

THE MANGLED EXTREMITY

**TO SALVAGE OR SEVERE: Myths
and Misconceptions**

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MYTH #1

Dr. Knudson knows how to mangle!!!



DEFINITION OF MANGLED EXTREMITY

- **Def. #1:** a combination of injuries to arteries, bone, tendons, nerves and soft tissue
- **Def. #2:** a mangled extremity is one in which **amputation** is a potential outcome

***Current Problems in Surgery, Nov. 2009*



MYTH #2

Tourniquets are an instrument of the devil and should never be applied!

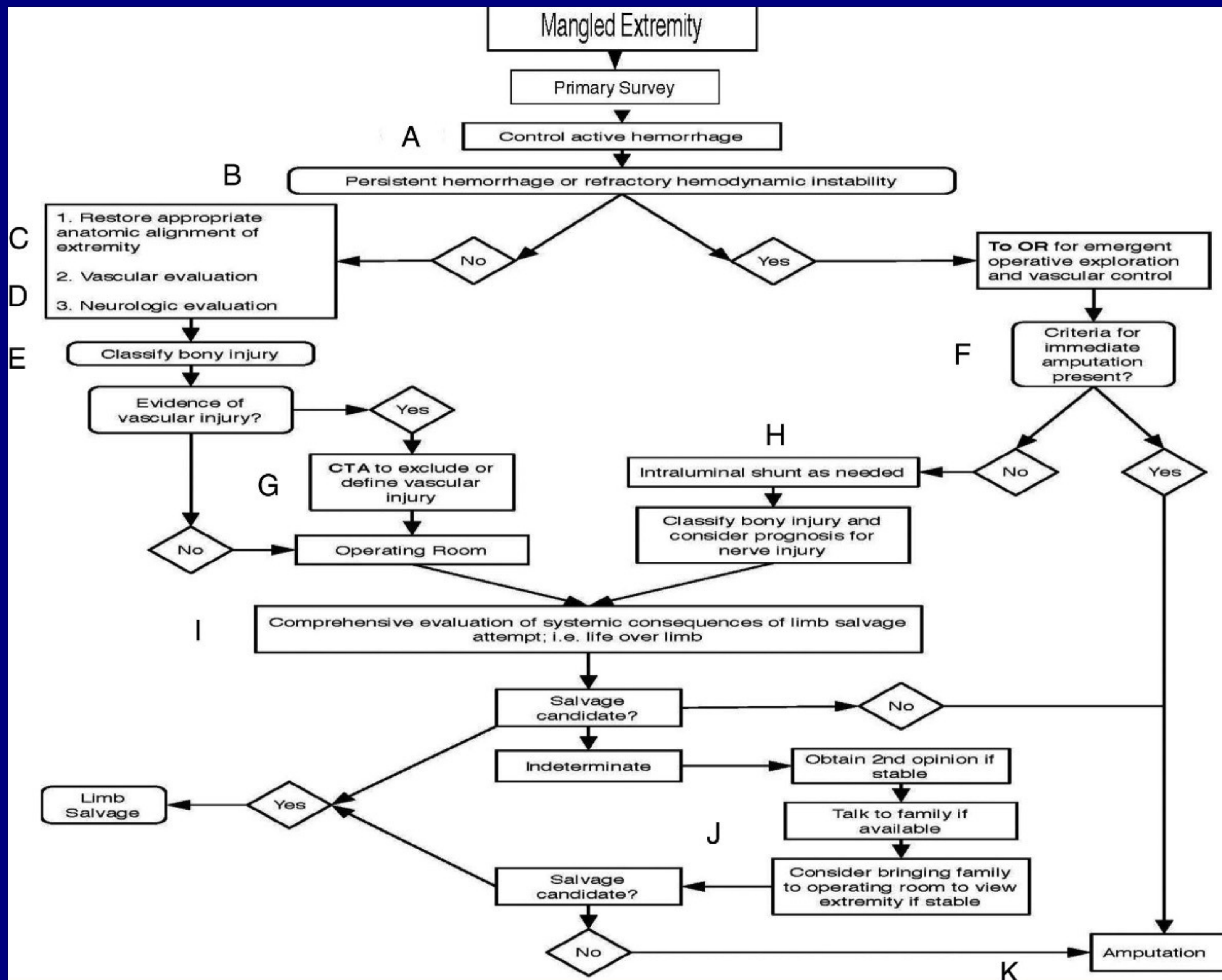
Prehospital Tourniquet Use Life-Saving in Military Casualties

- Should be applied close to the wound
- Use a **CAT** tourniquet (not makeshift)
- Should be tightened until **pulse disappears**
- Consider a second tourniquet for bleeding
- Should be applied to the skin directly
- **Record time of application**
- Remove within 2 hours???

Krugh et al, Ann Surg 2009



Myth #3: Care algorithms are helpful and should always be followed



Don't be distracted by the obvious!

- Remember your ABCs of trauma care
- High index of suspicion for other injuries
- **Save the patient first, the limb second**



MYTH #4: WHAT YOU SEE IS WHAT YOU GOT



MOREL-LAVALLEE

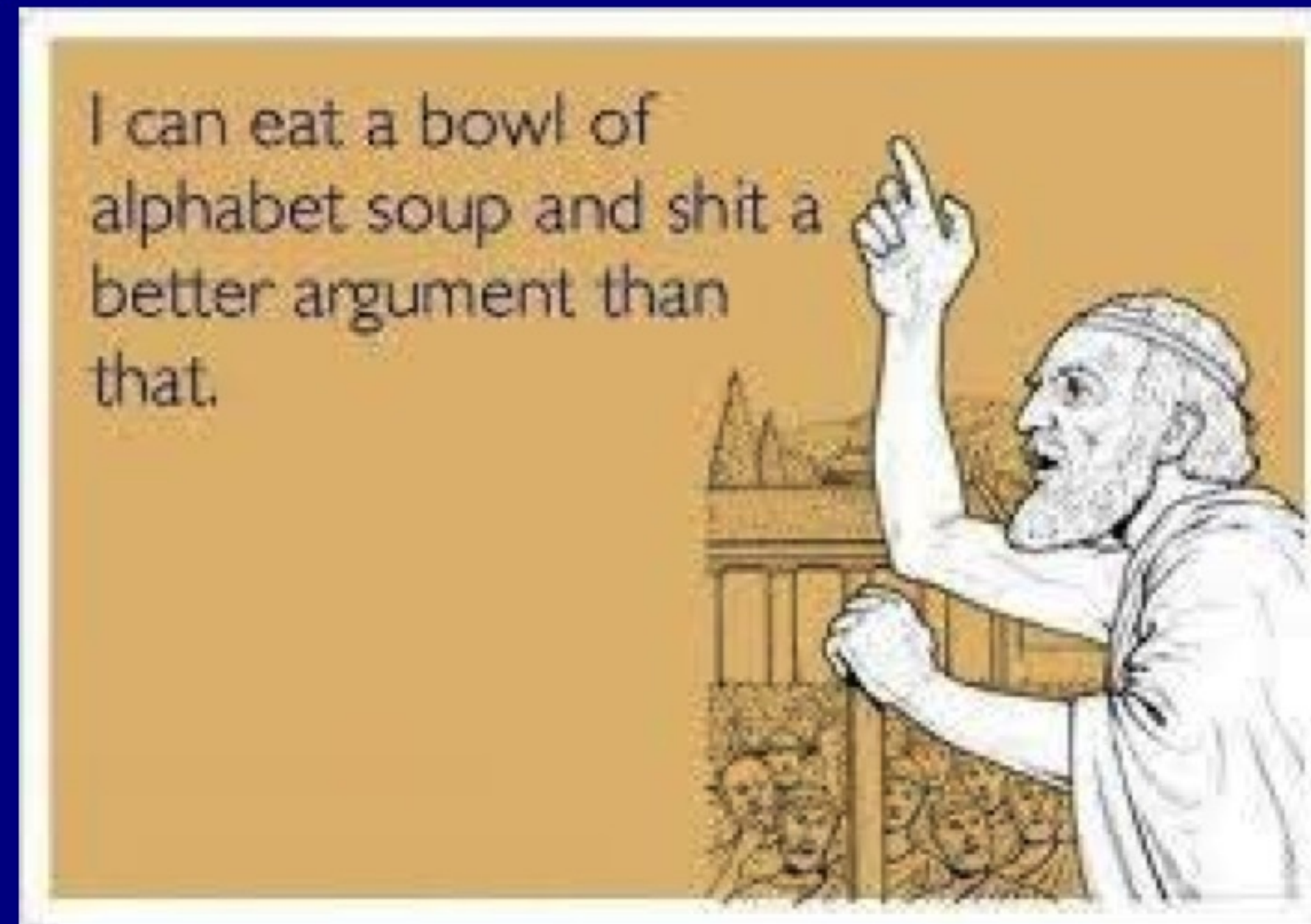
- Closed, internal degloving injury
- Traumatic separation of the skin and subQ from the underlying fascia
- Results from shearing force/crush injury
- **Large lesions: skin necrosis**

Nickerson J Trauma ACS 2014



MYTH #5: SCORING SYSTEMS ARE HELPFUL IN PREDICTING OUTCOME

- Entire alphabet soup of scoring systems
- Developed to predict the **need for amputation**
- Primarily applied to lower extremity fractures



Mangled Extremity Scoring Systems

| Score | bone | tissue | nerve | Vasc. | shock | time | age | Co-mb | Cont. |
|-------|------|--------|-------|-------|-------|------|-----|-------|-------|
| MESI | Y | Y | Y | Y | Y | Y | Y | Y | N |
| PSI | Y | Y | Y | Y | N | Y | N | N | N |
| HFS | Y | Y | Y | Y | N | Y | N | Y | Y |
| MESS | Y | Y | N | Y | Y | N | Y | N | N |
| LSI | Y | Y | Y | Y | N | N | N | N | N |
| NISSA | Y | Y | Y | Y | Y | N | Y | N | N |

Summary of Scoring Systems

- Low scores are predictive of salvage
- **But HIGH scores do not necessarily correlate with the need for amputation**
- **All scores need updating in this age of advanced soft tissue coverage, free flaps, antibiotic beads, nerve transfers and vascular techniques**

One Score to Know

Modified **Gustilo-Andersen** Class for Open Fxs:

I: a fx with a clean laceration < 1cm; low velocity

II: a fx with a lac > 1cm

III: a fx with soft tissue loss:

IIIA: adequate coverage

IIIB: periosteal striping; flap required

IIIC: open fracture plus arterial injury



A Pragmatic Approach to Limb Salvage

- Consider the time/delay
- **Blunt** worse than penetrating
- Lower ext. worse than upper
- Age/physiologic health
- **Clinical presentation/shock**
- Associated injuries
- Environment: combat/austere/mass casualties

Pasquale et al ACS/COT 2006

Myth #6: Nothing good ever comes from Orthopods



Along Came LEAP

- Lower Extremity Assessment Project **(LEAP)**
- Multi-center, prospective observational study
- Funded by NIH
- Co-PIs: Ellen MacKenzie, Michael Bosse
- Focus: **Decision to amputate or salvage severely injured lower extremities**

Inclusion Criteria for LEAP study

- Traumatic amputations below femur
- Gustilo IIA with nerve, bone, muscle injury
- Gustilo IIIB/IIIC open tibia fractures
- **Vascular injuries** below the femur
- Major soft tissue injuries below the femur
- Grade III open pilon fractures
- Grade IIIB open ankle fractures
- Open hindfoot/midfoot with degloving/nerve

LEAP STUDY and MYTH #5

- 556 patient from 8 major trauma centers
- Prospectively evaluated 5 different mangled extremity scoring systems
- **NONE were useful in predicting the need for amputation**
- No evidence-based alternative was proposed
- *Bosse JBJS 2001*



Myth #7: Plantar Sensation

- **Lack of plantar sensation at the initial presentation demands an amputation**

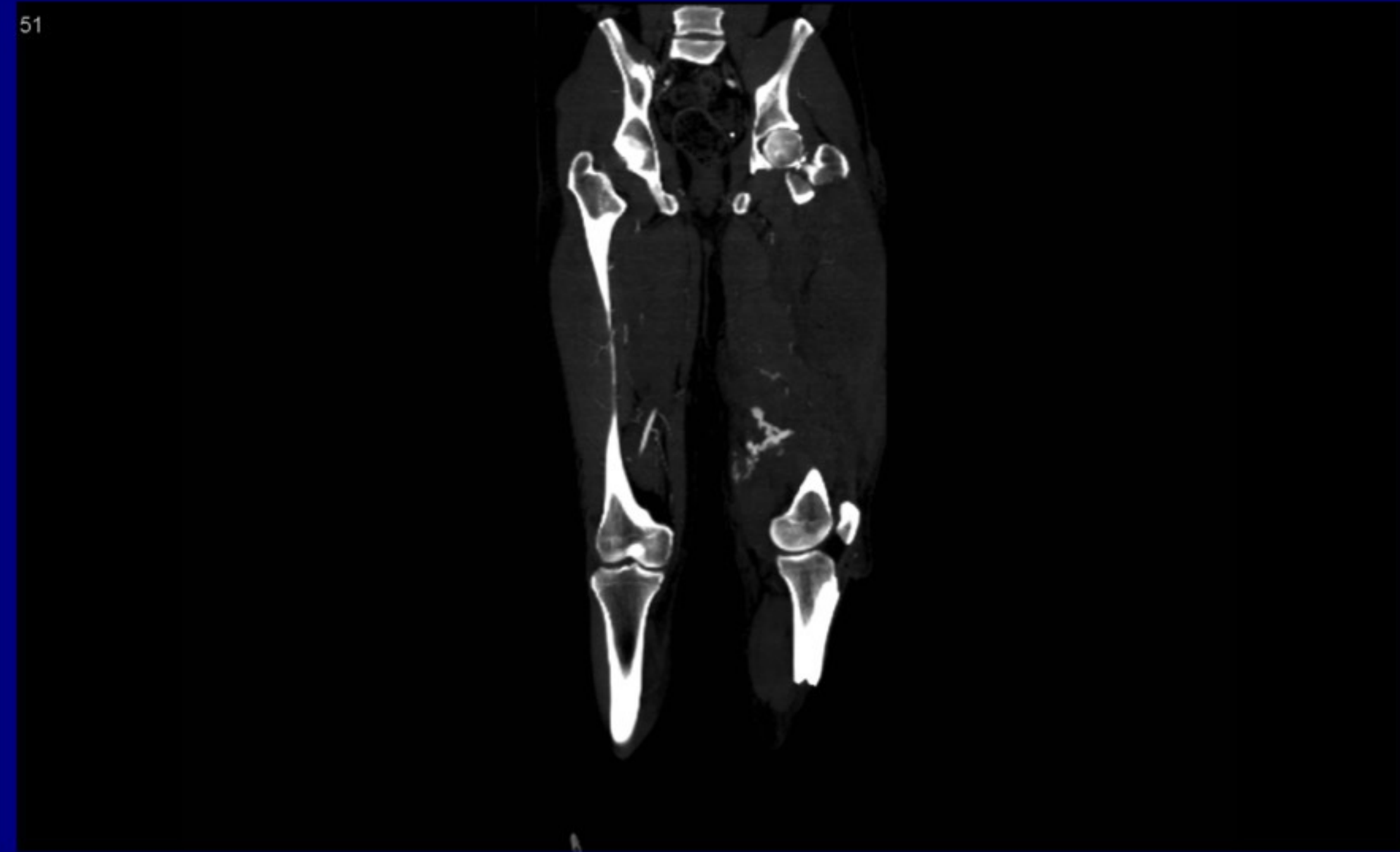


LEAP TO THE RESCUE!

- 26 insensate plantar feet that were amputated
- 29 insensate feet that were salvaged
- 29 matched controls
- **2-year follow-up: most plantar sensation was restored**
- Lack of initial plantar sensation was *not* an indication for amputation nor did it predict long-term *functional* outcome



Myth #8: A single tibial vessel run-off is sufficient in the mangled extremity



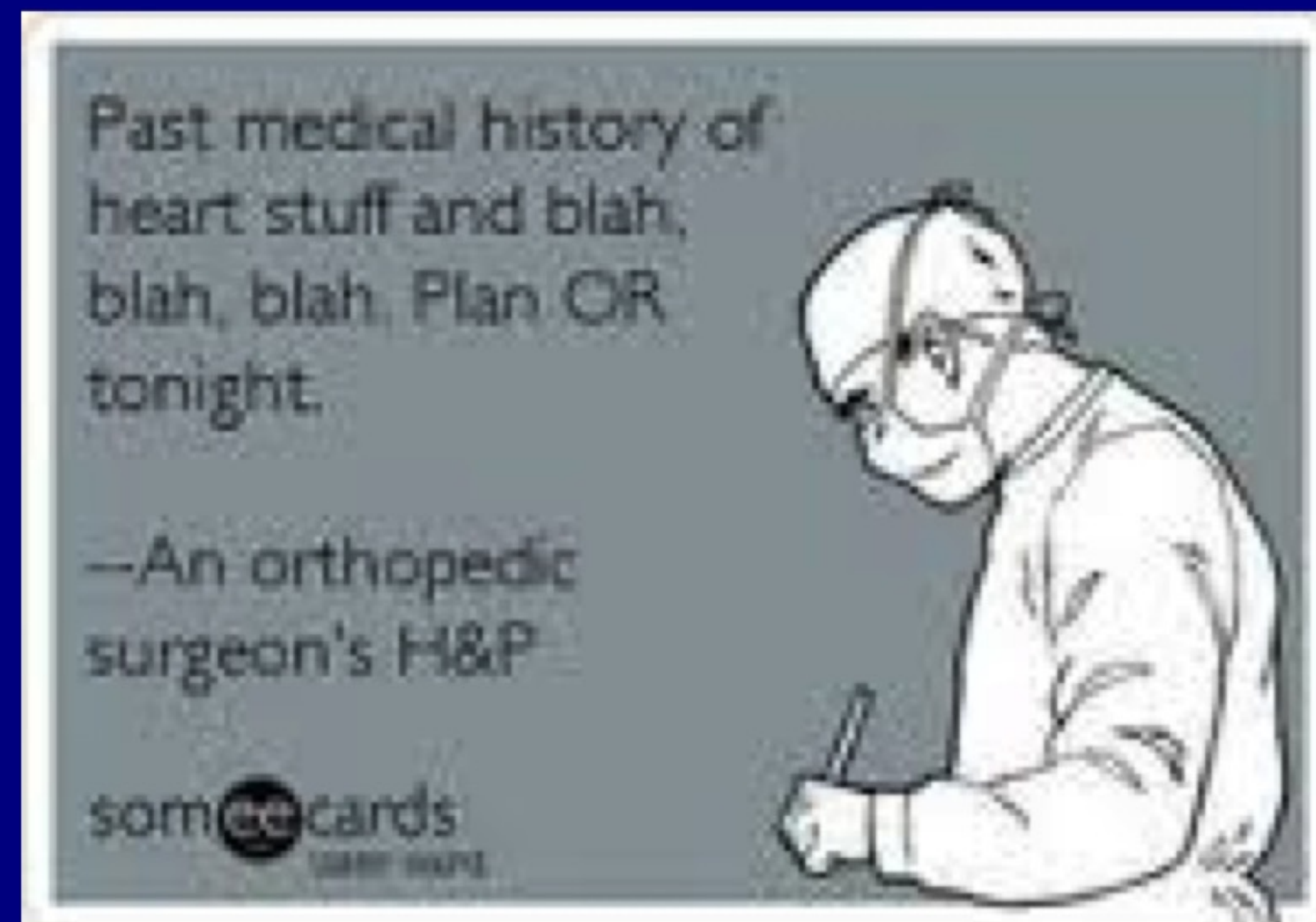
Limb Salvage and Tibial Vessels

- AAST Poster Presentation 2014
- 84 Patients: limited/no flow in AT, PT peroneal arteries; **observed initially**
- # of open vessels=limb salvage
- Limb salvage group: **2.7** open vessels
- Amputation group: **1.1** open vessels ($p<0.05$)
- *Dua, Dubose, Holcomb UT Houston*



Myth #9: A SALVAGED LIMB IS ALWAYS BETTER THAN AN AMPUTATION

- Sub-set of Myth #9: Orthopedic surgeons will never be caught reading the **NEJM!!**



LEAP Study and Functional Outcomes

- 601 patients from 8 trauma centers
- Main Outcome variable: **Sickness Impact Profile (SIP)**
- Self-reported health status, 136 statements
- At 2 years, no significant difference in SIP scores between **amputees and salvaged limbs**
- *Bosse, Mackenzie NEJM 2002*

Limb Salvage Lesson 101

- Limb salvage is not always safe!

Limb salvage is not always safe

Limb salvage attempted despite concern by attending trauma surgeon.....

ICU Code

- Bleeding out from severe venous hypertension
- Required emergency guillotine amputation!

Myth #10: Limb salvage is more expensive than amputations

- Costs included initial and subsequent hospitalizations, in and outpatient rehab, physician visits, and prosthetics
- Life-time projected costs were **3 times higher** for the amputation group (\$509k vs. \$163k)

**Leap Investigators JBS 2007*



FINAL THOUGHTS ON AMPUTATION VERSUS SALVAGE

“Absolute” indications for amputation:

- Complete or near-complete amputation
- Irreparable vascular injuries
- Large soft-tissue defect with bone and nerve loss that will not allow a functional recovery
- Warm ischemia time > 8 hours
- Cadaveric foot
- **2-surgeon agreement (?3)**

Final Thoughts: Amputate or Save?

Relative indications for amputation:

- Gustilo Grade IIIC (extensive tissue loss and vascular injury)
- Failed vascular graft with ongoing ischemia
- Infected limb with clostridia/necrotizing
- A patient in extremis
- **Multiple casualties**

The Mangled Extremity Score: Time for a Revision

- AAST-Prospective Vascular Injury Registry
- Demographic, diagnostic, treatment and outcome data-14 U.S. Level 1 trauma centers
- 230 pts: lower extremity arterial injuries
- **9.1%: immediate amputation**
- $MESS \geq 8$: more transfusions, ICS LOS
- **Only predicted amputation in 32.7%**



FAILURE OF OLD MESS SCORE

| MESS Elements | Amputations (mean score) n=42 | Not Amputated n=137 | P-value unadjusted | P-value adjusted* |
|-------------------------------|-------------------------------------|---------------------------|-----------------------|----------------------|
| Skeletal/soft tissue score | 2.58 | 1.71 | <0.0001 | 0.54389 |
| Limb ischemia | 1.93 | 1.16 | <0.0001 | 0.5560 |
| shock | 0.51 | 0.32 | 0.20 | 0.5150 |
| Age score | 0.86 | 0.66 | 0.22 | 0.2272 |
| Total MESS | 6.58 | 4.29 | <0.0001 | 0.2643 |

***Adjusted for significant confounders including mechanism, arterial transection
Concomitant nerve and orthopedic injuries**

Final Myth

You would love to listen to Dr. Knudson lecture on this subject for several more hours rather than watch video.....

