

Advancing Pre-Hospital Care: Battlefield to Street- Street to Battlefield

LTC Bob Mabry, MD

Director, Military EMS and Disaster Medicine
Fellowship Program



Standard 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.”***
- May not represent the position of:
 - The DoD
 - The AMEDD
 - My boss
 - My boss’s boss
 - Etc...

GEN Patton on War *(if he were around today)*

“No bastard ever won a war
by making PowerPoint slides
for his country.”

“He won it by making
the other poor dumb bastard
make slides for his country.”

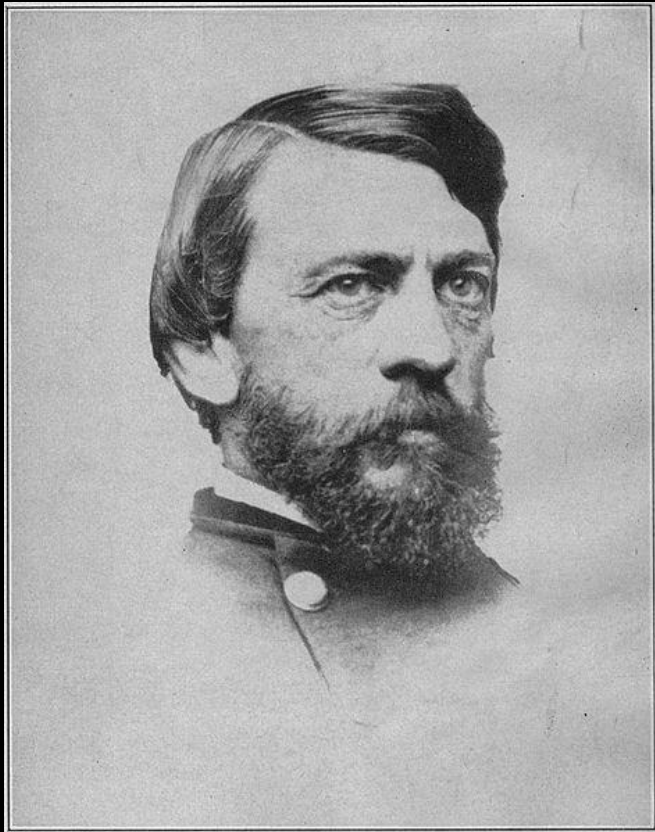


George C. Scott as George S. Patton Jr.

Evolution of Military EMS



Evolution of Military EMS



Early Military Trauma Systems

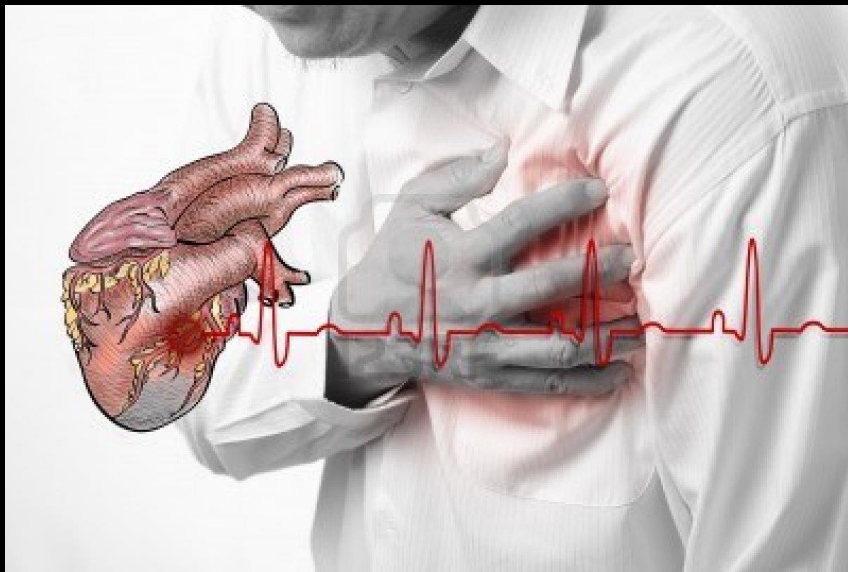


THE PAST

- 1926- First use of Army aircraft for medical evacuation
- 1950-53 –Korea-17,700 patients by helicopter
- 1961-1975 – Vietnam -900,000 patients by helicopter
- 1966- Trauma White Paper / NHTS Act passed
- 1967-First paramedic training program in US
- 1970- MAST / Maryland State Police
- 1977- EMT-Ps operating in every state
- 1979-Emergency Medicine becomes a Specialty
- 1980-32 HEMS Systems operating in US
- 1984- NAEMSP – Practice of medicine out of hospital
- 1987-First Level I trauma center designated in US
- 2001- US Army adopts EMT-B standard for medics

Development of Civilian EMS Systems

Cardiac or ACLS



Trauma or ATLS





Are these the same?



Applying Civilian Trauma Principles to the Military Trauma Setting

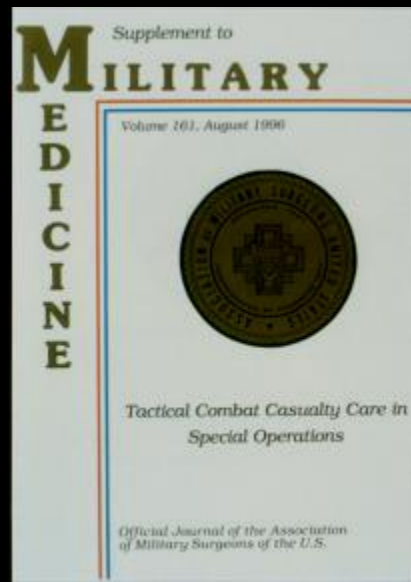


ROUND PEG,
SQUARE HOLE

It still doesn't work...

Threat- based care guidelines

- Tactical Combat Casualty Care (TCCC)
 - Paradigm shift
 - Significant decreases in combat mortality





- This is bad



EMS Responsibility

1) Make air go in and out

—O₂ into lung

2) Make blood go round and round

—Keep blood on the inside, not the outside

Vietnam: 9% KIA

Death From Extremity Wounds



OIF/OEF: 2-3 % KIA

Death From Extremity Wounds



Iraq or Afghanistan?



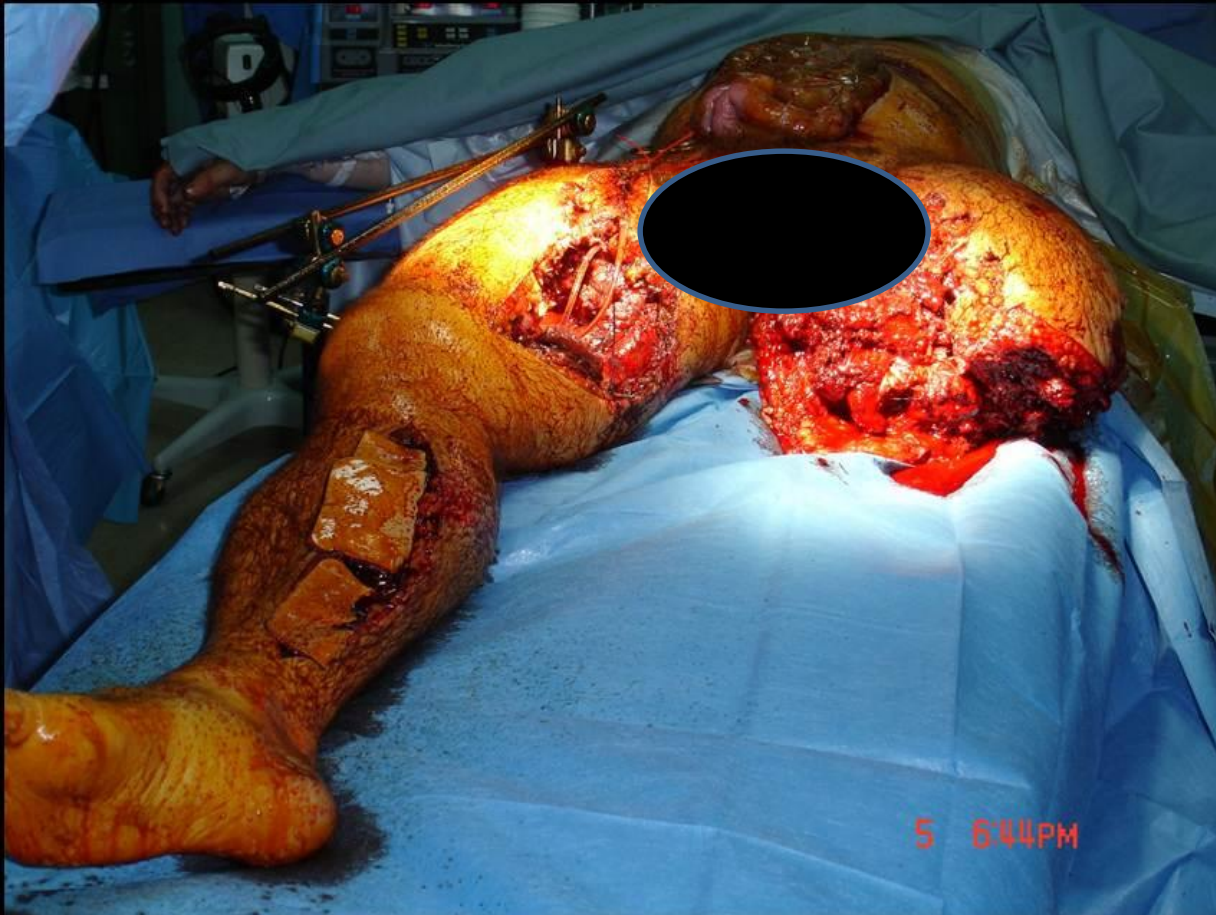


THE TOURNIQUET

Each Stretcher bearer, each officer, each man if possible, should know how to fix a garrot. The use of the garrot has been much criticized, but if it causes the loss of a limb it may save a life. Many men die unnecessarily from hemorrhage on the battlefield and at the ambulance.

Vincent
Amer. Red. Cross. Soc. Bulletin
April 1918

Wounds that May Result in Junctional Hemorrhage



Typically caused by dismounted IED attacks

Recommended Hemostatic Agents

Combat Gauze



Chito gauze



Combat Ready Clamp



Abdominal Aortic Tourniquet

Today



1800's



New Drugs

- Tranexamic acid (TXA)





Got Bleeding?

NOW APPROVED FOR POINT OF INJURY

Tranexamic Acid **TXA**

LNAME: TRANEXAMIC ACID INJECTION 1 ML OF
STER SOL 10 ML AMPULES 10S
NSN: 6505-015917298



Technical Questions: 318-431-4441
or JTTS_LDRS.MAIL@swa.army.mil











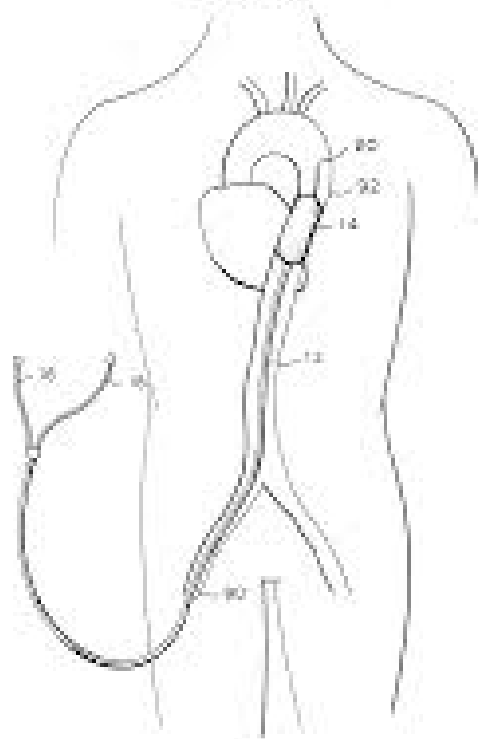
Endovascular balloon occlusion of the aorta is superior to resuscitative thoracotomy with aortic clamping in a porcine model of hemorrhagic shock.

Surgery. 2011 Sep. [White JM](#), [Cannon JW](#), [Stannard A](#),

CONCLUSION:

Resuscitative aortic BO increases central perfusion pressures with less physiologic disturbance than thoracotomy with aortic clamping in a model of hemorrhagic shock. Endovascular BO of the aorta should be explored further as an option in the management of noncompressible torso hemorrhage.

FIG. 5



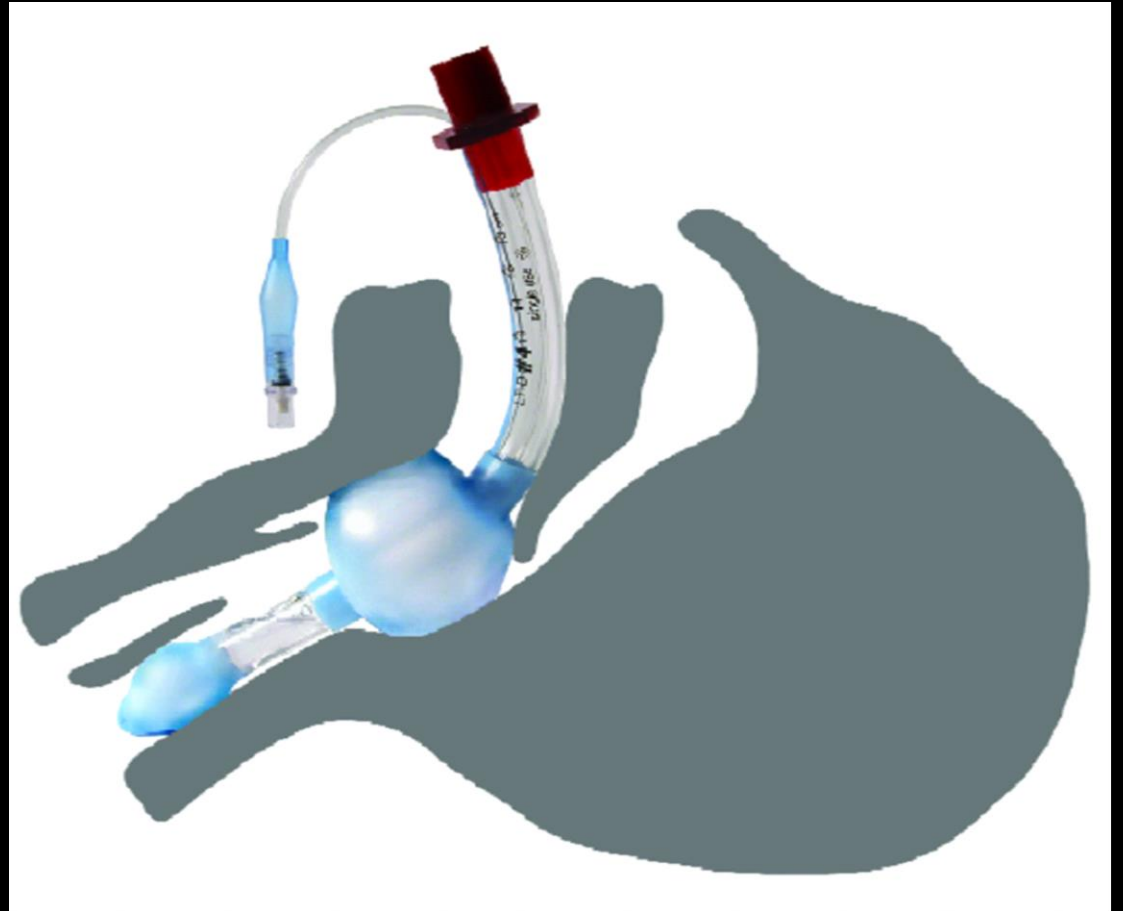
Making Air Go In and Out



Survival of trauma patients who have prehospital tracheal intubation without anaesthesia or muscle relaxants: **Lockey D, BMJ. 2001 Jul 21;323**

- In a six year period, from January 1990 to December 1996
- **492 (33.2%) were intubated** without drugs:
 - 275 (55.8%) by physicians
 - 216 (43.9%) by paramedics
- **One patient (0.2%) survived.**
 - This person had a cardiac arrest after penetrating chest trauma and underwent a thoracotomy on scene

SGA's - The Combitube and King



***Advanced airway management in combat casualties
by medics at the point of injury:***

Mabry RL, J Spec Oper Med. 2011 Spring;11(2):16-9.

- 20 trauma casualties with advanced airway management done by a medic at the Point of Injury
 - 1 LMA
 - 10 Combitubes
 - 3 Crics (two also with Combitube)
 - 6 ETT

Who dies from an airway?

MILITARY MEDICINE

FATAL AIRWAY INJURIES DURING OPERATION ENDURING FREEDOM AND OPERATION IRAQI FREEDOM

Robert L. Mabry, MD, Jason W. Edens, MD, Lisa Pearse, MD,
Joseph F. Kelly, MD, Howard Harke, MD

ABSTRACT

Introduction. Airway compromise is the third leading cause of potentially preventable death on the battlefield. An understanding of the injuries associated with fatal airway compromise is necessary to develop improvements in equipment, training, and prehospital management strategies in order to maximize survival. **Objective.** To determine injury patterns resulting in airway compromise in the combat setting. **Methods.** This was a subgroup analysis of cases previously examined by Kelly and colleagues, who reviewed autopsies of military personnel who died in combat in Iraq and Afghanistan between 2003 and 2006. Casualties with potentially survivable (PS) injuries and deaths related to airway compromise previously identified by Kelly et al. were reviewed in depth by a second panel of military physicians. **Results.** There were 982 cases that met the inclusion criteria. Of these, 232 cases had PS injuries. Eighteen (1.8%) cases were found to have airway compromise as the likely cause of primary death. All had penetrating injuries to the face or neck. Twelve deaths (67%) were caused by gunshot wounds, while six deaths (33%) were caused by explosions. Nine cases had concomitant injury to major vascular structures, and eight had significant airway hemorrhage. Cricothyroidotomy was attempted in five cases; all were unsuccessful. **Conclusion.** Airway

compromise from battlefield trauma results in a small number of PS fatalities. Penetrating trauma to the face or neck may be accompanied by significant hemorrhage, severe and multiple facial fractures, and airway disruption, leading to death from airway compromise. Cricothyroidotomy may be required to salvage these patients, but the procedure failed in all instances in this series of cases. Further studies are warranted to determine the appropriate algorithm of airway management in combat casualties sustaining traumatic airway injuries. **Key words:** airway; tactical; cricothyroidotomy; Operation Iraqi Freedom; Operation Enduring Freedom; Iraq War; combat

PREHOSPITAL EMERGENCY CARE 2010;14:272-277

INTRODUCTION

Historically, airway compromise represents the third leading mechanism of potentially preventable death on the battlefield, behind compressible hemorrhage and tension pneumothorax.¹ Significant advances have recently been made in the battlefield management of severe hemorrhage. Tourniquets are being used at higher rates for severe extremity injuries, and evidence supports their use for hemorrhage control in combat casualties.²⁻⁴ Hemostatic dressings are being employed in the field of battle for use in instances of hemorrhage not amenable to tourniquets, and recent studies demonstrate successful outcomes with the use of the agents.^{5,6} Additionally, further work is showing the efficacy of newer hemostatic dressings to control severe hemorrhage.⁷ Field medics are instructed on the diagnosis of tension pneumothorax in those casualties demonstrating respiratory distress with associated torso trauma. These medics are given 14-gauge, 3.25-inch needles and have the necessary training to perform needle thoracostomy in any casualty in whom a tension pneumothorax is suspected.⁸ To date, there are no studies examining combat-related airway injuries or prehospital airway management on the battlefield.

In order to formulate treatment strategies, design new equipment, and develop appropriate training

- 18/1000 airway deaths
- All from trauma
- Most from GSW, most of those single GSW
- Disrupted anatomy
- Bloody
- Aspiration of blood
- Failed crics

Received May 11, 2009, from the United States Army Department of Combat Medic Training (RLM), Fort Sam Houston, Texas; the United States Army Institute of Surgical Research (JWE, JPK), Fort Sam Houston, Texas; and the Office of the Armed Forces Medical Examiner (LJP, HH), Rockville, Maryland. Revision received November 12, 2009; accepted for publication November 20, 2009.

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

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

Address correspondence and reprint requests to: Robert L. Mabry, MD, U.S. Army, Department of Combat Medic Training, ATTN: MCCS-HW, 3151 W.W. White, Fort Sam Houston, TX 78114. e-mail: robert.mabry@us.army.mil

doi: 10.3109/10903120903537205

Prehospital SC in OEF and OIF

- Review of 72 cricothyroidotomies performed in OIF and OEF
- Over 30% failure rate among combat medics performing a surgical airway at the point of injury (Mabry JSOM).

An Analysis of Battlefield Cricothyrotomy in Iraq and Afghanistan

Robert L. Mabry, MD; Alan Frankfurt, MD

ABSTRACT

Objective

Historical review of modern military conflicts suggests that airway compromise accounts for 1–2% of total combat fatalities. This study examines the specific intervention of pre-hospital cricothyrotomy (PC) in the military setting using the largest studies of civilian medics performing PC as historical controls. The goal of this paper is to help define optimal airway management strategies, tools and techniques for use in the military pre-hospital setting.

Methods

This retrospective chart review examined all patients presenting to combat support hospitals following pre-hospital cricothyrotomy during combat operations in Iraq and Afghanistan during a 22-month period. A PC was determined "successful" if it was documented as functional on arrival to the hospital. All PC complications that were documented in the patients' record were also noted in the review.

Results

Two thirds of the patients died. The most common injuries were caused by explosions, followed by gunshot wounds (GSW) and blunt trauma. Eighty-two percent of the casualties had injuries to face, neck or head. Those injured by gunshot wounds to the head or thorax all died. The largest group of survivors had gunshot wounds to the face and/or neck (38%) followed by explosion related injury to the face, neck and head (33%).

Pre-hospital cricothyrotomy was documented as successful in 68% of the cases while 26% of the PCs failed to cannulate the trachea. In 6% of cases the patient was pronounced dead on arrival without documentation of PC function. The majority of PCs (62%) were performed by combat medics at the point of injury. Physicians and physician assistants (PA) were more successful performing PC than medics with a 15% versus a 33% failure rate.

Complications were not significantly different than those found in civilian PC studies, including incorrect anatomic placement, excessive bleeding, air leak and right main stem placement.

Conclusions

The majority of patients who underwent PC died (66%). The largest group of survivors had gunshot wounds to the face and/or neck (38%) followed by explosion related injury to the face, neck and head (33%). Military medics have a 33% failure rate when performing this procedure compared to 15% for physicians and physician assistants. Minor complications occurred in 21% of cases. The survival rate and complication rates are similar to previous civilian studies of medics performing PC. However the failure rate for military medics is three to five times higher than comparable civilian studies. Further study is required to define the optimal equipment, technique, and training required for combat medics to master this infrequently performed but lifesaving procedure.

Background

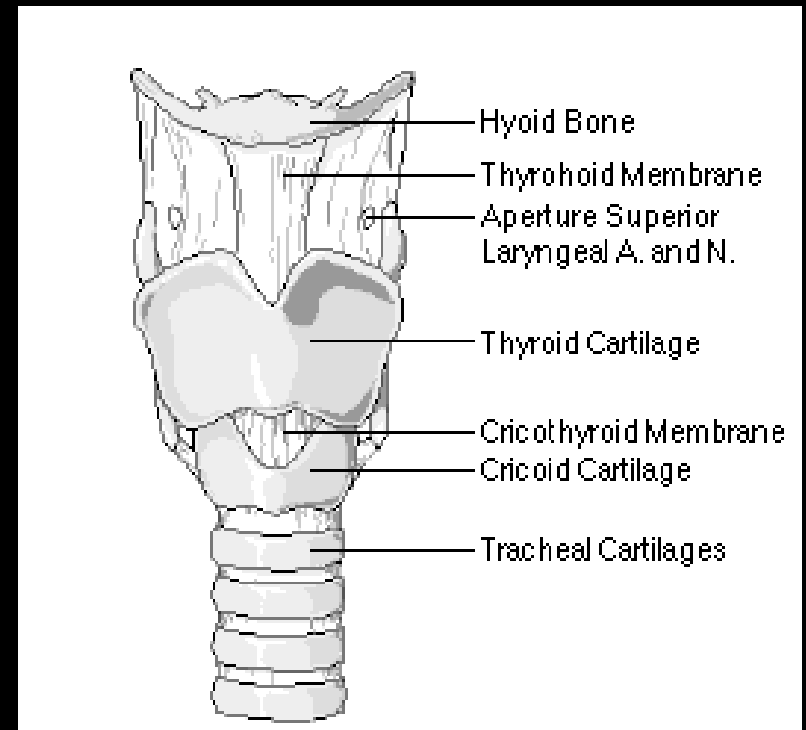
Historical review of modern military conflicts suggests that airway compromise accounts for 1–2% of total combat fatalities.^{1,2} One recent autopsy study examining United States military casualties sustained in recent operations in Iraq and Afghanistan showed that eighteen cases or 1.8% of 982 deaths were found to have airway compromise as the likely primary cause of death.³ Though airway related battlefield mortality is low compared to hemorrhage, the impact of airway related morbidity due to inadequate oxygenation and ventilation in the military pre-hospital setting remains undefined, and may in fact be where advances in airway management in the field holds its greatest promise. Untreated hypoxemia is not only directly detrimental to the casualty, but



SURGICAL AIRWAYS

Indications

- Obstruction
- Facial Trauma
- Intubation or other alternatives impossible
- Trismus (clenching)
- >8-12 years old (for open procedures)



FIRST OR LAST RESORT?



Yellow Lab



Black Lab



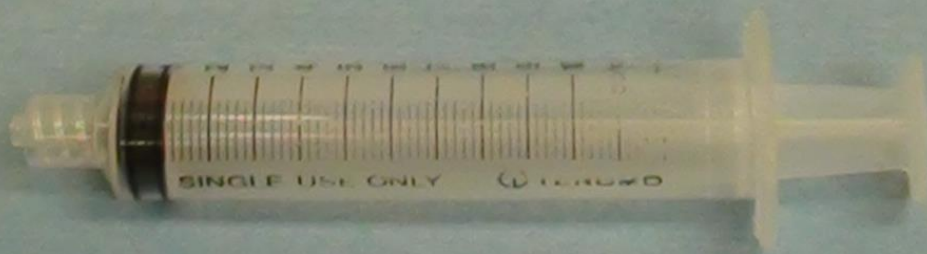
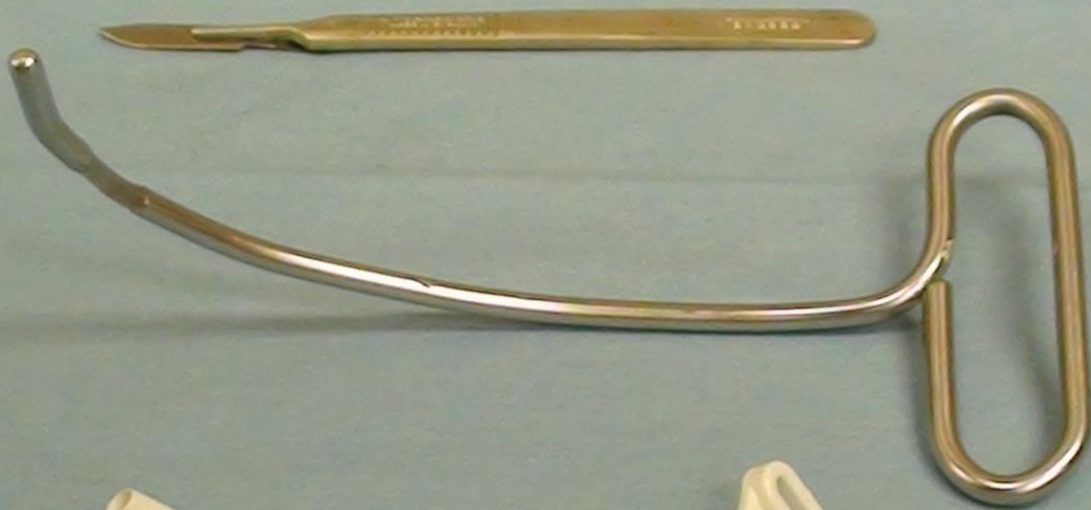
Chocolate Lab



Meth Lab

Lots of ways to skin this cat...





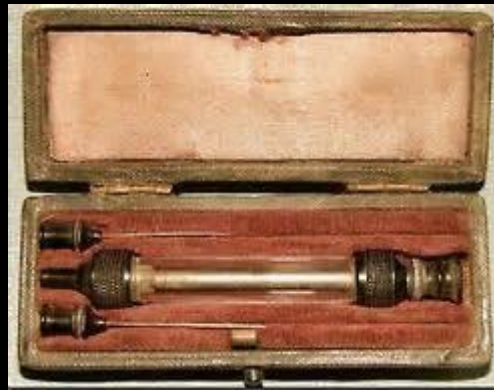
New Technique



Morphine



1804



1857



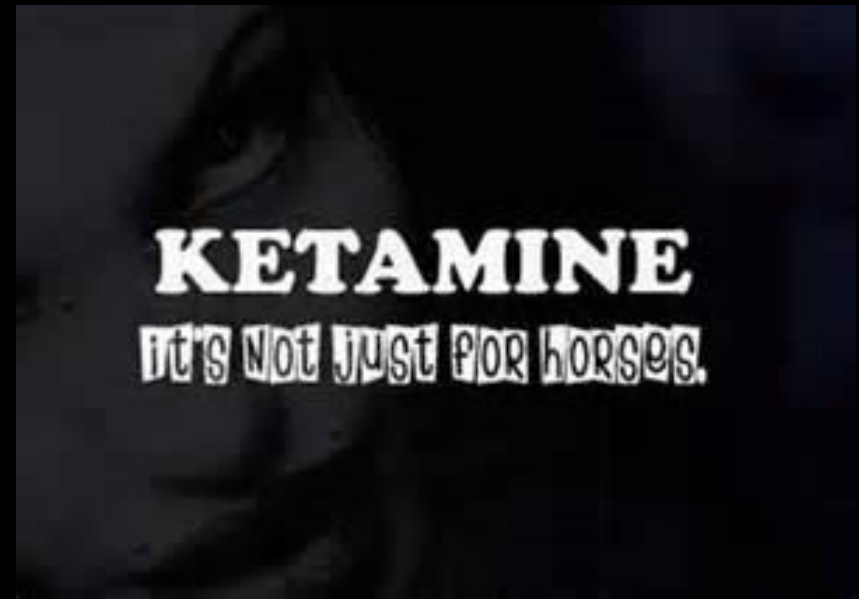
1874

“Pain control in Baghdad, 2003, was the same as in the Civil War—a nurse with a syringe of morphine.”



Ketamine

- How it works?
 - Ketamine is a noncompetitive NMDA receptor antagonist that blocks glutamate. Low (subanesthetic) doses produce analgesia, and modulate central sensitization, hyperalgesia and opioid tolerance. Reduces polysynaptic spinal reflexes.
 - Translation
- Dosing per TC3: 50 mg IN or IM, or 20 mg IV
- Benefits
 - Respiratory Drive
 - Good hemodynamic effects
 - Reduces opioid requirements
 - PTSD?
- Risks
 - Mental Status
 - TBI
 - Rapid administration
 - Laryngospasm (IM primarily)





Battlefield Analgesia – Are TCCC guidelines being followed?

CPT Steven G Schauer, DO RDMS*, MAJ John B Robinson, PA-C**, LTC Robert L Mabry, MD***

*Bayne-Jones Army Community Hospital, **AMEDD Center and School, ***United States Army Institute for Surgical Research



BACKGROUND

Inadequate point-of-injury (POI) analgesia has significant downstream healthcare quality effects and associated costs. Untreated or undertreated pain not only causes physical and emotional suffering but also is associated with an increased risk of Post-Traumatic Stress Disorder (PTSD), depression, chronic pain, opioid dependence, delayed recovery, and long-term disability. Early and effective pain control in the prehospital setting has been shown to reduce the sequelae of untreated pain.

GOAL

To determine compliance rates of newly implemented Tactical Combat Casualty Care pain management guidelines instituted in October, 2013.

METHODS

This was a process improvement (PI) project to study the before and after effects of the recent release of the latest iteration of the Tactical Combat Casualty Care (TCCC) guidelines on 31 OCT 2013. Documentation of the point of injury (POI) care was reviewed. The pre-intervention period was considered 31 JUL to 31 OCT 2013. The post-intervention period was considered 01 NOV 2013 to 31 MAR 2014.

The primary measurement was the administration of analgesia in accordance with contemporary TCCC guidelines at the POI. Secondary measurements included the types of medications being administered.

CON = conventional forces SOF = special operations forces MS = morphine sulfate

OTFC = oral transmucosal fentanyl citrate TCCC = tactical combat casualty care POI = point of injury

*55 patients received 62 doses of medications

BEFORE

| | Casualties | (-) Meds | (+) Meds | Met TCCC |
|---------|------------|----------|----------|----------|
| CON | 21 | 81% (17) | 19% (4) | 14% (3) |
| SOF | 45 | 58% (26) | 42% (19) | 18% (8) |
| CON+SOF | 66 | 65% (43) | 35% (23) | 17% (11) |

| | MS IM | MS IV | OTFC | Ketamine |
|---------|---------|---------|----------|----------|
| CON | 0% (0) | 25% (1) | 25% (1) | 50% (2) |
| SOF | 26% (5) | 5% (1) | 63% (12) | 32% (6) |
| CON+SOF | 22% (5) | 9% (2) | 57% (13) | 35% (8) |

AFTER

| | Casualties | (-) Meds | (+) Meds | Met TCCC |
|---------|------------|----------|----------|----------|
| CON | 41 | 66% (27) | 34% (14) | 17% (7) |
| SOF | 27 | 33% (9) | 67% (18) | 48% (13) |
| CON+SOF | 68 | 53% (36) | 47% (32) | 29% (20) |

| | MS IM | MS IV | OTFC | Ketamine |
|---------|---------|---------|----------|----------|
| CON | 43% (6) | 36% (5) | 21% (3) | 0% (0) |
| SOF | 17% (3) | 5% (1) | 40% (8) | 40% (8) |
| CON+SOF | 28% (9) | 19% (6) | 34% (11) | 25% (8) |

| | |
|---------------------------|----|
| Dismounted blast | 13 |
| Mounted blast | 16 |
| Mortar/artillery | 8 |
| RPG or grenade | 16 |
| Crush/Structural collapse | 3 |
| Fragmentation/Shrapnel | 15 |
| Gun shot wound | 60 |
| Blast Other | 3 |

DATA

PATIENT POPULATION

- 346 US casualties evacuated to higher level of care
- 185 had POI records available for review
- 134 met criteria for POI analgesia (66 pre-intervention, 68 post-intervention)

PRE INTERVENTION

- 17% of eligible patients received TCCC POI analgesia
- 81% of conventional forces and 58% of SOF forces received no analgesia at POI

POST INTERVENTION

- 29% of eligible patients received TCCC POI analgesia
- 66% of conventional forces and 33% of SOF forces received no analgesia at the POI
- IM morphine, which is not a TCCC recommended analgesic, was the most frequently agent used by conventional forces (43%)
- Only 14% in before group and 17% in after group of eligible conventional force casualties received analgesia IAW current TCCC guidelines

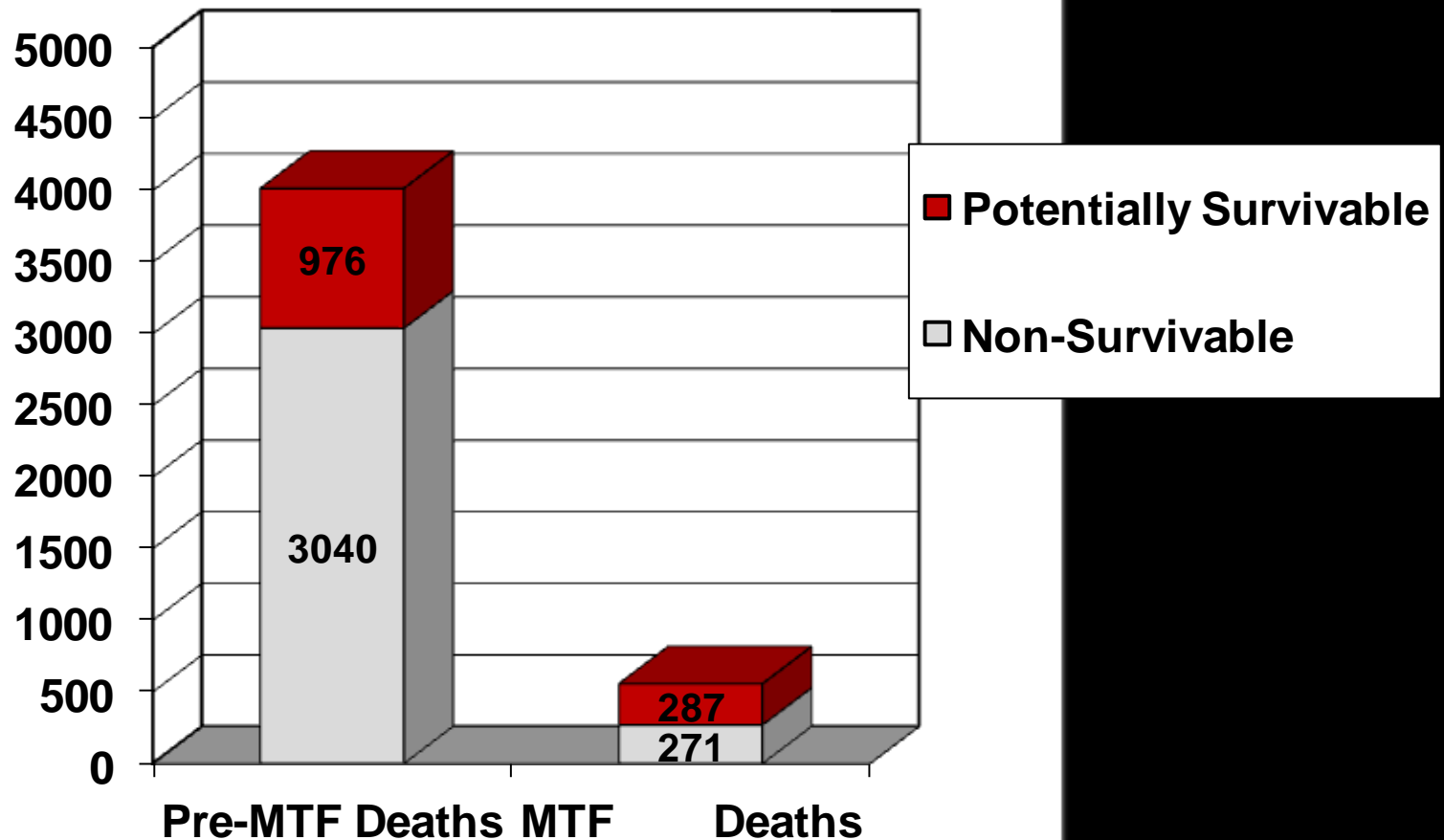
CONCLUSIONS

- While battlefield analgesia administration has improved since implementation of the TCCC Triple Option guidelines, 66% of CON casualties and 33% of SOF casualties received no pain medication in the prehospital setting
- IM morphine, which is not TCCC recommended, is the most common analgesic given by conventional forces
- Further research is needed to improve prehospital pain management

EMS Lessons for the Military



Where can we save the most lives?



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

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

Who / where are the Experts in Battlefield Medicine?



Combat Medic: Today's reality

- Frequently assigned to isolated outpost far from a provider
- Required to perform primary care and preventive medicine tasks with very little training
 - Civilians: Peds, geriatrics, dental
- Formerly only Special Forces medics or medical officers did this

Future Model:

Skills increase with rank?

- E1-E4 (Basic EMT)
 - Focus on Point of Injury care..."plug the smoking hole"
 - Present focus of 68W IET
- E4-E6 (Advanced EMT or EMT-"Military")
 - Should be able to operate independently at remote location with a company sized element
 - Sick call
 - Camp hygiene
 - Civilian and coalition care
 - Dental?
- E6-E8 (EMT-P)
 - "Master Medic"
 - Mentor and instructor
 - Run BAS with PA/ MD
 - Additional provider during MASCAL

Military vs Civilian HEMS

Military

- Platforms / Aviation Focus
- Single EMT-B
- Medical Direction-An intern
- No Army Standard Protocol
- Documentation rarely gets to medical record
- No Standard PI/QI

Civilians

- Patient Care Focus
- Two CC paramedics or nurses
- Medical Direction- EMS physician
- Standard Protocols
- Required documentation
- Required PI/QI

Snapshot of one MEDEVAC units deployment to OEF

- 86% Trauma Cases
- 14% Medical Cases
 - Includes AMI, COPD, CVA, toxic exposure, psychosis, Sz
- 14% Critical care level
 - Intubation, vent management, chest tube insertion, advanced medications, etc.
 - 6% moderate to severe head injuries
- 62% EMT-P level (includes CC cases)
- 94% Adult (age range from 1 to 68 years old)
- 6% Pediatric
 - 2% critical care pediatrics

THE *NEW* REALITY...



***Impact of critical care-trained flight paramedics
on casualty survival during helicopter
evacuation in Afghanistan. J Trauma Acute
Care Surg. Mabry RL, 2012 Aug;73:S32-7***

- Compared regular medevac units to California Guard unit with 75% civilian trained CCFP's
- Survival of critically injured patients at 48 hours
- Standard group- 16% mortality
- CCFP group- 8% mortality

New Army Critical Care Flight Paramedic Program

- Three phases- 9 months
- 11th Class
 - 100% NRP pass rate
- Anticipate expansion to local NRP programs and possibly various critical care training sites
- Challenges
 - Bridging 3-5 years of ALS experience
 - Sustainment

Military Lessons for Civilian EMS



Ft. Hood Incident

November 5, 2009

- Ft. Hood Army Base in Killeen, TX
- Major Nidal Hassan opened fire at a crowded Army Soldier Readiness Center
- Shooting lasted 10 minutes
- 30 wounded and 13 killed



Tucson, AZ

January 8, 2011



Aurora, CO

July 20, 2012



Boston, MA
April 15, 2013



New Paradigm in “Tactical Medicine”

- **New tactics**
 - Explosives
 - Active Shooter
 - Dynamic small unit tactics
 - Lone wolf
 - Targeting first responders
- **Yet what do we exercise?**



Mumbai, India

November 26, 2008







Nation's largest church opens in stadium Congregation takes over arena where Houston Rockets played

Members of the Lakewood Church — all 16,000 of them — worship on Saturday at the grand opening of their new building in a Houston arena that was formerly home of the city's NBA team



Day after Thanksgiving at the Mall



Challenges

- How do we train?
- How do we collect data?
- How do we act on data?
- How do we sustain?
- How do we learn from each other?

To those who risk their lives for
others...