

# Forward Surgical Care

Using Intensive Training and Augmented Reality to  
Improve Access

COL Tyler E. Harris, MD, FAAOS  
Orthopaedic Surgeon/Hand Surgeon

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# Afghanistan, Ghazni, 2014



# No Evacuation, What now?





# Surgical Care in Austere Locations



## SOF Perspective: The Golden Hour Does Not Exist In Africa Populations at Risk

100% of SOCFWD-NWA personnel are **NOT** within 4 hours of acceptable damage control surgical (DCS) intervention



20% of SOCFWD-EA personnel are **NOT** within 4 hours of acceptable damage control surgical (DCS) intervention

100% of SOCFWD-CA personnel are **NOT** within 4 hours of acceptable damage control surgical (DCS) intervention

\* SORT is NOT surgical team and will not be sourced beyond FY16.

## SOF Perspective: The Golden Hour Does Not Exist In Africa

- Risk
  - In 4 hours, 50% of blunt chest/abdominal casualties will die without surgery
  - Blunt trauma is the number one serious injury for USASOC in this AO
- Critical Gap
  - Intra-theater lift assets to transport injured to surgical teams



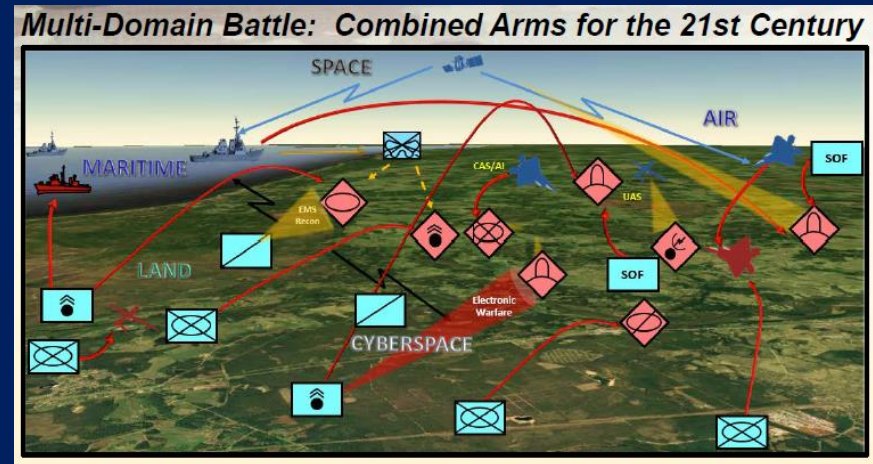
# The War on Terror

- Long Term Low Level Counter Insurgency Operation
  - Enemy technologically inferior / low lethality weapons systems
  - US enjoys air superiority & uncontested mobility
- Golden Hour Doctrine / Surgical Advances
  - Position medical assets so no soldier is more than 1 hour away from a surgery suite on the battlefield.
  - Tourniquet use and fresh whole blood reinvigorated
  - Casualty rate so low triage almost never used



# Multi-Domain Operations

- Sensor-rich military of several peer states
- U.S. forces face large numbers of precision guided weapons
- Highly lethal battlefields
- Traditional U.S. air & maritime superiority challenged
- Space, cyberspace, electromagnetic spectrum domains exploited to create weaknesses
- Coordinated enemy advanced technical reconnaissance, satellite based communications.
- Precision employment of enemy sea power, air power, and long range fires



# Casualties & Personnel

- Recent War Fighter Exercises (WFX); 1 Corps fight
  - Near peer fight
  - 10 day battle
  - 40-50,000 Casualties (20-30K KIA, 20K WIA)
  - 150 severe open fx/day X 10 days
- Personnel for large scale combat ops (6 Corps)
  - General Surgeons
    - 10% of needed surgeons available
    - Approx 120 active duty/ 18 reserves
  - Orthopaedic Surgeons
    - 30% of needed surgeons available
    - Approx 135 active duty /14 reserves



# Medical Implications MDO

- Golden Hour Doctrine Meaningless
  - Sporadic availability air/ground evacuation
  - Demand for continuous mobility
  - Decreased safety/security of “rear areas”
  - Increased capability needed for forward medical assets
- Prolonged Field Care
  - Not enough resources
  - Contested Resupply / Battlefield Congestion
  - Medics / PAs / Physicians / Surgeons all overwhelmed

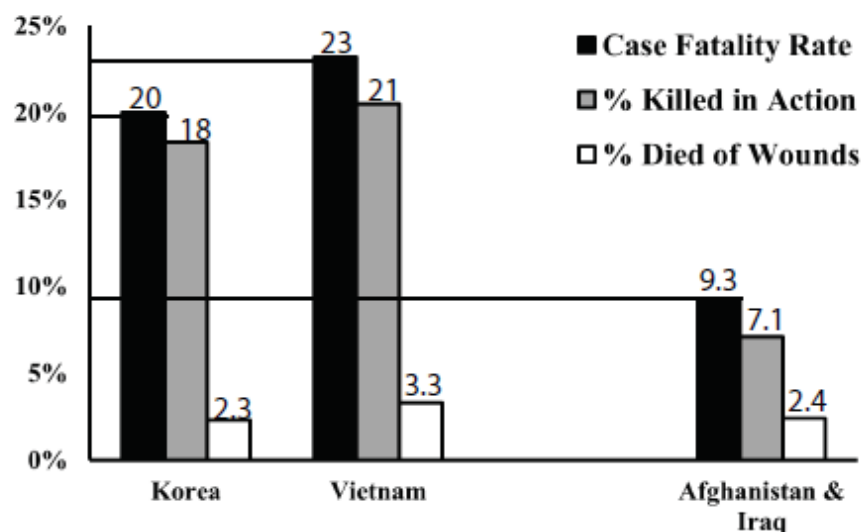


# Trauma Readiness: Perception

48

A NATIONAL TRAUMA CARE SYSTEM

## Concluding Casualty Statistics from Afghanistan & Iraq (2001-2014)\* with Historical Context



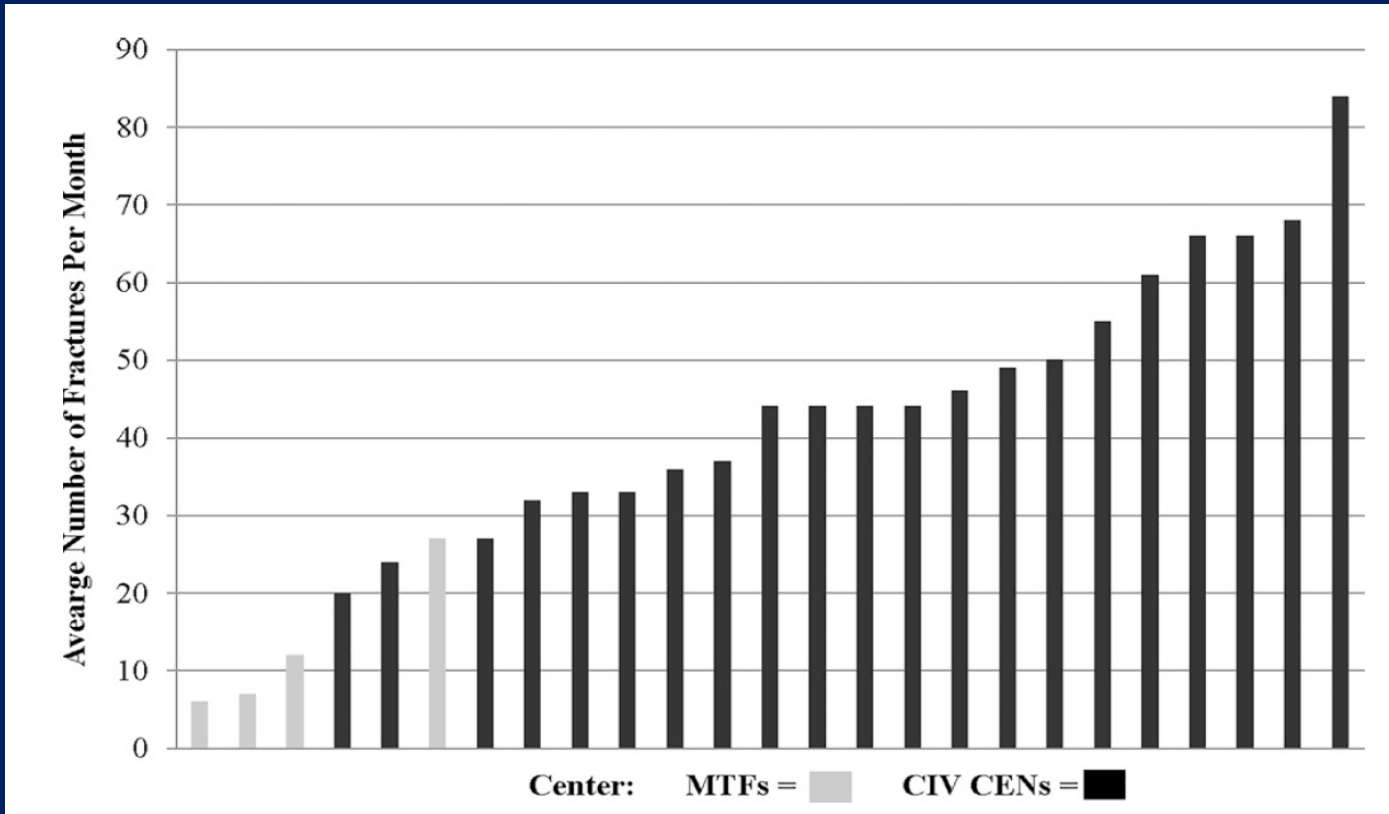
\* DoD Combat Casualty Care Research Program & Defense Casualty Analysis System

**FIGURE 1-3** Case fatality rates during the Korean War, the Vietnam War, Operation Enduring Freedom, and Operation Iraqi Freedom.

NOTES: The statistics presented in this figure were calculated using data collected from the Defense Casualty Analysis System (DCAS), not from the DoD Trauma Registry. In calculating percent killed in action and percent died of wounds, the number of wounded individuals returned to duty (RTD) was not subtracted from the total number of wounded service members because RTD data are not collected in DCAS.

SOURCE: Proceedings of 2014 Military Health System Research Symposium, 2015.

# Actual Readiness #s for Trauma Care



MILITARY MEDICINE, 182, 3/4:10, 2017

## Military and Civilian Collaboration: The Power of Numbers

MAJ Daniel J Stinner, MC USA\*; Joseph C Wenke, PhD†; COL James R. Ficke, MC USA (Ret.)‡;  
 Lt Col Wade Gordon, USAF MC§; CAPT James Toledano, MC USN||; Anthony R. Carlini, MS¶;  
 Daniel O Scharfstein, ScD\*\*; Ellen J. MacKenzie, PhD††; Michael J. Bosse, MD‡‡; Joseph R. Hsu, MD††;  
 the Major Extremity Trauma Research Consortium (METRC)†



# USASOC BESST

- USASOC Battlefield Emergent Stabilization Skills Triad (BESST)
  - Trained non-surgeons
  - Damage control procedures
  - Stabilize until arrival at surgical facility
  - Supported with telemedicine

# Telementoring & Telestration

- Telementoring
  - Mentoring by means of telecommunications or computer networks
- Telestration
  - Drawing over a moving video or still image



# Surgical Telementoring Exists



# Fieldable Surgical Telementoring

- Relatively low bandwidth
- Durable
- Does not require fixed positioning over operative field
- Capable of surgical telestration
- Does not require a lot of extra pieces of equipment/setup



# Telementoring Alone Not Adequate

## **USASOC BESST Needed Procedures**

1. Fasciotomy (upper / lower extremity)
2. Expose / access anterior femoral vessels
3. Expose / access anterior axillary vessels
4. Lateral Canthotomy
5. Femur external fixation
6. Complete an amputation
7. Cranial Burr Hole
8. REBOA Catheter Placement
9. Vascular Reperfusion Shunt





# BESST Demo 11 May 2017

- Technology Osterhout Design Group R-6 Glasses
- Can connect to available network via Bluetooth, Wireless, Cellphone or Satellite
- Eye protective to ANSI ZB7.1
- Meets military standards for heat, dust, shock, moisture and EMI
- Can operate at relative low bandwidth (120kps and lower)

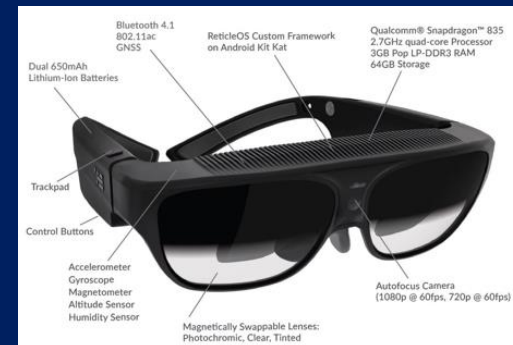
## DESIGNED TO MEET:

- ✓ MIL-STD 810G and 461F
- ✓ 61000-4-2 ESD  
Electro Static Discharge
- ✓ ANSI Z87.1
- ✓ Hazardous Environment



# Training

- The augmented reality technology may be the least important part
- Multimedia based training curriculum
- Rapid iterative skills training.
- Expert level surgical supervision and coaching
- Anatomically correct surgical manikin



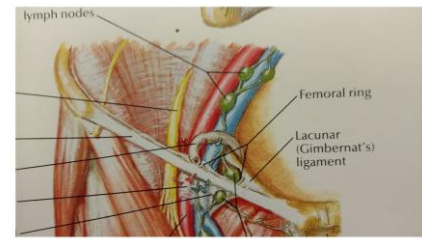
# Training & Practice

- Both surgeon and mentee get the same training for the procedure
- Both surgeon and mentee practice during the iterative skills training
- Both surgeon and mentee practice with the glasses
- Surgeon practices with the software and telestration platform

Junctional GSW-  
exit ipsilateral buttock



Artery is lateral to vein



Cut thru ligament, fascia and muscle  
with scissors- **toward umbilicus**



# Telementoring & Telestration

- Telementoring practiced iteratively with mentee
- Bidirectional voice communications
- Mentor receives real-time full motion video of mentee's visual field
- Telestration lines and circles show up superimposed on the anatomy in mentee's visual field
- Ability to guide the procedure step by step
- Ability to "call out" on visual field structures to protect



# Mentee performance

- Mentee was combat experienced Navy Special Operations physician assistant (PA)
- Mentor was experienced staff orthopaedic surgeon with multiple combat zone deployments
- PA was able to control the distal iliac vessels in under five minutes
- This is not the same as doing this procedure on a cadaver or a live person.
- Work by McKenzie and Shackelford demonstrates that a novice's capability is overestimated on a surgical manikin versus a cadaver.





# Augmented Reality Forward Surgical Care (ARFSC) Phase II

- Purpose of study to integrate
  - Training
  - Simulation
  - Technology
  - Decision support tool
- Demonstrate plausibility

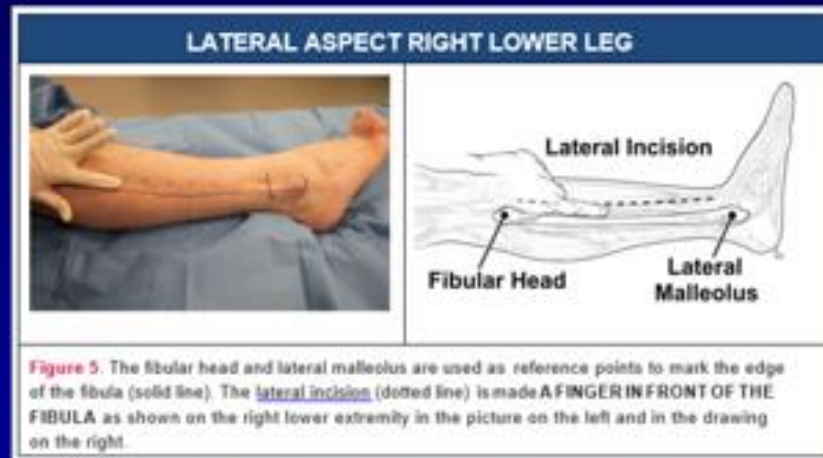


# AFRSC II Methods

- Six non-surgical Special Operations medical providers: two physicians, two physician assistants, two Special Operations medics
- Intensive multimedia and simulation-based instruction
- Rapid iterative expert-supervised skills training
- Two damage control procedures (ASSET):
  - Four compartment fasciotomy of the lower extremity
  - Anterior exposure of the common femoral artery
- AR telestration with on demand assistance
- Decision support tool

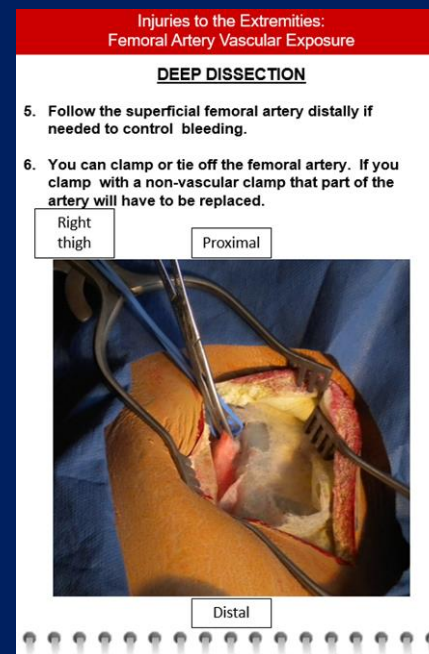
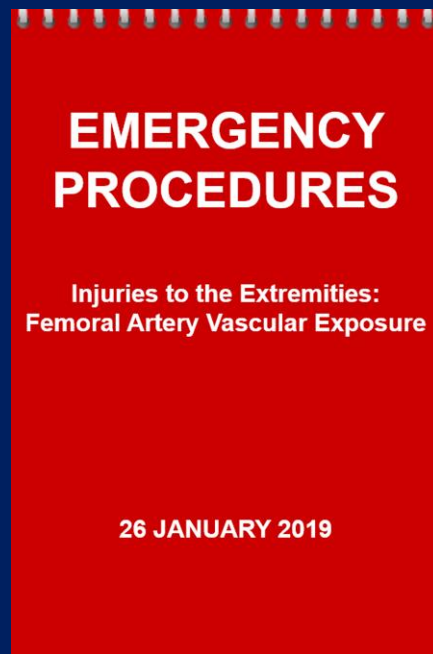
# AFRSC Example Training Slide

## PROCEDURE



- Mark the patella, tibial tuberosity and tibial crest
- Mark fibular head, lateral malleolus and fibular shaft
- Incision is one finger anterior to fibular shaft
- Length: 2-3 fingers (3-6cm) distal to the knee (inferior patella)
- To 2-3 fingers (3-6cm) proximal to the lateral malleolus

# AFRSC Procedural Support Tool



# AFRSC Rapid Iterative Training





# AFRSC Testing

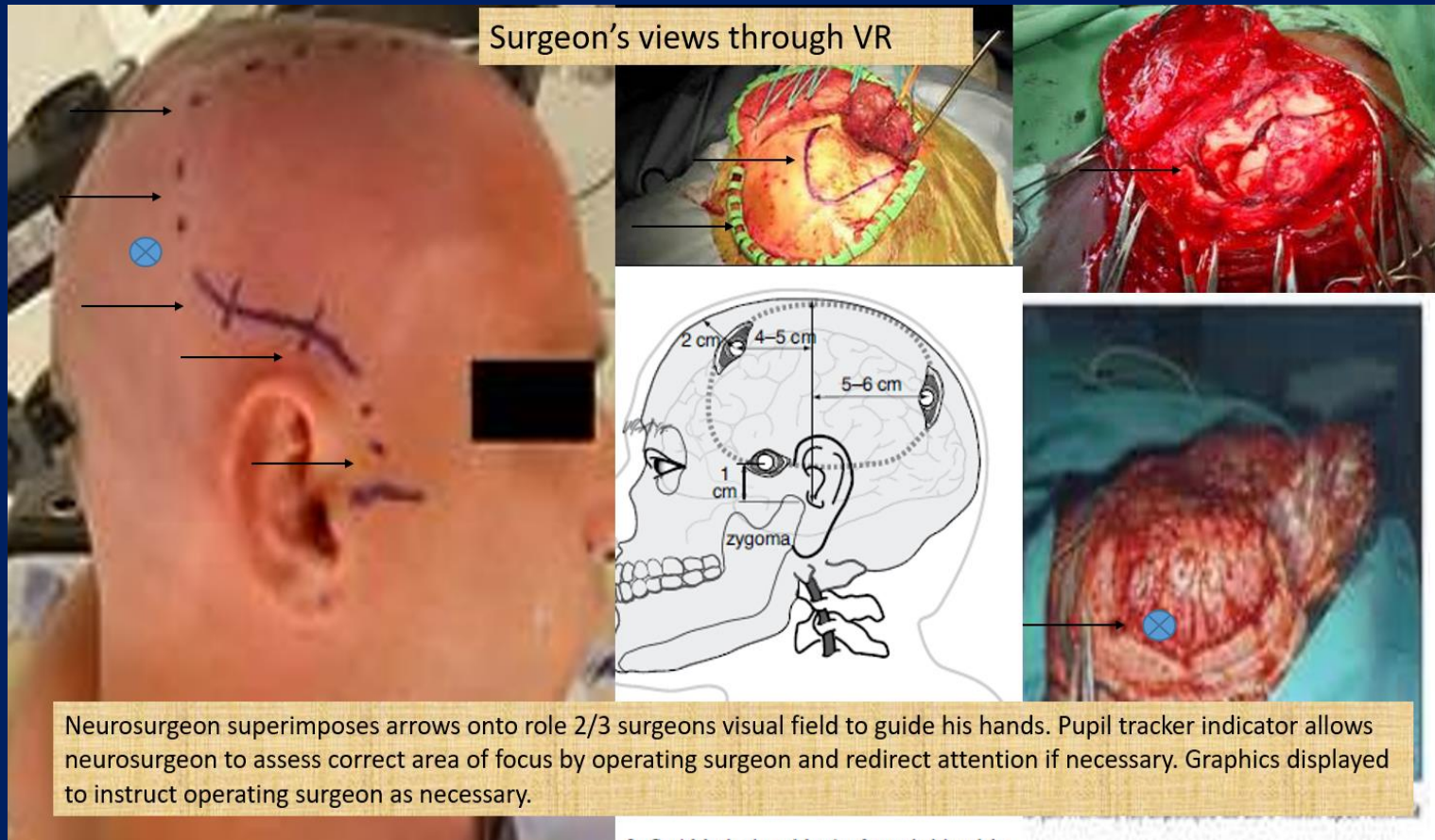




# Conclusion

- Telemedicine with enhanced training of nonsurgical providers may be a way to improve forward surgical access
  - Remotely located troops
  - Dispersed battlefield
  - Multi-Domain Operations

# The Future



Questions?

Back Up Slides

# So lets go back to the War on Terror

- No tolerance for casualties in America
- Death rates plummeting since WW2
  - Generations have passed since death of the young was routine
  - 80 years ago infant mortality 150/1000 and maternal mortality 7/1000
  - Today it is 7/1000 and 7/100,000 respectively
- Zero Preventable Deaths Act
- National Defense Authorization Act 2017
  - 200 pages on military medical topics, previous record # of pages was 20
  - Mandates Mil Civ partnerships
  - Readiness the new buzzword

# Dismounted Complex Blast Injury Patterns

- Bilateral, high, lower extremity amputations
  - Zone of injury confluent with pelvic girdle
- Upper extremity amputations/injuries
  - Dependent on rifle holding position
- Open pelvis fractures
- Severe genitourinary injuries
- Open abdominal injuries
- Traumatic brain injuries

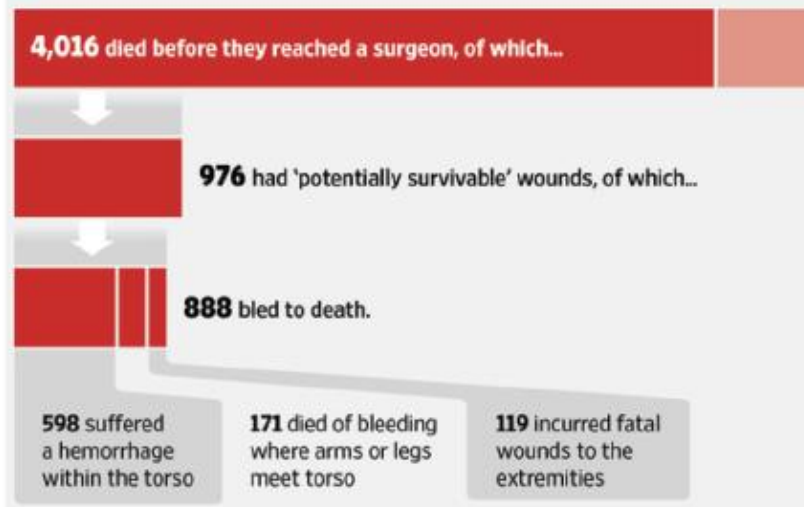




# Where are the Preventable Deaths?

## Could They Have Survived?

Over six months, a team of military doctors reviewed 4,596 autopsies of troops killed in Iraq and Afghanistan between Oct. 2001 and June 2011. Of those men and women...



**FIGURE 1-4** Military preventable deaths in the prehospital setting.

SOURCE: Reprinted with permission of Dow Jones Company, from *Are U.S. soldiers dying from survivable wounds?* Phillips, M. M., *Wall Street Journal*, 2014; permission conveyed through Copyright Clearance Center, Inc.

# Damage Control

- US Navy Term and Strategy
- Pre-established / practiced protocols used to “save the ship”
  - Fire and flooding control



# Damage Control: General Surgery

- *Defined as treatment techniques that enhance the immediate survival of the patient with the least stress to the patient's physiology.*
- Applied at laparotomy

Rotondo J Trauma 35:375-383, 1993

# Trauma Readiness: ICTL

- General Surgery

- Maintain Board certification and unrestricted credentials
- Emergency War Surgery Course q 4 years
- Combat Extremity Surgery Course q 4 years
- ACLS and ATLS
- 120 cases q year
  - 10 open abdominal (50% sim)
  - 5 trauma (60% sim)
  - 2 thoracic (100% sim)
  - 2 craniotomies (100% sim)
  - 5 chest tubes (100 % sim)
  - Needle decompression (100% sim)
  - eFAST US Exams (60% sim)
  - 2 cricothyroidotomies (100% sim)
  - 5 Intubations (100% sim)
  - 5 central lines (60% sim)
- 1 MASCAL exercise q year

- Ortho Surgery

- Maintain Board certification and unrestricted credentials
- Emergency War Surgery Course or Combat Extremity Surgery Course or instruct twice q 4 years
- JFCTMC or ATTC within 4 years
- ATLS
- Pass Ortho CPG Test q 3 years
- 100 cases q year
  - 5 long bones (open or closed)
  - 5 external fixation (100% sim)
  - 2 fasciotomy (100% sim)
  - Vascular access / shunt (100% sim)
  - 5 wound debridements (100% sim)
- 1 MASCAL exercise q year

# Competency for Trauma Care

| Skill Level              | Description  | Trauma-Related Example  |
|--------------------------|--|---|
| <b>Novice</b>            | The novice has no experience in the environment in which he or she are expected to perform.  | Administrator or technician who has never worked in a trauma center.  |
| <b>Advanced beginner</b> | The advanced beginner demonstrates marginally acceptable performance and has enough experience to note recurrent meaningful situational components.  | Medic that has had didactic trauma training but no clinical trauma experience.  |
| <b>Competent</b>         | Competence is achieved when one begins to see one's actions in terms of long-range goals or plans. This individual demonstrates efficiency, coordination, and confidence in his/her actions. | Board-eligible/certified physician, but has only rotated as a resident at a trauma center.  |
| <b>Proficient</b>        | The proficient individual perceives situations holistically and possesses the experience to understand what to expect in a given situation.  | Board-eligible/certified physician or new nurse, starting their career at a high-volume and best-quality Level I trauma center.                 |
| <b>Expert</b>            | The expert has an intuitive and deep understanding of the total situation and is able to deliver complex medical care under highly stressful circumstances.                                  | Trauma nurse coordinator or fellowship trained trauma surgeon with years of experience at a high-volume and best-quality Level I trauma center. |

SOURCES: Adapted from Benner, 1982; Dreyfus, 1981; Dreyfus and Dreyfus, 1980.

# Theater War Medical Support Problem Statement

## 1. How to save the highest number of soldiers

- a. When most of these soldiers will die from hemorrhage
- b. Prior to reaching the first medical facility (Battalion Aid Station)

## 2. Given a near peer conflict in MDO or distributed operations

- a. In the setting of delayed evacuation with prolonged field care
- b. Under the conditions of not enough surgeons
- c. Where deployed medical facilities are under threat



# Student Remarks

- Telestration more likely needed remote from training
- Mismatch eyes/glasses visual field disorienting
- Boldface guides too busy, need streamlining
- Liked lecture-video-demo-practice to mastery pattern
- Suggest add cadaver at end
- Consider off visual axis telestration or toggle on/toggle off
- Option of medical overwatch/help very desirable

# Technology limitations

- Looking under the glasses until visual shield installed
- Glasses uncomfortable to wear
- Heat generation with light or swapping external batteries
- Single front facing camera destroys true stereopsis
- No stabilization for telestrated instructions with head movement
- Not compatible with corrective eyewear (requires inserts)
- Reticle Operating System cumbersome and complex
- Buttons/trackpad on eyeglass frame not intuitive

# Study limitations

- Only a tech integration study, not proof of anything
- Have not shown this can be done on a cadaver or person
- Have not shown can be done with or without telestration
- Have not shown if the decision support tool helps
- Have not demonstrated the need for telestration