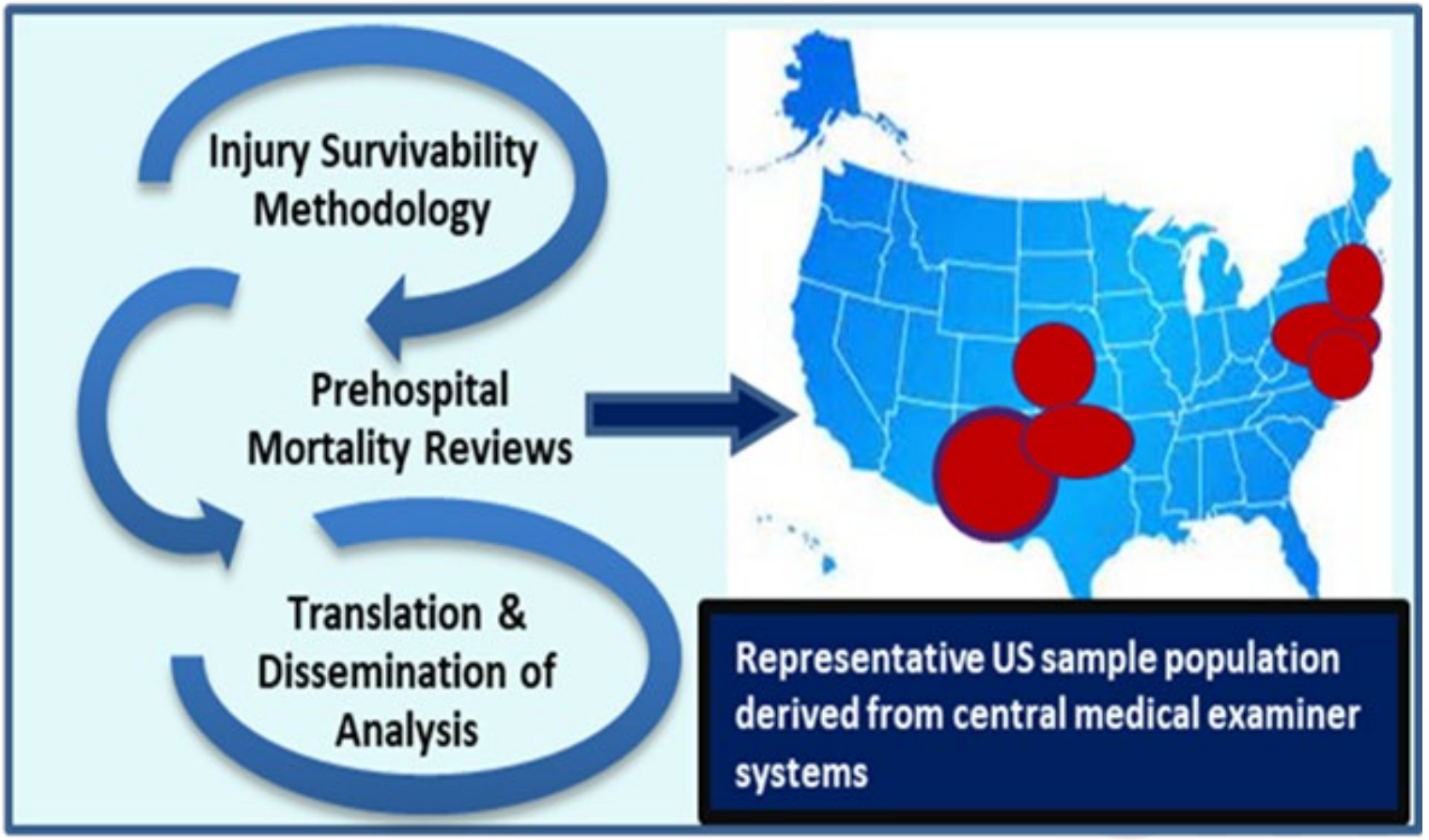
Identifying high priority areas for injury prevention, trauma systems performance improvement and research and development.

Study Setting
Six Regions in the Country

(all have a centralized ME system and use an 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.

MIMIC ME Sites



Methods

Steering Committee (Military and Civilian) to define definitions and process

Expert review panels (~ 80 Military and Civilian reviewers) (3-5 individuals each) will be identified and trained (Trauma Surgery, Emergency Medicine, Neurosurgery, Orthopedic Surgery, Forensic Pathology, EMS, Trauma Systems)

Panels will each review a certain number of cases using the PROFILER and assign a determination of survivability to each case – members of the panels will review cases independently (on-line without discussion with other panels members)

Discrepancies in determination of survivability will be identified by Coordinating Center and the panel will discuss these cases (either in person or via webex) and a second vote taken – ideally to reach consensus for each case

Methods

Collaborate with selected centralized OCME sites to identify 3,000 cases that meet criteria

Research Coordinators at each OCME will abstract defined set of data on each case and enter these data into REDCap

Data will then be used for following:

- Assign AIS injury codes (centrally by expert) and compute ISS, NISS … Abstractors will be trained on best way to describe each injury in detail
- ICD 10 injury codes and external causes of injury codes
- Geospatial mapping
- NEMSIS cross-referencing

Specific data from CRFs will be used to populate an on-line 'Case PROFILER' that will summarize the pertinent information about each case and provide electronic access to specific documents (e.g. ME summary, EMS run sheet) for electronic case review

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. Due to a blunt, penetrating or other sharp force
3. Adequate forensic record

Exclusion Criteria:

1. Non-mechanical causes: poisoning, incl. drug overdoses, asphyxia, drowning,
2. Decomposed remains only (not fully fleshed with distinguishable organs)

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

Anatomic Survivability

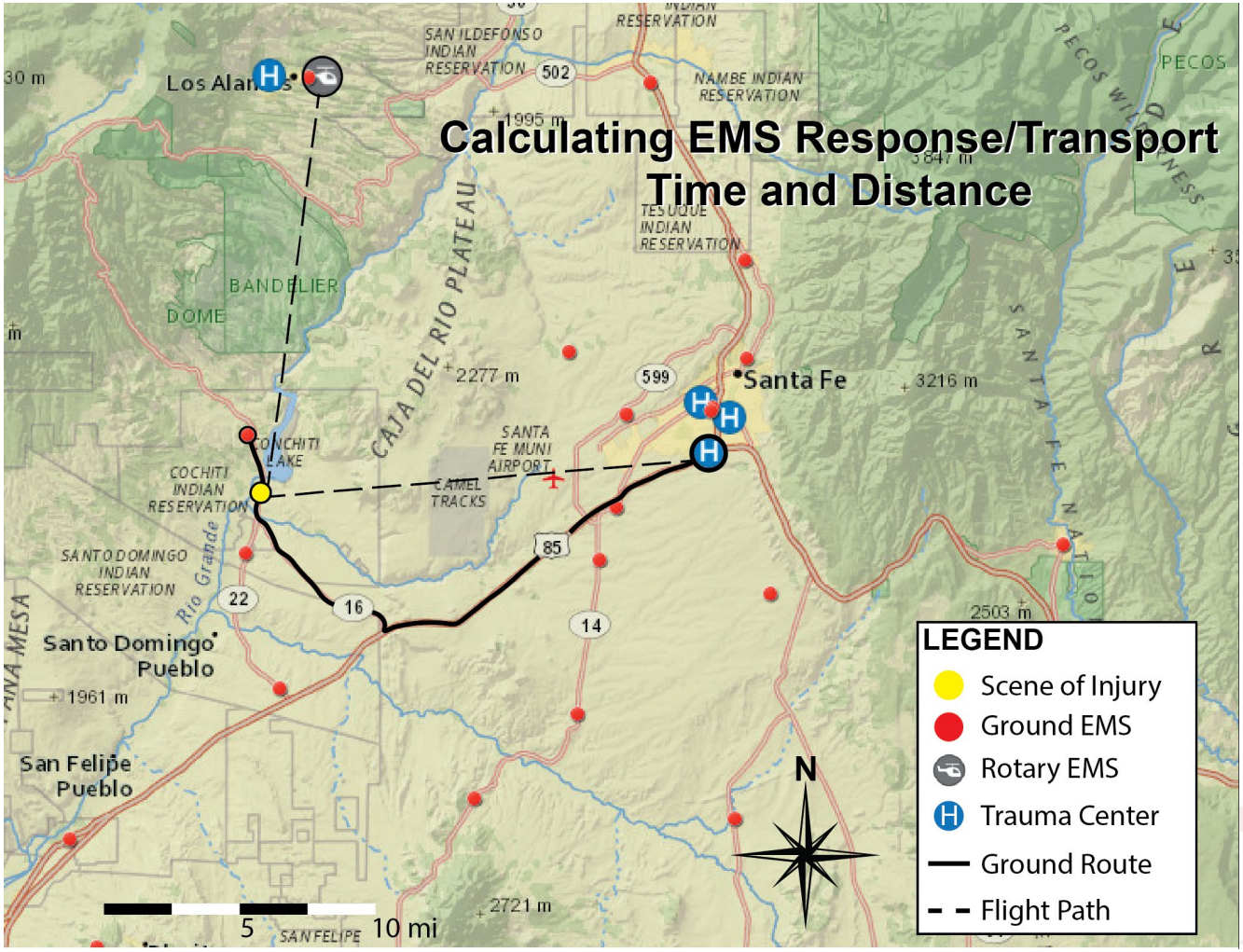
Medically Non-Survivable (MNS)

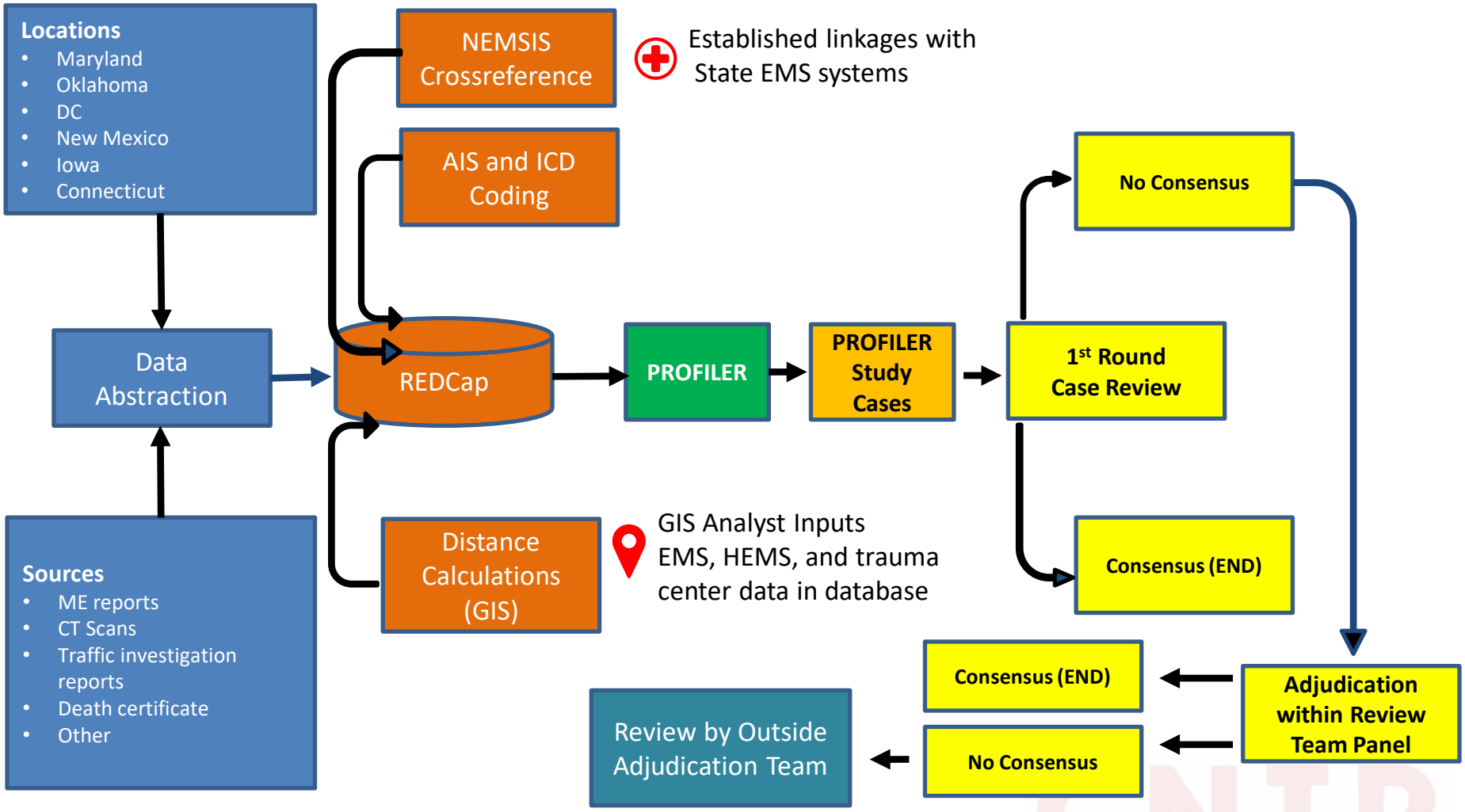
- Dismemberment / decapitation
- Traumatic Brain evisceration
- Cervical cord transection (above C3)
- Airway transection within thorax
- Cardiac injury > 2cm
- Uncontained hemorrhage, thoracic aorta
- Uncontained hemorrhage, pulmonary artery
- Hepatic avulsion
- Junctional lower extremity amputations 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

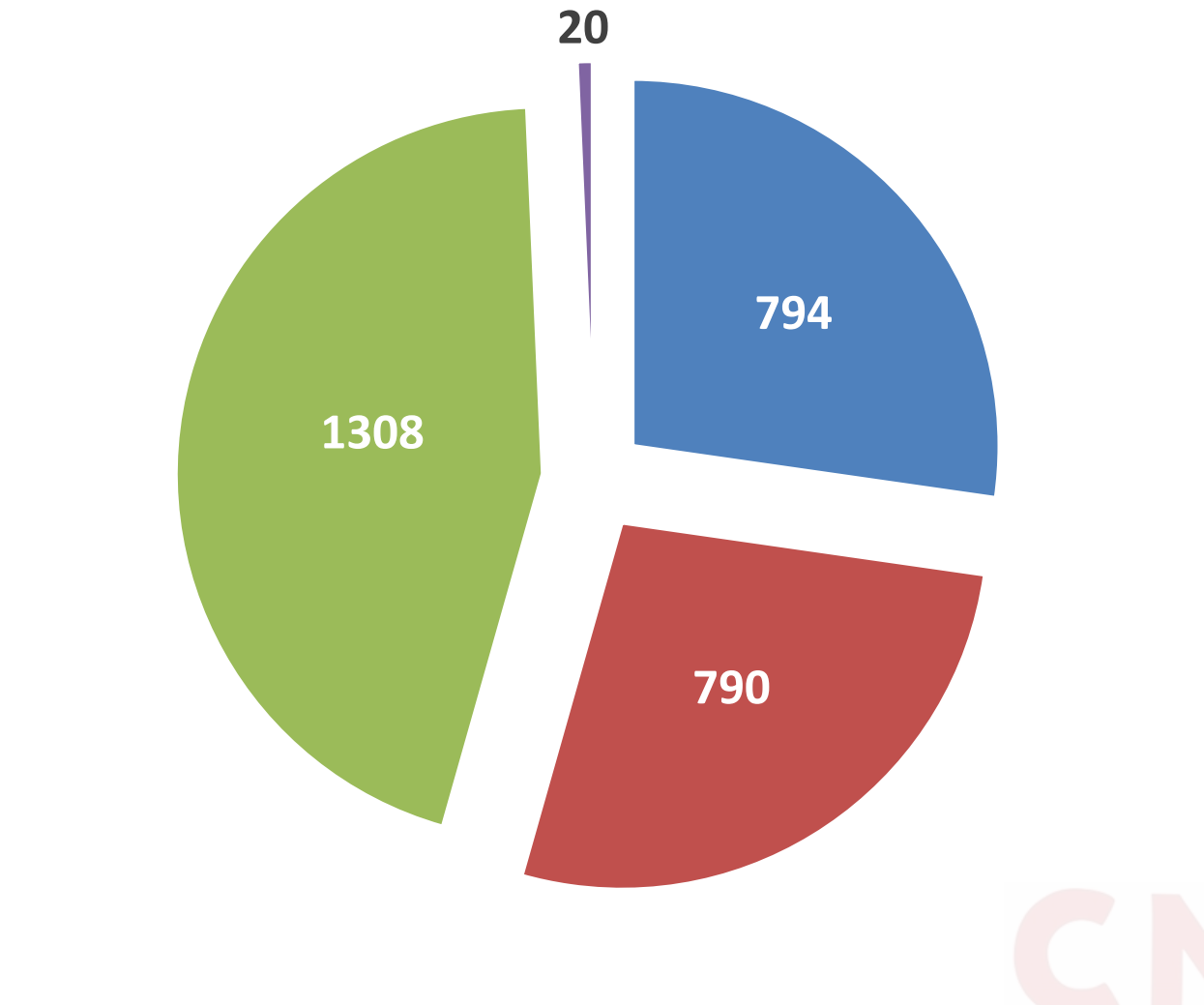
Integrating Geospatial Modeling





Results

Manner of Death



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

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

Preliminary 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

Preliminary Data
(All Pati

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%)

Preliminary Data (Excluding Suicide)

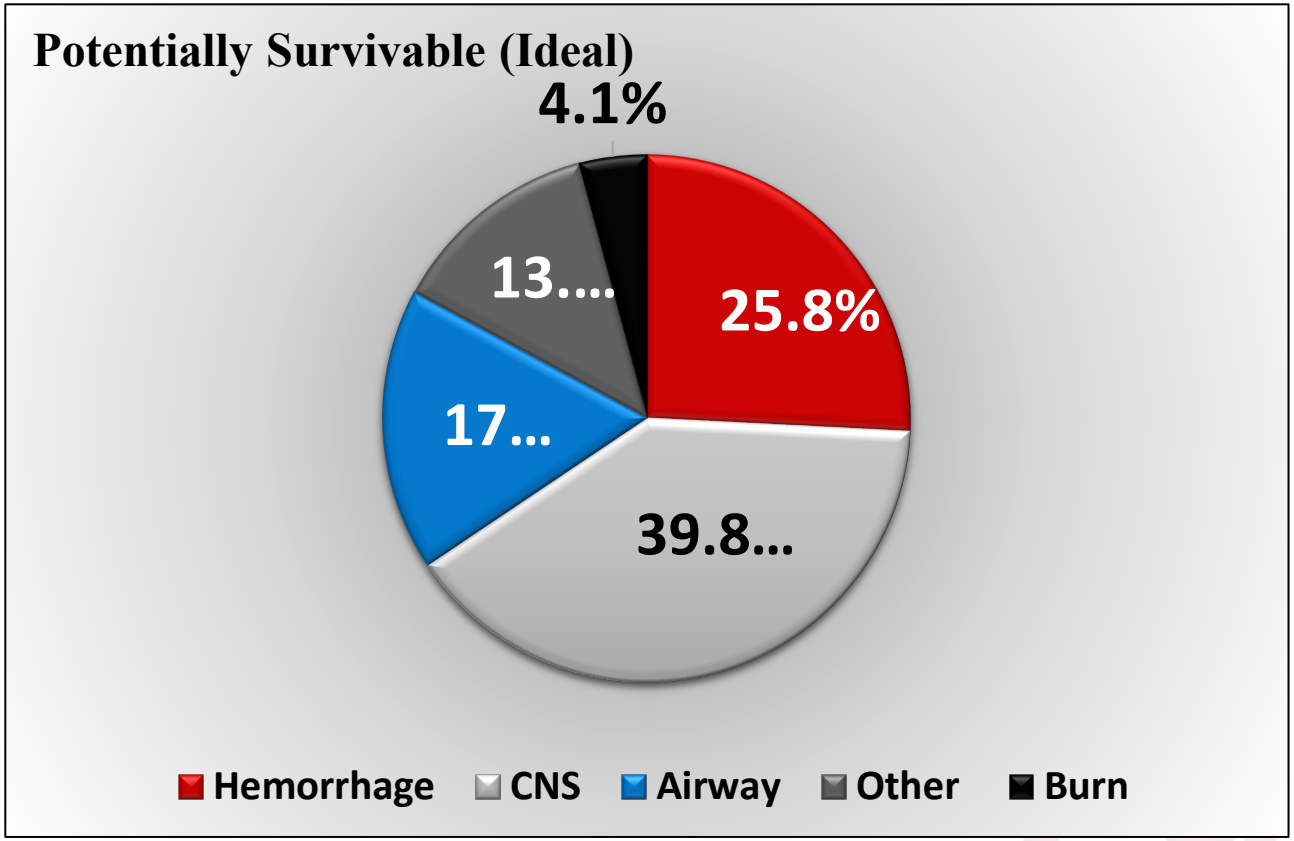
Survivability	Immediate Access (Excluding Suicide)	Actual Scenario (Excluding Suicide)
Non-survivable	150 (67.9%)	202 (91.4%)
Potentially Survivable	68 (30.8%)	19 (8.6%)
Definitely Survivable	3 (1.4%)	0 (0.0%)
Cannot Judge	0 (0.0%)	0 (0.0%)

Preliminary Data (Excluding Suicide)

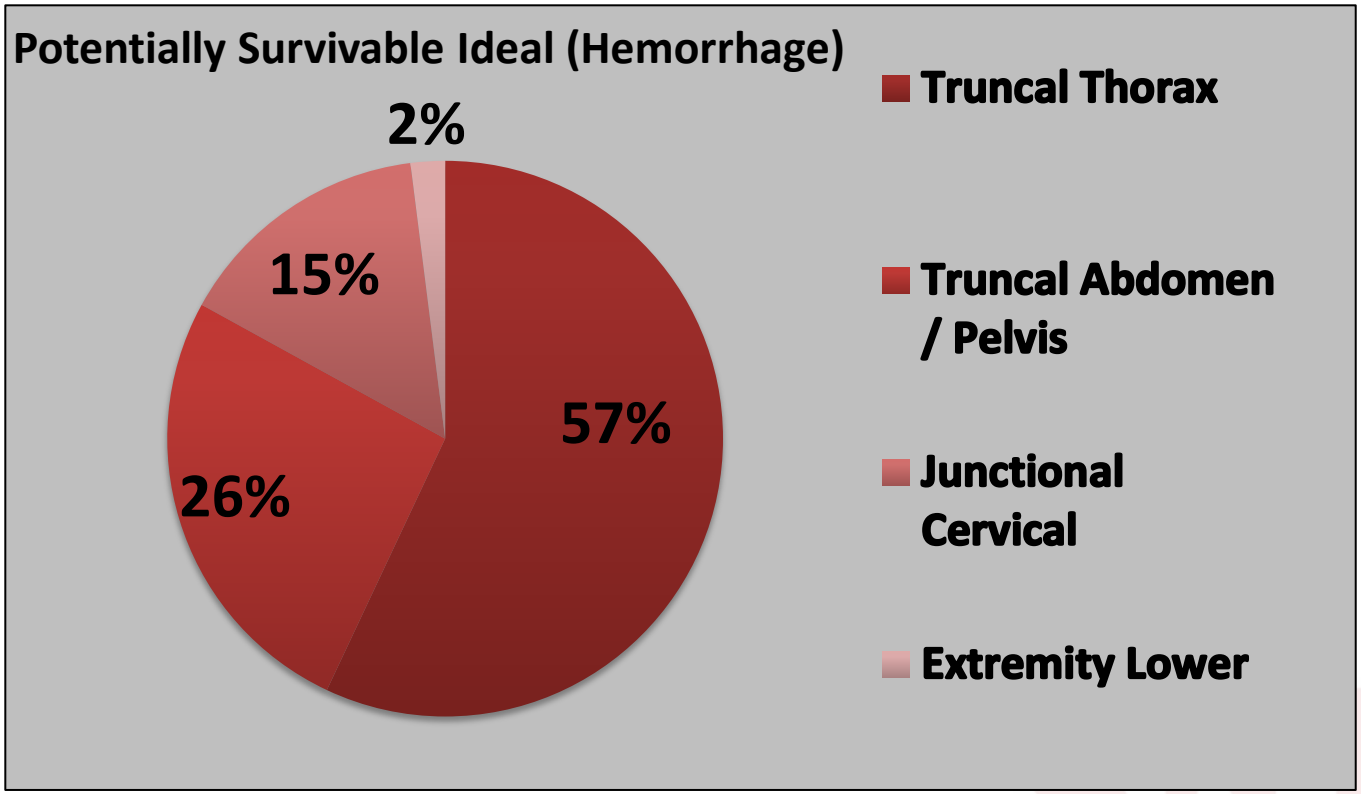
Survivability	Immediate Access (Excluding Suicide)	Actual Scenario (Excluding Suicide)
Non-survivable	150 (67.9%)	202 (91.4%)
Potentially Survivable	68 (30.8%)	19 (8.6%)
Definitely Survivable	3 (1.4%)	0 (0.0%)
Cannot Judge	0 (0.0%)	0 (0.0%)

POTENTIALLY PREVENTABLE DEATHS

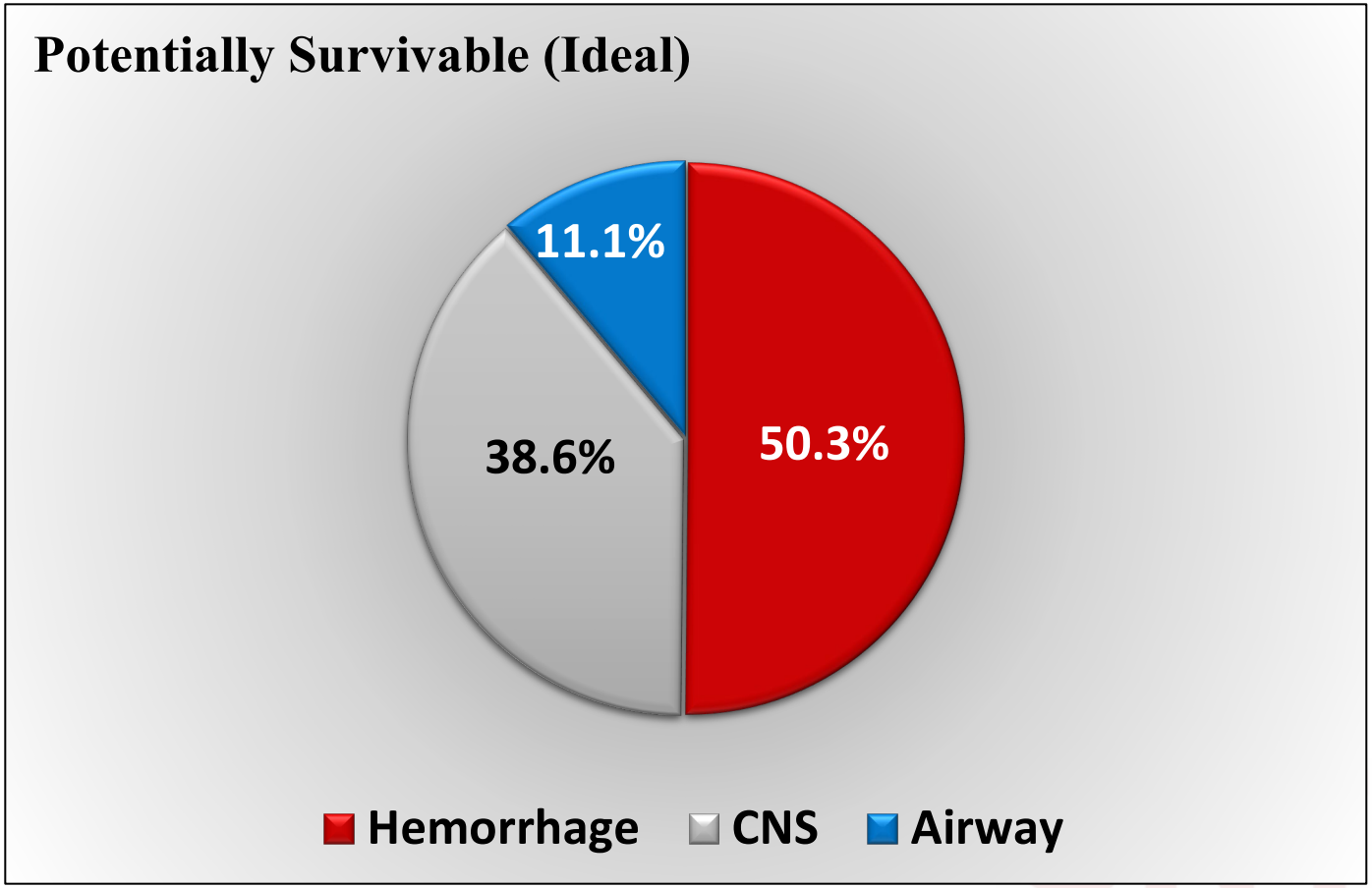
Mechanism of Death (All)
Ideal Circumstance



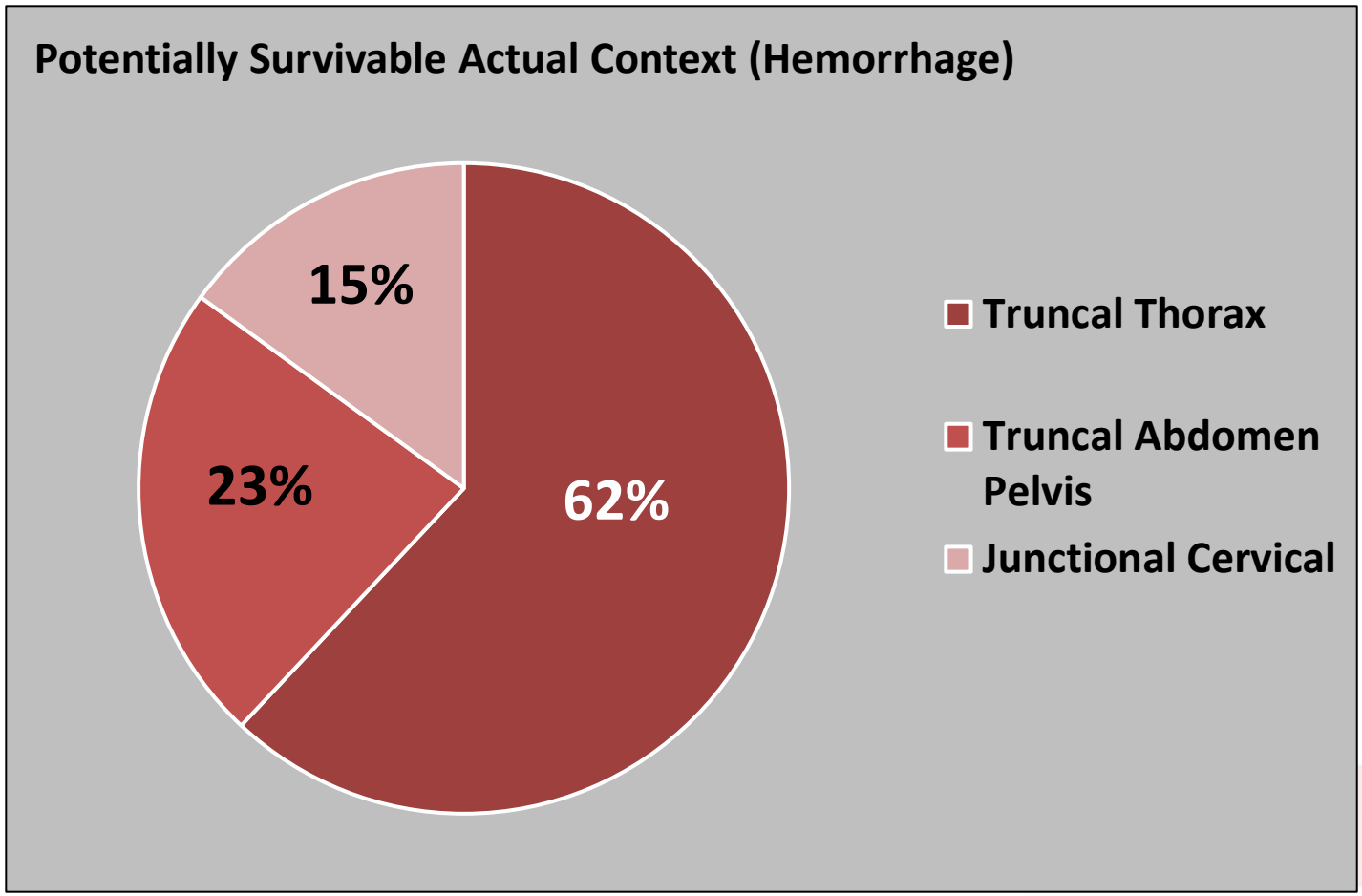
Potentially Survivable (Hemorrhage Focus) Ideal Circumstance



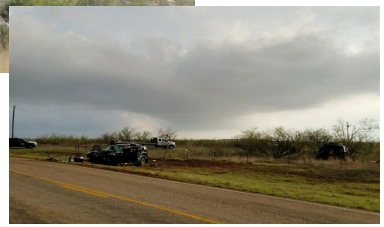
Mechanism of Death (All)
Actual Circumstance

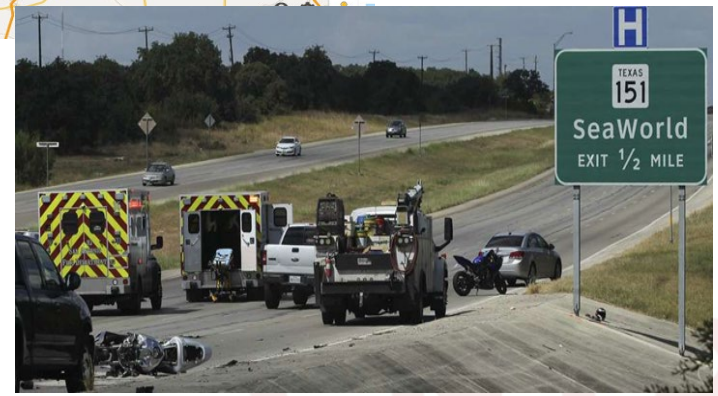


Potentially Survivable (Hemorrhage Focus) Actual Circumstance

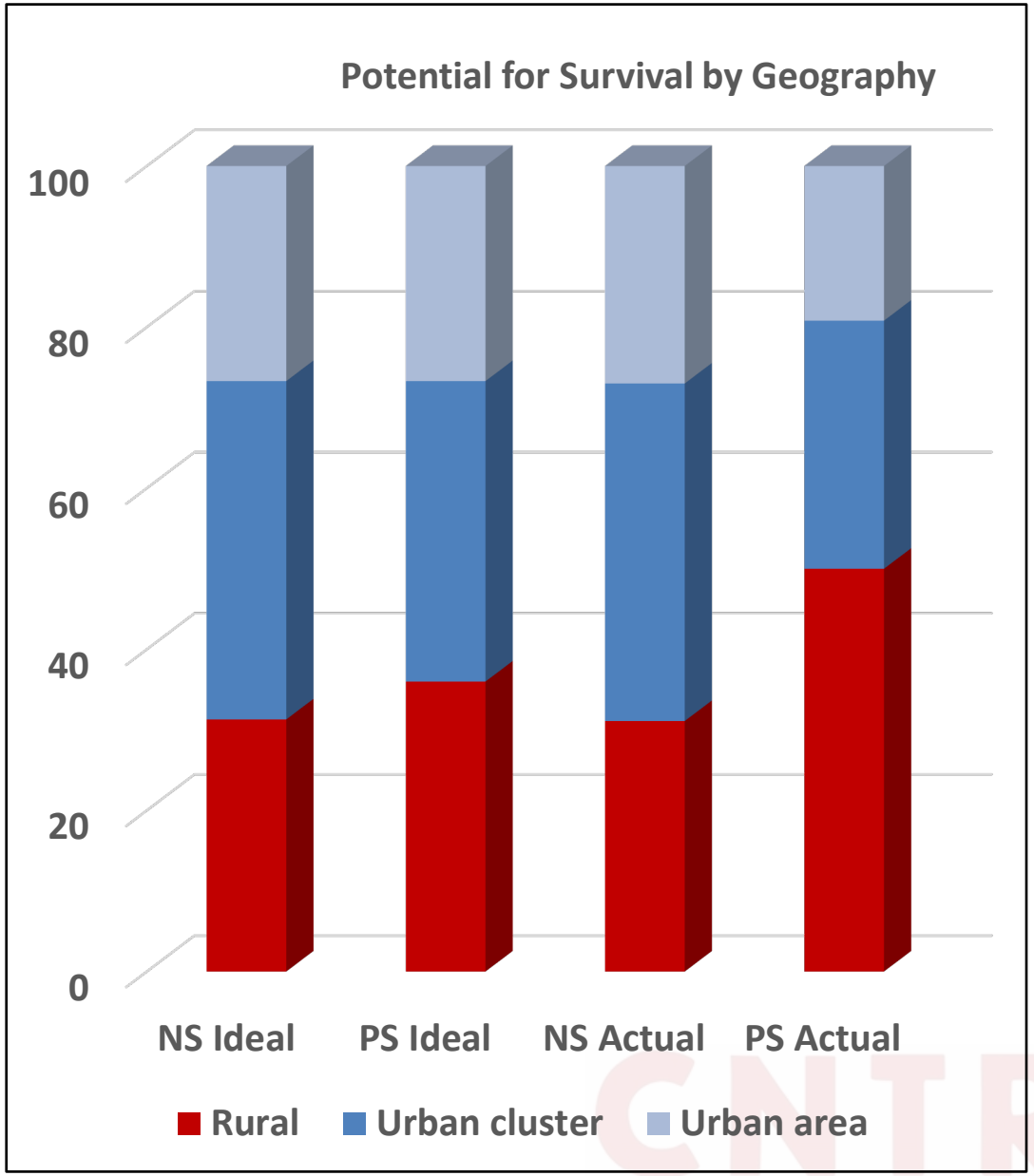


Importance of Context (Location)
Does Where You Live Determine Whether You Live?





Potential for Survival by Location



Preliminary 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

Trauma System Potential Benefits

Trauma

- Military / civilian trauma system evolution
- Performance improvement
  - Engineering
  - Medical devices / procedures
  - EMS value validation
  - Injury Prevention
- Integration of ME and injury data sources
- Collaboration between trauma and ME communities

Medical Examiner

- Support for enhanced ME systems / resources
- Funding for radiological imaging / advanced technology
- Bridge the gap between ME and trauma care providers

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**

Civilian Prehospital Trauma Mortality

NAEMT / EMS World
October 5, 2021

Brian Eastridge, MD, FACS
COL, MC, USAR
Professor, Department of Surgery
Jocelyn and Joe Straus Endowed Chair in Trauma Research
Division of Trauma and Emergency Surgery
University of Texas Health Science Center at San Antonio

Disclosures

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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.

Scope of the Problem

All Cause Death

10 Leading Causes of Death, United States
2017, All Races, Both Sexes

	Age Groups										
Rank	<1	1-4	5-9	10-14	15-24	25-34	35-44	45-54	55-64	65+	All Ages
1	Congenital Anomalies 4,580	Unintentional Injury 1,267	Unintentional Injury 718	Unintentional Injury 860	Unintentional Injury 13,441	Unintentional Injury 25,669	Unintentional Injury 22,828	Malignant Neoplasms 39,266	Malignant Neoplasms 114,810	Heart Disease 519,052	Heart Disease 647,457
2	Short Gestation 3,749	Congenital Anomalies 424	Malignant Neoplasms 418	Suicide 517	Suicide 6,252	Suicide 7,948	Malignant Neoplasms 10,900	Heart Disease 32,658	Heart Disease 80,102	Malignant Neoplasms 427,896	Malignant Neoplasms 599,108
3	Maternal Pregnancy Comp. 1,432	Malignant Neoplasms 325	Congenital Anomalies 188	Malignant Neoplasms 437	Homicide 4,905	Homicide 5,488	Heart Disease 10,401	Unintentional Injury 24,461	Unintentional Injury 23,408	Chronic Low. Respiratory Disease 136,139	Unintentional Injury 169,936
4	SIDS 1,363	Homicide 303	Homicide 154	Congenital Anomalies 191	Malignant Neoplasms 1,374	Heart Disease 3,681	Suicide 7,335	Suicide 8,561	Chronic Low. Respiratory Disease 18,667	Cerebro-vascular 125,653	Chronic Low. Respiratory Disease 160,201
5	Unintentional Injury 1,317	Heart Disease 127	Heart Disease 75	Homicide 178	Heart Disease 913	Malignant Neoplasms 3,616	Homicide 3,351	Liver Disease 8,312	Diabetes Mellitus 14,904	Alzheimer's Disease 120,107	Cerebro-vascular 146,383
6	Placenta Cord Membranes 843	Influenza & Pneumonia 104	Influenza & Pneumonia 62	Heart Disease 104	Congenital Anomalies 355	Liver Disease 918	Liver Disease 3,000	Diabetes Mellitus 6,409	Liver Disease 13,737	Diabetes Mellitus 59,020	Alzheimer's Disease 121,404
7	Bacterial Sepsis 592	Cerebro-vascular 66	Chronic Low. Respiratory Disease 59	Chronic Low. Respiratory Disease 75	Diabetes Mellitus 248	Diabetes Mellitus 823	Diabetes Mellitus 2,118	Cerebro-vascular 5,198	Cerebro-vascular 12,708	Unintentional Injury 55,951	Diabetes Mellitus 83,564
8	Circulatory System Disease 449	Septicemia 48	Cerebro-vascular 41	Cerebro-vascular 56	Influenza & Pneumonia 190	Cerebro-vascular 593	Cerebro-vascular 1,811	Chronic Low. Respiratory Disease 3,975	Suicide 7,982	Influenza & Pneumonia 46,862	Influenza & Pneumonia 55,672
9	Respiratory Distress 440	N 44	33	51	Disease 188	513	804	2,441	5,838	Nephritis 41,670	Nephritis 50,633
10	Neonatal Hemorrhage 379	Perinatal Period 42	Benign Neoplasms 31	Benign Neoplasms 31	Complicated Pregnancy 168	Complicated Pregnancy 512	HIV 831	Homicide 2,275	Nephritis 5,671	Parkinson's Disease 31,177	Suicide 47,173

WISQARS™ Produced By: National Center for Injury Prevention and Control, Centers for Disease Control and Prevention
Data Source: National Center for Health Statistics (NCHS), National Vital Statistics System

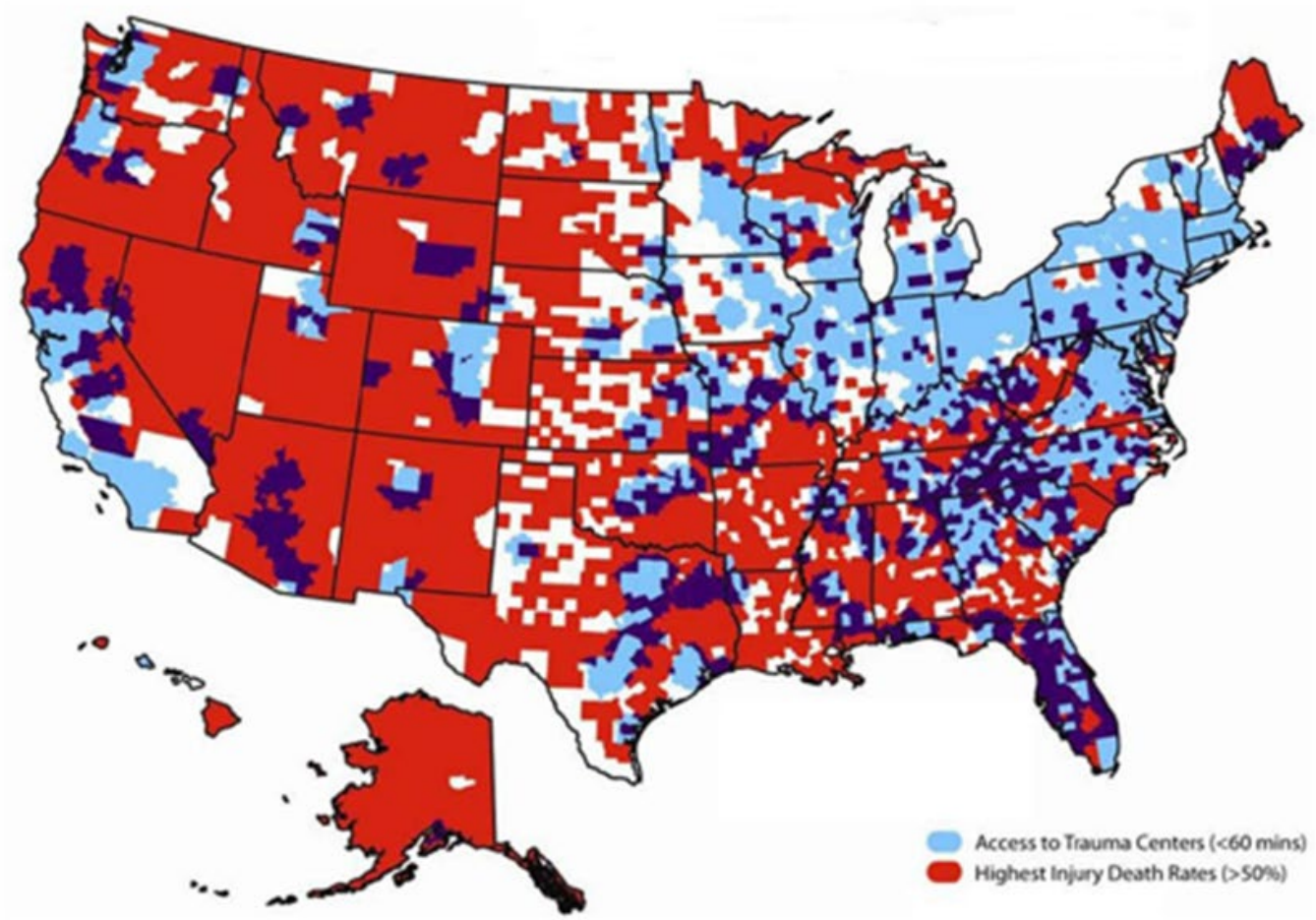


FIGURE 2-3 Lack of access to an appropriate level of trauma care is associated with higher trauma patient mortality.

SOURCE: Map provided by Charles Branas, Ph.D., Professor of Epidemiology, University of Pennsylvania, 2016.

110

 # people in United States

who will

DIE today

from potentially survivable injury

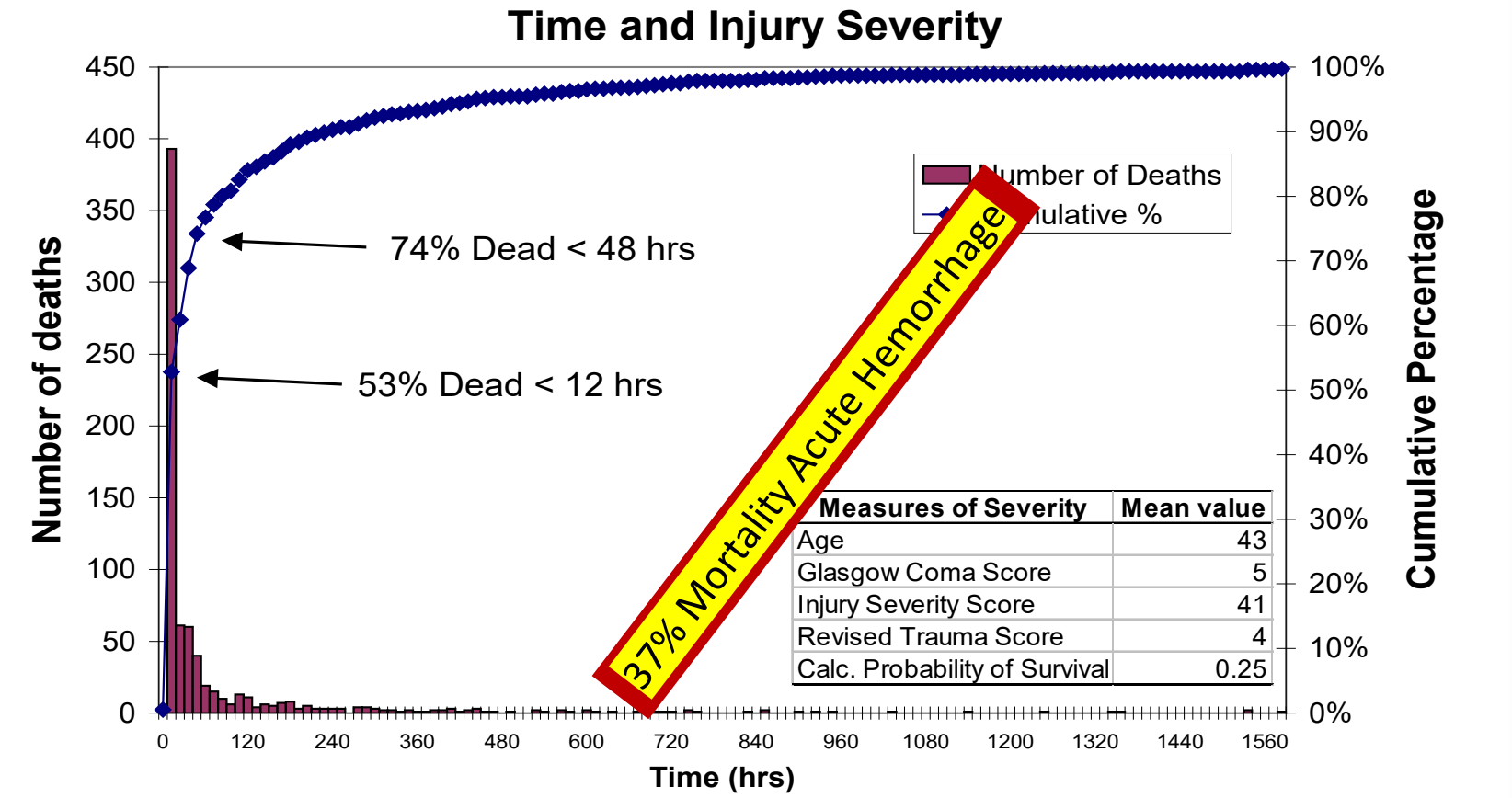
before reaching medical care

Perspective

In one year, that number will ~ equal the number of people it takes to fill Sun Trust Park in Atlanta

Hospital Injury Mortality

Trauma Center Mortality



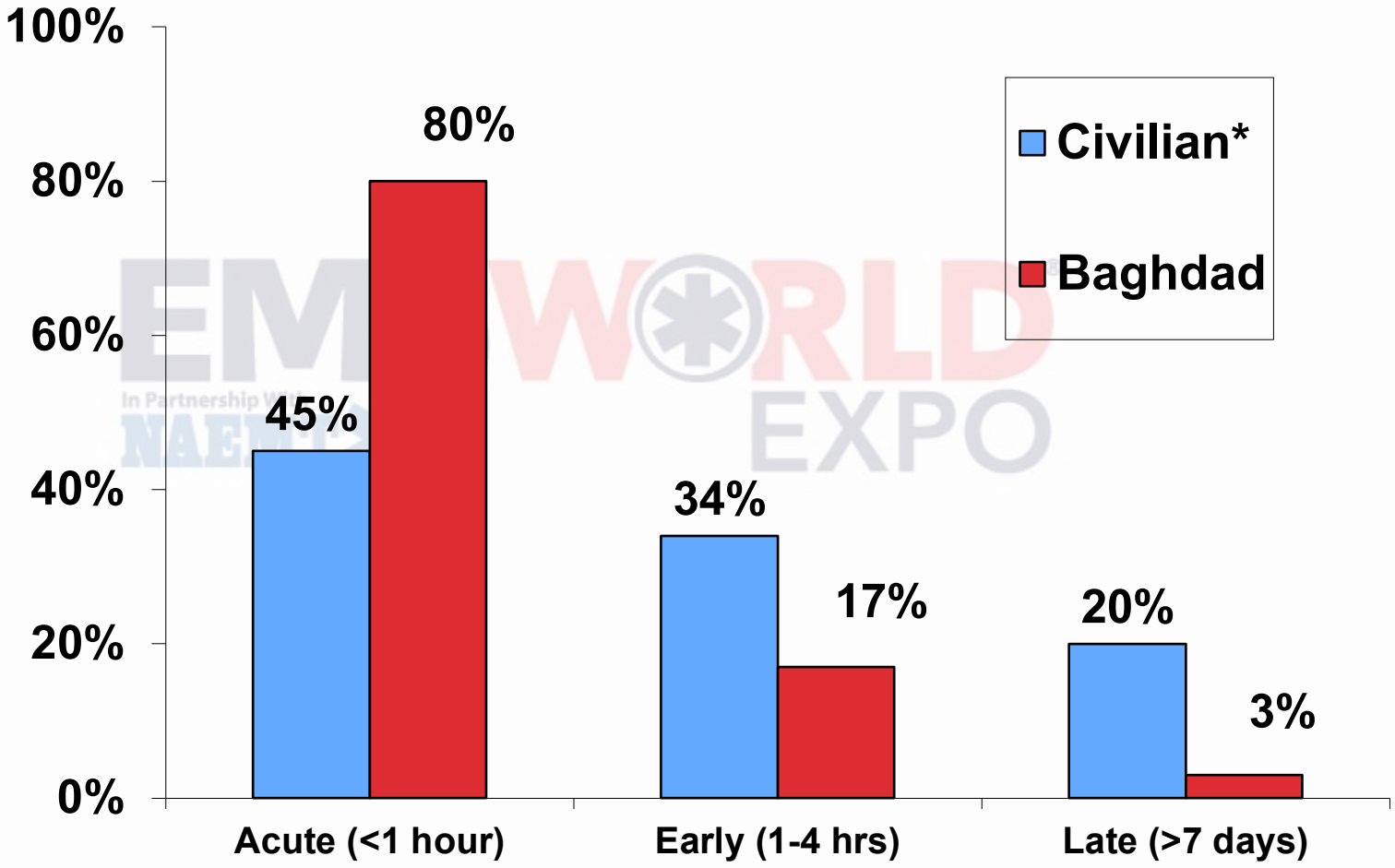
Stewart: Analysis of 753 deaths in a Level I Trauma Center. J Trauma 2003.

Death Classification

Classification	N	Percent
Not Therapeutically Preventable	701	93.1%
Possibly Preventable	32	4.2%
Preventable	20	2.7%

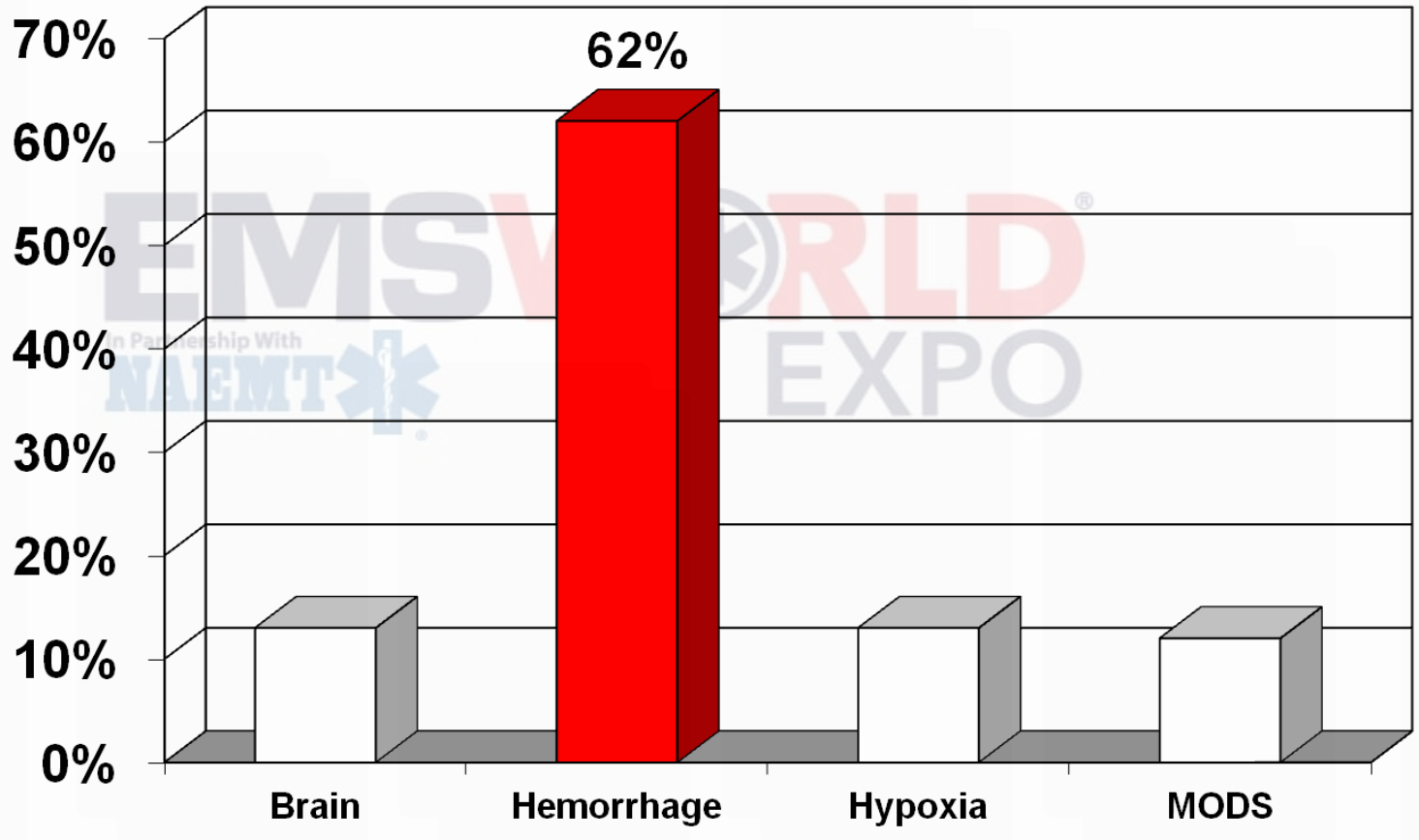
Eliminating ALL errors, curing MOF, sepsis, DVT/PE, and secondary brain injury would theoretically reduce the number of deaths by 6.9%

Timing of Trauma Death



Martin et al., J Trauma 2009

Combat Hospital Death



Martin et al., J Trauma 2009

Died of Wounds Analysis

DOW Analysis

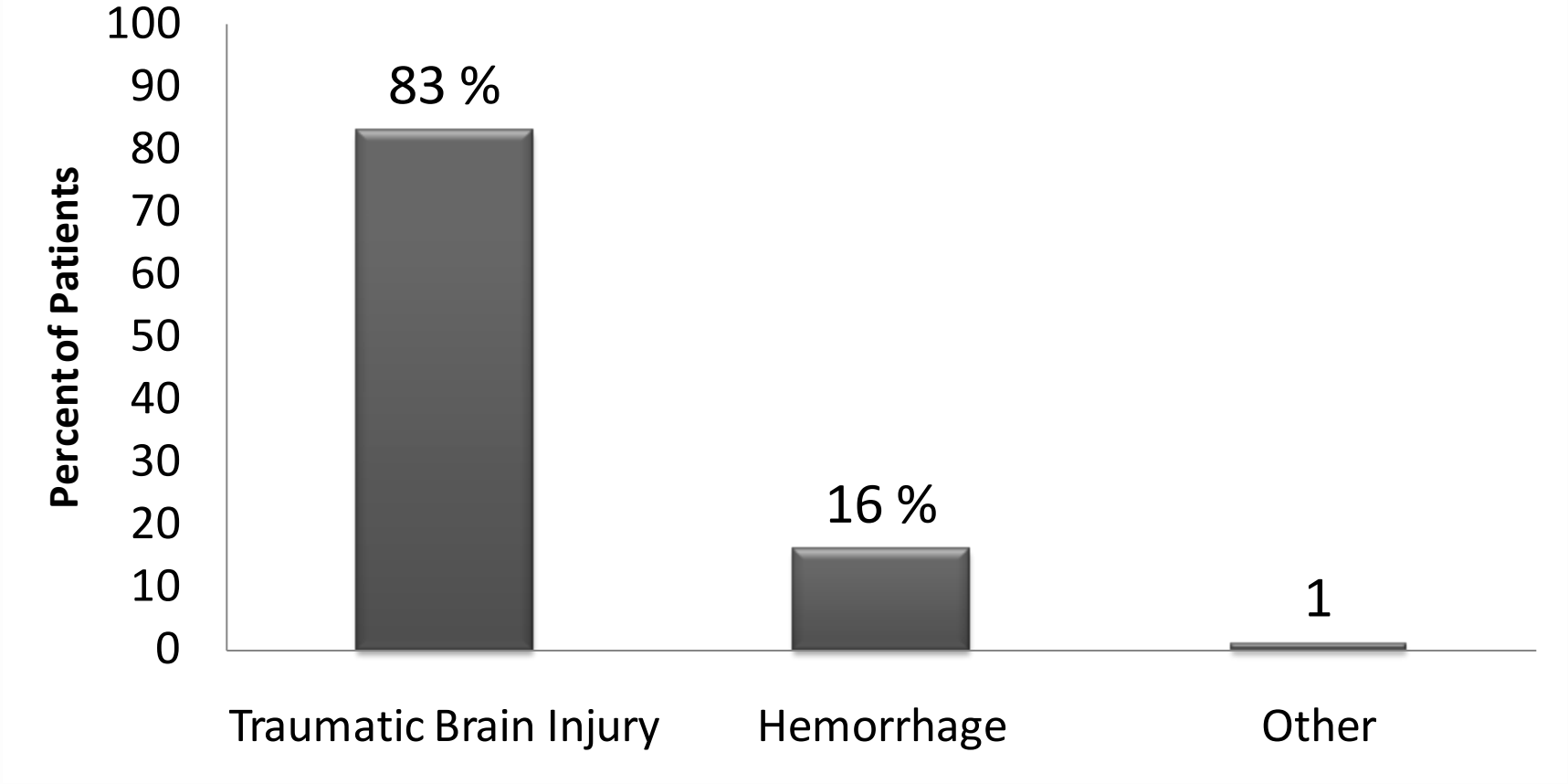
- Review died of wounds (DOW)deaths n=558
- Data sources
  - DoD Trauma Registry
  - Armed Forces Medical Examiner System (AFMES)
- Variables
  - Demographics
  - Mechanism and cause
  - Injury severity
- Expert panel trauma surgeons, emergency physician, neurosurgeon, and forensic pathologist graded deaths as non survivable or potentially survivable.

- Goal: Identify areas for improved training, medical care, material, research and development

DOW Analysis

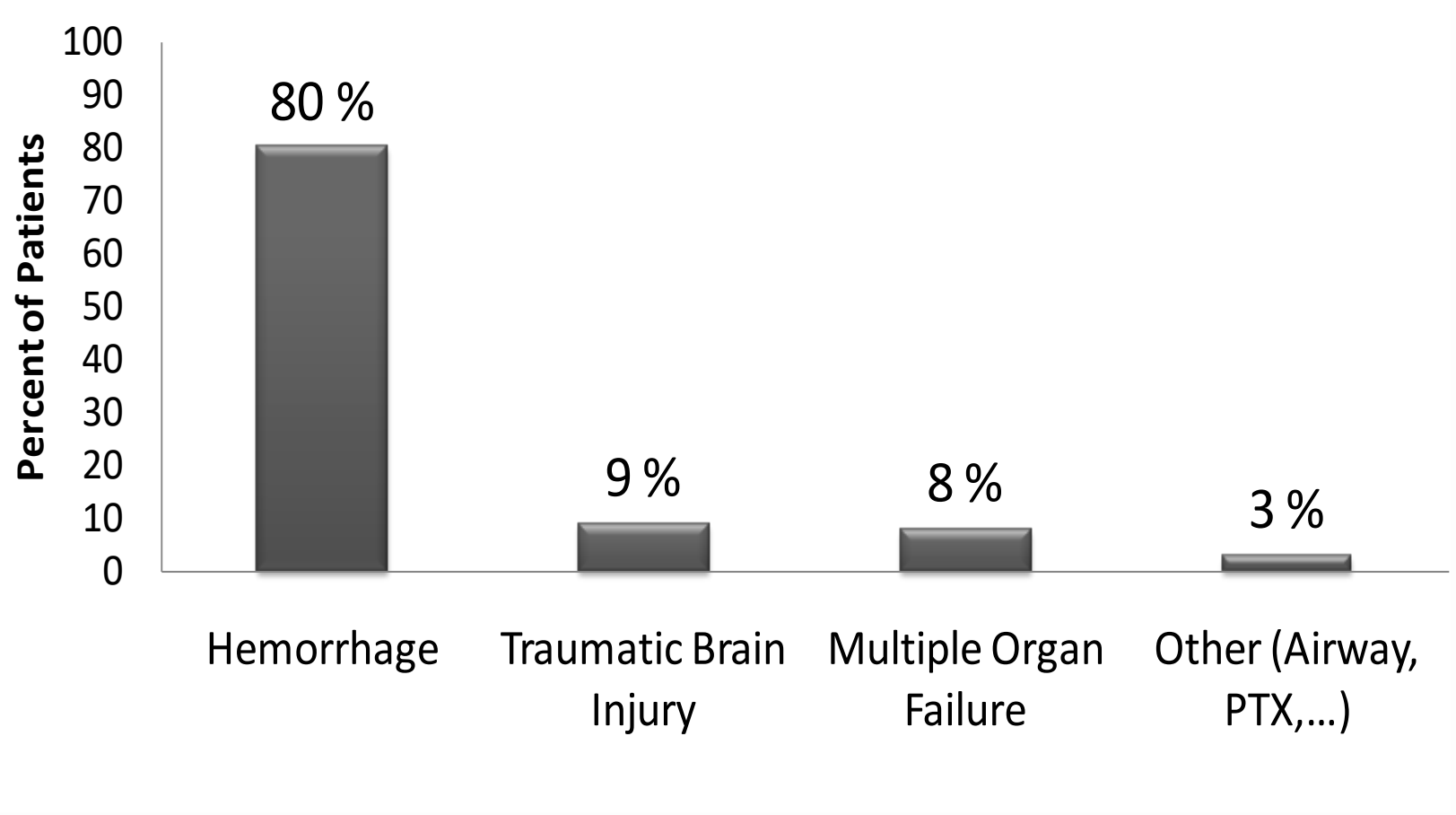
- DOW rate 4.6%
- Non-Survivable = 271 (48.6%)
- Potentially Survivable = 287 (51.4%)
- 51% presented in extremis with CPR on admission

DOW
Non-Survivable Etiology



Eastridge et al: Died of Wounds on the Battlefield. J Trauma 2011

DOW
Potentially Survivable Etiology



Eastridge et al: Died of Wounds on the Battlefield. J Trauma 2011

The Therapeutic Turnip

With respect to hospital injury outcomes

"…there is very little blood to be squeezed from the therapeutic turnip"

- Trauma centers
- Trauma systems
- Performance improvement
- Technological advances
- GME focus on training

Jonathan Rhoads, M.D.

William T. Fitts Lecture

American Association for the Surgery of Trauma, 1995

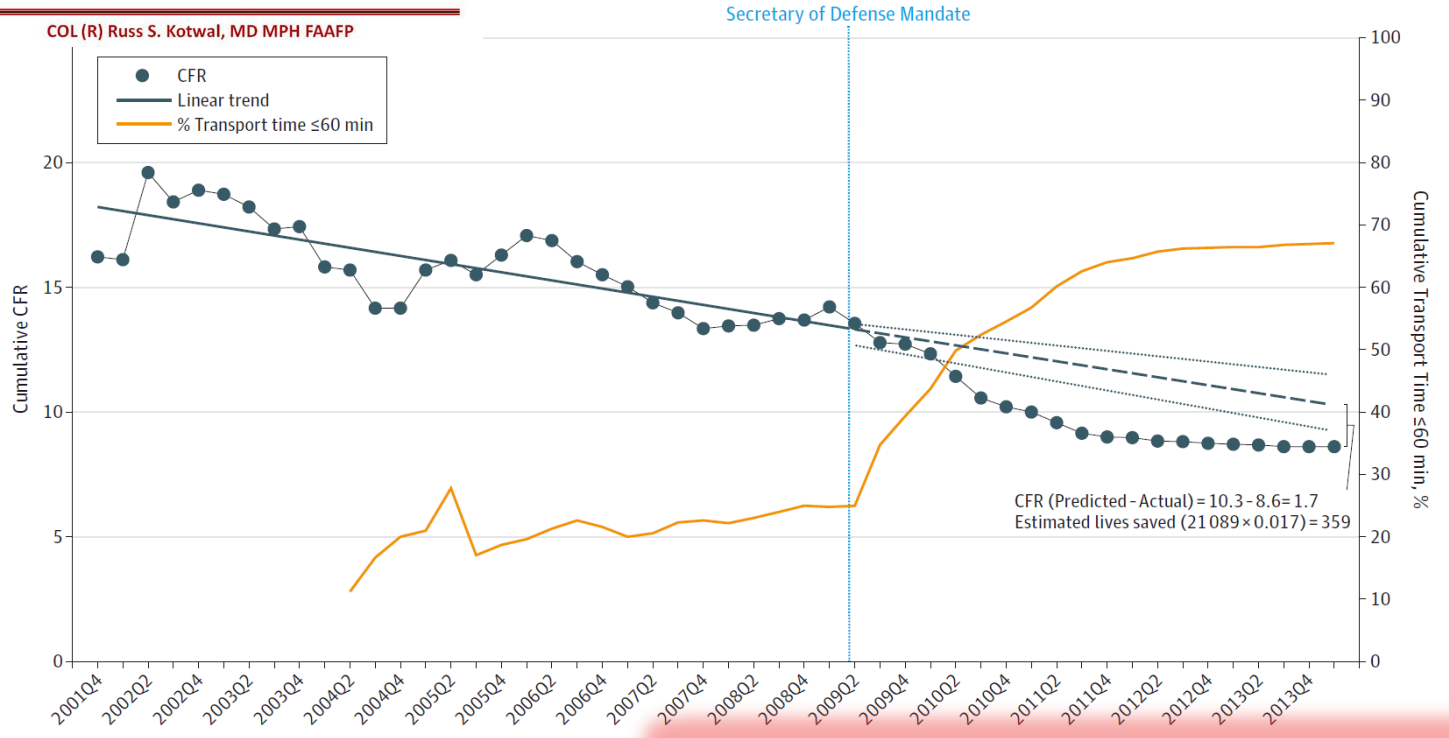
Prehospital - Hospital Transitional Injury Mortality

Abstract Presentation for:
Committee on Tactical Combat Casualty Care Meeting
Atlanta, Georgia – February 4, 2015

Saving Lives on the Battlefield: The Golden Hour and the Gates Effect

COL (R) Russ S. Kotwal, MD MPH FAAFP

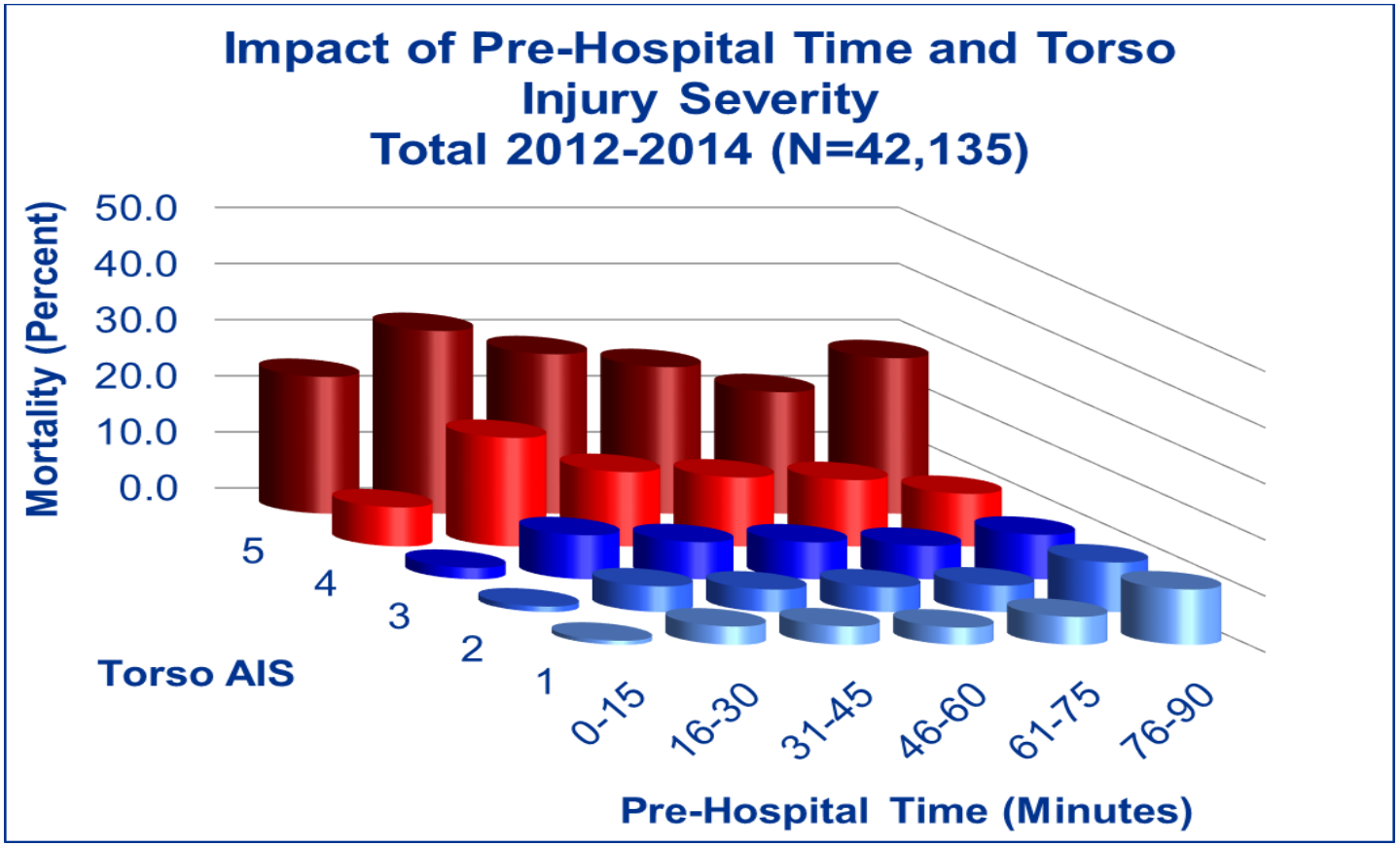
Gates Effect



Conclusions

A 2009 mandate by Secretary of Defense Gates reduced the time between critical injury and definitive care for combat casualties in Afghanistan. Despite evidence of increased severity and complexity of wounds from explosive devices, the combination of reduced prehospital transport time and increased treatment capability are likely contributors of casualty survival.

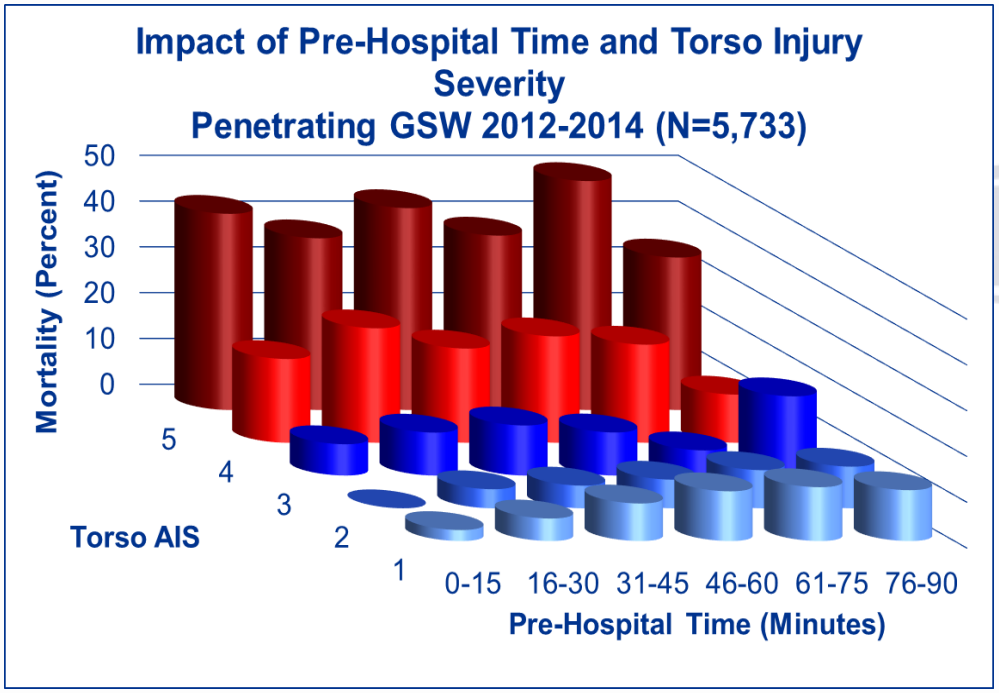
Prehospital Time
Noncompressible Torso Hemorrhage (All)



Alarhayem, Eastridge, et al: Mortality in Trauma Patients with Hemorrhage from Torso Injury Occurs Long Before the "Golden Hour" Presented at Southwestern Surgical Congress April 2016

Time is the Enemy

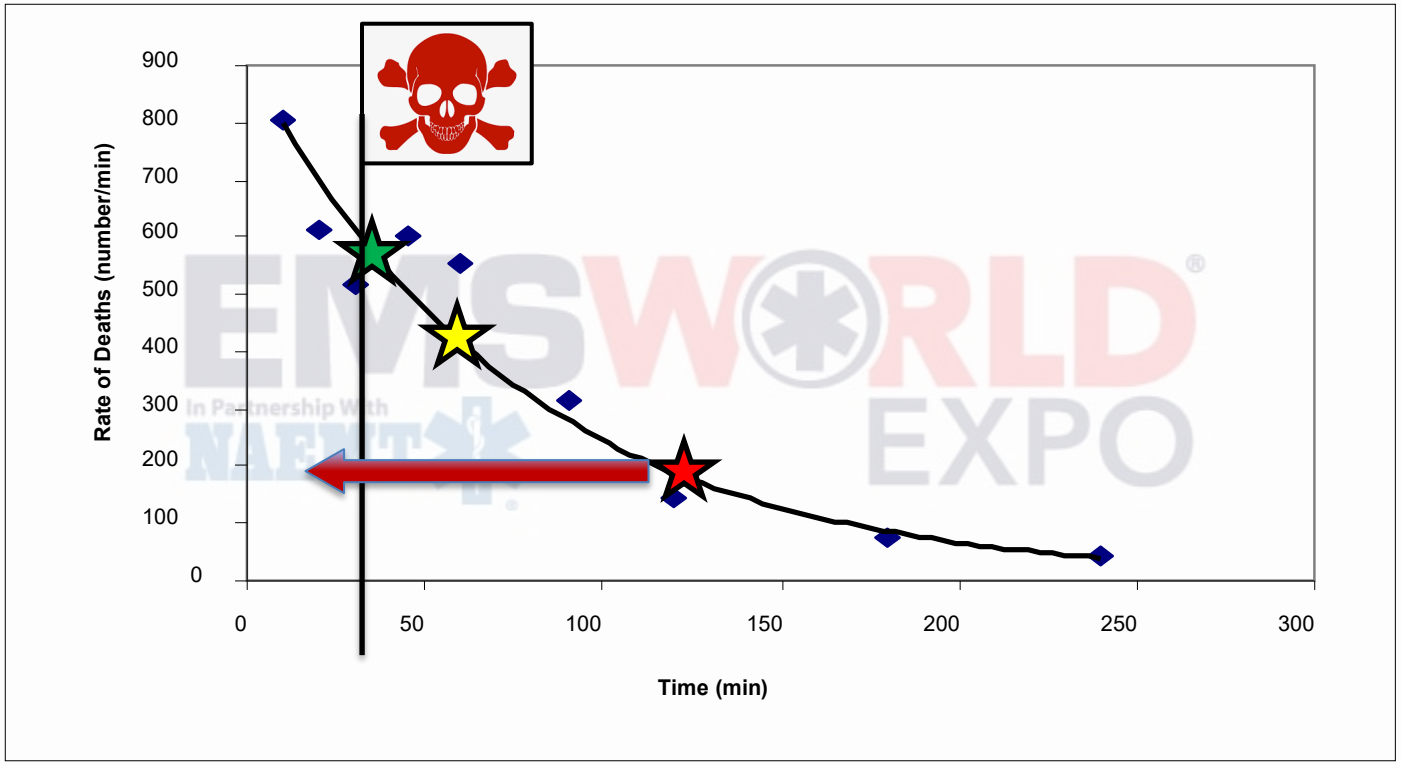
Prehospital Time in Noncompressible Torso Hemorrhage (GSW)



Alarhayem, Eastridge, et al: Mortality in Trauma Patients with Hemorrhage from Torso Injury Occurs Long Before the "Golden Hour" Am J Surg 2016

- High grade torso injury, AIS grades ≥ 4, associated with significant hemorrhage.
- Rise in patient mortality was exhibited in high grade injury demonstrated at prehospital times < 30 minutes
- Highlights critical nature of prehospital time in patients with non-compressible torso hemorrhage.
- Evacuation times < 30 minutes not realistic, particularly in rural or austere environments,
- Future efforts should be directed toward the development of therapies to increase the window of survival in the prehospital environment.

Time to Hemorrhage Control Critical



Transport Time and Preoperating Room Hemostatic Interventions Are Important: Improving Outcomes After Severe Truncal Injury

John B. Holcomb, MD, FACS

CCM 2018

Understanding Prehospital Injury Mortality

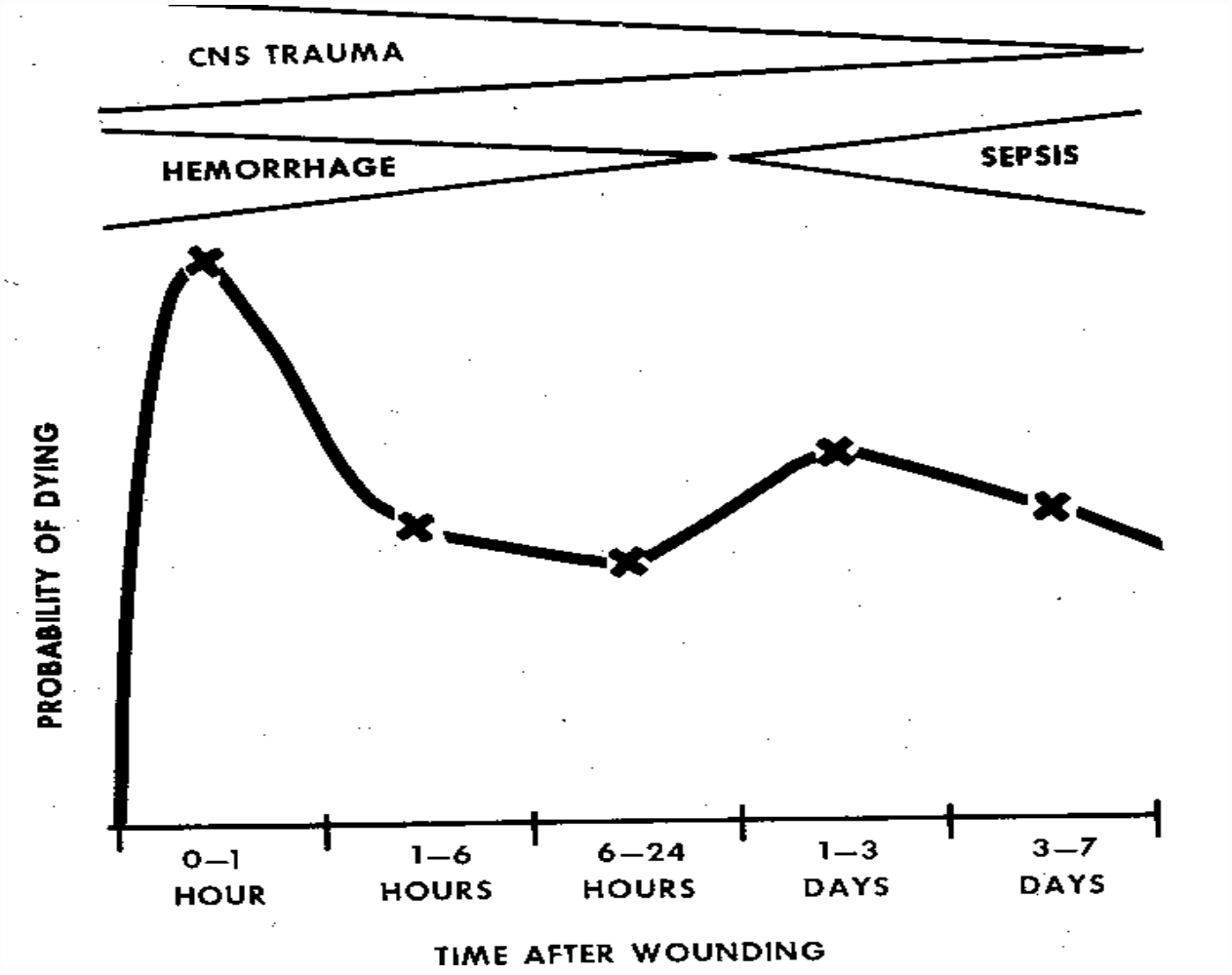
How do we determine of survivability of those that never reach hospital care?

Much bigger population injury mortality

*Most future opportunities to effect injury outcomes will be prehospital

Prehospital Mortality Battlefield

Empiric Probability Combat Death



Bellamy, J Trauma, 1984

Killed in Action Analysis

Battlefield Death Analysis

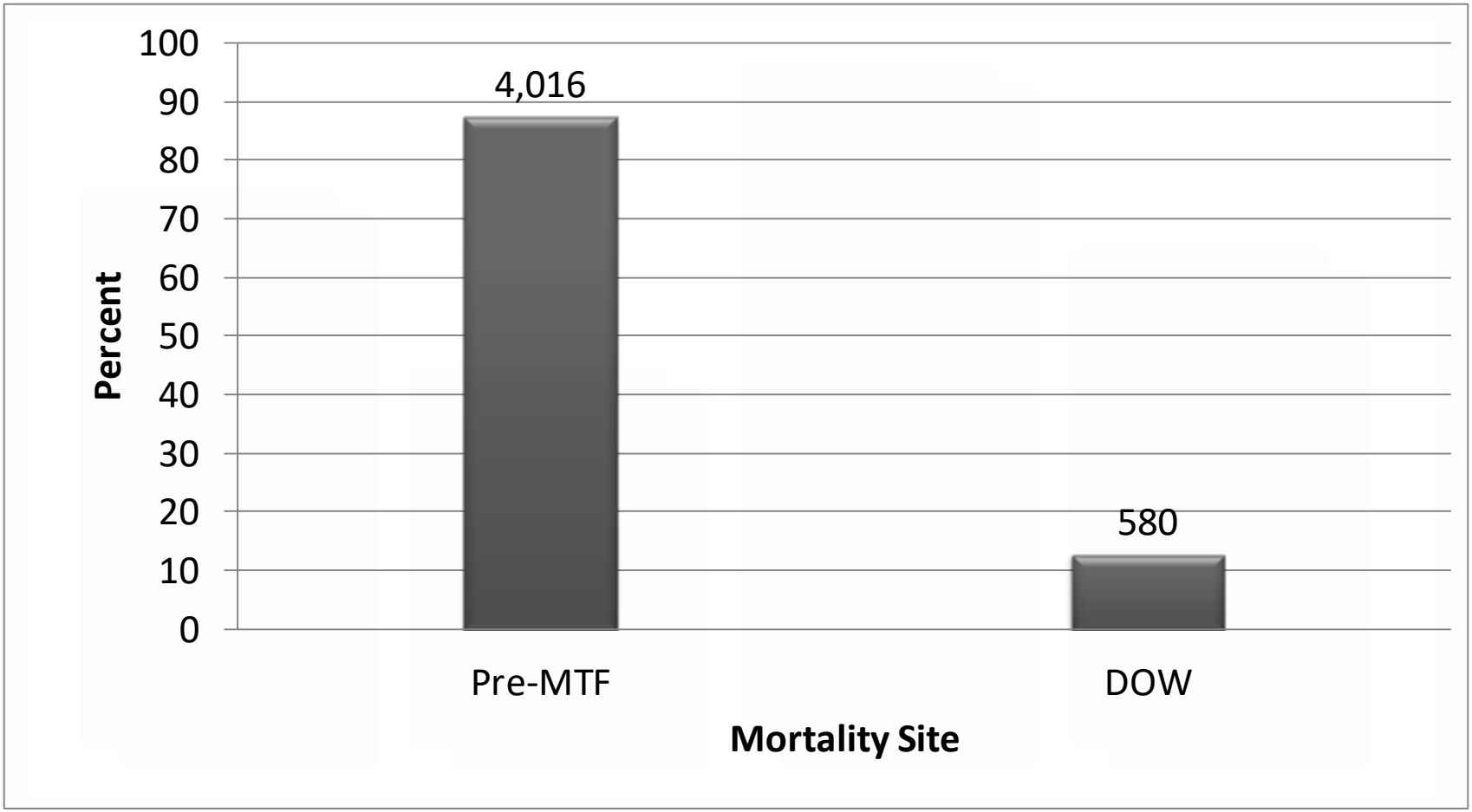
- Review battlefield deaths (n=4,596)
- Data sources
  - DoD Trauma Registry
  - Armed Forces Medical Examiner System (AFMES)
- Variables
  - Demographics
  - Mechanism and cause
  - Injury severity
- Expert panel trauma surgeons, emergency physician, neurosurgeon, and forensic pathologist graded deaths as non survivable or potentially survivable.

- Goal: Identify areas for improved training, medical care, material, research and development

KIA Analysis

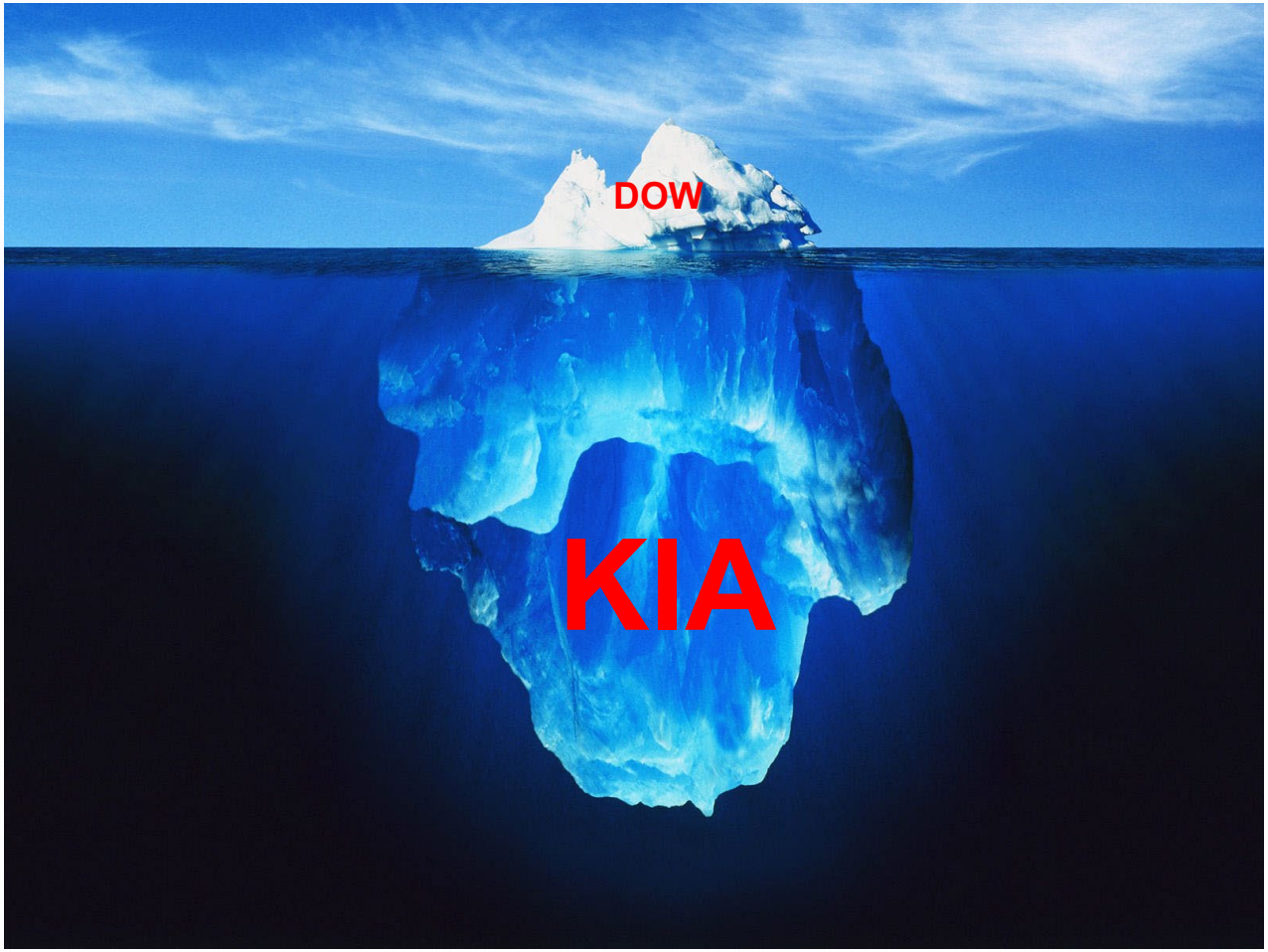
- Nonsurvivable
  - Dismemberment
  - Traumatic brain injury
  - Cervical cord transection (above C3)
  - Airway transection within thorax
  - Cardiac injury (>1/2”), thoracic aorta injury, pulmonary artery
  - Hepatic avulsion
  - Junctional lower extremity amputations with open pelvis with soft tissue loss
- Potentially survivable
  - All other injuries

Where Battlefield Casualties Die n=4,596

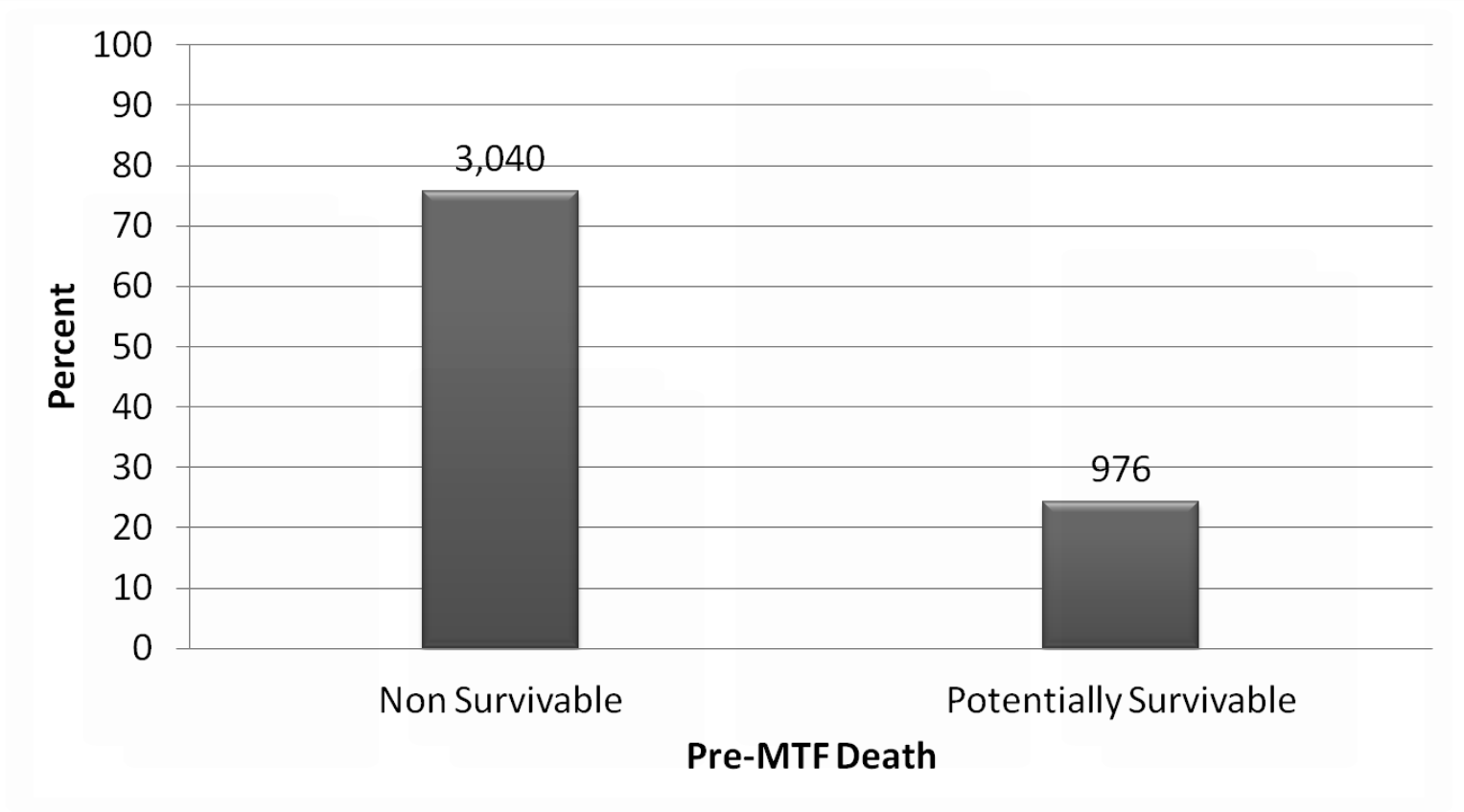


Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Putting it in Perspective

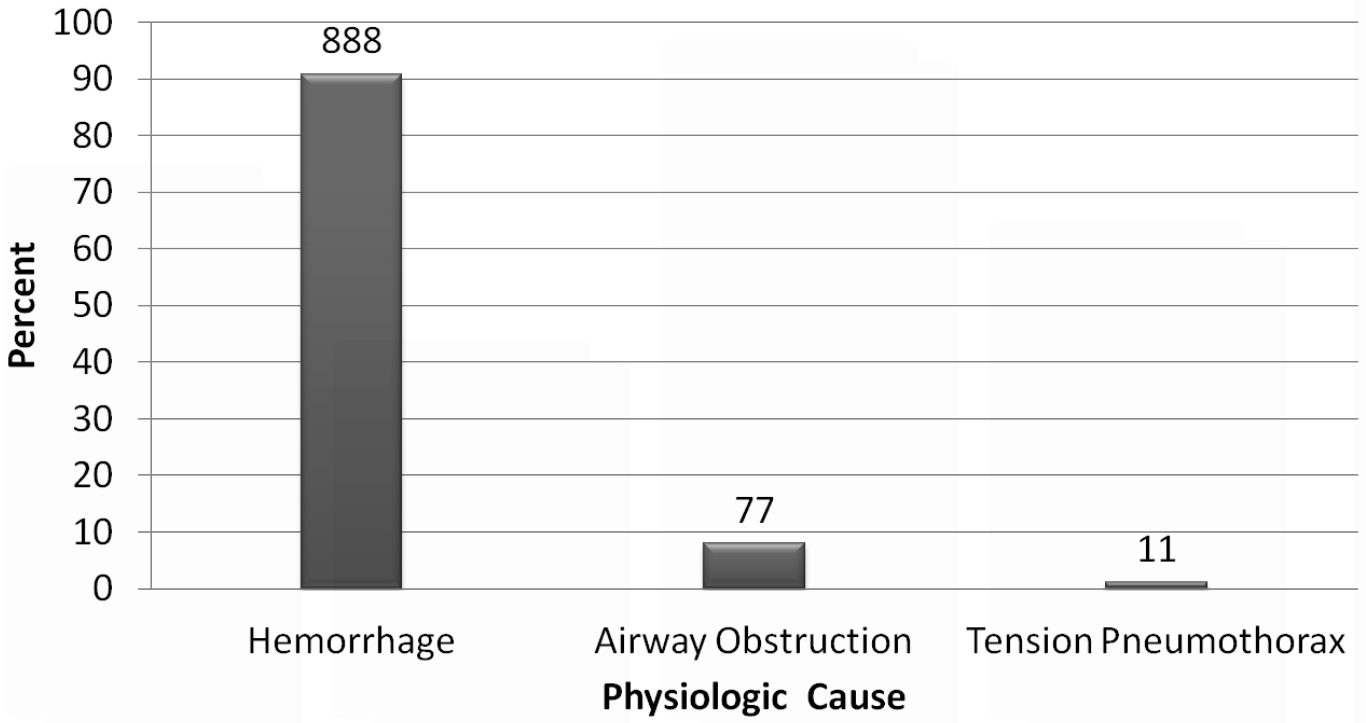


Battlefield Pre-Hospital Death Analysis n=4,016 (DOW excluded)



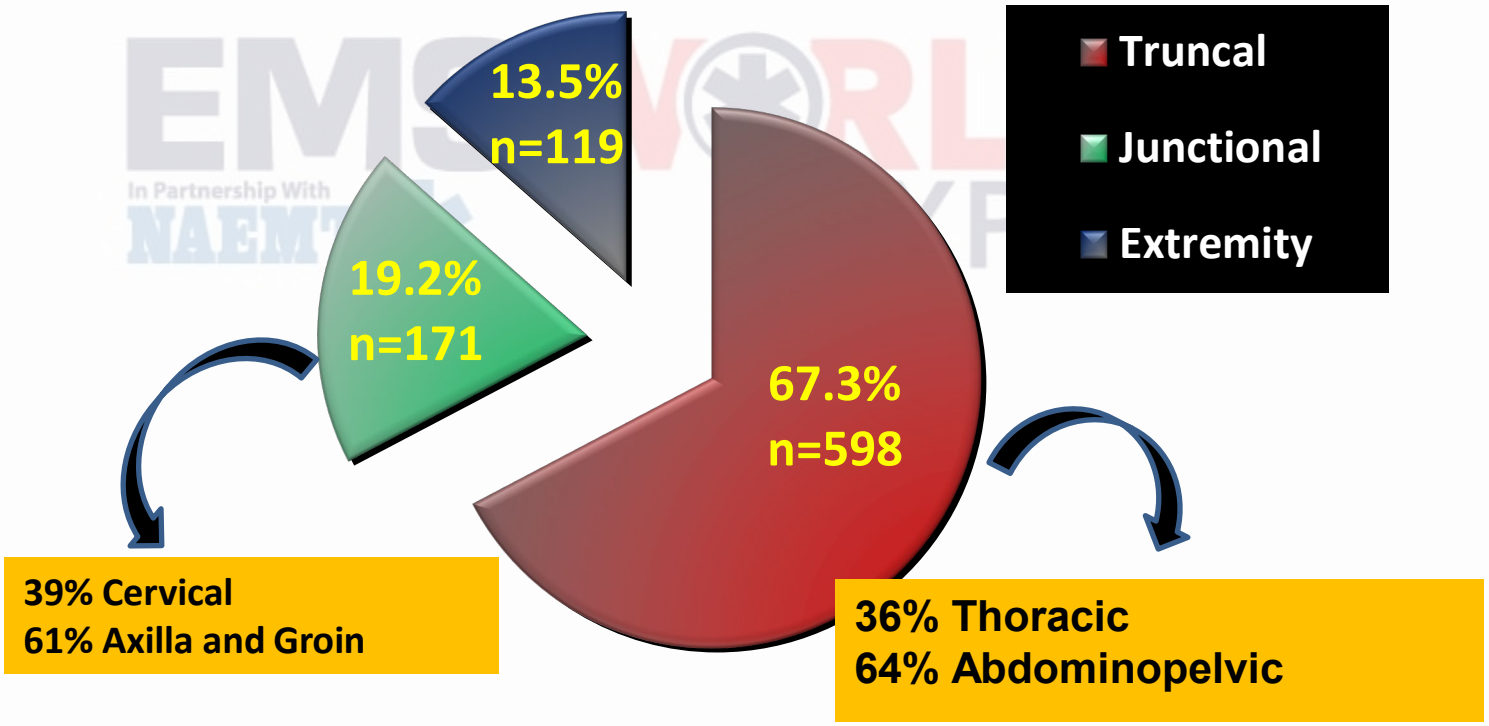
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Battlefield Acute Lethality Potentially Survivable n=976



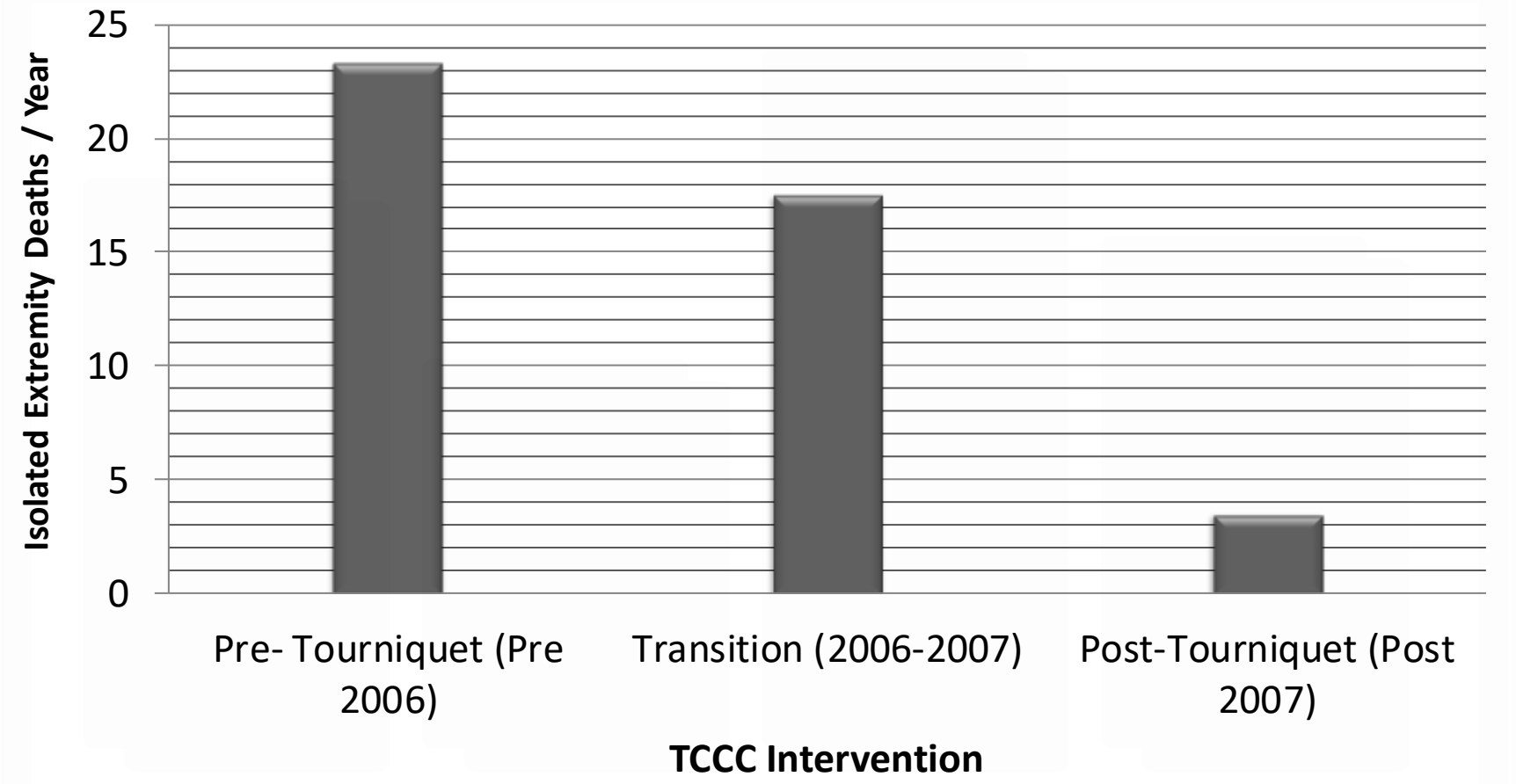
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Anatomic / Physiologic Cause of 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. In press.

Can We Have An Impact?



Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

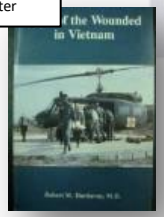
History of Battlefield Medical Innovation

World War I
- IV fluids
- Blood transfusions
- Motorized ambulances
- Topical antisepsis

World War II
- Whole blood/plasma a
- Specialty-specific surgical groups
- Antibiotics
- Fixed wing aero-medical evacuation

Korean Conflict
- Improved fluid resuscitation
- Forward availability of definitive surgery
- Helicopters for patient evac/transport
- Primary repair/grafts for vascular injury

Vietnam
- Improved use of helicopters
- Improved laboratory support
- Portable radiology equipment
- Mechanical ventilators in theater



Desert Shield/Storm
- Burn team augmentation of evacuation hospitals to provide theater-wide burn care
- Intercontinental aeromedical transport of burn patients

OEF / OIF
- **Military trauma system (JTS / DoDTR)**
- **Damage control resuscitation**
- **Tactical Combat Casualty Care**
- **Tourniquet**
- **Understanding of preventable death**
- **Combat casualty care research**

Summary

- **Most battlefield casualties (87.3 %) die on the battlefield**
- **Majority of battlefield deaths (75.7%) are non-survivable**
  - **Mitigation strategy: prevention**
- **Hemorrhage is the major mechanism of death in (90.9 %) of Potentially Survivable combat injuries**
  - **Mitigation strategy: hemorrhage control**
    - **Tourniquets**
    - **Junctional hemorrhage control**
    - **Intracorporeal hemostasis**
      - **Freeze dried plasma**
      - **TXA**
      - **Novel therapeutics**
    - **Damage control to point of injury**
    - **Extending the survival time window from POI to MTF**

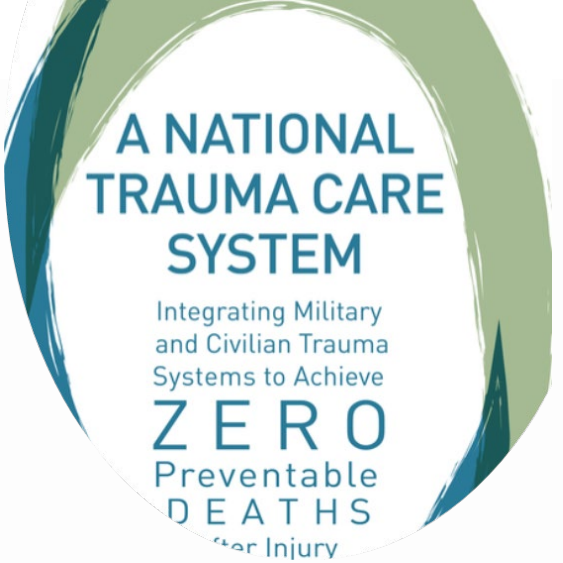
Conclusion

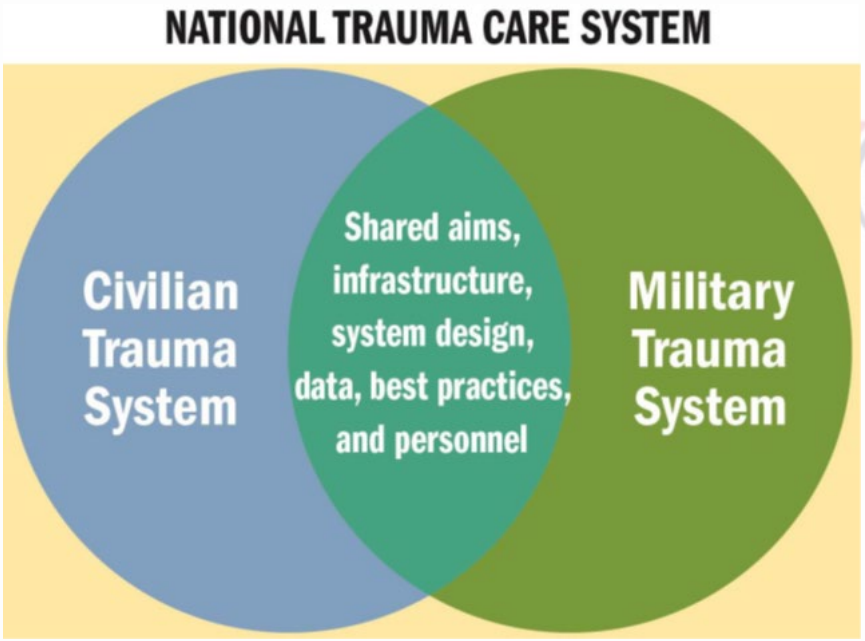
- Value of understanding battlefield mortality in military context
  - Joint Trauma System
    - Strategic decision making
  - TCCC improvements
  - Reprioritized some combat casualty care research and development
  - Command / leadership emphasis

Translation of Combat Casualty Care Lessons to Civilian Injury Management

- Death secondary to injury major problem for civilians and troops
- Most deaths in occur pre-hospital environment
- Many die from potentially survivable injury

National Trauma System Vision



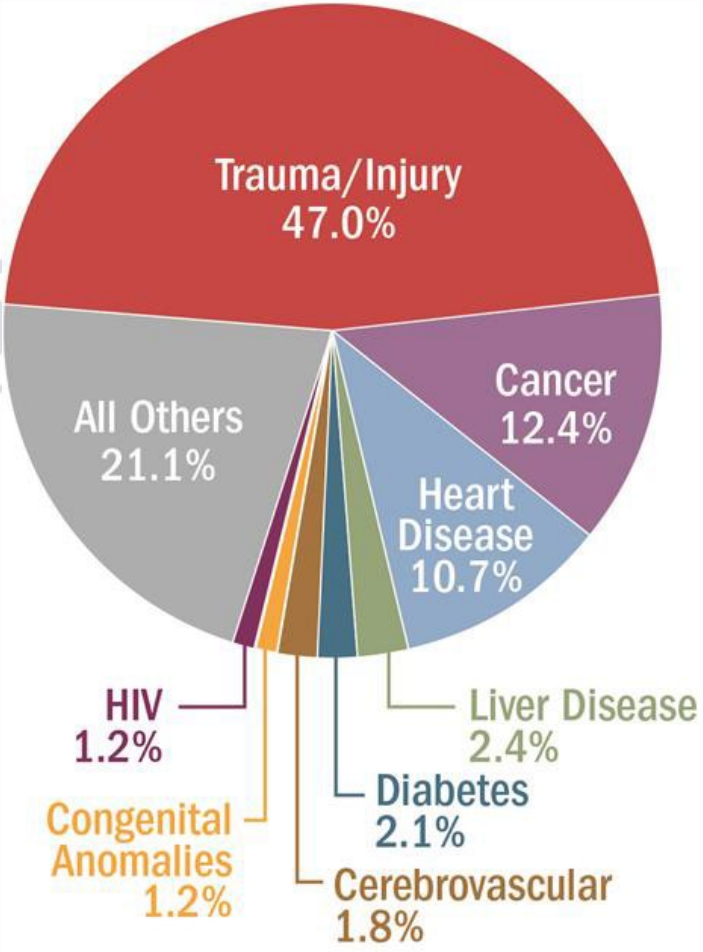


A unified effort is needed to ensure the delivery of optimal trauma care to save the lives of Americans injured within the United States and on the battlefield.

Trauma System
Scope of the Problem

- **Potentially survivable injuries US military operations**
  - **1,273 / 4,574 (27.6%)**

- **Potentially survivable injuries US civilian population 2014**
  - **147,790 x 0.276 = 40,790**



110

 # people in United States

who will

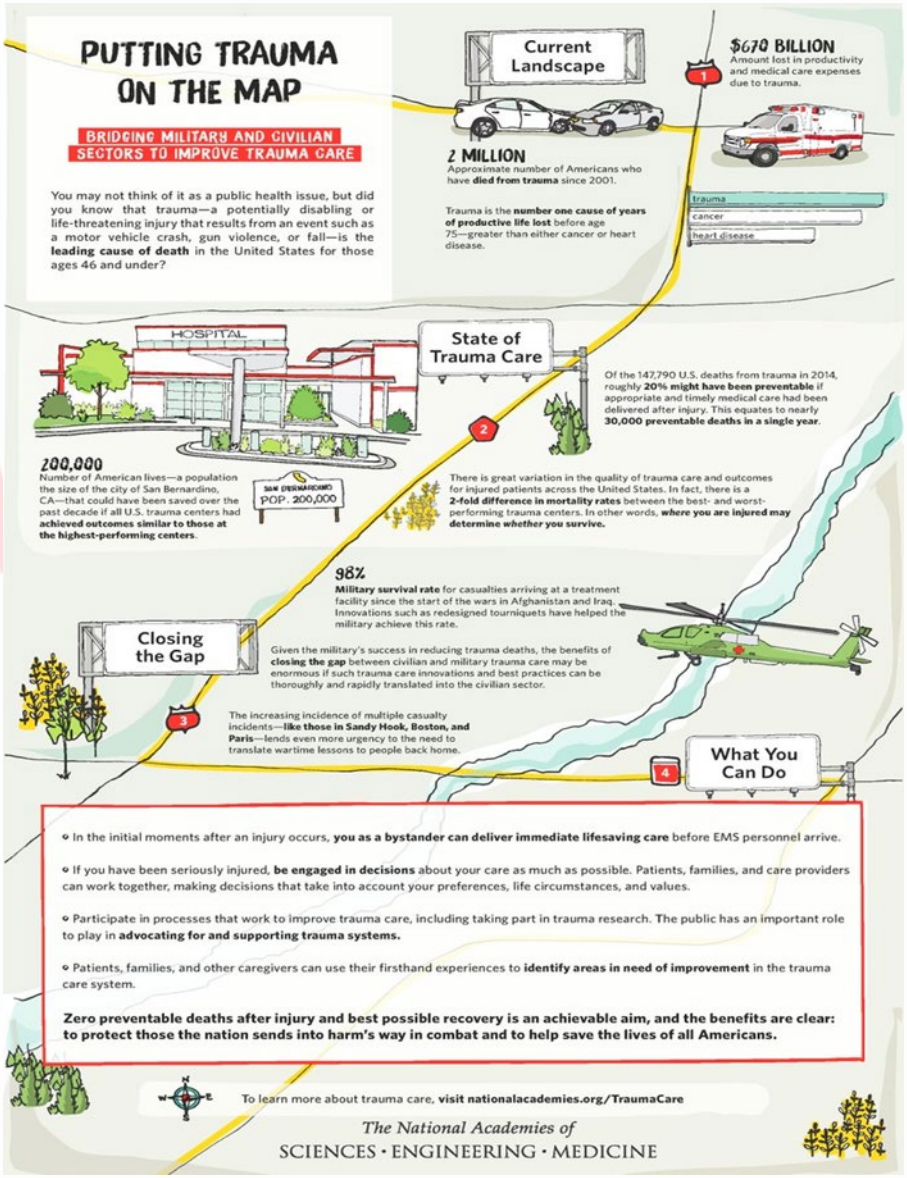
DIE today

from potentially survivable injury

before reaching medical care

Research Needed to Get Beyond Estimates

Objective Establishment of the Impact on Society



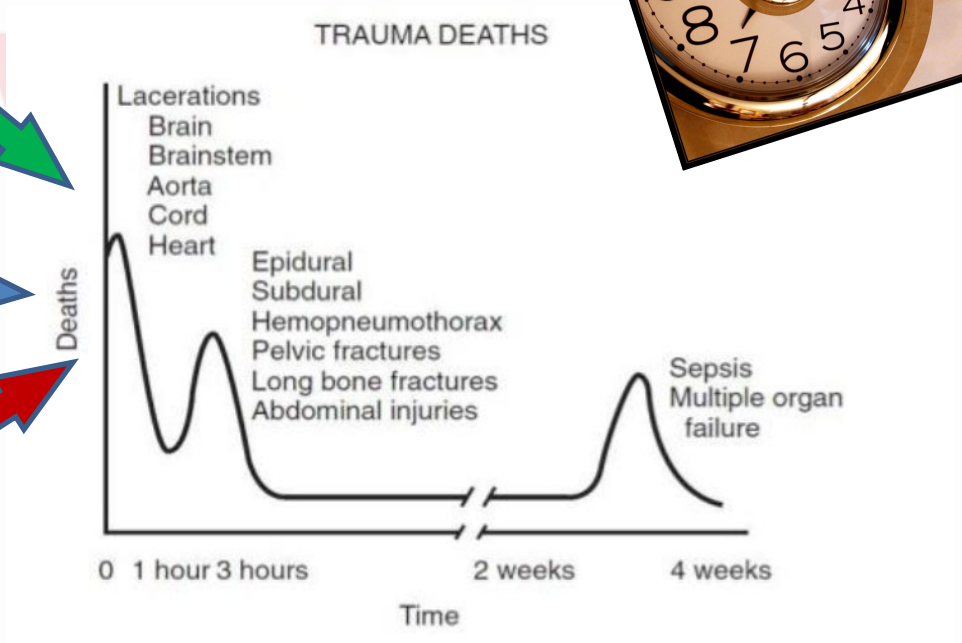
Civilian Prehospital Injury Mortality

Background/Scientific Rationale Pre-Hospital Mortality Civilian

Impact Not Well Quantitated

Potential Survivability Poorly Defined

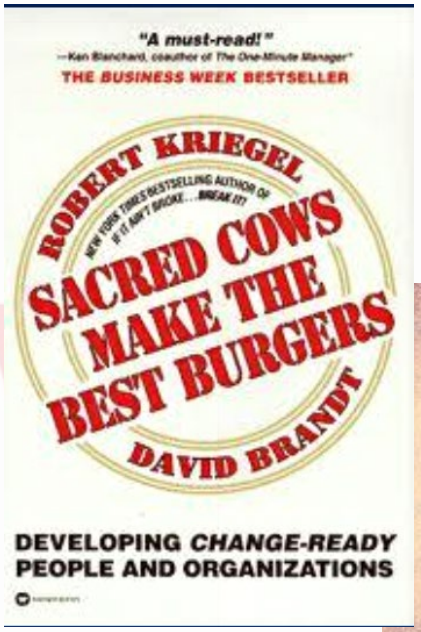
NASEM Report Emphasis

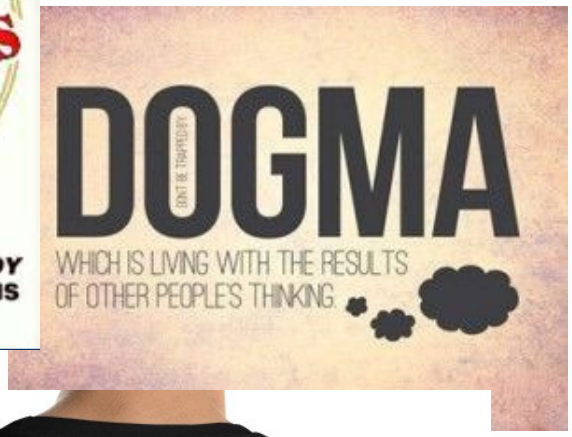


Case Fatality Rate (CFR) ~ 4.1% /
2-5 % Hospital Mortality Potentially Preventable

Revisit the Sacred Cows

- "Golden Hour"
- Hemorrhage control
- Prehospital resuscitation





Multiinstitutional Multidisciplinary Injury Mortality Investigation in Civilian PreHospital Environment

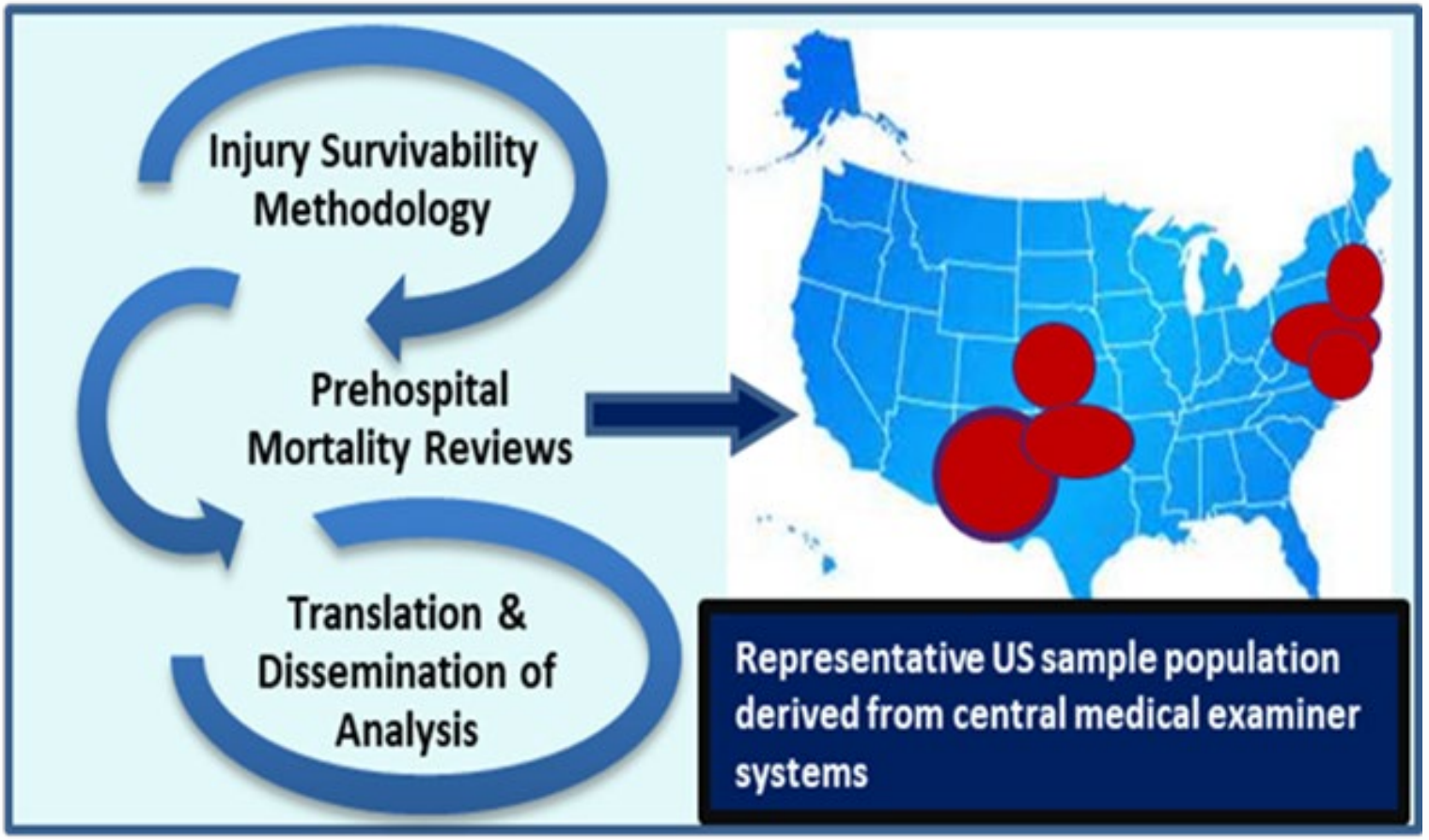
PIs:Eastridge, Nolte, MacKenzie

Funded by USAMRMC
(Department of Defense)

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.

MIMIC ME Sites



Study Population

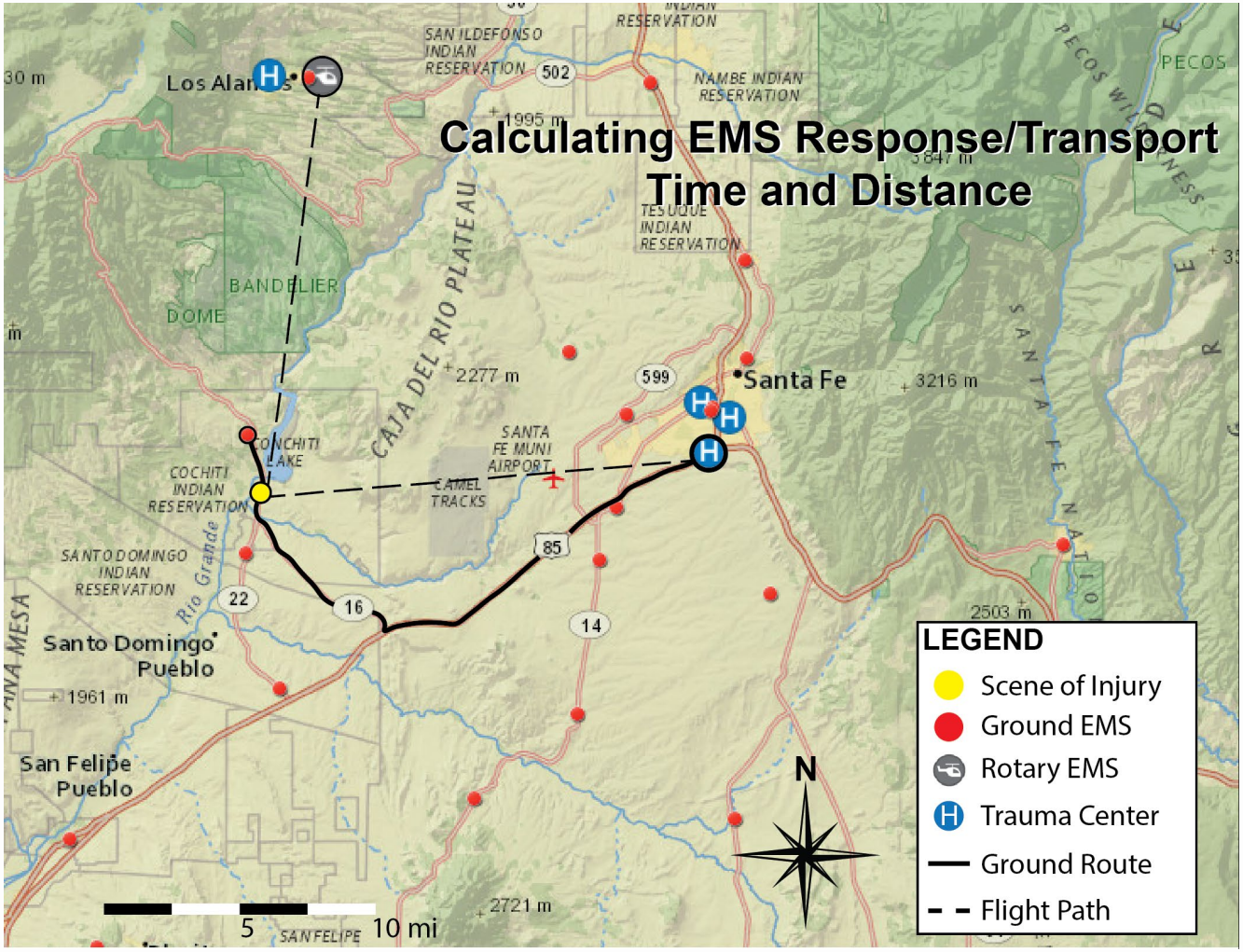
Inclusion Criteria:

1. Pre-hospital deaths (at scene, en route to hospital or DOA – defined as no vitals upon arrival at hospital)
2. Due to a blunt, penetrating or other sharp force
3. Adequate forensic record

Exclusion Criteria:

1. Non-mechanical causes: poisoning, incl. drug overdoses, asphyxia, drowning,
2. Decomposed remains only (not fully fleshed with distinguishable organs)

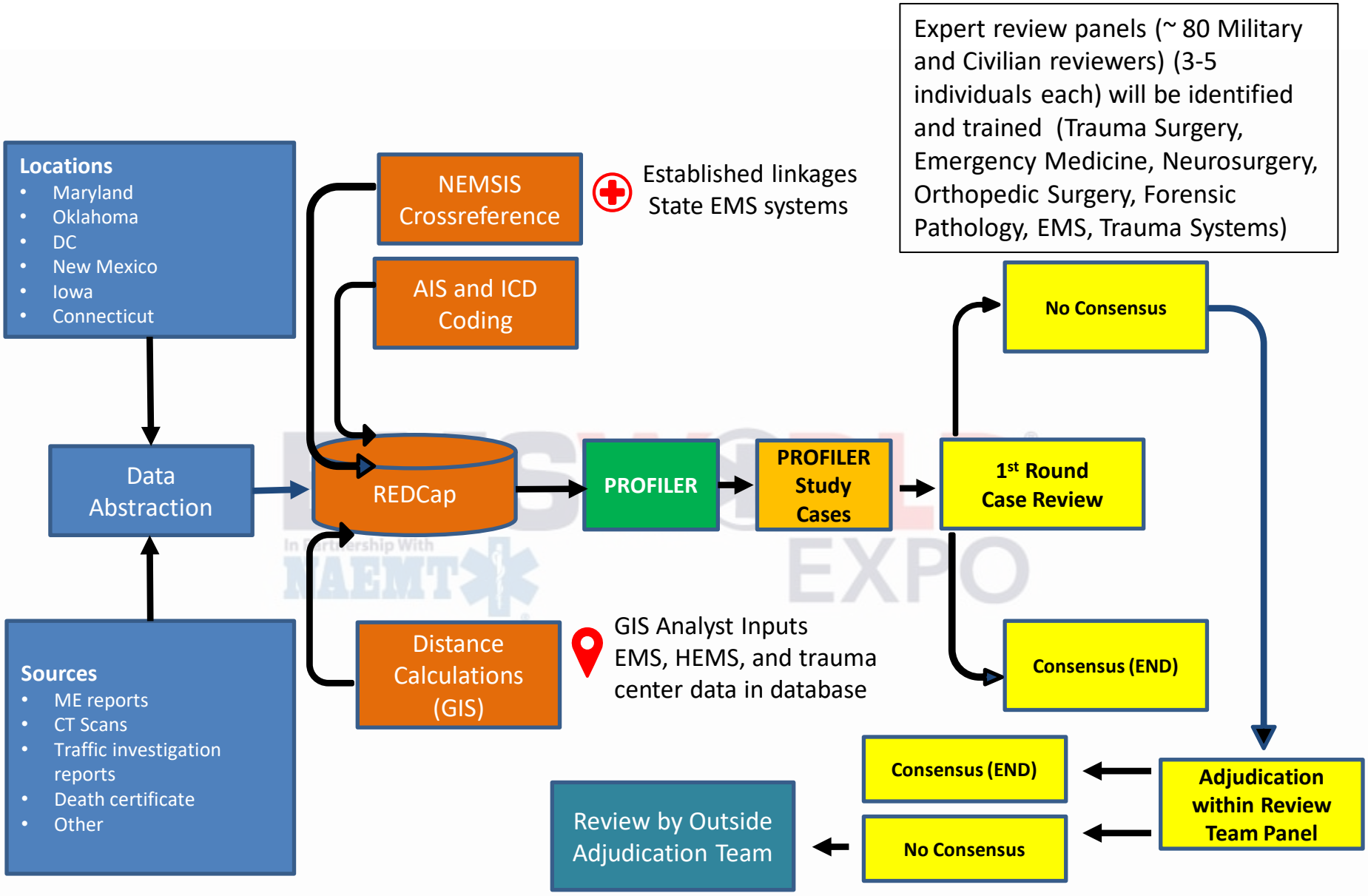
Integrating Geospatial Modeling



Survivability Definitions

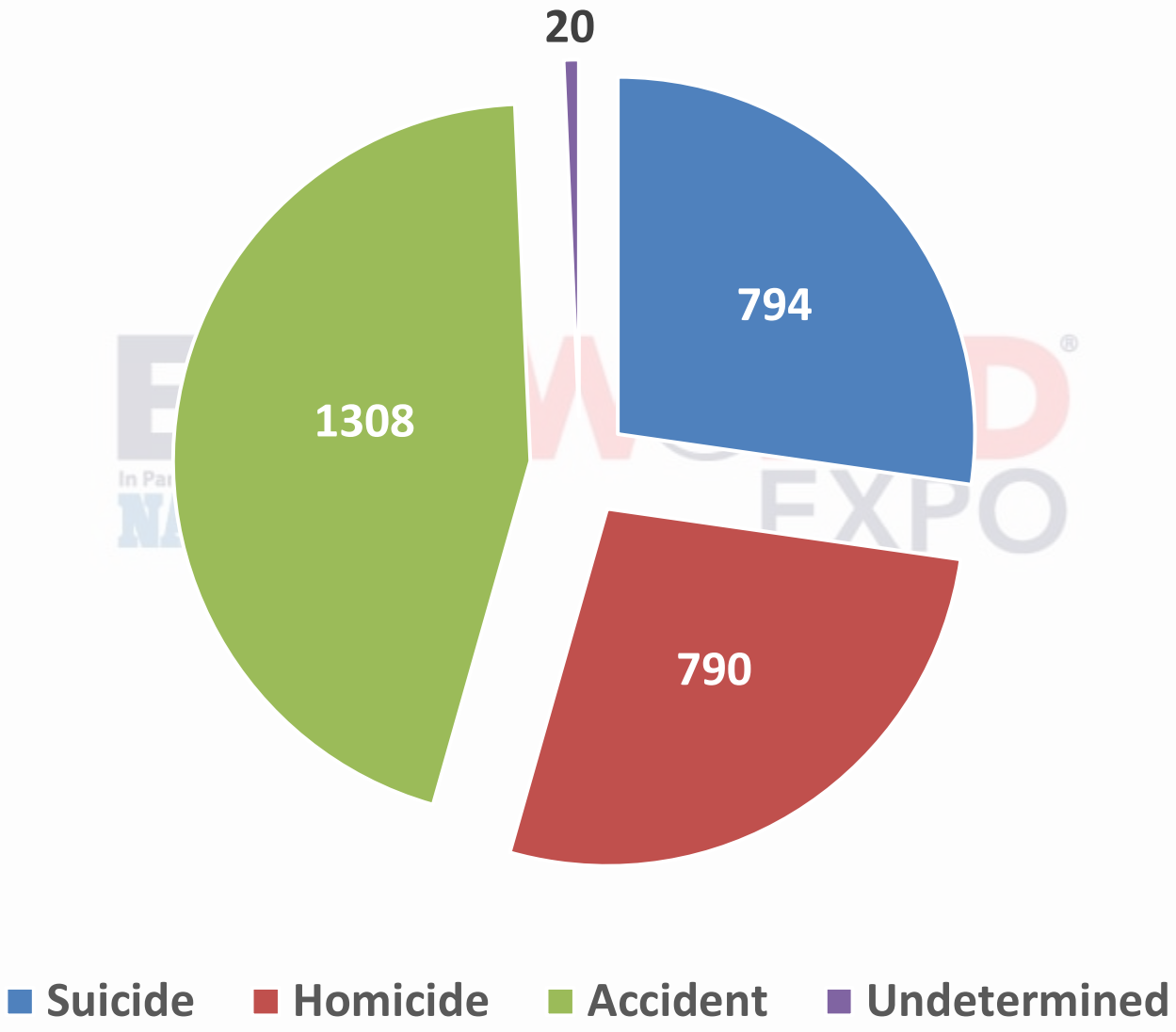
- **Non-Survivable-** Death as a result of catastrophic anatomic injuries
- **Possibly Survivable -** Anatomic injuries that were severe but medically survivable
- **Definitely Survivable-** Minimal anatomic injuries with a high likelihood of survival

- **Circumstances** optimal versus actual


Expert review panels (~ 80 Military and Civilian reviewers) (3-5 individuals each) will be identified and trained (Trauma Surgery, Emergency Medicine, Neurosurgery, Orthopedic Surgery, Forensic Pathology, EMS, Trauma Systems)
Locations
Maryland
Oklahoma
DC
New Mexico
Iowa
Connecticut
NEMSIS Crossreference
Established linkages 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
Consensus (END)
Adjudication within Review Team Panel
Review by Outside Adjudication Team
No Consensus

Results

Manner of Death



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

Preliminary Data (All Patients)

Survivability	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

Preliminary Data (All Patients)

Survivability	Immediate Access (All)	Actual Scenario (All)
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OPPORTUNITIES TO IMPROVE CURRENT TRAUMA SYSTEM

Preliminary Data
(All Pati

RESEARCH AND DEVELOPMENT OPPORTUNITIES TO IMPROVE FUTURE TRAUMA SYSTEMS

Survivability	Immediate Access (All)	Actual Scenario (All)
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Preliminary 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%)

Preliminary Data (Excluding Suicide)

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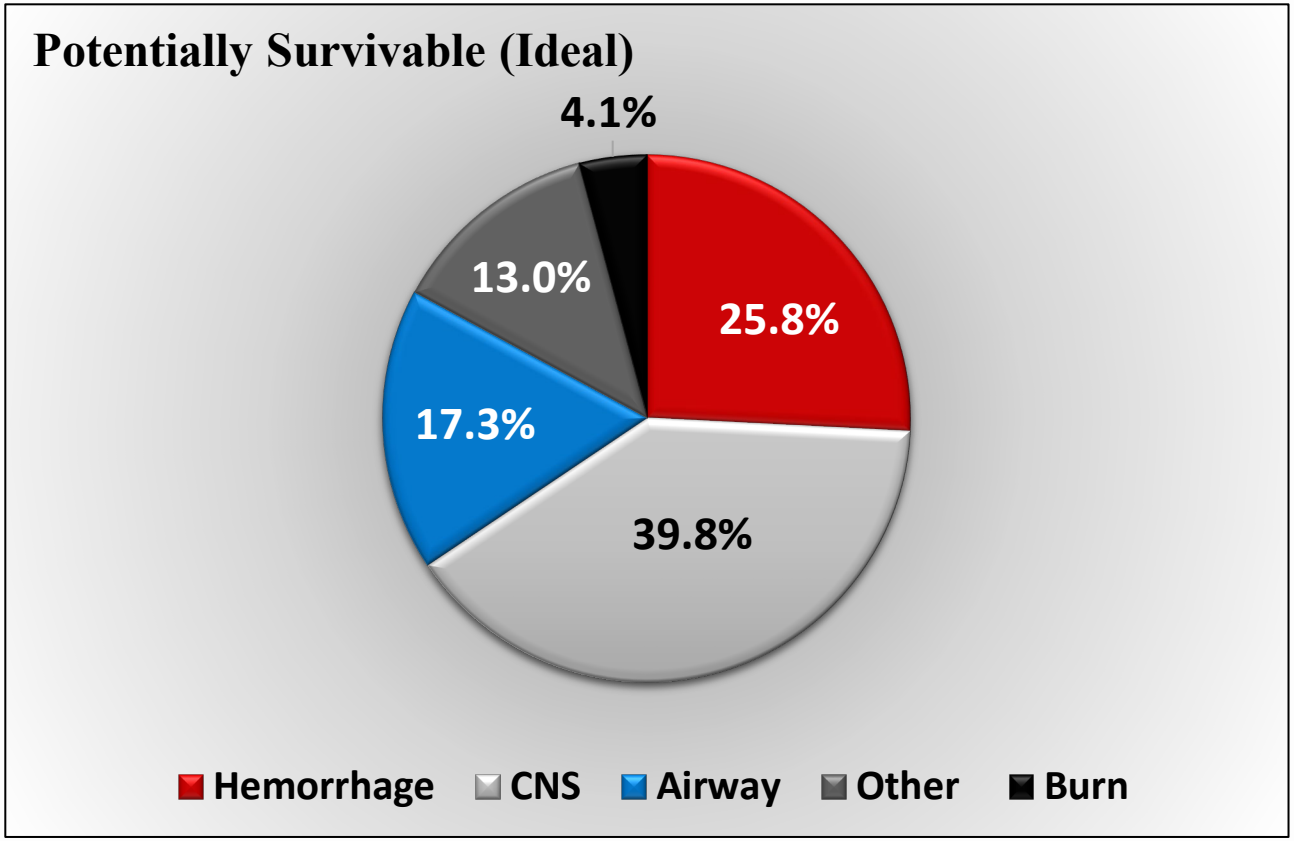
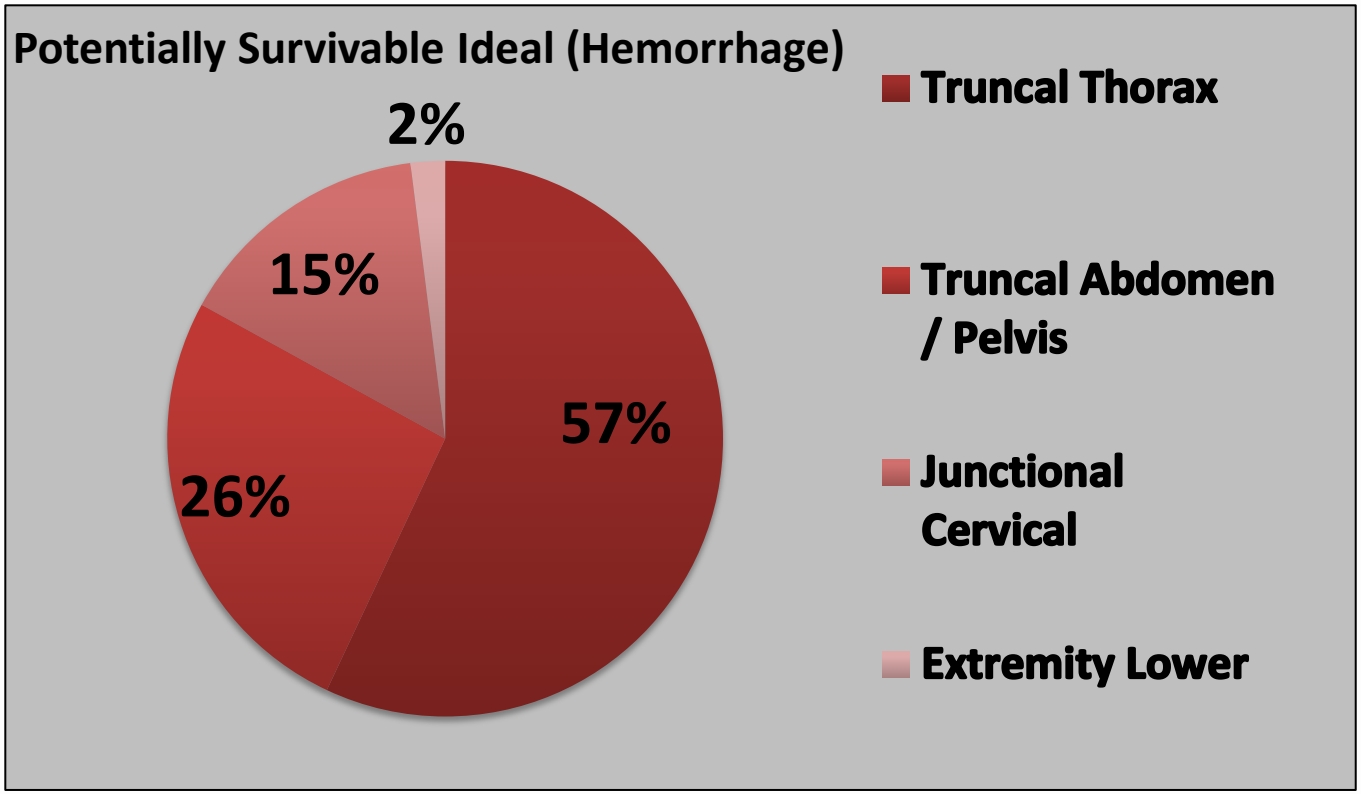
POTENTIALLY PREVENTABLE DEATHS

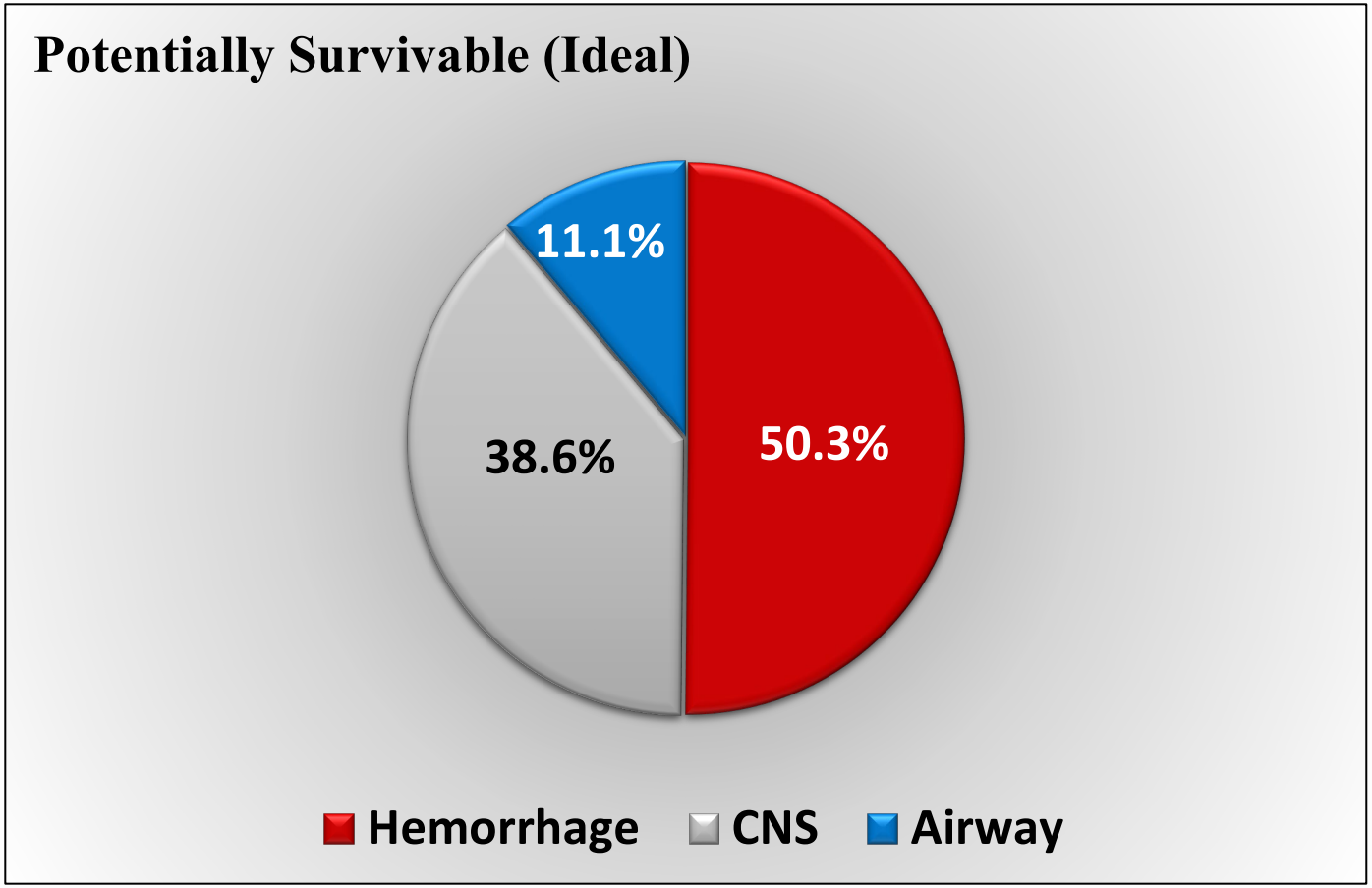
Mechanism of Death (All)
Ideal Circumstance



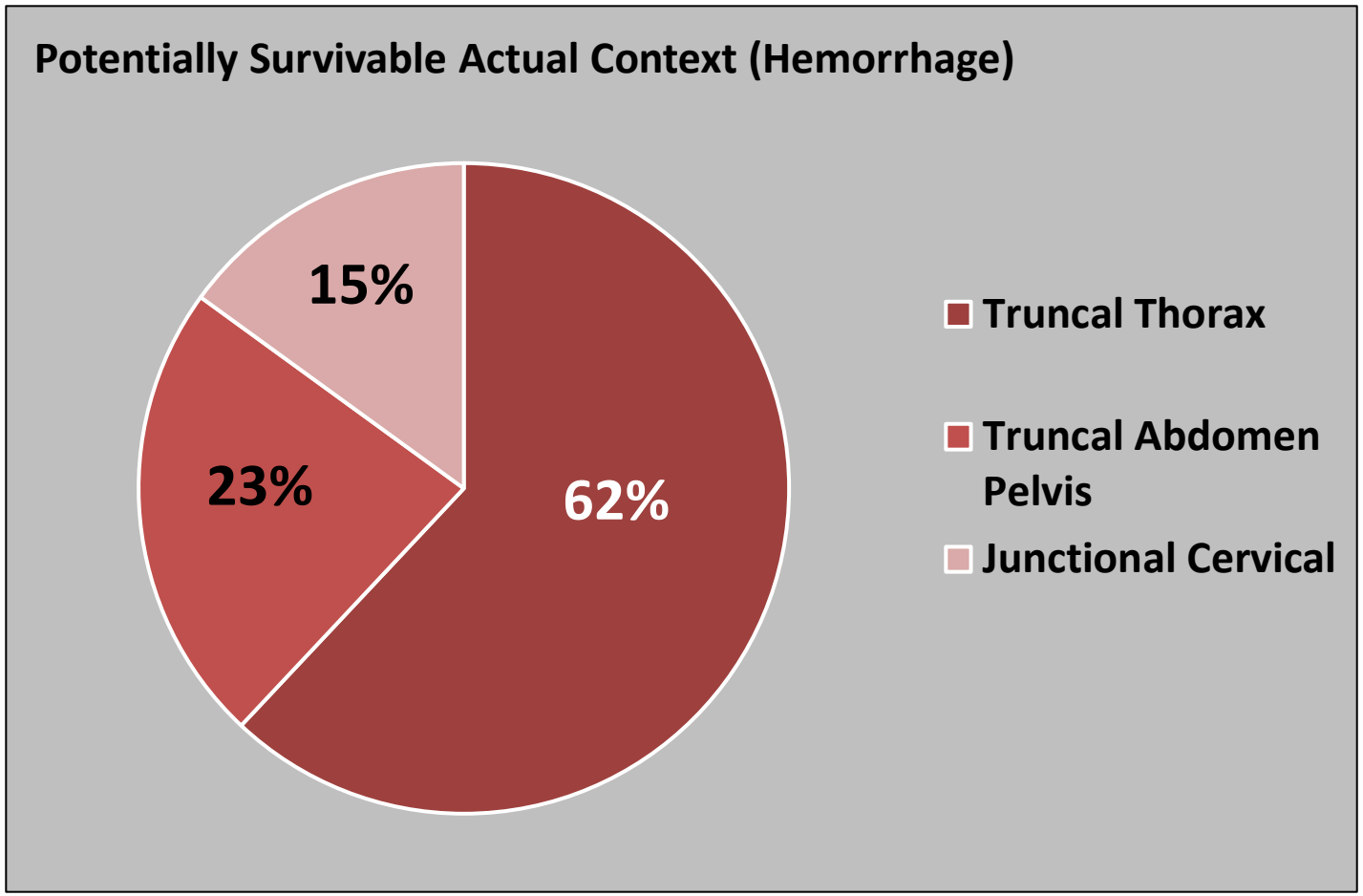
Potentially Survivable (Hemorrhage Focus) Ideal Circumstance



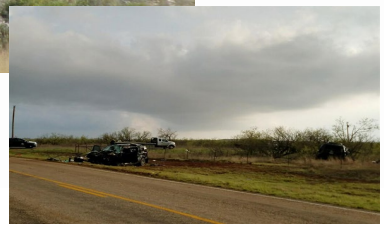
Mechanism of Death (All)
Actual Circumstance

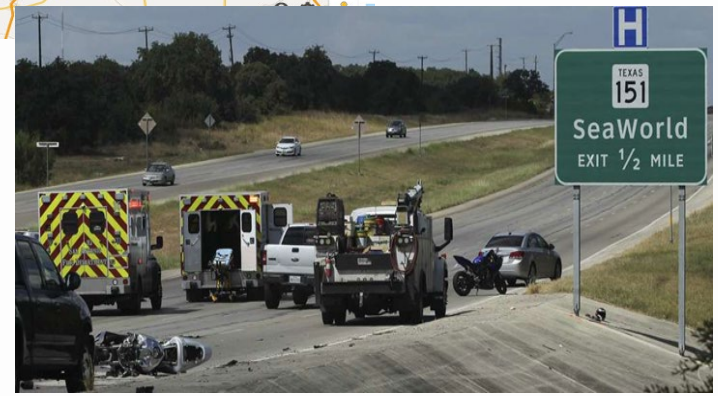


Potentially Survivable (Hemorrhage Focus) Actual Circumstance

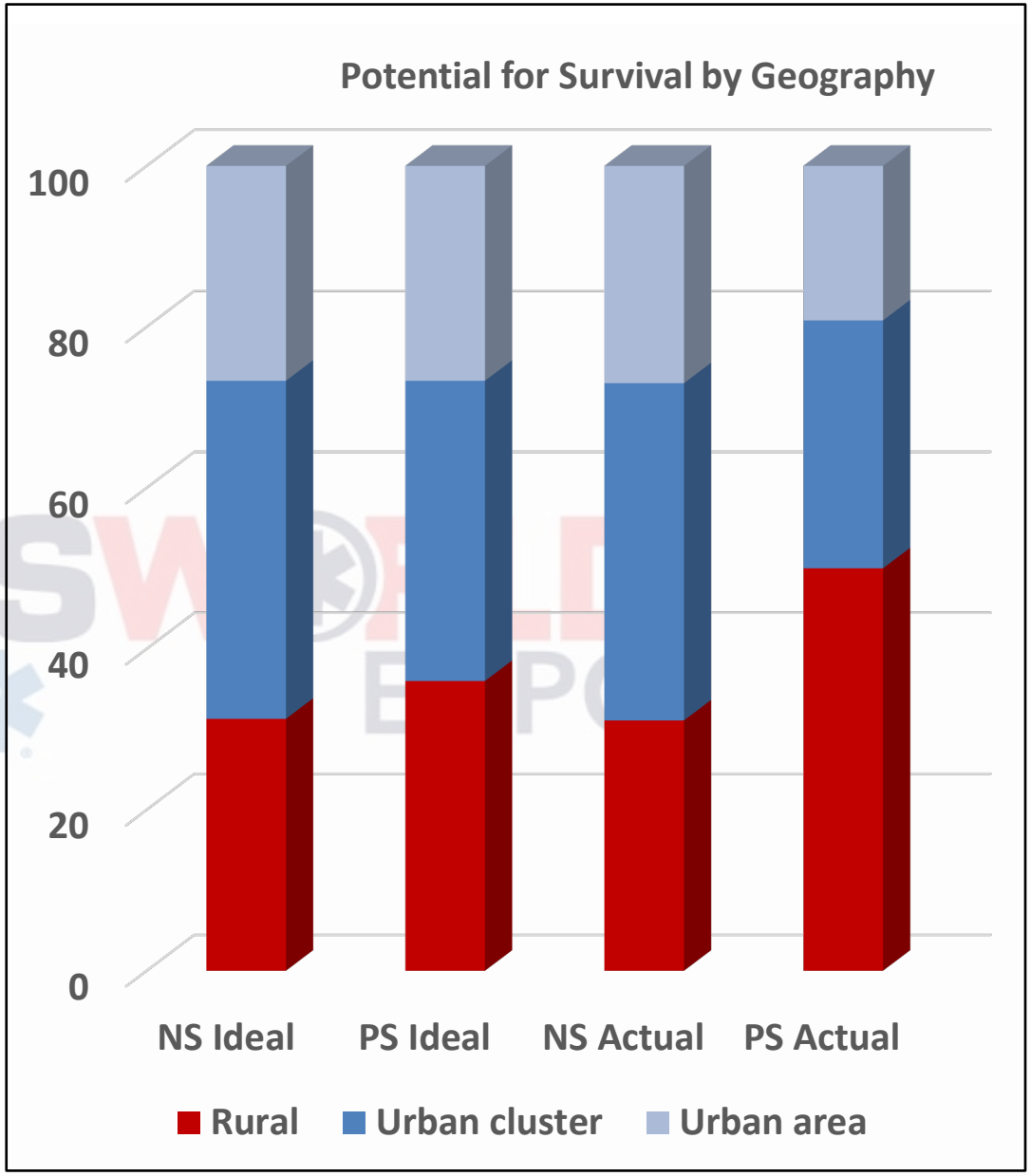


Importance of Context (Location)
Does Where You Live Determine Whether You Live?





Potential for Survival by Location



Preliminary 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

Conclusions

- More comprehensive understanding of pre-hospital injury mortality vital to future improvements in trauma care
- Specific targets for future focus of R&D to improve the pre-hospital management and outcomes of the injured patient
  - Resuscitation
  - Novel technologies
  - Automatic notification systems
- Useful in the development and implementation of mitigation strategies for therapy and injury prevention to improve trauma systems

THE COMMITTEE ON TRAUMA

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

Trauma System Implications Civilian Prehospital Trauma Mortality

Brian Eastridge, MD, FACS
COL, MC, USAR
Professor, Department of Surgery
Jocelyn and Joe Straus Endowed Chair in Trauma Research
Division of Trauma and Emergency Surgery
University of Texas Health Science Center at San Antonio

AMERICAN COLLEGE OF SURGEONS
Inspiring Quality:
Highest Standards, Better Outcomes
100+years

Disclosures

THE COMMITTEE ON TRAUMA

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.

Scope of the Problem

All Cause Death

10 Leading Causes of Death, United States

2017, All Races, Both Sexes

	Age Groups										
Rank	<1	1-4	5-9	10-14	15-24	25-34	35-44	45-54	55-64	65+	All Ages
1	Congenital Anomalies 4,580	Unintentional Injury 1,267	Unintentional Injury 718	Unintentional Injury 860	Unintentional Injury 13,441	Unintentional Injury 25,669	Unintentional Injury 22,828	Malignant Neoplasms 39,266	Malignant Neoplasms 114,810	Heart Disease 519,052	Heart Disease 647,457
2	Short Gestation 3,749	Congenital Anomalies 424	Malignant Neoplasms 418	Suicide 517	Suicide 6,252	Suicide 7,948	Malignant Neoplasms 10,900	Heart Disease 32,658	Heart Disease 80,102	Malignant Neoplasms 427,896	Malignant Neoplasms 599,108
3	Maternal Pregnancy Comp. 1,432	Malignant Neoplasms 325	Congenital Anomalies 188	Malignant Neoplasms 437	Homicide 4,905	Homicide 5,488	Heart Disease 10,401	Unintentional Injury 24,461	Unintentional Injury 23,408	Chronic Low. Respiratory Disease 136,139	Unintentional Injury 169,936
4	SIDS 1,363	Homicide 303	Homicide 154	Congenital Anomalies 191	Malignant Neoplasms 1,374	Heart Disease 3,681	Suicide 7,335	Suicide 8,561	Chronic Low. Respiratory Disease 18,667	Cerebro-vascular 125,653	Chronic Low. Respiratory Disease 160,201
5	Unintentional Injury 1,317	Heart Disease 127	Heart Disease 75	Homicide 178	Heart Disease 913	Malignant Neoplasms 3,616	Homicide 3,351	Liver Disease 8,312	Diabetes Mellitus 14,904	Alzheimer's Disease 120,107	Cerebro-vascular 146,383
6	Placenta Cord Membranes 843	Influenza & Pneumonia 104	Influenza & Pneumonia 62	Heart Disease 104	Congenital Anomalies 355	Liver Disease 918	Liver Disease 3,000	Diabetes Mellitus 6,409	Liver Disease 13,737	Diabetes Mellitus 59,020	Alzheimer's Disease 121,404
7	Bacterial Sepsis 592	Cerebro-vascular 66	Chronic Low. Respiratory Disease 59	Chronic Low. Respiratory Disease 75	Diabetes Mellitus 248	Diabetes Mellitus 823	Diabetes Mellitus 2,118	Cerebro-vascular 5,198	Cerebro-vascular 12,708	Unintentional Injury 55,951	Diabetes Mellitus 83,564
8	Circulatory System Disease 449	[illegible]	Cerebro-	Cerebro-	Influenza	Cerebro-	Cerebro-	Chronic Low.	[illegible]	Influenza & Pneumonia 46,862	Influenza & Pneumonia 55,672
9	Respiratory Distress 440	Benign Neoplasms 44	Septicemia 33	Influenza & Pneumonia 51	Chronic Low. Respiratory Disease 188	HIV 513	Septicemia 854	Septicemia 2,441	Septicemia 5,838	Nephritis 41,670	Nephritis 50,633
10	Neonatal Hemorrhage 379	Perinatal Period 42	Benign Neoplasms 31	Benign Neoplasms 31	Complicated Pregnancy 168	Complicated Pregnancy 512	HIV 831	Homicide 2,275	Nephritis 5,671	Parkinson's Disease 31,177	Suicide 47,173

WISQARS™

Produced By: National Center for Injury Prevention and Control, Centers for Disease Control and Prevention

Data Source: National Center for Health Statistics (NCHS), National Vital Statistics System

110

 # people in United States

who will

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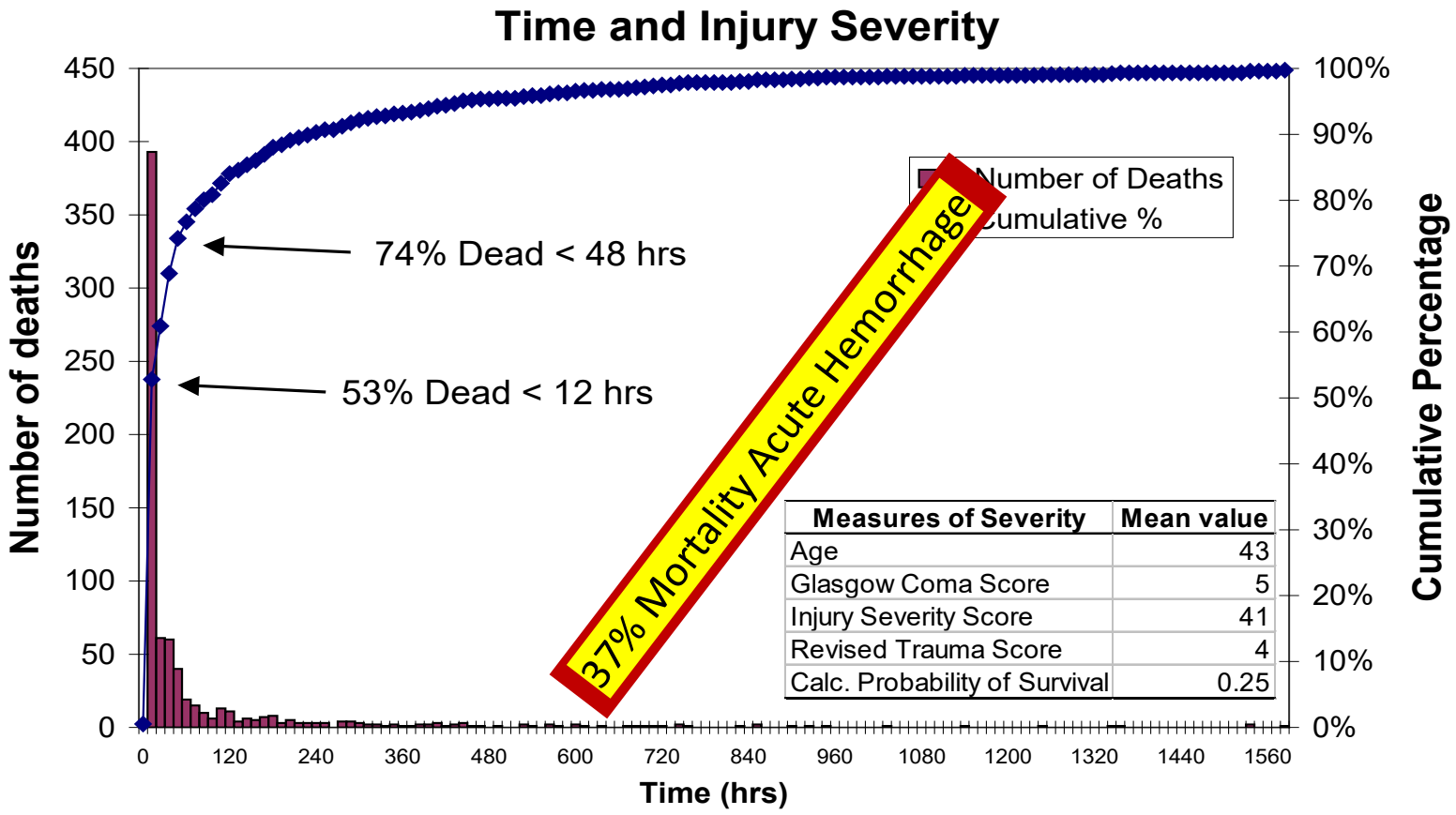
Hospital Injury Mortality

Trauma Center Mortality



Stewart: Analysis of 753 deaths in a Level I Trauma Center. J Trauma 2003.

Death Classification

Classification	N	Percent
Not Therapeutically Preventable	701	93.1%
Possibly Preventable	32	4.2%
Preventable	20	2.7%

Eliminating ALL errors, curing MOF, sepsis, DVT/PE, and secondary brain injury would theoretically reduce the number of deaths by 6.9%

With respect to hospital injury outcomes

"…there is very little blood to be squeezed from the therapeutic turnip"

- Trauma centers
- Trauma systems
- Performance improvement
- Technological advances
- GME focus on training

Jonathan Rhoads, M.D.

William T. Fitts Lecture

American Association for the Surgery of Trauma, 1995

Understanding Prehospital Injury Mortality

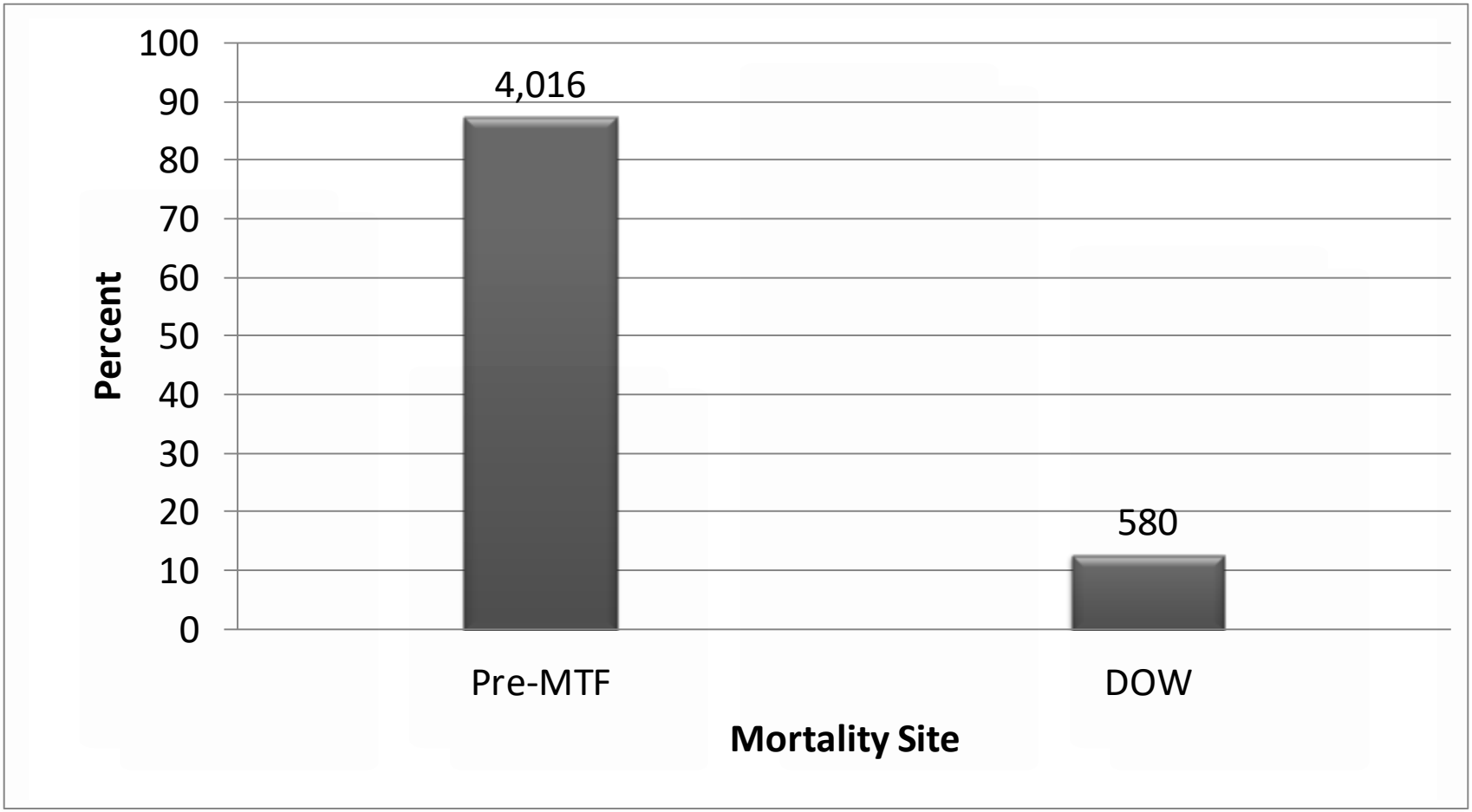
How do we determine of survivability of those that never reach hospital care?

Much bigger population injury mortality

*Most future opportunities to effect injury outcomes will be prehospital

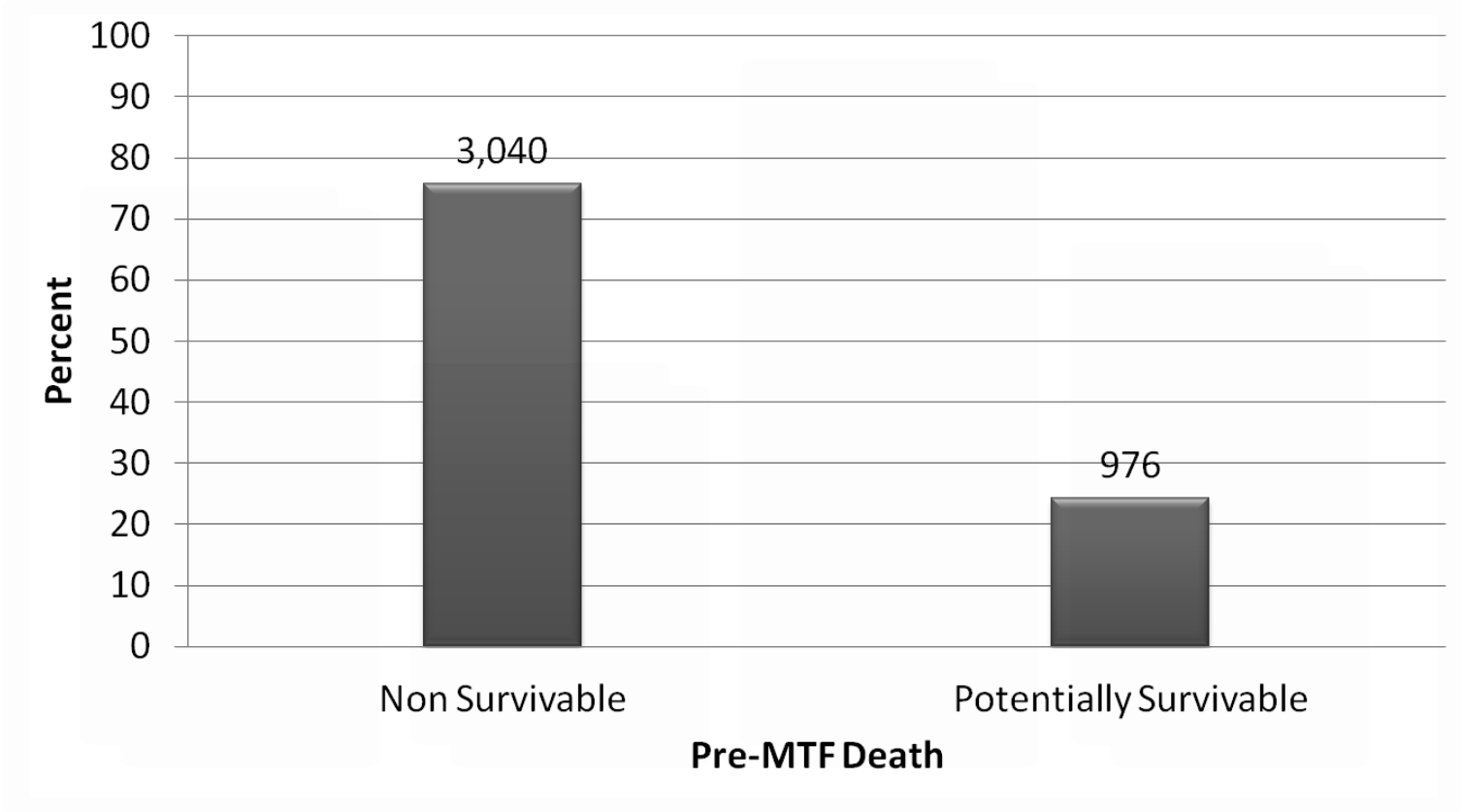
Prehospital Mortality Battlefield

Where Battlefield Casualties Die



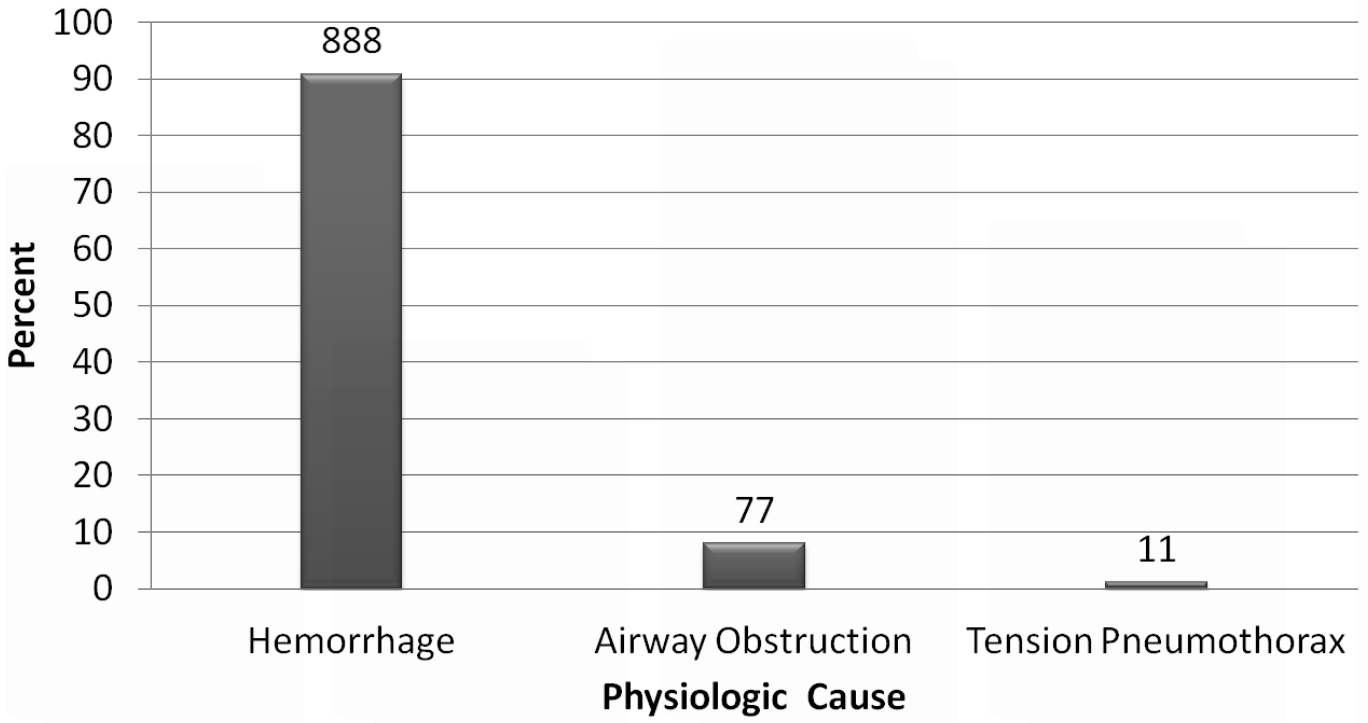
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Battlefield Pre-Hospital Death Analysis n=4,016 (DOW excluded)



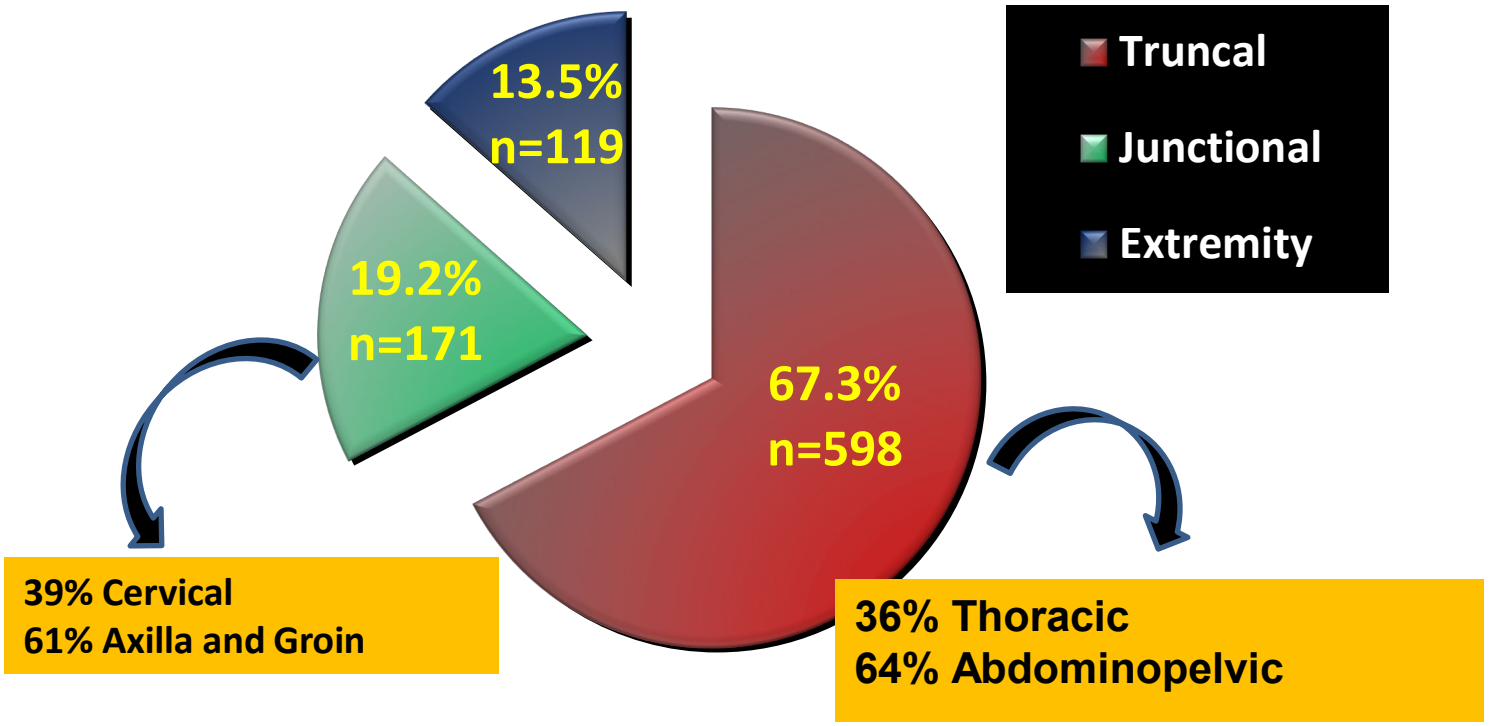
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Battlefield Acute Lethality Potentially Survivable n=976



Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Anatomic / Physiologic Cause of 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. In press.

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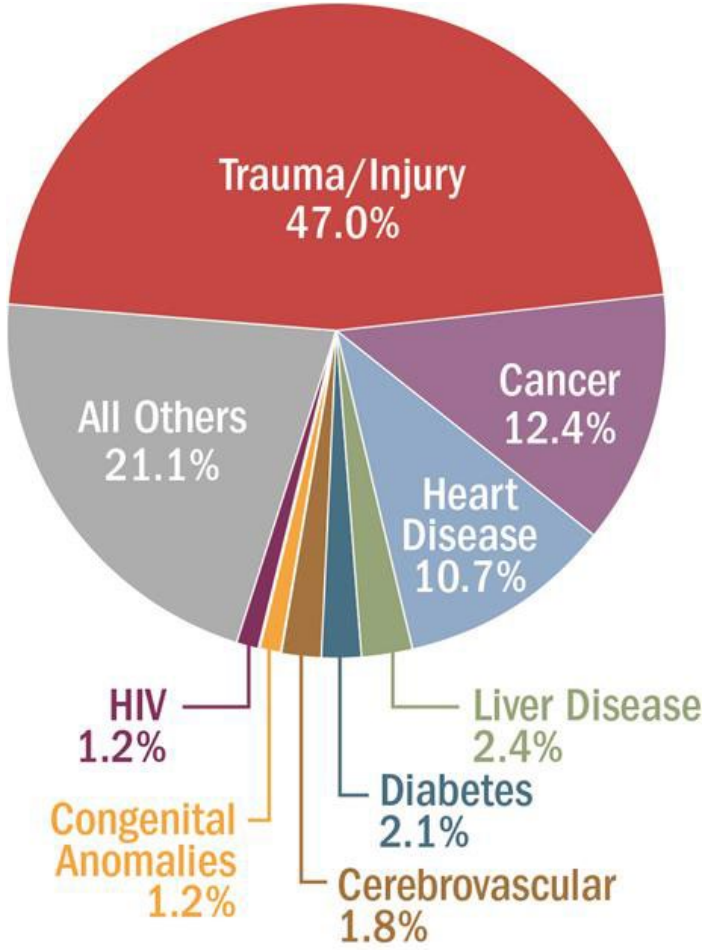

Research Needed to Get Beyond Estimates

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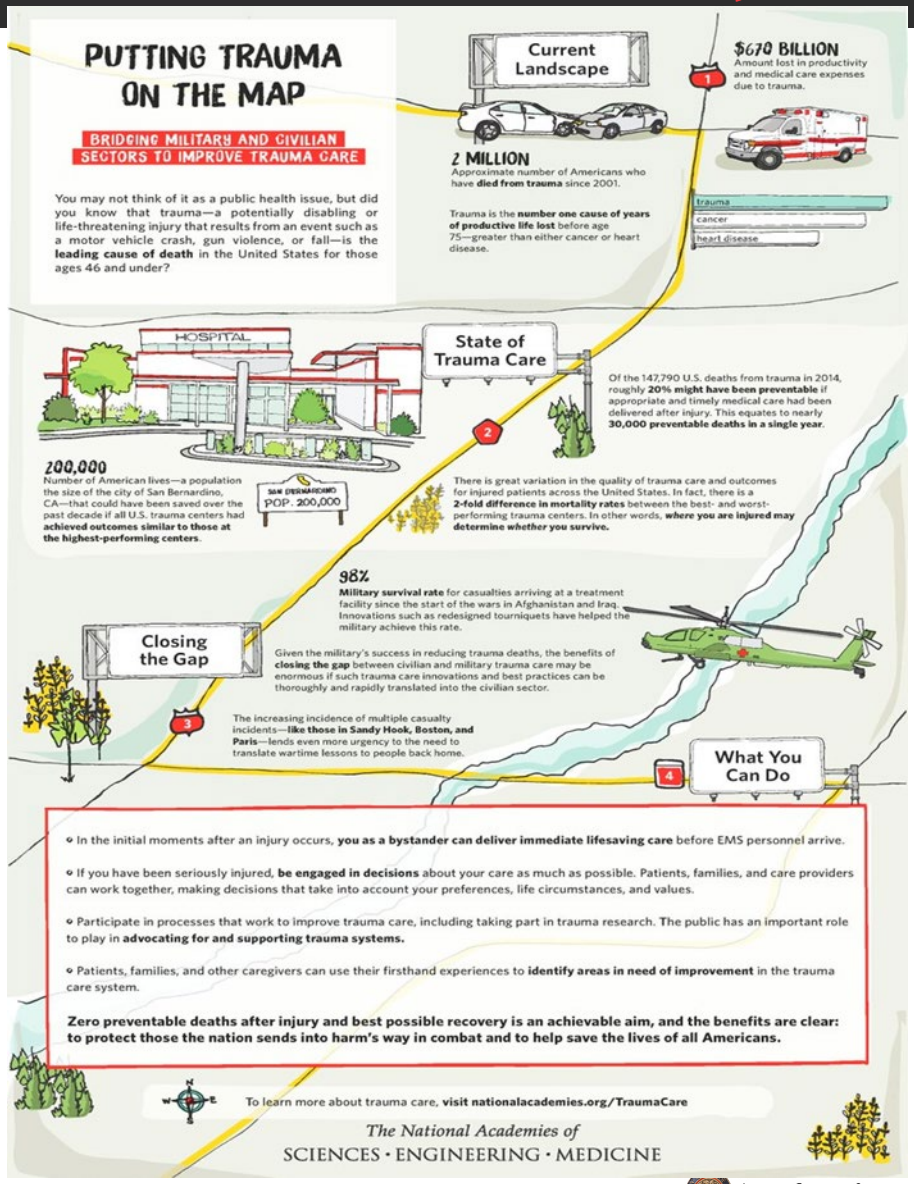

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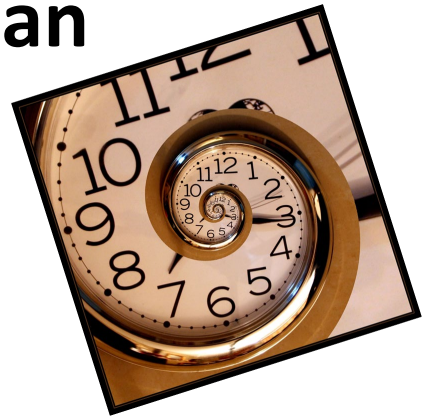
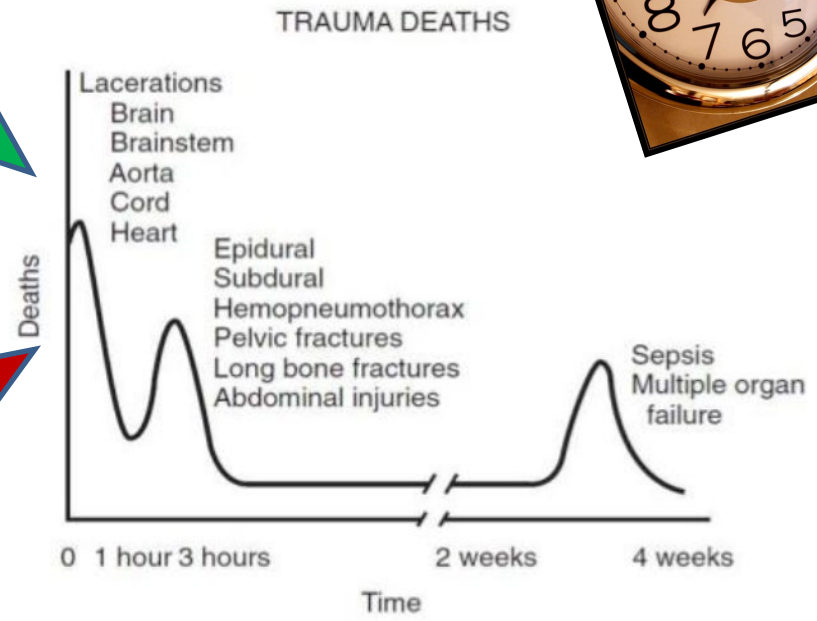


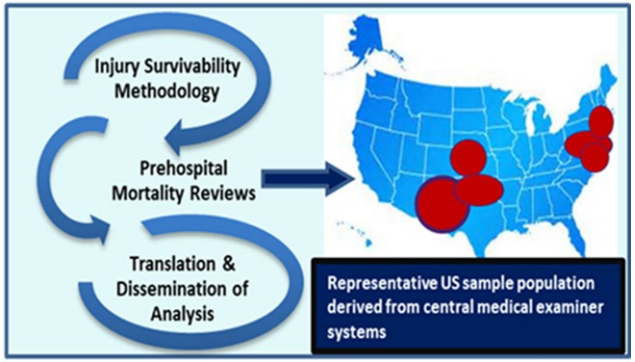


Case Fatality Rate (CFR) ~ 4.1% /
2-5 % Hospital Mortality Potentially Preventable

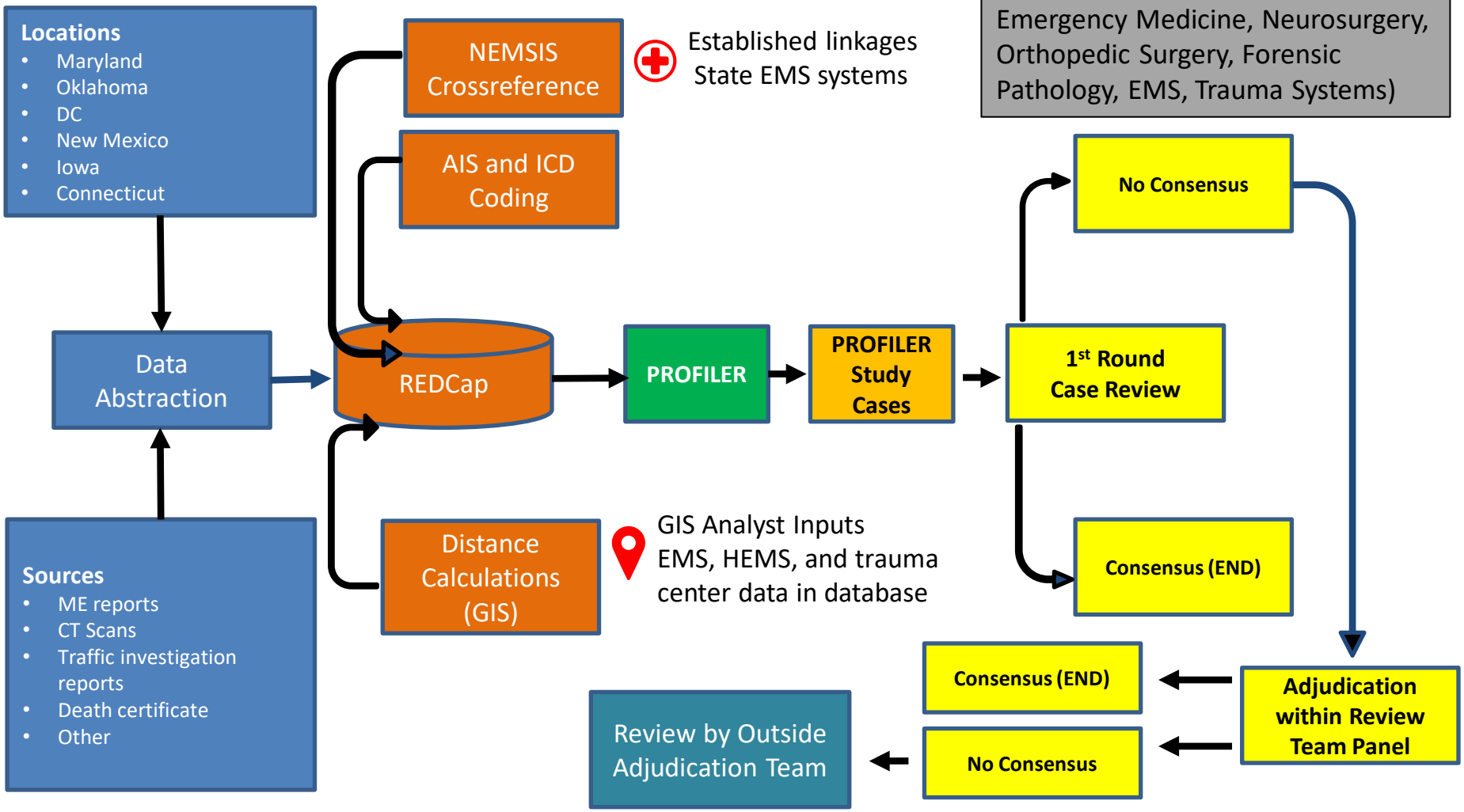
MIMIC
Multi-Institutional Multidisciplinary Injury Mortality Investigation in the Civilian Pre-Hospital Environment

(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

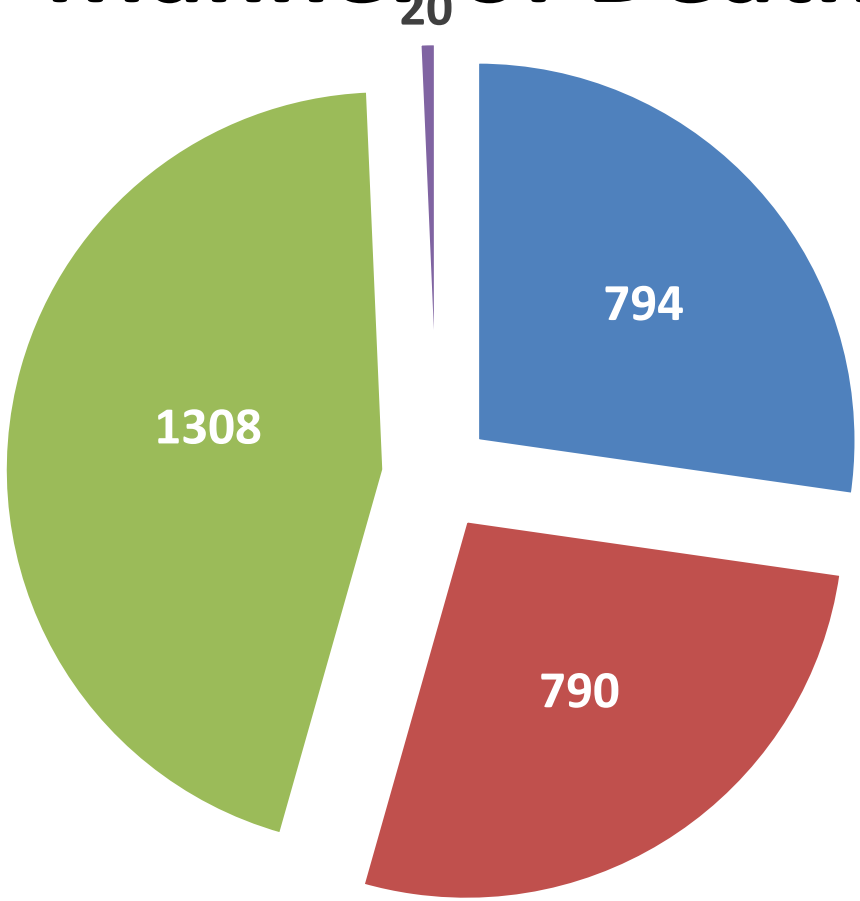


Expert review panels (~ 80 Military and Civilian reviewers) (3-5 individuals each) will be identified and trained (Trauma Surgery, Emergency Medicine, Neurosurgery, Orthopedic Surgery, Forensic Pathology, EMS, Trauma Systems)



Preliminary Partial Results

Manner of Death



Preliminary Data

Principal Mechanism(s) of Death	Frequency
Massive tissue disruption	146
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Neurological - Spinal Cord	246
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Hemorrhage - Junctional	44
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Preliminary Data (All Patients)

Survivability	Immediate Access (All)	Actual Scenario (All)
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Survivable	78 (19.5%)	20 (5.0%)
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RESEARCH AND DEVELOPMENT OPPORTUNITIES TO INFORM INJURY PREVENTION

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OPPORTUNITIES TO IMPROVE CURRENT TRAUMA SYSTEM

Prelimina
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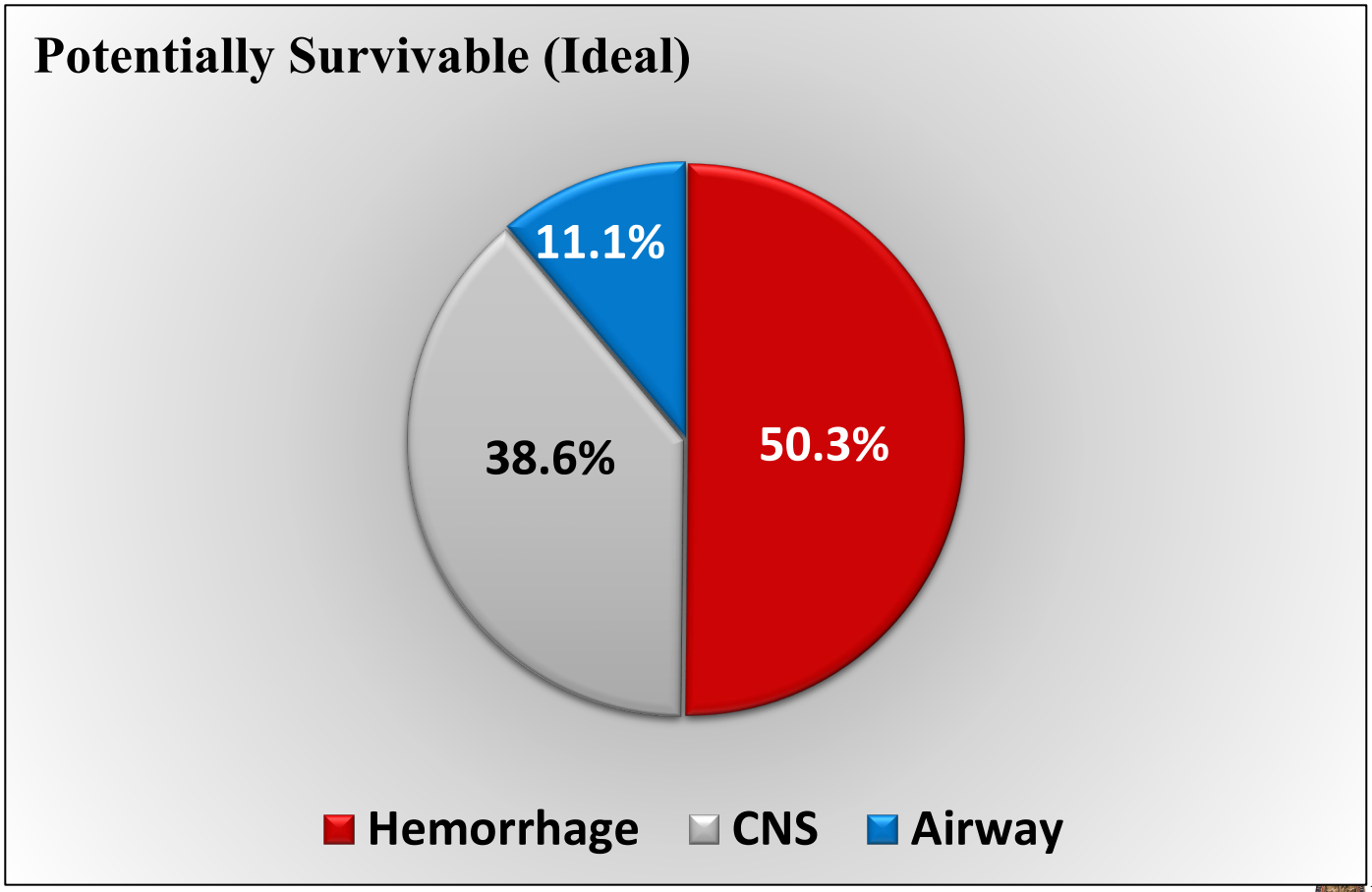
POTENTIALLY PREVENTABLE DEATHS

Mechanism of Death (All)
Actual Circumstance



Conclusions

- More comprehensive understanding of pre-hospital injury mortality vital to future improvements in trauma care
- Specific targets for future focus of R&D to improve the pre-hospital management and outcomes of the injured patient
  - Resuscitation
  - Novel technologies
  - Automatic notification systems
- Useful in the development and implementation of mitigation strategies for therapy and injury prevention to improve trauma systems

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

Establishing Societal Impact and Remediation Strategies

2021 Military City USA Trauma Collaborative Research Conference

Brian Eastridge, MD, FACS
COL, MC, USAR
Professor, Department of Surgery
Jocelyn and Joe Straus Endowed Chair in Trauma Research
Division of Trauma and Emergency Surgery
University of Texas Health Science Center at 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

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Scope of the Problem

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All Cause Death

10 Leading Causes of Death, United States
2017, All Races, Both Sexes

	Age Groups										
Rank	<1	1-4	5-9	10-14	15-24	25-34	35-44	45-54	55-64	65+	All Ages
1	Congenital Anomalies 4,580	Unintentional Injury 1,267	Unintentional Injury 718	Unintentional Injury 860	Unintentional Injury 13,441	Unintentional Injury 25,669	Unintentional Injury 22,828	Malignant Neoplasms 39,266	Malignant Neoplasms 114,810	Heart Disease 519,052	Heart Disease 647,457
2	Short Gestation 3,749	Congenital Anomalies 424	Malignant Neoplasms 418	Suicide 517	Suicide 6,252	Suicide 7,948	Malignant Neoplasms 10,900	Heart Disease 32,658	Heart Disease 80,102	Malignant Neoplasms 427,896	Malignant Neoplasms 599,108
3	Maternal Pregnancy Comp. 1,432	Malignant Neoplasms 325	Congenital Anomalies 188	Malignant Neoplasms 437	Homicide 4,905	Homicide 5,488	Heart Disease 10,401	Unintentional Injury 24,461	Unintentional Injury 23,408	Chronic Low. Respiratory Disease 136,139	Unintentional Injury 169,936
4	SIDS 1,363	Homicide 303	Homicide 154	Congenital Anomalies 191	Malignant Neoplasms 1,374	Heart Disease 3,681	Suicide 7,335	Suicide 8,561	Chronic Low. Respiratory Disease 18,667	Cerebro-vascular 125,653	Chronic Low. Respiratory Disease 160,201
5	Unintentional Injury 1,317	Heart Disease 127	Heart Disease 75	Homicide 178	Heart Disease 913	Malignant Neoplasms 3,616	Homicide 3,351	Liver Disease 8,312	Diabetes Mellitus 14,904	Alzheimer's Disease 120,107	Cerebro-vascular 146,383
6	Placenta Cord Membranes 843	Influenza & Pneumonia 104	Influenza & Pneumonia 62	Heart Disease 104	Congenital Anomalies 355	Liver Disease 918	Liver Disease 3,000	Diabetes Mellitus 6,409	Liver Disease 13,737	Diabetes Mellitus 59,020	Alzheimer's Disease 121,404
7	Bacterial Sepsis 592	Cerebro-vascular 66	Chronic Low. Respiratory Disease 59	Chronic Low. Respiratory Disease 75	Diabetes Mellitus 248	Diabetes Mellitus 823	Diabetes Mellitus 2,118	Cerebro-vascular 5,198	Cerebro-vascular 12,708	Unintentional Injury 55,951	Diabetes Mellitus 83,564
8	Circulatory System Disease 449	[illegible]	Cerebro-	Cerebro-	Influenza	Cerebro-	Cerebro-	Chronic Low.	[illegible]	Influenza & Pneumonia 46,862	Influenza & Pneumonia 55,672
9	Respiratory Distress 440	Benign Neoplasms 44	Septicemia 33	Influenza & Pneumonia 51	Chronic Low. Respiratory Disease 188	HIV 513	Septicemia 854	Septicemia 2,441	Septicemia 5,838	Nephritis 41,670	Nephritis 50,633
10	Neonatal Hemorrhage 379	Perinatal Period 42	Benign Neoplasms 31	Benign Neoplasms 31	Complicated Pregnancy 168	Complicated Pregnancy 512	HIV 831	Homicide 2,275	Nephritis 5,671	Parkinson's Disease 31,177	Suicide 47,173

WISQARS™
Produced By: National Center for Injury Prevention and Control, Centers for Disease Control and Prevention
Data Source: National Center for Health Statistics (NCHS), National Vital Statistics System

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110

 # people in United States

who will

DIE today

from potentially survivable injury

before reaching medical care

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Hospital Injury Mortality

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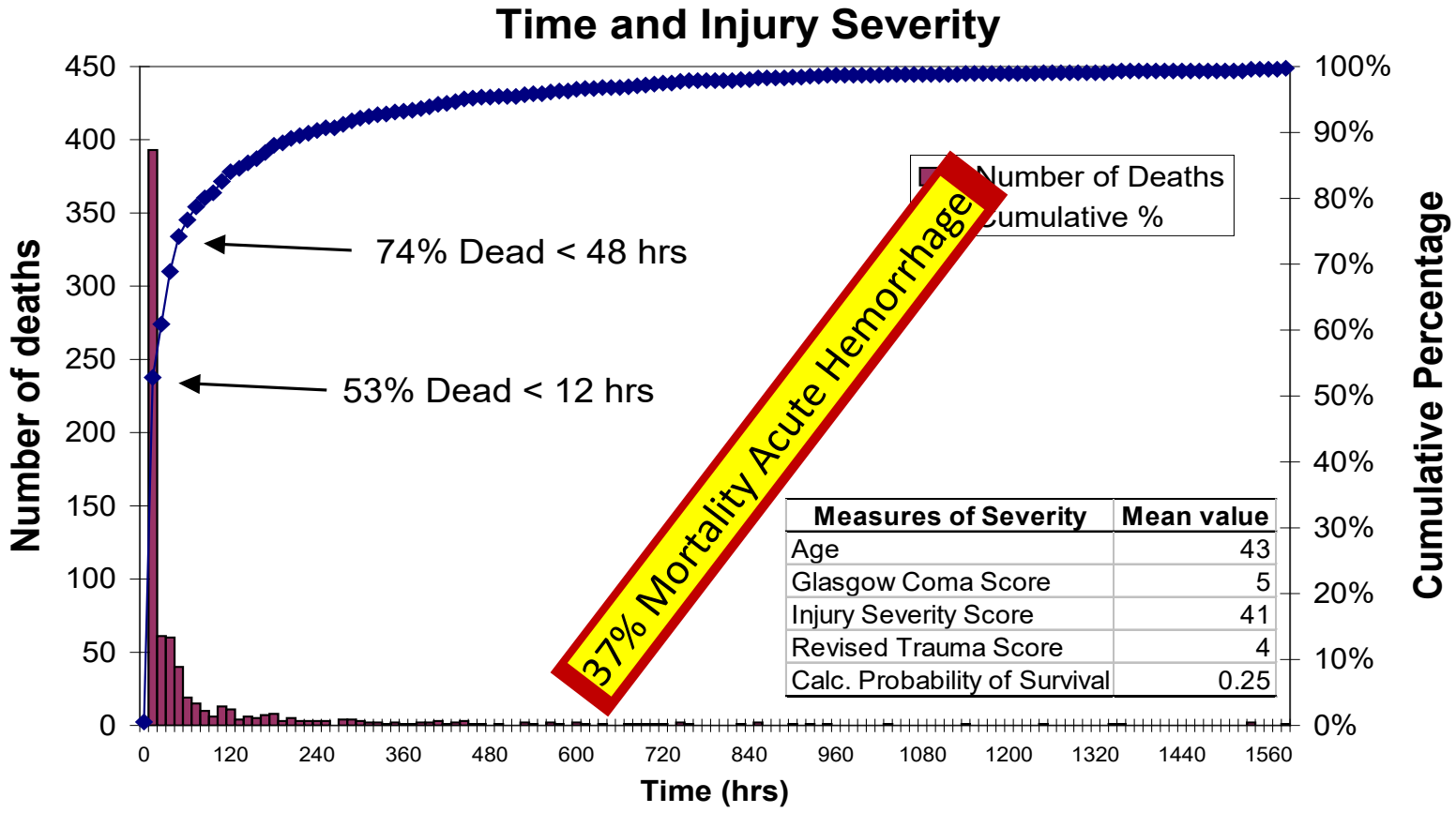
Trauma Center Mortality



Stewart: Analysis of 753 deaths in a Level I Trauma Center. J Trauma 2003.

Death Classification

Classification	N	Percent
Not Therapeutically Preventable	701	93.1%
Possibly Preventable	32	4.2%
Preventable	20	2.7%

Eliminating ALL errors, curing MOF, sepsis, DVT/PE, and secondary brain injury would theoretically reduce the number of deaths by 6.9%

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With respect to hospital injury outcomes

"…there is very little blood to be squeezed from the therapeutic turnip"

- Trauma centers
- Trauma systems
- Performance improvement
- Technological advances
- GME focus on training

Jonathan Rhoads, M.D.

William T. Fitts Lecture

American Association for the Surgery of Trauma, 1995

Understanding Prehospital Injury Mortality

How do we determine of survivability of those that never reach hospital care?

- Much bigger population injury mortality
- *Most future opportunities to effect injury outcomes will be prehospital

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Prehospital Mortality
Battlefield

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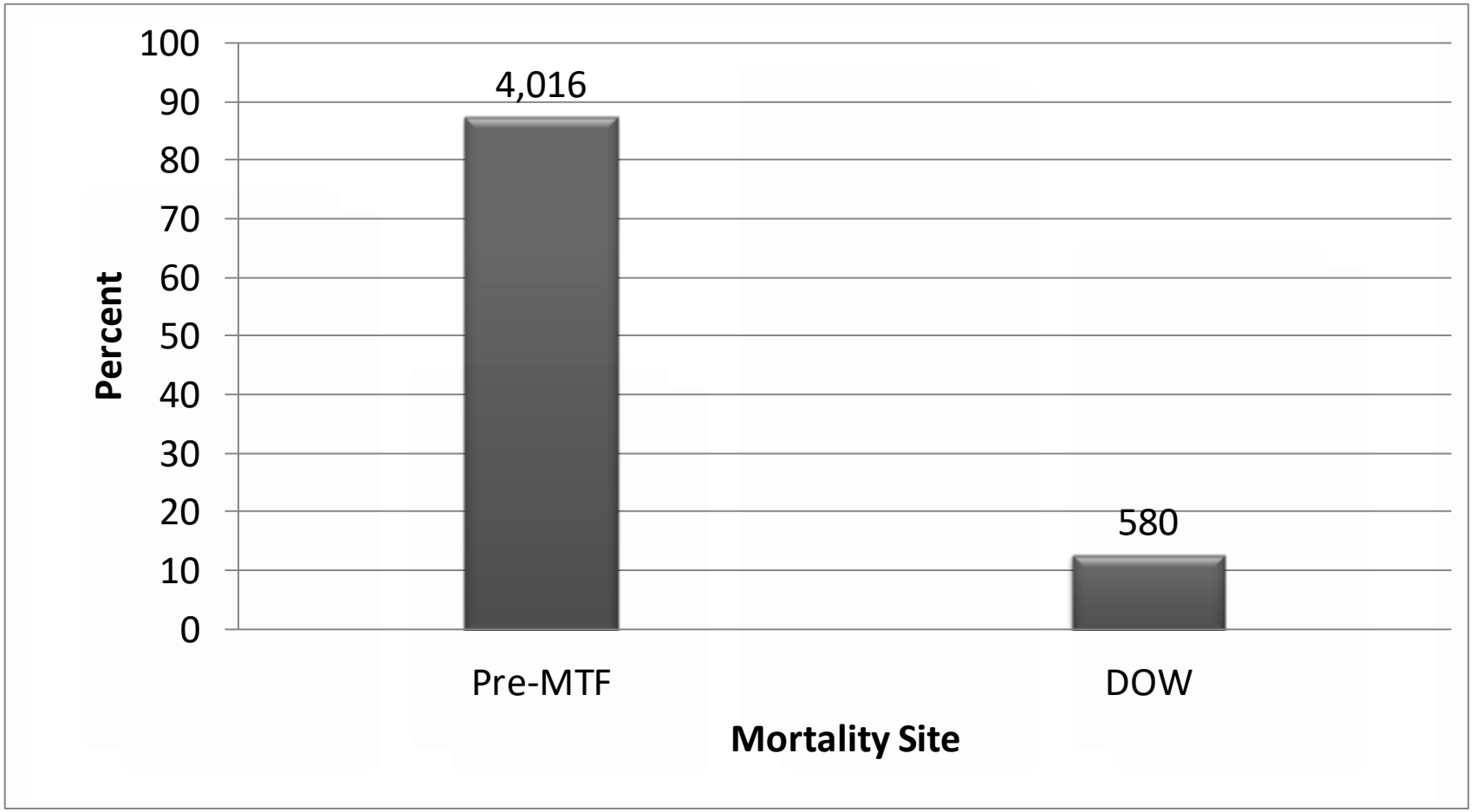
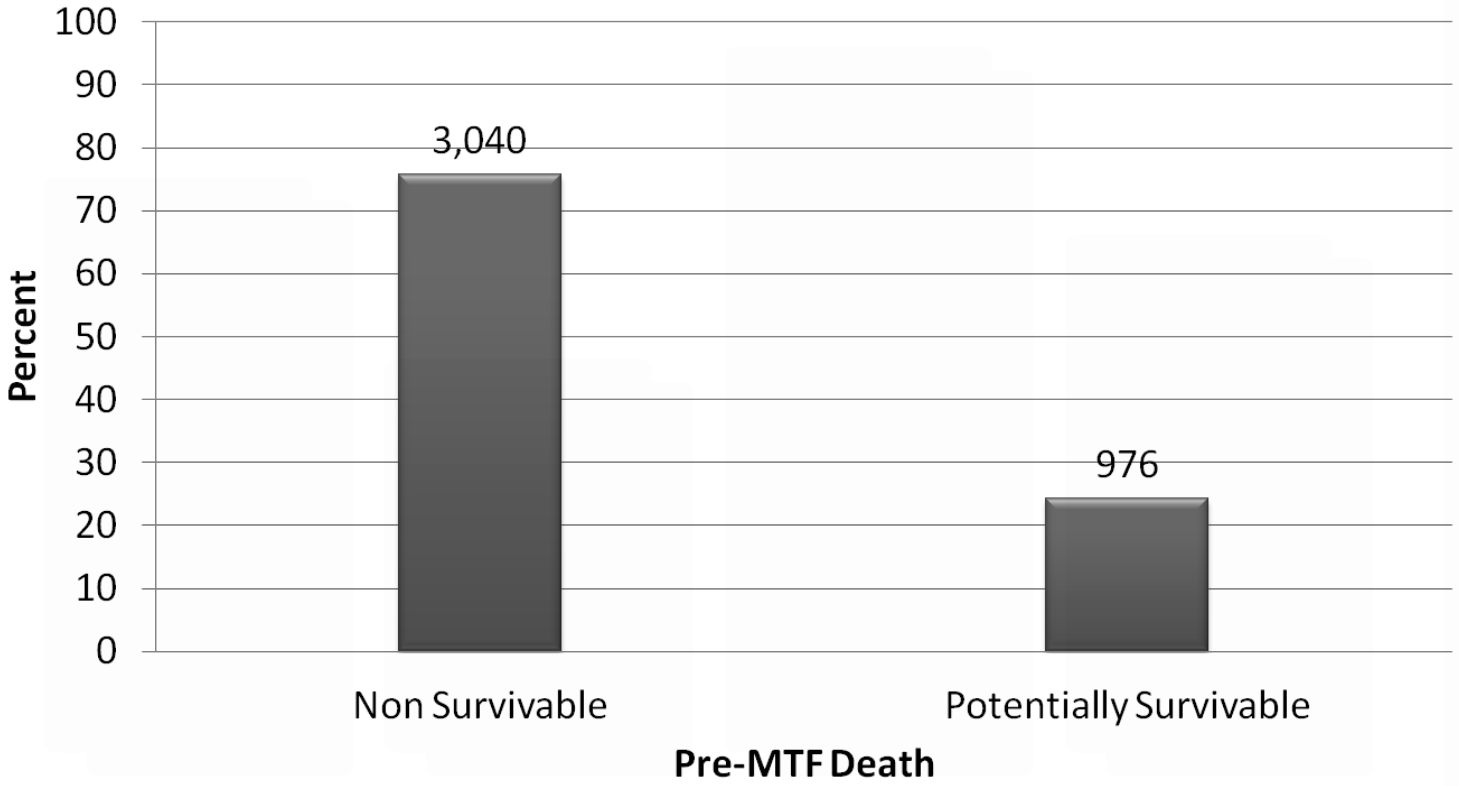
Where Battlefield Casualties Die



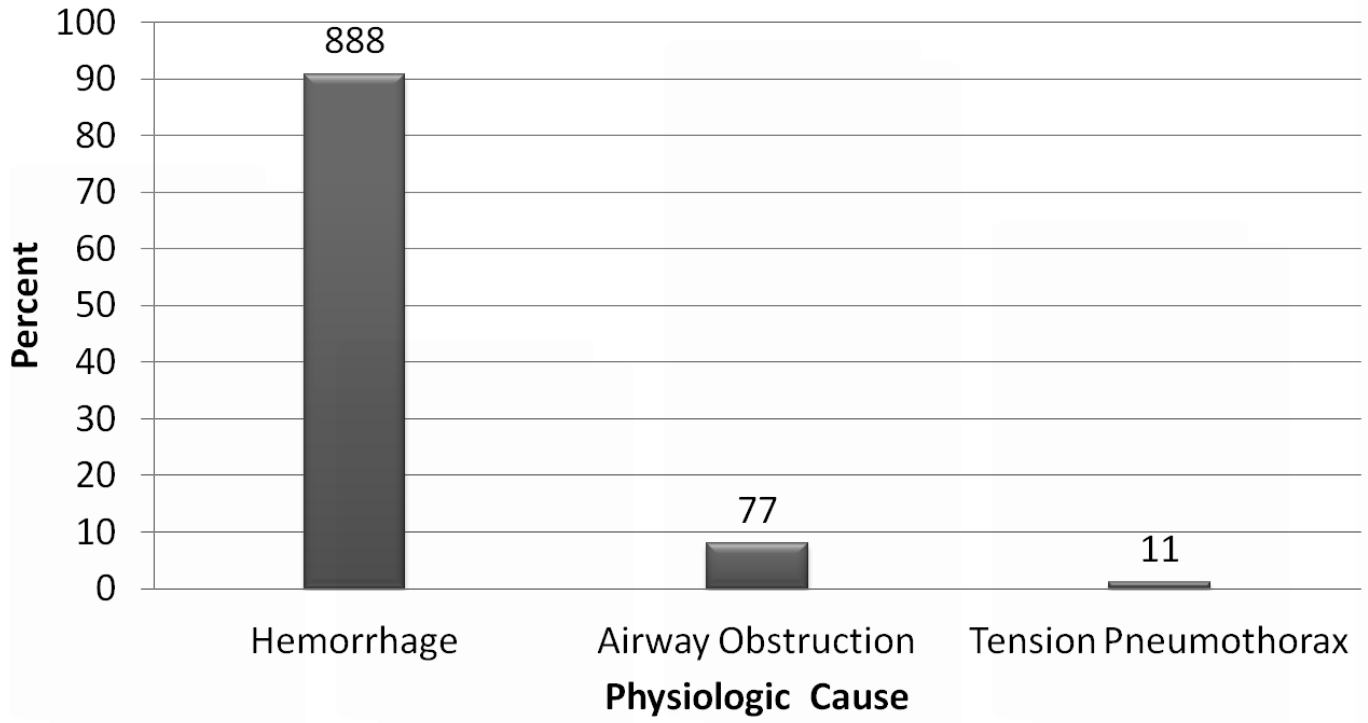
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Battlefield Pre-Hospital Death Analysis n=4,016 (DOW excluded)



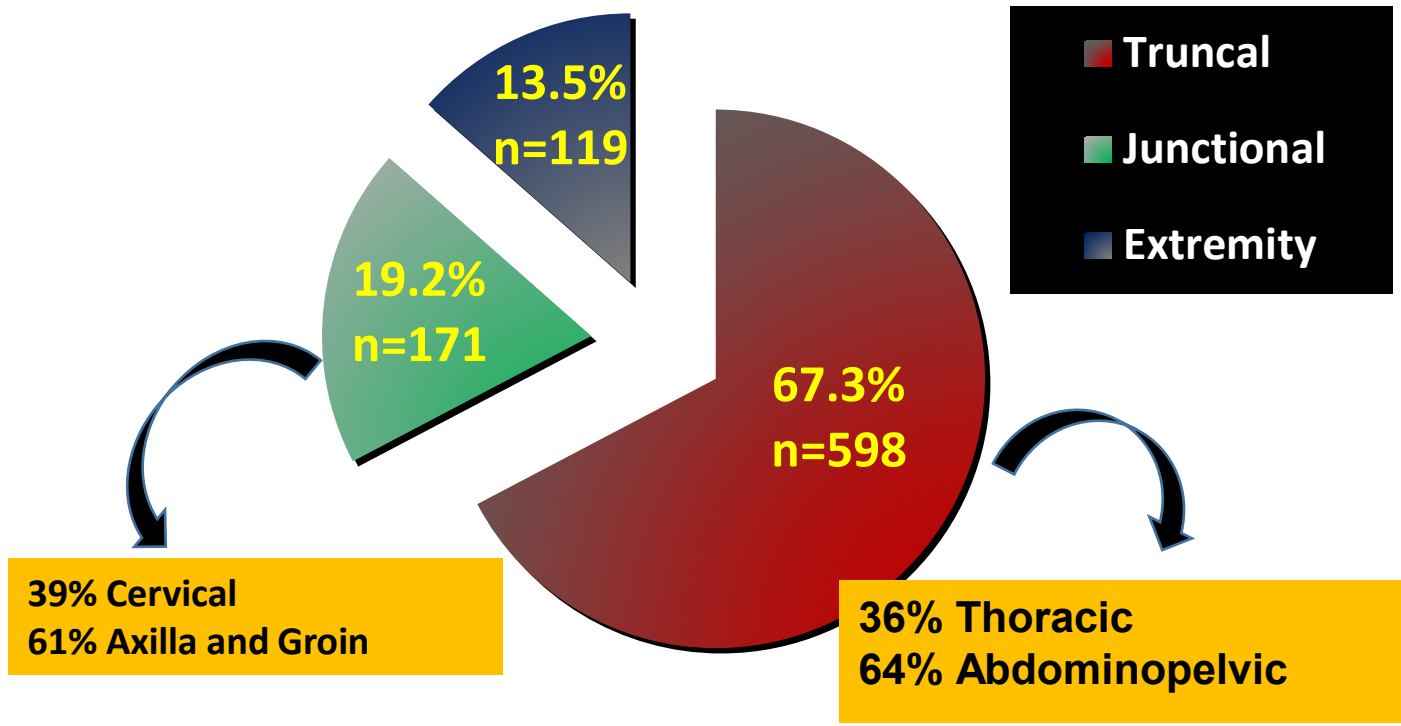
Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Battlefield Acute Lethality
Potentially Survivable
n=976



Eastridge et al: Death on the Battlefield: Implications for the Future of Combat Casualty Care. J Trauma 2012

Anatomic / Physiologic Cause of 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. In press.

Summary

- **Most battlefield casualties (87.3 %) die on the battlefield**
- **Majority of battlefield deaths (75.7%) are non-survivable**
  - **Mitigation strategy: prevention**
- **Hemorrhage is the major mechanism of death in (90.9 %) of Potentially Survivable combat injuries**

  - **Mitigation strategy: hemorrhage control**
    - **Tourniquets**
    - **Junctional hemorrhage control**
    - **Intracorporeal hemostasis**
      - **Freeze dried plasma**
      - **TXA**
      - **Novel therapeutics**
    - **Damage control to point of injury**
    - **Extending the survival time window from POI to MTF**

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Conclusion

- Value of understanding battlefield mortality in military context
  - Joint Trauma System
    - Strategic decision making
  - TCCC improvements
  - Reprioritized some combat casualty care research and development
  - Command / leadership emphasis

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Translation of Combat Casualty Care Lessons to Civilian Injury Management

- Death secondary to injury major problem for civilians and troops
- Most deaths in occur pre-hospital environment
- Many die from potentially survivable injury

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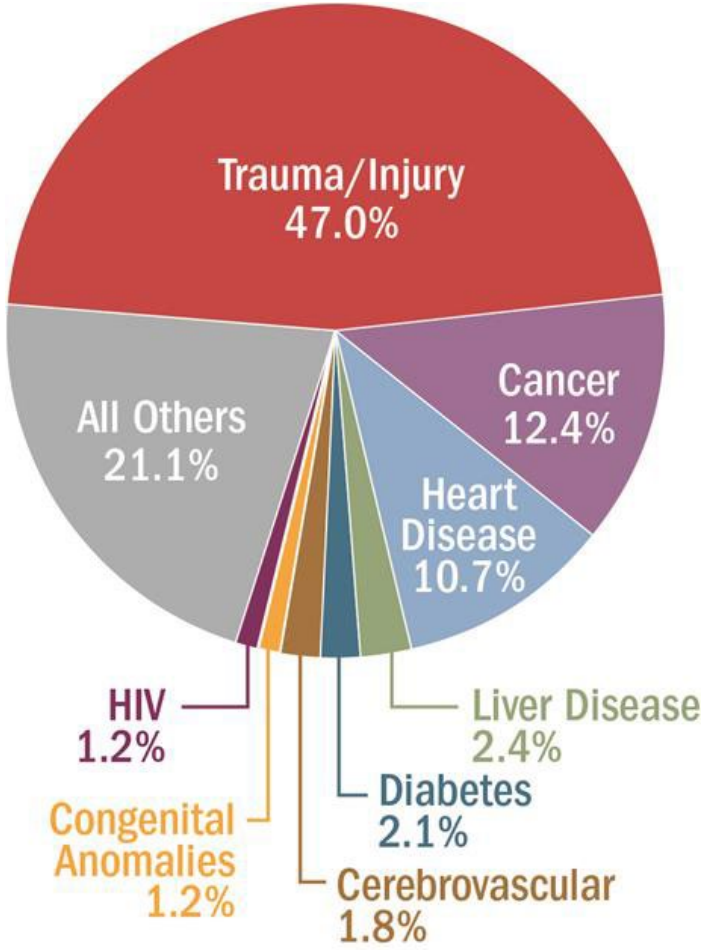
Trauma System Scope of the Problem

- **Potentially survivable injuries US military operations**
  - **1,273 / 4,574 (27.6%)**

- **Potentially survivable injuries US civilian population 2014**
  - **147,790 x 0.276 = 40,790**



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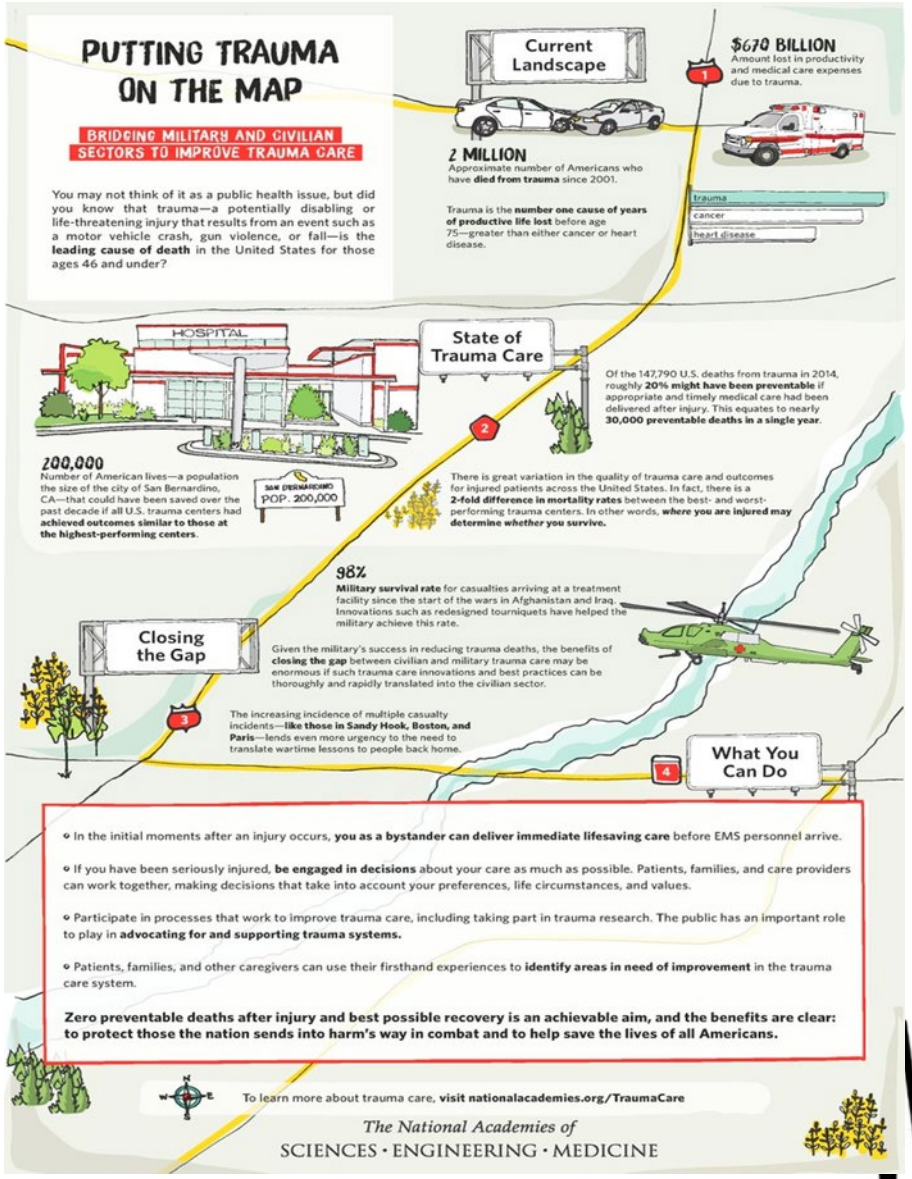
Research Needed to Get Beyond Estimates

Objective Establishment of the Impact on Society



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Civilian Prehospital Injury Mortality

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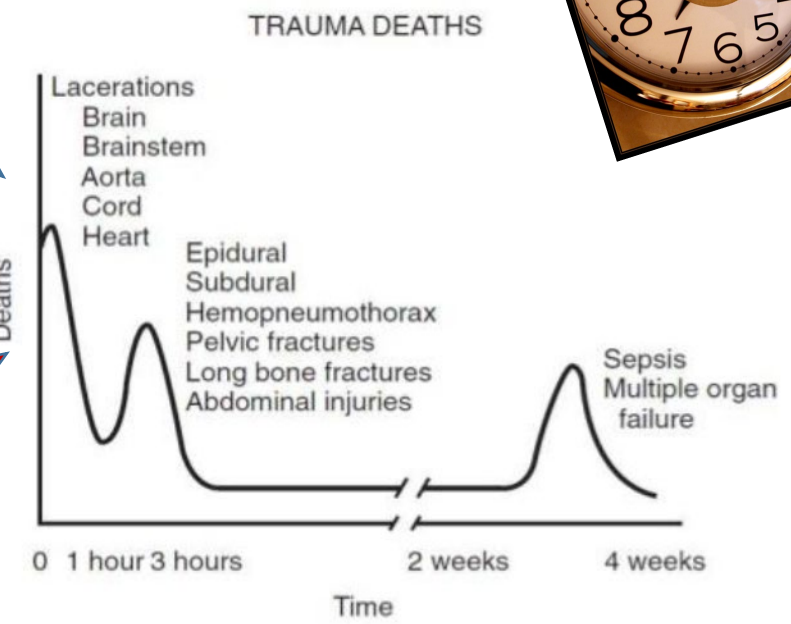
Background/Scientific Rationale
Pre-Hospital Mortality Civilian

Impact Not Well Quantitated

Potential Survivability Poorly Defined

NASEM Report Emphasis



Case Fatality Rate (CFR) ~ 4.1% /
2-5 % Hospital Mortality Potentially Preventable

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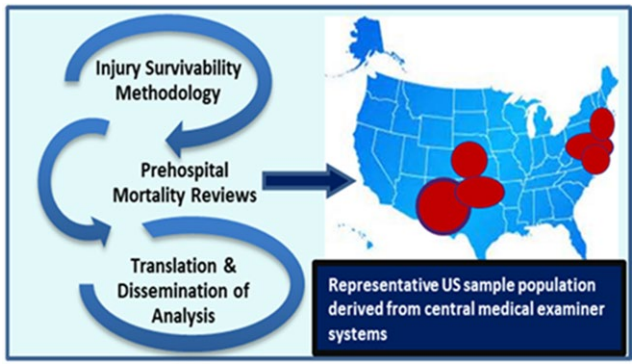
Multi-Institutional
Multidisciplinary
Injury Mortality
Investigation in
the Civilian Pre-
Hospital
Environment

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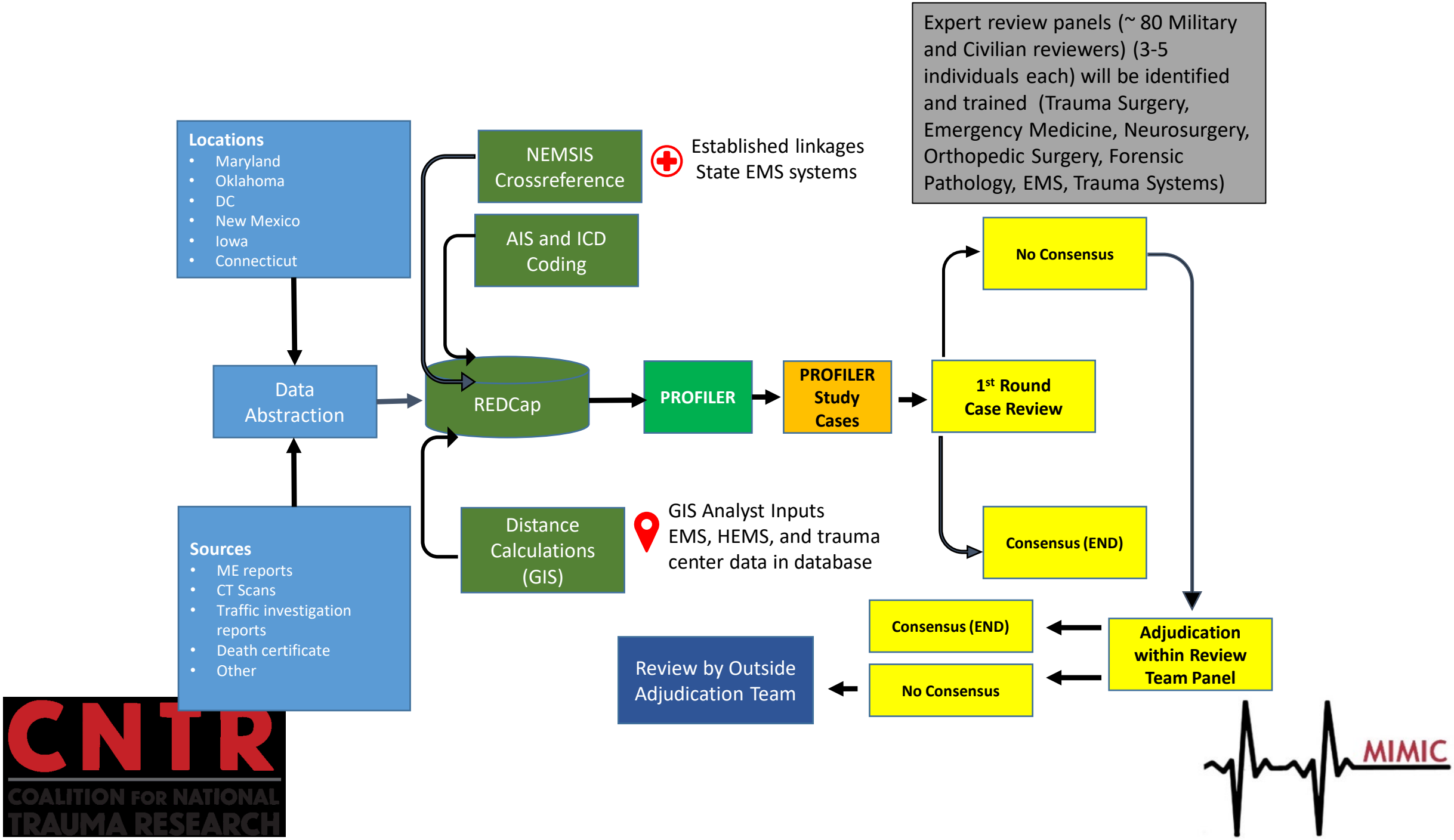
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Locations
Maryland
Oklahoma
DC
New Mexico
Iowa
Connecticut
NEMSIS Crossreference
Established linkages State EMS systems
AIS and ICD Coding
Data Abstraction
REDCap
PROFILER
PROFILER Study Cases
No Consensus
1st Round Case Review
Consensus (END)
Sources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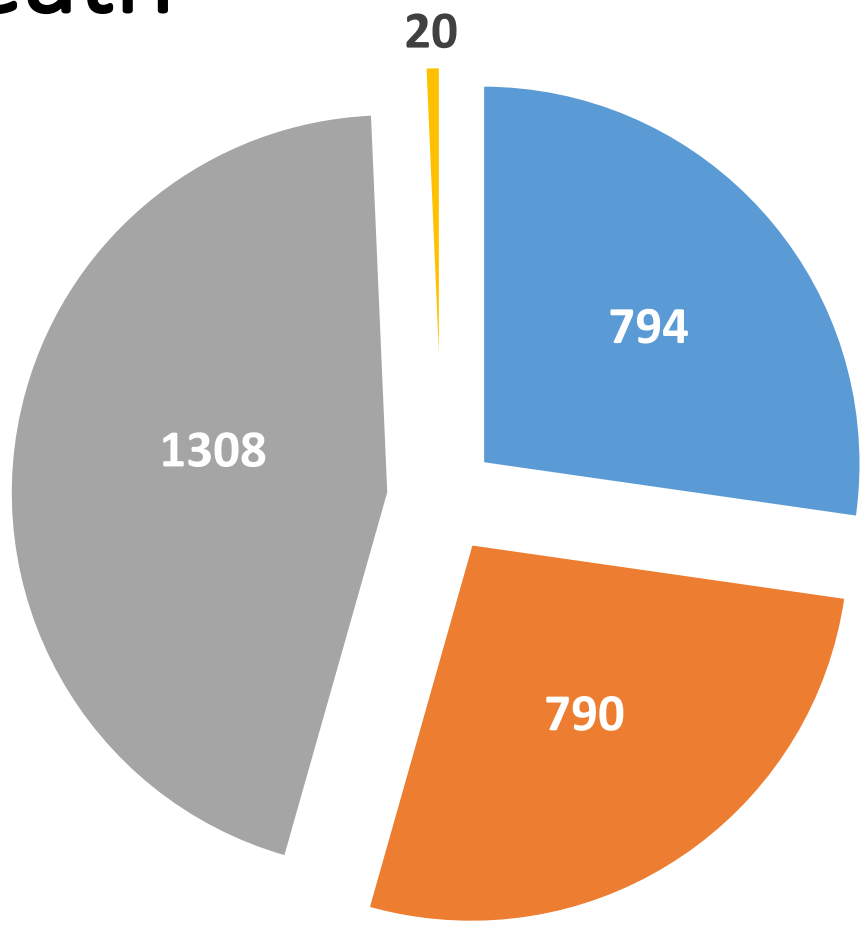
Preliminary Partial Results

Manner of Death



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RESEARCH AND DEVELOPMENT OPPORTUNITIES TO INFORM INJURY PREVENTION

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OPPORTUNITIES TO IMPROVE CURRENT TRAUMA SYSTEM

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Preliminary Data (All Patients)

RESEARCH AND DEVELOPMENT OPPORTUNITIES TO IMPROVE FUTURE TRAUMA SYSTEMS

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POTENTIALLY PREVENTABLE DEATHS

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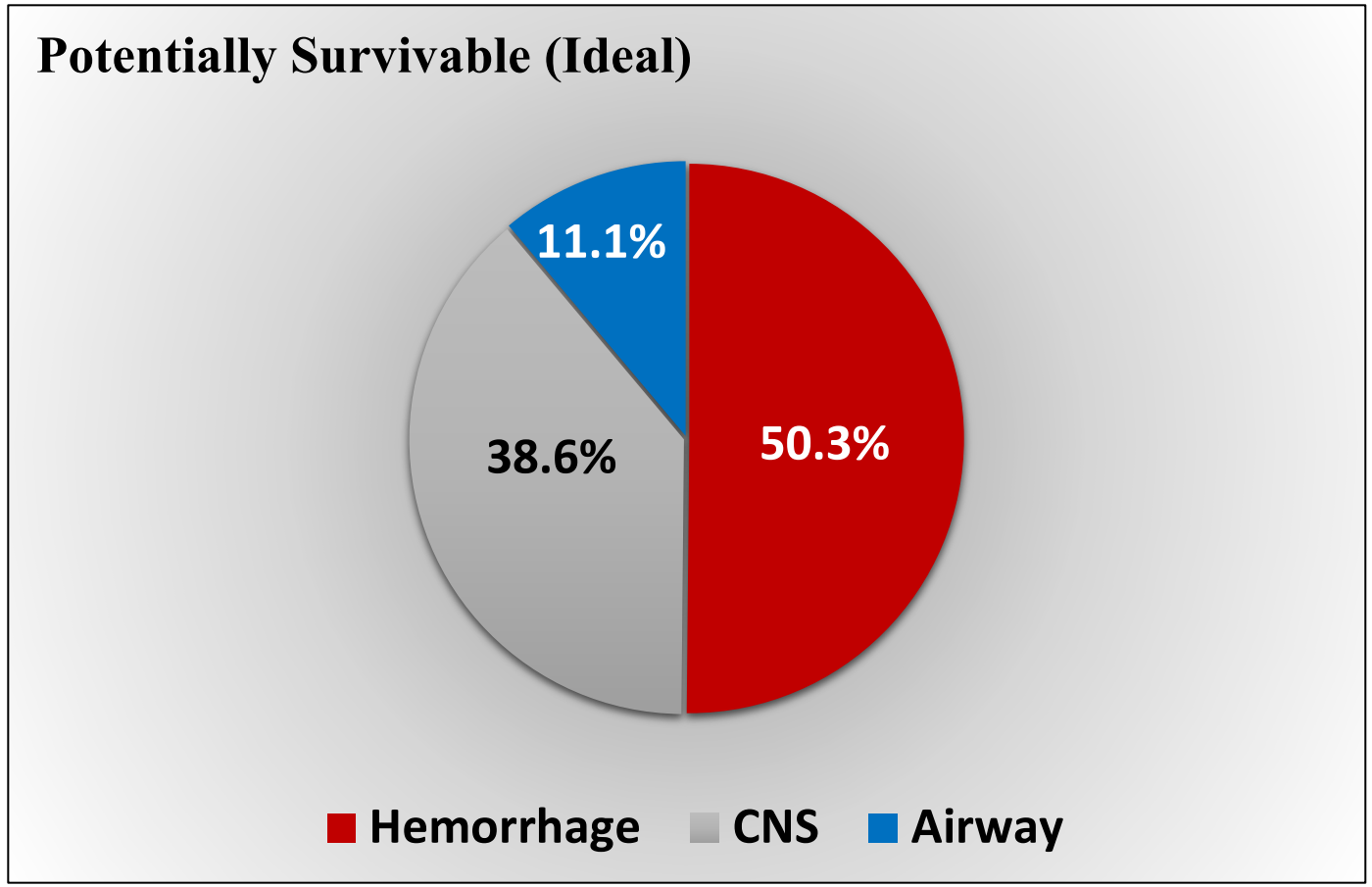
Mechanism of Death (All)
Actual Circumstance



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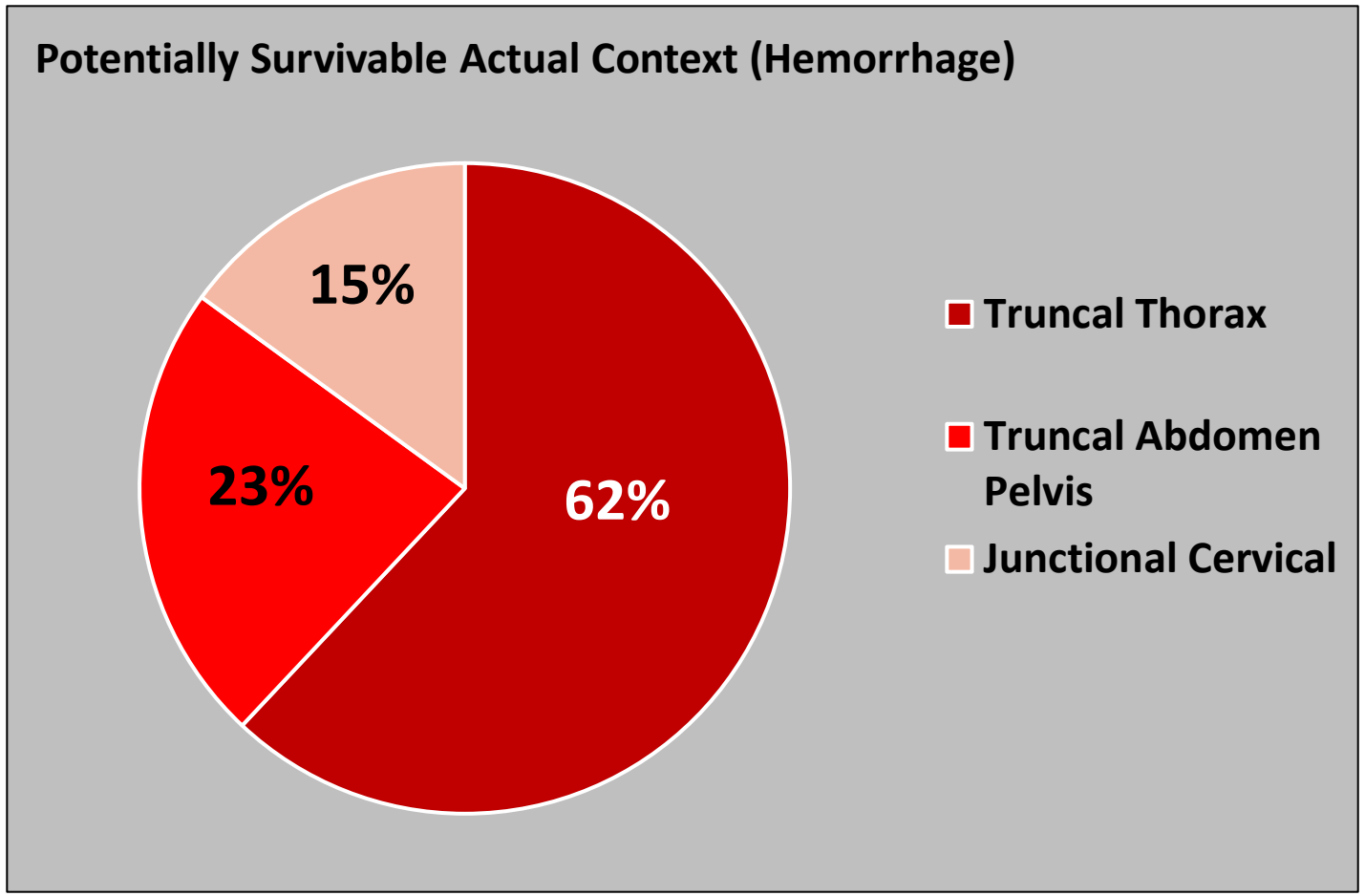
Potentially Survivable (Hemorrhage Focus)
Actual Circumstance



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2021 Military City USA Trauma Collaborative Research Conference

Virtual, Livestreamed Podium Presentations via Microsoft Teams

Hosted by: UT Health San Antonio Trauma & Emergency Surgery

October 20-21, 2021

AGENDA

Wednesday, October 20, 2021

1:00-1:10pm **Welcome and Announcements**

Susannah E. Nicholson, MD, MS, FACS, Associate Professor, Director of Trauma Research, Division of Trauma and Emergency Surgery, Department of Surgery, UT Health San Antonio

1:10-1:15pm **Introduction of Keynote Speaker**

Byron C. Hepburn, M.D., FAAFP, Maj Gen, USAF, (Ret), Director, Military Health Institute, Associate Vice President, UT Health San Antonio; Holder, USAA Patty and Joe Robles, Jr. Distinguished Chair for Military Health

1:15-2:00pm **Keynote Speaker**

Raquel C. Bono, MD, MBA, FACS VADM US NAVY (Ret), Chief Health Officer, Viking Cruise; Former Director and Chief Executive Officer, Defense Health Agency

MHS Resiliency

2:00-3:00pm **Oxygen Delivery and Shock Management**

Moderator: James A. Bynum, PhD, Research Scientist and Capability Area Manager, Blood and Blood Products, United States Army Institute of Surgical Research

Maxwell Braverman, DO — UT Health San Antonio

Reduction in Early Mortality for Patients with Hemorrhagic Shock: The Whole Blood Difference

Michael Meledeo, PhD — US Army Institute of Surgical Research

Trauma Biomarkers in Military Casualties' Plasma in the First 24 Hours

Angelo Ciaraglia, MD — UT Health San Antonio

Effects of Hypocalcemia in Hemorrhagic Shock on Outcomes and Mortality

Xiaowu Wu, MD — US Army Institute of Surgical Research

Administration of Prolyl Hydroxylase Domain Inhibitor Improves Survivability in Rats with Lethal Hemorrhagic Shock?

Wednesday, October 20, 2021 (continued)

3:00-4:00pm **Hemorrhage and Vascular Dysfunction**

Moderator: Donald H. Jenkins, MD, FACS, Professor, Division of Trauma and Emergency Surgery, Vice Chair for Quality, Department of Surgery, Betty and Bob Kelso Distinguished Chair in Burn and Trauma Surgery, Associate Director, Military Health Institute, UT Health San Antonio

Zhangsheng Yang, PhD — US Army Institute of Surgical Research
Intercommunication of Tri-opathies: Complementopathy, Endotheliopathy and Coagulopathy and Their Clinical Significance in Severe Poly-trauma Patients

Stacy Shackelford, MD, Col, USAF, MC — Joint Trauma System
Analysis of Damage Control Surgery Procedures Performed by Small Surgical Teams

Craig Nowadly, MD, Capt, USAF, MC — US Air Force 59th Medical Wing
Automated Aortic Endovascular Balloon Titration Prevents Re-arrest After Return of Spontaneous Circulation: A Pilot Study in a Swine Model of Nontraumatic Cardiac Arrest

Erika Brigmon, MD — UT Health San Antonio
Whole Blood Transfusion in Non-trauma Patients

4:00-5:00pm **Metabolic Failure and Organ Dysfunction**

Moderator: Andrew D.J. Meyer MD, MS, Associate Professor with Tenure of Pediatric Critical Care, UT Health San Antonio; Research Physician, US Army Institute of Surgical Research; Associate Faculty, Joint Graduate Program in Biomedical Engineering, UTHSA/UTSA

Andrew D.J. Meyer, MD, MS — UT Health San Antonio/USAISR
Thrombin Generation in Extracorporeal Membrane Oxygenation is Reduced by Leukodepletion

Rafael Veraza, PhD, MPH — Vascular Perfusion Solutions, Inc.
Novel Biostasis-inducing Compound for Prolonged Ex-vivo Preservation of Amputated Limbs

Robert Laverty, MD, Capt, USAF — Brooke Army Medical Center
Tube Thoracostomy Complications in Patients with ARDS Requiring ECMO: Worse in COVID-19 Patients?

Kelly M. Ivins-O'Keefe, MD, CPT, MC — Brooke Army Medical Center
Percutaneous Pulmonary Artery Cannulation to Treat Acute Secondary Right Heart Failure While on Veno-venous Extracorporeal Membrane Oxygenation

5:00pm **Closing Comments**

6:00-8:00pm Social Networking Event: **BIG'Z Burger Joint**, 2303 N Loop 1604 W, San Antonio, TX 78258

Thursday, October 21, 2021

1:00-1:15pm **Welcome and Announcements**

Susannah E. Nicholson, MD, MS, FACS, Associate Professor, Director of Trauma Research, Division of Trauma and Emergency Surgery, Department of Surgery, UT Health San Antonio

1:15-1:45pm **Plenary Speaker**

COL Andrew P. Cap, MS, MD, PhD, FACP, Director of Research, US Army Institute of Surgical Research; Hematology-Oncology Consultant to the US Army Surgeon General; Professor of Medicine, Uniformed Services University

Transformational Change in Combat Casualty Care Research

1:45-2:45pm **Wound Progression and Infection**

Moderator: Valerie G. Sams, MD, Lt Col, MC, USAF, Trauma Medical Director, Brooke Army Medical Center, Department of Surgery, Trauma Critical Care Division

Kaitlin Pruskowski, PharmD, BCPS, BCCCP — US Army Institute of Surgical Research

Fungal Infections in Burn Patients from 2014-2019: A 5-year Retrospective Review

Holly Chapapas, MS — Joint Base San Antonio Lackland

Directed Energy Exposure Medical Evaluation using a Swine (Sus scrofa domestica) Magnetic Resonance Imaging and Biomarker Model

William Davis, MD, MPH, Maj, USAF — En Route Care Research Center

Descriptive Analysis of COVID-19 Aeromedical Evacuations by Critical Care Air Transport Teams

Alexandra Adams, MD, MPH — Brooke Army Medical Center

Tracheostomy Placement in Patients with ARDS Requiring ECMO: Did COVID-19 Change Our Practice?

2:45-3:45pm **Pain, Sensory Trauma, and Mental Status**

Moderator: Firas Kaddouh, MD, Assistant Professor/Clinical, Department of Neurosurgery, UT Health San Antonio

John Clifford, PhD — US Army Institute of Surgical Research

Analgesic Efficacy of a Non-euphoric Cannabinoid Extract (NEPE14) in a Rat Model for Burn Pain

Natasha Sosanya, PhD — US Army Institute of Surgical Research

Exploring the Secretome's Biomarker and Analgesic Potential

Carmen Hinojosa-Laborde, PhD, FAPS — US Army Institute of Surgical Research

Effects of the Opioid Analgesic, Sufentanil, on Respiration after Extremity Trauma and Severe Conscious Hemorrhage in Rats

Michael Urban, PhD — US Army Institute of Surgical Research

Battlefield Pain – Implications of Acute Trauma in an Experimental Combat and Operational Stress Model

3:45-4:45pm **Engineering Solutions to Enable Combat Casualty Care**

Moderator: Jose Salinas, PhD, Science Lead, Engineering, Technology, and Automation CRT (CRT 6); Capability Area Manager, Medical Robotics and Autonomous Systems (MedRAS) Program, US Army Institute of Surgical Research

Saketh Ram Peri, MS — University of Texas at San Antonio
Battlefield Ready Innovative Suction Kit (BRISK) for Combat and Civilian Emergencies

Derek Lumbard, MD — UT Health San Antonio
Pooled Analysis of Level I Trauma Centers Better Predicts Risk Factors for Gun Violence Recidivism

Steven Schauer, DO, MSCR, MAJ, USA, MC — US Army Institute of Surgical Research
A Concept for Development of a Novel Radio-frequency Based Ultrasound Machine Learning System

Brian Eastridge, MD, FACS — UT Health San Antonio/CNTR
Multiinstitutional Multidisciplinary Injury Mortality Investigation in Civilian Prehospital Environment (MIMIC): Establishing Societal Impact and Remediation Strategies

4:45-5:00pm **Awards Presentation**

From: Gonzales, Christine L

To: Kothare, Aishwarya Devesh (LiveMail); "ak@isecurityprod.com"; Peterson, Alan; "Alex Brown"; "alexander.penn.ctr@us.af.mil"; "Alicia Swan"; "alicia.t.crowder.civ@mail.mil"; Smith, Alison Annette; "Amanda Fowler"; "Amber Mallory"; "Amber Voelker (amber.n.voelker@gmail.com)"; "Anand Srinivasan"; "Andrea Giuffrida (girffrida@uthscsa.edu)"; Meyer, Andrew D; "Andrew Fisher"; "andrew.p.cap.mil@mail.mil"; "Andriy Batchinsky"; "Andriy Batchinsky"; Ciaraglia, Angelo Vincent; "Anthony Pusateri (anthony.e.pusateri.civ@mail.mil)"; Sherwani, Anusha Khan (LiveMail); McGinity, Ashley E; "Ashley Lock"; "Barbara Christy"; "Bin Liu"; "BK@isecurityprod.com"; "Bob Clark (clark@uthscsa.edu)"; Zelle, Boris A; Eastridge, Brian J; "Bunyen Teng"; Hepburn, Byron; "Carolina Cantu-Garza"; Zhu, Caroline; "Chao, Tony CTR USARMY MEDCOM AISR (US)"; "Chriselda Fedyk"; "Christopher Delavan"; Crane, Christopher E; Winckler, Christopher J; "Col Mark Stackle"; "COL. E. Lee Bryan (edward.l.bryan3.mil@mail.mil)"; "Colby McIntosh"; "Connie Luna"; "Corey Levenson (corey@saedc.org)"; Peebles, Courtney L; Sisson, Craig; "Daniel Darlington"; Dent, Daniel Lawrence; Miramontes, David A; Wampler, David A; "David Burmeister"; Schwartz, Deborah L; Mueller, Deborah; "Deidre Winnier (deidre.winnier@uhs-sa.com)"; Lumbard, Derek C; "Diana Chorn (Diana.Chorn@strac.org)"; "Diana del Monaco"; Morrison, Diana; "Dr. Jack (Chester) Hutcheson"; "Dr. Jason Rall"; "Dr. Teresa Evans (tevans@traumainsight.com)"; "Elizabeth Waltman (elizabeth.waltman@southtexasblood.org)"; "Ellen Robinson"; "Elsa Granato (elsa.c.granato.ctr@mail.mil)"; "Emma Richardson (richardsone@uthscsa.edu)"; "Eric Brey (eric.brey@utsa.edu)"; "Eric Epley- STRAC"; "Erik Dahlgren"; "Erik Weitzel"; Brigmon, Erika; Erickson, Ethan J (LiveMail); "evan.ross2.ctr@mail.mil"; Jaca, Evander; "Farber, Scott J"; Kaddouh, Firas; "Gomez, Belinda I CTR USARMY MEDCOM AISR (US)"; Gonzales, Christine L; "Grantham Peltier"; Corral, Hannah Elizabeth (LiveMail); "Harry McDonald"; Oh, Hyelin; "Jack Hucheson (hutcheson.jack@gmail.com)"; "Jacob Glaser"; "Jahanbi Roy (royj1@uthscsa.edu)"; Cleveland, James A; "James Bynum"; Strong, Janis R; "Jason Radowsky (jason.s.radowsky.mil@mail.mil)"; Jay.johannigman@gmail.com; "jd@5vs.life"; "Jeffrey Keesee"; "Jennifer Gurney"; Contreras, Jennifer Nicole; Potter, Jennifer; Jennifer.Northway@uhs-sa.com; Nelson, Jeremy T; "Jerome Buller (jerome.l.buller.mil@mail.mil)"; Michalek, Joel E; Fritz, John Anthony; John Barry; Myers, John G; "John McCarrey (John.McCarrey@utsa.edu)"; "John Quarles"; "John Quarles"; "Johnson, Taylor Renee"; "Jose Salinas"; "Joseph Maddry "; "Josh Wenke"; Hudiburgh, Katherine; Stevens, Kathleen R; "Kathy Ryan "; Sponhaltz, Kelly; "Kevin Akers"; "Kevin Kupferer"; "Kimberly Medellin"; "Krista Covey (krista@velocitytx.org)"; "Kristi Hargrove"; "Kristin Cardenas"; "Larry Estlack"; "lason@lifescienceplus.com"; Barry, Lauran; "Leopolfo Cancio"; Greebon, Leslie J; Liao, Lillian; "Linda Sousse (linda.e.sousse.civ@mail.mil)"; "Lizabeth Summerfield (Lizabeth.m.summerfield.ctr@mail.mil)"; Lizette Villarreal; "LJ Winkler (winkler@uthscsa.edu)"; Krokar, Lucijana (LiveMail); Bownds, Marian R; DeRosa, Mark; Muir, Mark; Foster, Mark T; "Maryanne Herzig"; Maia, Matthew (LiveMail); Braverman, Maxwell A; "mdermd@gmail.com"; "Megan Blackburn"; Boytos, Megan C; Foster, Megan Sue; "Michael Boulding (michael.boulding@strac.org)"; "Michael Dubick"; "Michael L Stringfellow (Michael.Stringfellow@sanantonio.gov)"; "Michael Meledeo"; "Michael R Davis (Michael.r.davis.mil@mail.mil)"; "Michael Scherer"; michael.shiels@uhs-sa.com; Michelle Price; West, Molly B; Luevano, Monzerrat; Talathoti, Naresh Babu; "Neslihan Cingoz"; Dawson, Nicholas Arthur (LiveMail); Oh, Thomas (LiveMail); "Ohlhausen, Dawn Marie (LiveMail)"; "Patrick Ketter"; Pham, Tommy T (LiveMail); "Prajeeda Nair"; Jonas, Rachelle Babbitt; Rafael Tolentino Aquino (tolentinoaqu@uthscsa.edu); Riviello, Ralph; Cestero, Ramon; "Randi Schaefer"; "Raquel Clark (Raquel.clark@uhs-sa.com)"; "Remealle How"; "Rene Dominguez (RDominguez@trtf-id.org)"; "Robbie Montgomery"; Clark, Robert A; Delorenzo, Robert A; "Ron Bryant"; stewartr@uthscsa.edu; Willis, Ross; Tamirisa, Saraaga Varada (LiveMail); Smith, Sawyer G; Seifi, Ali; Seifi, Ali; shahanc@uthscsa.edu; Sharon Smith; ShawnCCOLUSARMYMEDCOMAISR "; "Stefanie Shiels"; DeMoor, Stephanie; Venticinque, Steven; "steven.g.schauer.mil@mail.mil"; Sullivan, Taylor Leigh; Nicholson, Susannah; Castillo, Sylvia Z; tamara.l.fraker.ctr@mail.mil; "Tataka Perry-Johnson"; "Teryn Roberts"; Reistetter, Timothy Andrew; "Timothy Nunez (timothy.c.nunez.civ@mail.mil)"; "Tracee Rose (traceee.rose@strac.org)"; "tyler.j.schroeder@boeing.com"; "Tyson Becker (tyson.e.becker.mil@mail.mil)"; "Umang Sharma"; Glatt, Vaida; "vicky.feng@lifescienceplus.com"; "Victor Convertino"; Bartanusz, Viktor; Weaver, Alan J Jr CTR (USA); "Xiaowu Wu"; yansong.li.ctr@mail.mil; Brooke, Zachary

Subject: Think Tank Meeting Fri 11/12/2021

Date: Monday, November 8, 2021 4:39:55 PM

Attachments: image002.png

Good Afternoon,

There will be a Think Tank meeting this Friday, November 12th at 12pm. Dr. Brian Eastridge will be presenting, "Multi-Institutional Multidisciplinary Injury Mortality Investigation in Civilian Prehospital Environment [MIMIC]: Establishing Societal Impact and Remediation Strategies". This will be a hybrid meeting.

If you plan to attend the meeting onsite, please reply to this email by 10:00am on Thursday November 11th, so that I know to order a box lunch for you. Please also let us know of any dietary restrictions. Note: If you do not RSVP for your attendance, you will not receive a box lunch.

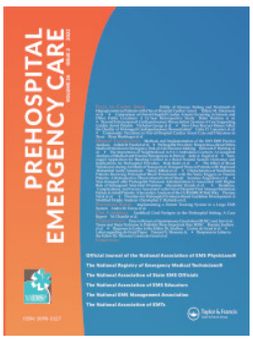
Calendar invite to follow this email.

Christine L. Gonzales – Sent on behalf of Dr. Susannah Nicholson

Administrative Assistant

UT Health Trauma & Surgery Department

Main #:(210) 743-4130 | Fax: (210) 702-6292 | Email: gonzalesc10@uthscsa.edu



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Activation and On-Scene Intervals for Severe Trauma EMS Interventions: An Analysis of the NEMSIS Database

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Activation and On-Scene Intervals for Severe Trauma EMS Interventions: An Analysis of the NEMSIS Database

Nicolas W. Medrano[a], Cynthia Lizette Villarreal[a], N. Clay Mann[b], Michelle A. Price[a], Kurt B. Nolte[c], Ellen J. MacKenzie[d], Pam Bixby[a], Brian J. Eastridge[e], for the MIMIC Study Group[†]

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ABSTRACT

Objective: Time to care is a determinant of trauma patient outcomes, and timely delivery of trauma care to severely injured patients is critical in reducing mortality. Numerous studies have analyzed access to care using prehospital intervals from a Carr et al. meta-analysis of studies from 1975 to 2005. Carr et al.'s research sought to determine national mean activation and on-scene intervals for trauma patients using contemporary emergency medical services (EMS) records. Since the Carr et al. meta-analysis was published, the National Highway Traffic Safety Administration (NHTSA) created and refined the National Emergency Medical Services Information System (NEMSIS) database. We sought to perform a modern analysis of prehospital intervals to establish current standards and temporal patterns.

Methods: We utilized NEMSIS to analyze EMS data of trauma patients from 2016 to 2019. The dataset comprises more than 94 million EMS records, which we filtered to select for severe trauma and stratified by type of transport and rurality to calculate mean activation and on-scene intervals. Furthermore, we explored the impact of basic life support (BLS) and advanced life support (ALS) of ground units on activation and on-scene time intervals.

Results: Mean activation and on-scene intervals for ground transport were statistically different when stratified by rurality. Urban, suburban, and rural ground activation intervals were 2.60 ± 3.94, 2.88 ± 3.89, and 3.33 ± 4.58 minutes, respectively. On-scene intervals were 15.50 ± 10.46, 17.56 ± 11.27, and 18.07 ± 16.13 minutes, respectively. Mean helicopter transport activation time was 13.75 ± 7.44 minutes and on-scene time was 19.42 ± 16.09 minutes. This analysis provides an empirically defined mean for activation and on-scene times for trauma patients based on transport type and rurality. Results from this analysis proved to be significantly longer than the previous analysis, except for helicopter transport on-scene time. Shorter mean intervals were seen in ALS compared to BLS for activation intervals, however ALS on-scene intervals were marginally longer than BLS.

Conclusions: With the increasing sophistication of geospatial technologies employed to analyze access to care, these intervals are the most accurate and up-to-date and should be included in access to care models.

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Introduction

Injury remains the leading cause of death in individuals up to the age of 44 and the leading cause of morbidity and mortality among children in the U.S. (1). Of these trauma deaths, between 200,000 and 300,000 over 10 years would be potentially preventable if the patients received rapid and high-quality trauma care (2, 3). Furthermore, a 2016 report from the National Academies of Science, Engineering and Medicine (NASEM), entitled "A National Trauma Care System: Integrating Military and Civilian Trauma Systems to Achieve Zero Preventable Deaths After Injury," estimated that approximately 30,000 of the 147,790 people who died as a result of trauma in 2014 had potentially survivable injuries (4). During the last several decades, advances in care in trauma centers and across trauma systems have substantially reduced death and disability associated with injury (5, 6). However, there remains a substantial opportunity to further reduce the number of deaths in the prehospital setting.

The first hour after traumatic injury is historically known as the "golden hour" and is the period of care following an injury in which rapid assessment and resuscitation are fundamental to survival (7). Though there is no true golden hour, the time lapse between injury and care is a critical element for patients with severe injury (8–12), with longer prehospital transport times likely contributing to higher mortality rates in more severely injured patients. This effect is more prominent among rural trauma patients than similarly injured urban patients (13–17). To substantiate this assertion, it has been demonstrated that states with poor trauma care access have more prehospital deaths,

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[†]MIMIC Study Group members found in Appendix 1

Table 1. Data elements used for trauma case selection.

Data element	V2 code	V3 code	Code description
Type of service	30	2205001	911 response
Response mode to scene	390	2224015	Lights and sirens
Complaint reported by dispatch	410	2301005	Animal bite
	415	2301007	Assault
	N/A	2301009	Automated crash notification
	430	2301015	Burns
	470	2301029	Electrocution
	475	2301031	Eye problem
	480	2301033	Fall victim
	495	2301045	Heat/cold exposure
	500	4301043	Hemorrhage/laceration
	505	2301047	Industrial accident
	530	2301063	Stab/gunshot wound
	540	2301069	Traffic accident
	545	2301073	Traumatic injury
Possible injury	1	9922005	Yes
Transport mode from scene	4965	4218011	Lights and sirens
Type of destination	7280	4221003	Hospital
Unit transport and equipment	7340	4221015	Other EMS responder
	1030	2207011	Air transport-helicopter
		2207003	Ground transport
	990	2215001	BLS – first responder
	995	2215003	BLS – basic/EMT
		2215005	BLS – AEMT
		2215007	BLS – intermediate
		2215023	BLS – community paramedicine
	1000	2215009	
	1005	2215011	ALS – AEMT
	1010	2215013	ALS – intermediate
		2215015	ALS – paramedic
		2215017	ALS – community paramedicine
		2215019	ALS – nurse
			ALS - physician

contributing to higher overall injury mortality (9). Because of the "access effect" on mortality and morbidity rates, having an accurate understanding of prehospital intervals is imperative to identifying geographic "trauma care deserts," where there is decreased access to immediate care.

Numerous researchers have created models to analyze access to trauma care in recent years, breaking the total prehospital time into four time intervals: activation, response, on-scene, and transport. The activation interval is defined as the time from emergency call to ambulance dispatch. The response interval is the time from ambulance dispatch to arrival at the scene. The on-scene interval is the time from ambulance arrival at the scene to the time the ambulance departs from the scene. Finally, the transport interval is the time from ambulance departure from the scene to arrival at the hospital. Many of the models created to estimate access to care have used mean activation and on-scene intervals calculated from a 2005 meta-analysis conducted by Carr et al. (18). Some models combine mean activation and on-scene times from this meta-analysis with mean driving speeds based on rurality (19–22), while more recent studies have begun utilizing geographic information systems (GIS) and road networks built with actual traffic data (23–26). Results from the 2005 meta-analysis (18) of 49 observational studies have been immensely valuable; however, we believe mean activation and on-scene intervals derived from more current datasets will be more applicable to the current era of trauma care and systems and would better support future access to care research. This study aimed to recalculate and update activation and on-scene prehospital intervals using datasets from a single data source, the National Emergency Medical Services Information System (NEMSIS). In doing so, our goal was to produce empirically derived prehospital means from more contemporary data to support future access to care models and provide a blueprint for future utilization of the NEMSIS dataset for time analyses.

Methods

Data Collection

National Emergency Medical Services Information System records were obtained for 2016–2019, accounting for approximately 94.5 million EMS events over four years. The NEMSIS database is a product of the National Highway Traffic Safety Administration's (NHTSA) Office of EMS, which uses a universal standard for patient care information resulting from an emergency 911 call for assistance. The NEMSIS is a collaborative system created to improve patient care through standardization, aggregation, and utilization of point of care EMS data at a local, state, and national level. The data was submitted by more than 11,000 participating EMS agencies in 49 states. In 2017, the NEMSIS Version 2 data dictionary standard officially closed, and states migrated to Version 3. Therefore, this analysis comprises data from Version 2 and Version 3 data dictionaries (27).

Case Selection

Each year's dataset was imported into SAS 9.4 for analysis, where data elements were used to select EMS responses for

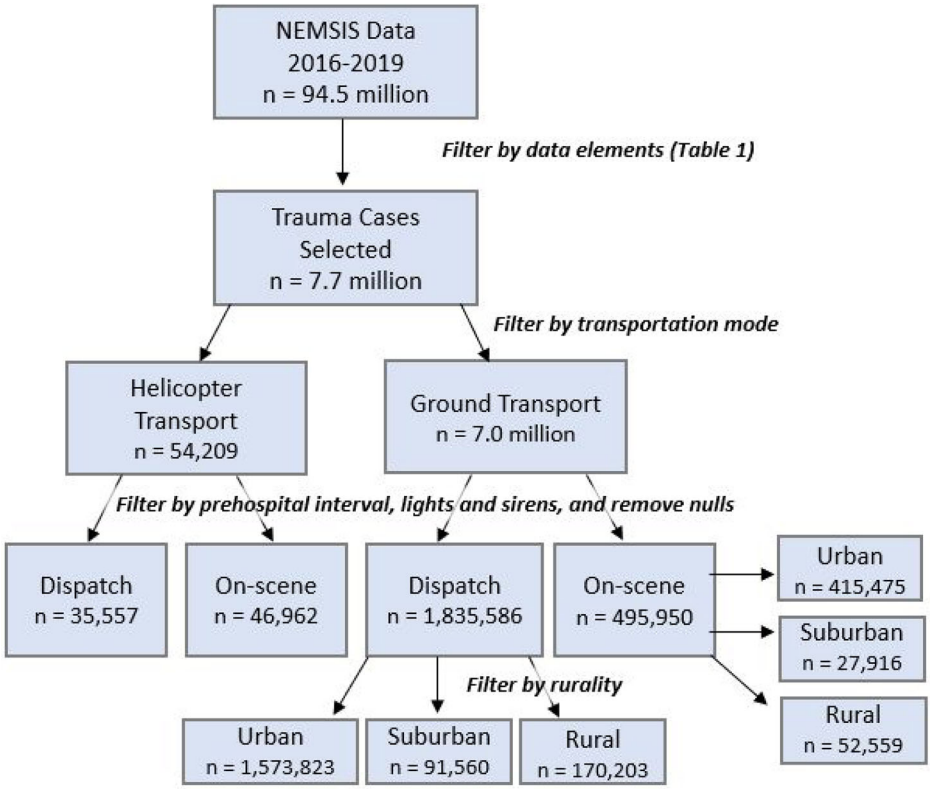

Figure 1. Filter diagram of NEMSIS data.

severe traumatic injury. We defined trauma cases through a combination of data elements: type of service, response mode to scene, complaint reported by dispatch, possible injury, transport mode from scene, and type of destination (Table 1). Lights and sirens being utilized for response mode to scene and transport mode from scene was used to identify time-sensitive severe trauma cases where EMS responders facilitated patient transport in an urgent manner.

After the selection of severe trauma cases, records were filtered by transportation type, level of care basic life support (BLS) and advanced life support (ALS), and rurality. Due to their lower frequency, helicopter transport cases were not stratified by rurality. Rurality in NEMSIS is categorized by USDA Urban Influence Codes that form a classification scheme distinguishing metropolitan counties by population size of the metro area, and nonmetropolitan counties by the size of the largest city or town and proximity to metro areas (28). Ground transport cases were stratified by rurality into urban, suburban, and rural cohorts. This is an important qualification, as EMS infrastructure, resources, and operations vary significantly among these environments. Events coded as frontier/wilderness were also classified as rural. Finally, the NEMSIS data element *EMSSceneTime* was used for mean on-scene interval; and the elapsed time intervals *EMSDispatchCenterTime* and *EMSChuteTime* were summed for the mean activation interval. *EMSDispatchCenterTime* represents the time difference between when the 911 call is received by dispatch and when the ambulance unit is notified. *EMSChuteTime* represents the time difference between when the ambulance unit is notified and when it is en route. For activation intervals, lights and sirens were required for the response interval to meet inclusion criteria. For the on-scene interval, lights and sirens were required for the transport interval to meet inclusion criteria (Figure 1).

Data Analysis

Case removal was required for records with null values for any time element, times less than or equal to zero, and outliers. Derived elapsed time elements were excluded from the analysis if outside the standardized range set by NEMSIS (29). This includes dispatch times greater than, or equal to, one hour and on scene times greater than, or equal to, one day. Median, mean and standard deviation was calculated for both activation intervals, and on-scene intervals, and Student's *t-Tests* were performed for statistical comparisons between transportation type and rurality. Finally, an Independent Samples *t-Test* was used to compare this NEMSIS analysis with Carr et al.'s meta-analysis results.

Results

In total, approximately 1.9 million records were identified for activation interval analysis, represented by 35,557 air transport and 1,835,586 ground transport activations. Urban EMS activations accounted for most ground transport findings, with 1,573,823 events. For the on-scene interval, 542,912 EMS activations were identified, represented by 46,962 helicopter transport and 495,950 ground transport events. Urban EMS on-scene events accounted for most ground transport findings, with 415,475 events. The EMS activations provided from the NEMSIS analysis were more

Table 2. Number of activations for prehospital intervals of helicopter and ground transport of trauma patients.

	Helicopter transport	Urban ground transport	Suburban ground transport	Rural ground transport
Activation interval				
NEMSIS	35,557	1,573,823	91,560	170,203
Carr et al	2,281	105,145	105,145	6,846
On-scene interval				
NEMSIS	46,962	415,475	27,916	52,559
Carr et al	4,047	139,866	127,850	30,047

robust than Carr et al., except for suburban ground data (Table 2).

Helicopter transport mean activation and on-scene time intervals were significantly longer than those for ground transport, regardless of rurality ($p < 0.01$) (Table 3). Statistically significant differences were noted between all mean ground intervals, with urban total activation and on-scene intervals being significantly shorter than suburban and rural ($p < 0.01$). Furthermore, while *EMSDispatchCenterTime* was quite similar between all ground units, *EMSChuteTime* varied, with rural being more than two times longer than urban.

When comparing NEMSIS data to the meta-analysis data, there were mixed results. Mean activation intervals for all NEMSIS data were significantly longer than those from Carr et al. ($p < 0.01$) (Table 3). The difference in the helicopter transport mean activation interval was quite stark. The NEMSIS interval was more than three times longer than the interval calculated from Carr et al. Alternatively, the mean helicopter interval for on-scene time was significantly less for the NEMSIS data ($p < 0.01$). All other NEMSIS mean on-scene intervals were significantly longer than those provided by Carr et al. ($p < 0.01$).

An extensive analysis evaluating the impact of advanced life support (ALS) and basic life support (BLS) of ground units showed mixed results. Shorter mean times were seen in ALS compared to BLS for all activation intervals across all ruralities ($p < 0.01$). The largest difference between ALS and BLS for the total activation interval was seen in the rural environment (3.10 ± 4.31 and 4.84 ± 5.86 respectively). Conversely, overall mean on-scene intervals were quite similar, with marginally longer intervals for ALS ($p < 0.01$). Intervals between ALS and BLS were quite similar in urban environments (15.54 ± 10.73 and 15.38 ± 9.47 minutes respectively) but varied substantially for suburban (18.02 ± 11.60 and 16.03 ± 9.93 minutes) and rural (18.67 ± 15.18 and 16.31 ± 18.57 minutes) responses (Table 4).

Discussion

Our analysis of EMS elapsed service times calculated activation and on-scene prehospital intervals using datasets from a single modern and uniform data source. These empirically derived prehospital intervals provide valuable data for future access to care models and serve as a blueprint for future utilization of the NEMSIS dataset. With longer prehospital times contributing to higher mortality rates in severely injured patients, making sure patients have timely access to trauma care is an essential component of reaching the goal of "Zero Preventable Deaths After Injury" set by the NASEM report (4). Therefore, accurately estimating trauma care accessibility is of utmost importance when identifying trauma care deserts, where timely access to care is absent.

Prehospital Intervals

Surprisingly, except for helicopter transport on-scene times, NEMSIS time intervals were significantly longer than results from the meta-analysis completed by Carr et al. We believe this may be due to a few reasons. First, as stated in the analysis by Carr et al., "… strict definitions of prehospital time intervals and conformity to existing definitions could not be controlled as inconsistencies exist with the literature reviewed for this analysis." This limitation should be minimized with the current analysis due to the standardization present within the NEMSIS database. Also, all cases with a time of zero were removed from this analysis, as these are not possible or useful when determining mean time intervals. If an EMS provider reported the same time for arrival and departure from a scene, we considered this a data reporting error or an instance when EMS did not provide aid. It is possible that some articles in the meta-analysis included times of zero and, therefore, lowered the mean time intervals. Second, the significantly longer times calculated from the NEMSIS dataset are due to a difference in the activation interval definition. According to Carr et al., the activation interval is defined as "the time from call was received to time of alarm." This assumes the ambulance is en route to the scene instantaneously at the time of notification. The two-component time definition of the activation interval is more accurate and realistic because it includes the time from the 911 call to unit notification and the time between when the unit is notified and when the unit is en route.

While all activation and on-scene times from our analysis are statistically different from one another, it was quite surprising to see such similarities, especially regarding all ground unit *EMSDispatchCenterTime* and on-scene time between suburban and rural communities. Furthermore, analysis of the two activation components suggests the activation interval variability among ruralities is mainly due to *EMSChuteTime*, the time from EMS notification until the unit is en route. We suspect this difference is due to the volunteer-based systems more commonly found in rural communities. Finally, if total activation and on-scene intervals are summed, more stark differences between the ruralities begin to emerge.

The analysis of the NEMSIS dataset showed considerable differences in activation intervals, but on-scene intervals were comparable. There was a difference of 1.47 minutes between BLS and ALS for total activation time, with ALS

Table 3. Mean and standard deviations for activation and on-scene intervals (mins) of helicopter and ground units for trauma responses.

	Helicopter transport	Urban ground transport	Suburban ground transport	Rural ground transport
Activation Interval				
NEMSIS				
EMSDispatchCenterTime	5.19 ± 6.79	1.59 ± 3.65	1.55 ± 3.31	1.36 ± 3.40
EMSChuteTime	8.57 ± 4.90	1.01 ± 1.56	1.34 ± 2.14	1.97 ± 3.00
Total activation interval	13.75 ± 7.44	2.60 ± 3.94	2.88 ± 3.89	3.33 ± 4.58
Median	12.00	1.68	2.00	2.00
Carr et al.	3.53 ± 3.81	1.40 ± 1.41	1.40 ± 1.41	2.89 ± 1.64
On-Scene Interval				
NEMSIS				
Median	16.00	14.00	16.00	15.92
Mean & SD	19.42 ± 16.09	15.50 ± 10.46	17.56 ± 11.27	18.07 ± 16.13
Carr et al.	21.60 ± 18.90	13.50 ± 3.71	13.45 ± 21.80	15.06 ± 16.80

Table 4. Mean and standard deviations for activation and on-scene intervals for BLS and ALS ground units for trauma responses.

	Urban BLS	Urban ALS	Suburban BLS	Suburban ALS	Rural BLS	Rural ALS	All BLS	All ALS
Activation Interval								
NEMSIS								
EMSDispatchCenterTime	2.48 ± 5.32	1.49 ± 3.40	1.96 ± 3.68	1.50 ± 3.27	1.61 ± 3.92	1.31 ± 3.32	2.35 ± 5.11	1.47 ± 3.39
EMSChuteTime	1.37 ± 2.15	0.97 ± 1.48	2.35 ± 3.56	1.22 ± 1.87	3.22 ± 4.26	1.78 ± 2.70	1.64 ± 2.65	1.06 ± 1.66
Total activation interval	3.86 ± 5.60	2.46 ± 3.69	4.30 ± 4.80	2.72 ± 3.73	4.84 ± 5.86	3.10 ± 4.31	4.00 ± 5.60	2.53 ± 3.75
Median	2.18	1.62	3.00	2.00	3.00	2.00	2.32	1.68
n	157,853	1,415,970	9,540	82,020	22,746	147,457	190,139	1,645,447
On-Scene Interval								
Median	13.92	14.00	14.00	16.00	14.00	16.00	14.00	14.25
Mean & SD	15.38 ± 9.47	15.54 ± 10.73	16.03 ± 9.93	18.02 ± 11.60	16.31 ± 18.57	18.67 ± 15.18	15.52 ± 10.93	16.00 ± 11.38
n	96,402	319,073	6,394	21,522	13,296	39,263	116,092	379,858

being 58% faster than BLS at getting en route to the scene. In urban environments, this discrepancy was driven by EMSDispatchCenterTime, while in suburban and rural environments it was caused more by EMSChuteTime. It is possible that the more expeditious ALS response were due to differences in injury severity, with ALS being utilized more frequently for severe injuries, and therefore urgency is prioritized. While total on-scene times were very similar, on-scene time for ALS was longer than BLS for all ruralities. These differences are very minor in urban environments but become substantial in suburban and rural locations. We believe this is due to the increased capabilities and invasive methods used by ALS.

Limitations

There are limitations associated with the NEMSIS dataset that must be acknowledged. First, the dataset is a large convenience sample, consisting solely of data submitted by participating EMS agencies and may not represent the entire U.S. population. It likely includes a disproportionate number of EMS agencies with the resources and leadership necessary to participate in the program. This may explain the large number of urban results compared to suburban and rural environments. While under the Census Bureau designation, roughly 23 percent of the population is considered rural, only approximately 10 percent of the sample was represented by rural EMS providers. Second, while the NEMSIS database contains data from a wide array of states, the authors cannot say for certain how many states are represented once case selection was completed. The NEMSIS public-release research does not disclose the state in which the record was generated. However, results include activations from all nine U.S. Census Divisions, representing a diverse geographic sample. Third, NEMSIS contains records from two-tier EMS response systems consisting of a first responder crew and transporting crew. In these two-tier systems, the transporting crew is often not required to respond with the same urgency as the first responding crew. There is no definitive way to identify records from these systems, and therefore both are potentially included, resulting in longer dispatch intervals. Finally, due to differences in inclusion/exclusion criteria, potential selection bias could have occurred and affected case selection during the filtering process (29).

Conclusion

As GIS technology is becoming more widely utilized in this field, accurate activation and on-scene intervals are essential for geospatial models analyzing access to trauma care. The values derived from this analysis represent a more accurate and up-to-date representation of prehospital intervals from EMS systems currently in place. This analysis more effectively defines the EMS activation and on-scene intervals by utilizing the national standardized data protocol from EMS agencies across the nation. In addition to establishing the modern baseline metric for these critical prehospital care intervals, these data will be important to identifying and quantifying areas for focused process improvement, enhancing access to care, and assessing the impact of any such interventions by comparing pre and post-intervention interval times.

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Disclosure Statement

No interest to declare.

Data Availability

The data that support the findings of this study are openly available in the Harvard Dataverse Repository.

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Appendix 1

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Bulger, EM	University of Washington
Burlew, CC	Denver Health Medical Center
Butler, FK	DSO Medical Associates
Callaway, DW	Atrium Health
Cannon, JW	University of Pennsylvania
Champion, HR	SimQuest
Chang, M	University of South Alabama
Coimbra, RS	Riverside University Health System & Loma Linda University
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Demarest, GB	University of New Mexico School of Medicine
Dorlac, WC	University of Colorado
Drake, SA	Texas A&M University
Eastman, AL	United States Department of Homeland Security
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Elster, EA	Uniformed Services University of the Health Sciences
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