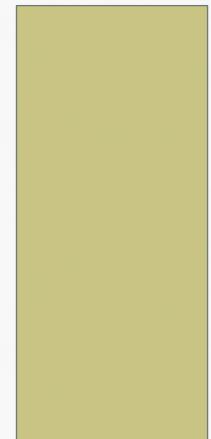




MANGLED EXTREMITY MANAGEMENT

ANTE KALSTAD- ST.OLAVS HOSPITAL,
NORWAY / NORWEGIAN ARMED FORCES



MANGLED EXTREMITY DEFINITION

A limb with an injury to at least three out of four systems:

- Soft tissue
- Bone
- Nerves
- Vessels

MANGLED EXTREMITY ETIOLOGY

- Motor vehicle accidents
- Industrial/farm accidents



High energy trauma

Explosion

- Blast injuries sustained in military action



MANGLED EXTREMITY EPIDEMIOLOGY

- Male 77%
- 20-45 years 71%
- Less educated
- Low income

J Orthop Trauma, 2000 Sep-Oct;14(7):455-66.

Characterization of patients with high-energy lower extremity trauma.

MacKenzie EJ¹, Bosse MJ, Kellam JF, Burgess AR, Webb LX, Swiontkowski MF, Sanders RW, Jones AL, McAndrew MP, Patterson TM, McCarthy ML.

MANGLED EXTREMITY ETIOLOGY

Increasing incidence



MANGLED EXTREMITY
KEY INFORMATION

1. Mechanism of injury
2. Time of injury
3. Pre-hospital evaluation
4. Age
5. Medical or social comorbidities

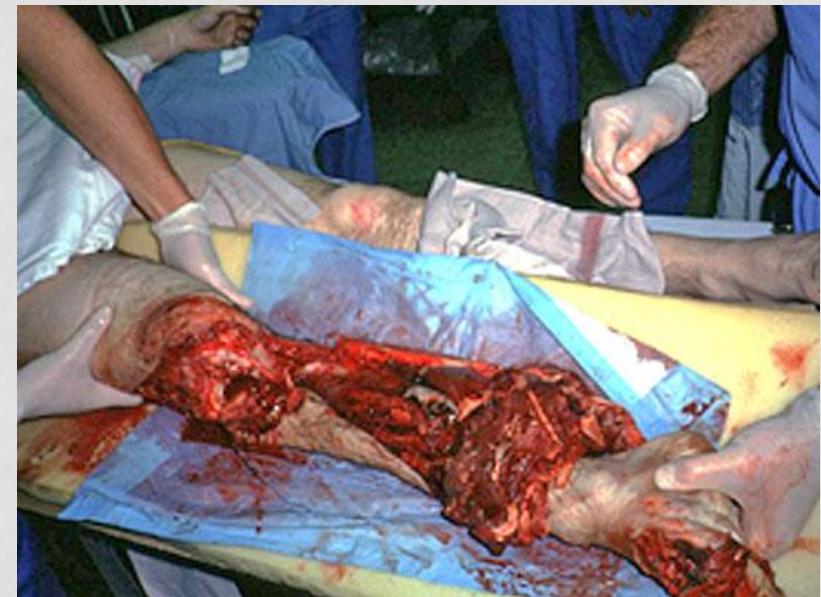
MANGLED EXTREMITY
INITIAL MANAGEMENT

Life before limb

10-17% have associated life-threatening injury

- Caudle RJ. J Bone Joint Surg Am. 1987
- Lange RH, J Trauma. 1985

ATLS protocol



MANGLED EXTREMITY

ORTHOPEDIC EVALUATION

- 1) Adequate vascular perfusion
- 2) Soft tissue and bone
- 3) Motor and sensory examination
- 4) Radiographic evaluation
- 5) Photographs

ORTHOPEDIC TREATMENT IN THE ER

1. Antibiotic and Tetanus profylaxis

ORTHOPEDIC TREATMENT IN THE ER

1. Antibiotic and Tetanus profylaxis

- 1. generation Cephalosporin + Gentamicin

Trends in the Management of Open Fractures

A Critical Analysis

Kanu Okike, BA; Timothy Bhattacharyya, MD

J Bone Joint Surg Am, 2006 Dec; 88 (12): 2739 -2748 . <http://dx.doi.org/10.2106/JBJS.F.00146>

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2. Reduction of fracture/joint dislocation

- motor-, sensory and perfusion examination is repeated after reduction

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4. Immobilize the extremity

- splint or cast

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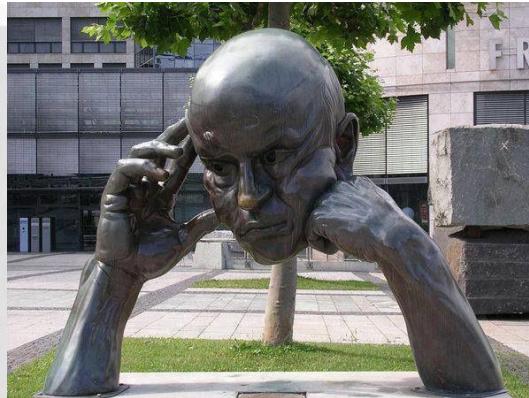
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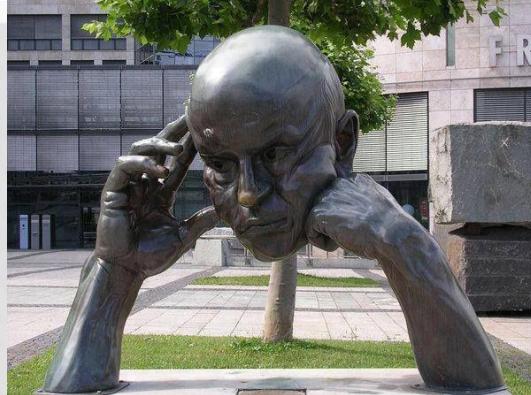
- splint or cast

5. Apply sterile dressing

THEN WHAT?



PLAN?



Acute amputation (< 24h)?



ACUTE AMPUTATION

INDICATIONS

- **Unstable patient**
- **Unsalvable extremity**
 - Ischemia time > 6 hours lower extremity
 > 8 (10) hours upper extremity

Orthopaedic Trauma Association Open Fracture Committee 2012

- Soft tissue loss beyond free flap reconstruction
- Muscle loss involving > 2 lower leg compartments
- Bone loss involving > 1/3 of the tibia

AMPUTATION OF THE MANGLE EXTREMITY

- Most distal level possible (not giliofine)
- Serial irrigation and debridements
 - Negative-pressure
 - Splint/cast
- Closure of the stump



PRIMARY OPERATION

- 1) Sterile tourniquet (not inflated)
- 2) Remove splint and dressing
- 3) Re-examine for perfusion
 - Vascular repair if needed
- 4) Thorough debridement
- 5) Skeletal stabilization

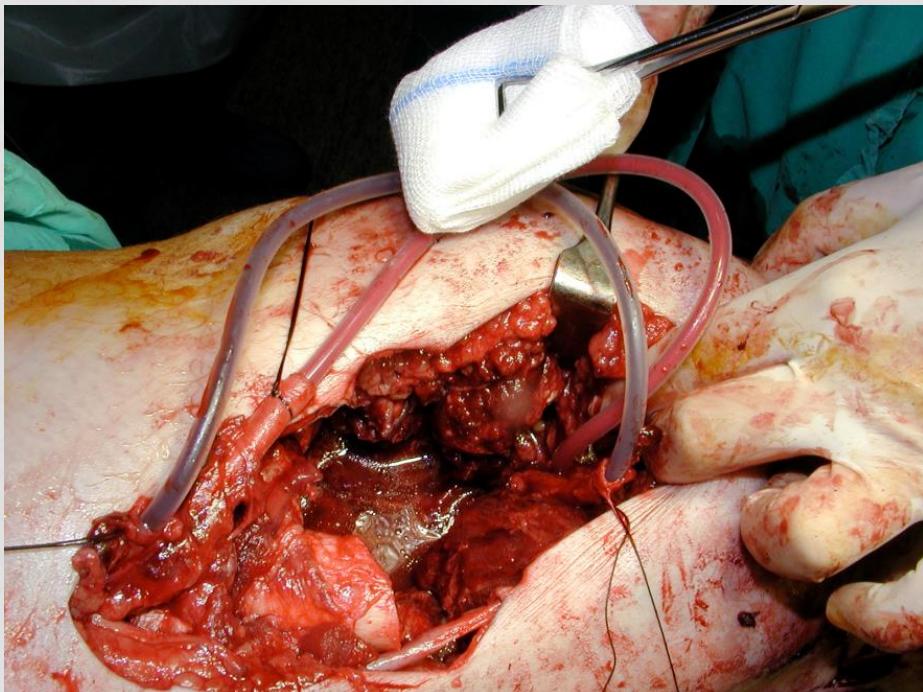
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PRIMARY OPERATION VASCULAR REPAIR

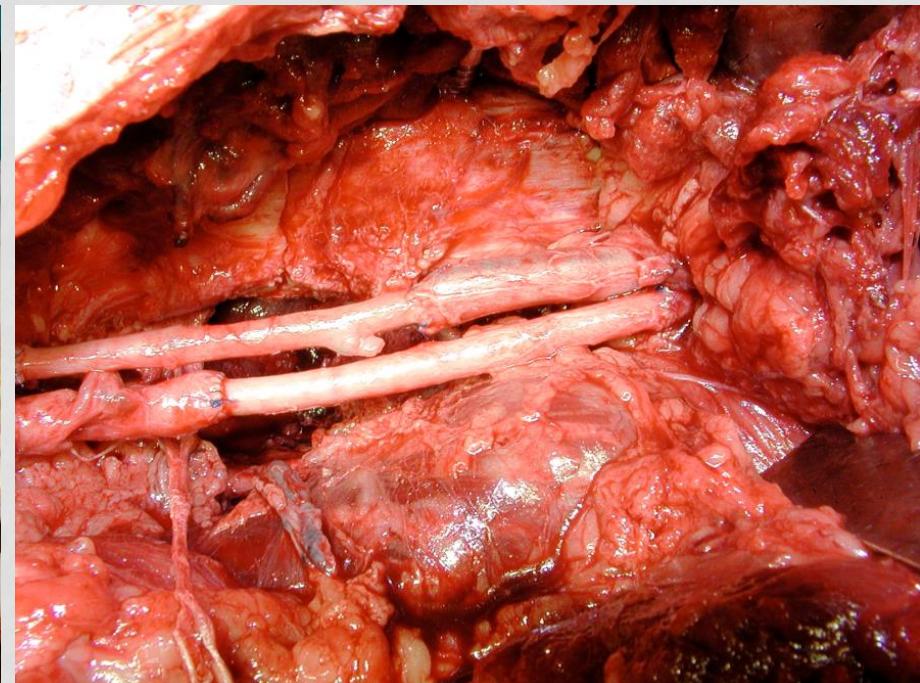
Damage Control

→ shunt



Early Total Care

→ venous by-pass



PRIMARY OPERATION DEBRIDEMENT

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J Bone Joint Surg Am, 2006 Dec; 88 (12): 2739 -2748 . <http://dx.doi.org/10.2106/JBJS.F.00146>

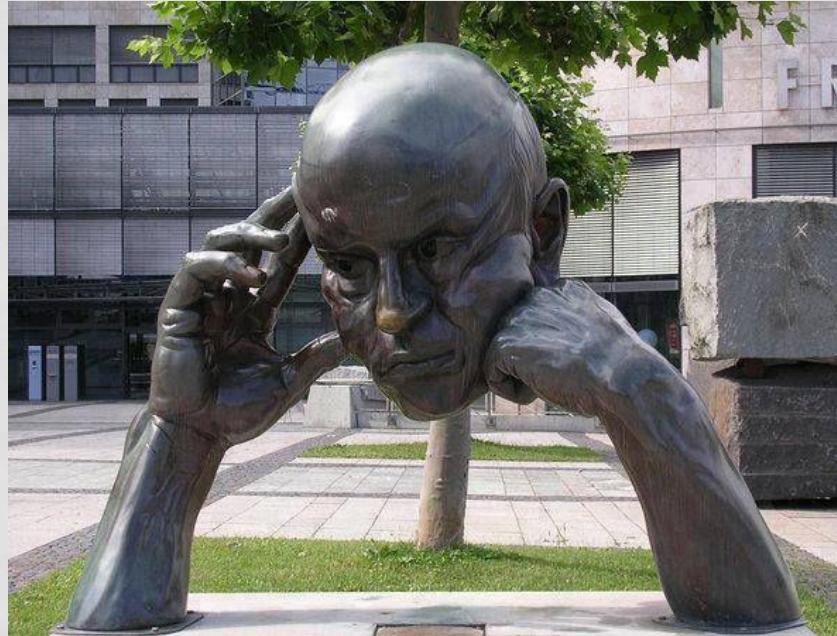
«Thorough operative debridement is the standard of care for all open fractures.»

«..required for proper wound classification»

«time to OR is probably less important than adequacy of debridement»

PLAN?

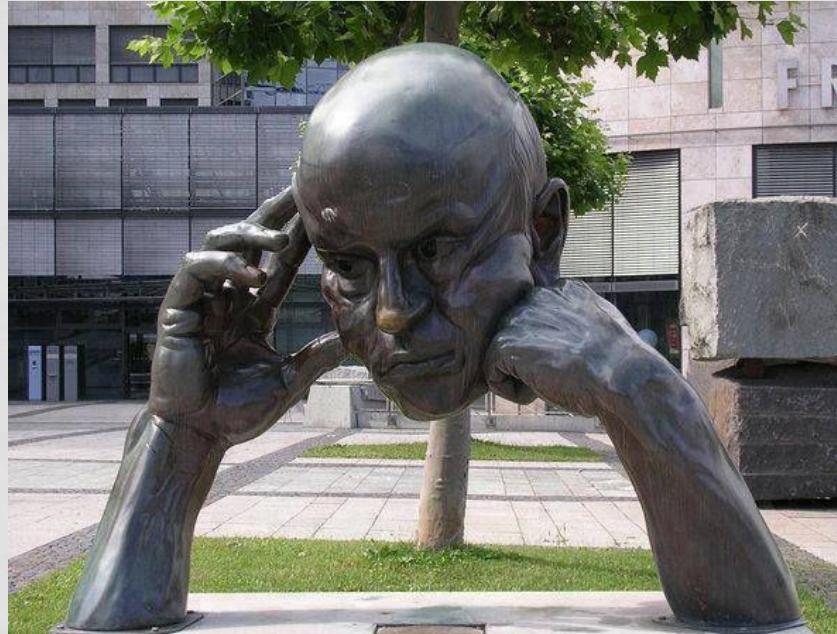
Salvage or primary amputation (< 30 days)



1. Is the limb salvable?
2. Does salvage give the best functional outcome

PLAN?

Salvage or primary amputation (< 30 days)



1. **Is the limb salvable?**
2. Does salvage give the best functional outcome

LIMB SALVAGE SCORES

MESI	- Mangled Extremity Syndrom Index	Gregory RT	1985
PSI	- Predictive Salvage Index	Howe HR	1987
MESS	- Mangled Extremity Severity Score	Johansen K	1990
LSI	- Limb Salvage Index	Russel WL	1991
NISSA	- Nerve injury, Ischemia, Soft tissue injury, Skeletal injury, Shock and Age	McNamara	1994
HFS 98	- Hanover Fracture Scale 98	Krettek C	2001

LIMB SALVAGE SCORES

Mangled Extremity Severity Score(MESS)*

Type	Characteristics	Injuries	Points
Skeletal/soft-tissue			
Group			
1	Low-energy	- Stab wounds, simple closed fractures, small-caliber gunshot wounds	1
2	Medium-energy	- Open or multiple-level fractures, dislocations, moderate crush injuries	2
3	High-energy	- Shotgun blast (close range) high-velocity gunshot wounds, crush injury	3
4	Very high-energy	- Above + gross contamination, soft tissue avulsion.	4
Shock group			
1	Normotensive hemodynamics	- BP stable in field and in operation theatre	0
2	Transiently hypotensive	- BP unstable in field but responsive to intravenous fluids	1
3	Prolonged hypotension	- Systolic BP less than 90mmHg in field and responsive to intravenous fluids only in operation theatre	2
Ischemia group			
1	None	- A pulsatile limb without signs of ischemia	0*
2	Mild	- Pulse reduced or absent but perfusion normal	1*
3	Moderate	- Pulseless; paresthesia, diminished capillary refill	2*
4	Advanced	- Pulseless, cool, paralyzed and numb without capillary refill	3*
Age group			
1	< 30 years		0
2	> 30 - <50 years		1
3	> 50 years		2

*Points x 2 if ischemia time exceeds six hours. BP - Blood pressure

Score 6 or less → salvageable limb
Score 7 or more → amputation

LIMB SALVAGE SCORES

LEAP study (Lower Extremity Assessment Project)

J Bone Joint Surg Am. 2001 Jan;83-A(1):3-14.

A prospective evaluation of the clinical utility of the lower-extremity injury-severity scores.

Bosse MJ¹, MacKenzie EJ, Kellam JF, Burgess AR, Webb LX, Swionkowski MF, Sanders RW, Jones AL, McAndrew MP, Patterson BM, McCarthy ML, Cyril JK.

Prospective n = 556

MESS, LSI, PSI, NISSA & HFS

«The low sensitivity of the indices **failed** to support the validity of the scores as **predictors of amputation.**”

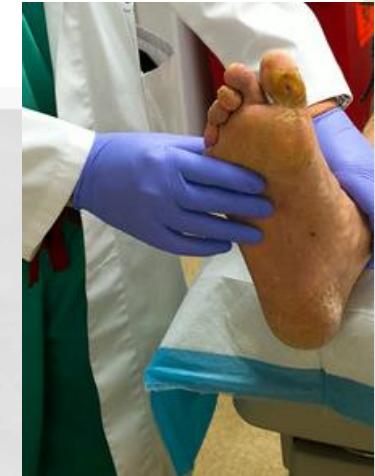
“The high specificity of the scores in all of the patient subgroups did confirm that **low scores could be used to predict limb-salvage potential.**”

PLANTAR SENSATION

The Insensate Foot Following Severe Lower Extremity Trauma: An Indication for Amputation?

Michael J. Bosse, MD; Melissa L. McCarthy, ScD; Alan L. Jones, MD; Lawrence X. Webb, MD; Stephen H. Sims, MD; Roy W. Sanders, MD; Ellen J. MacKenzie, PhD;

J Bone Joint Surg Am, 2005 Dec; 87 (12): 2601 -2608 . <http://dx.doi.org/10.2106/JBJS.C.00671>



29 patients with insensate foot at time of presentation

At 2 year follow up:

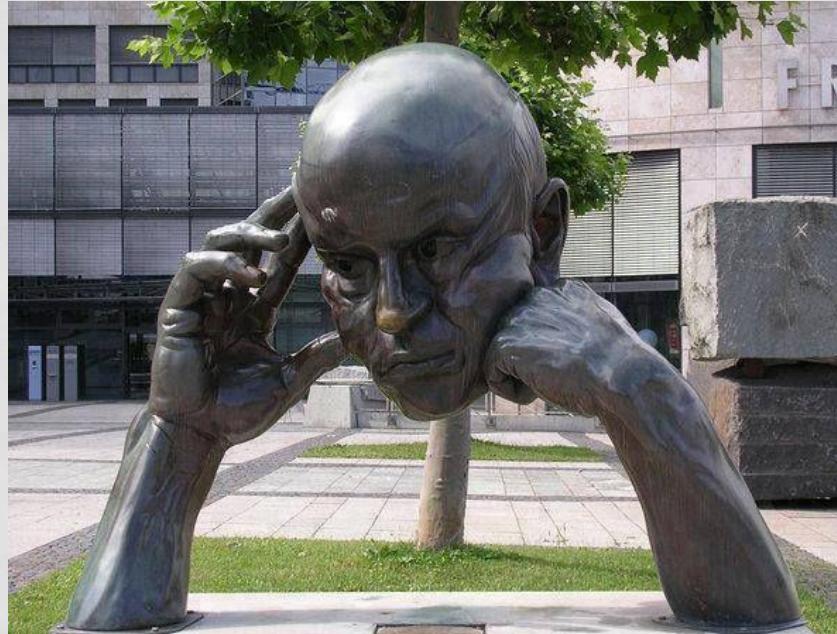
- 55% normal sensation
- 1/29 absent plantar sensation

CONCLUSION:

Initial plantar sensation should **not** be a component of a limb-salvage decision algorithm

PLAN?

Salvage or primary amputation (< 30 days)



1. Is the limb salvable?
2. Does salvage give the best functional outcome

LEAP STUDY

Sickness Impact Profile (SIP)
limb salvage vs. Amputation

→ **No significant difference** in SIP after 24 months

J Orthop Trauma, 2007 Jan;21(1):70-6.

Complex limb salvage or early amputation for severe lower-limb injury: a meta-analysis of observational studies.

Busse JW¹, Jacobs CL, Swionkowski MF, Bosse MJ, Bhandari M; Evidence-Based Orthopaedic Trauma Working Group.

Meta analysis – 9 observational studies - 7 years follow up

➤ Functional outcome **not significantly different**

SECONDARY AMPUTATION

(> 90 DAYS)

Delayed amputation

- Increased hospital stay
- Increased number of surgical procedures
- Increased mortality rate

(Bondurant FJ, 1988)

DECIDING FACTORS

- Upper extremity → salvage
- Foot injuries requiring flaps or ankle fusion do significantly worse than BKA → amputation

Ellington JK, 2013

- Ipsilateral mangled foot or hand → amputation
- Major nerve injury in lower extremity → amputation
- Smoking, high age, co-morbidities → amputation

NORWEGIAN/US FST IRAQ, AUGUST 2017

- 34 year old Iraqi soldier
- Shot through right humerus by ISIS fighter 3 hours ago.
- Arterial bleeding controlled with combat tourniquet
- Gustilo Anderson III C
- ABC stable after initial resuscitation in trauma bay

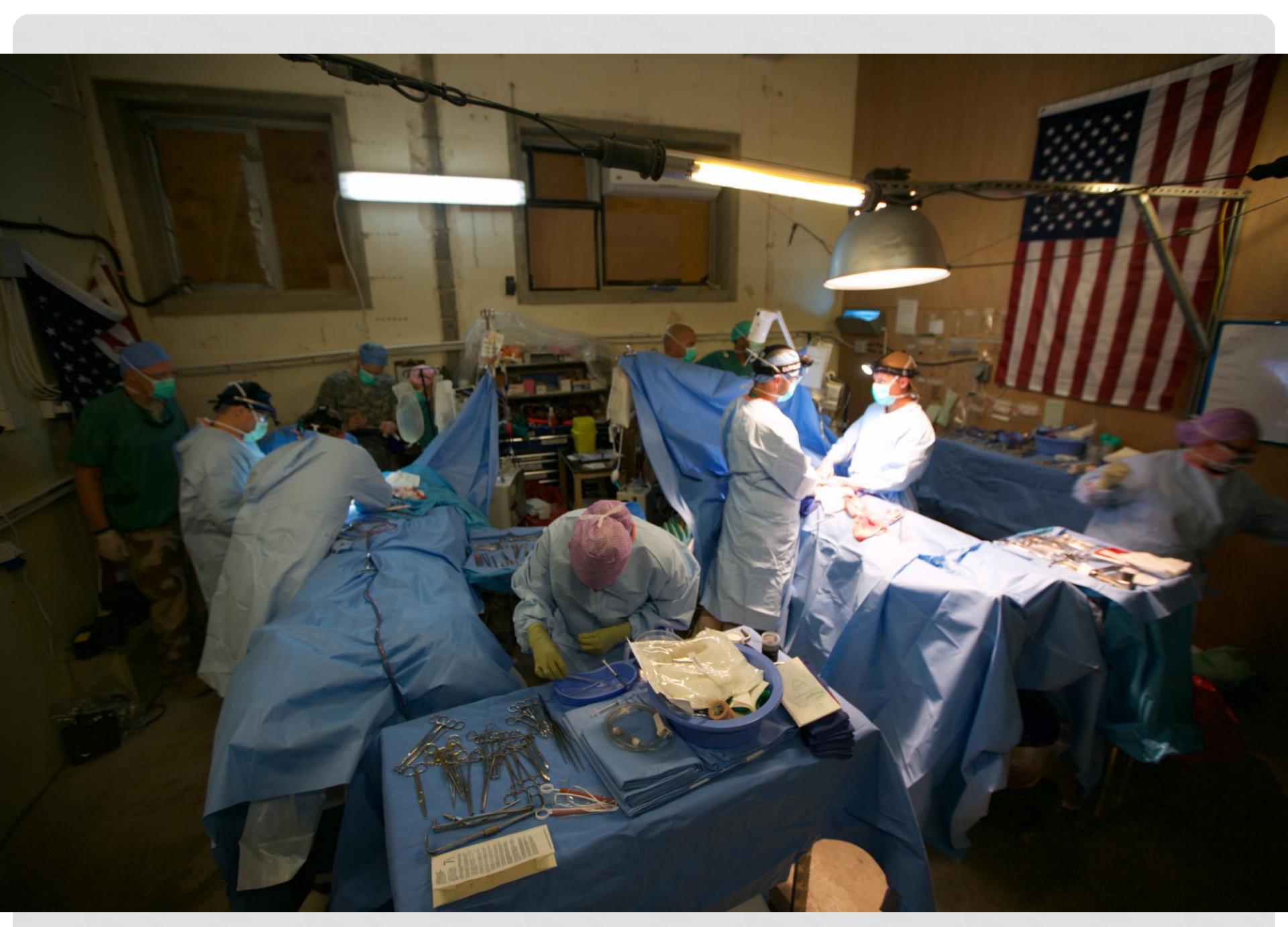














TAKE HOME MESSAGES

- Life before limb
- Acute amputation?
- Primary operation
 - Vascular repair
 - Thorough debridement
 - Skeletal stabilization
- Salvage or amputation?