



# *The mangled extremity – amputation or reconstruction?*

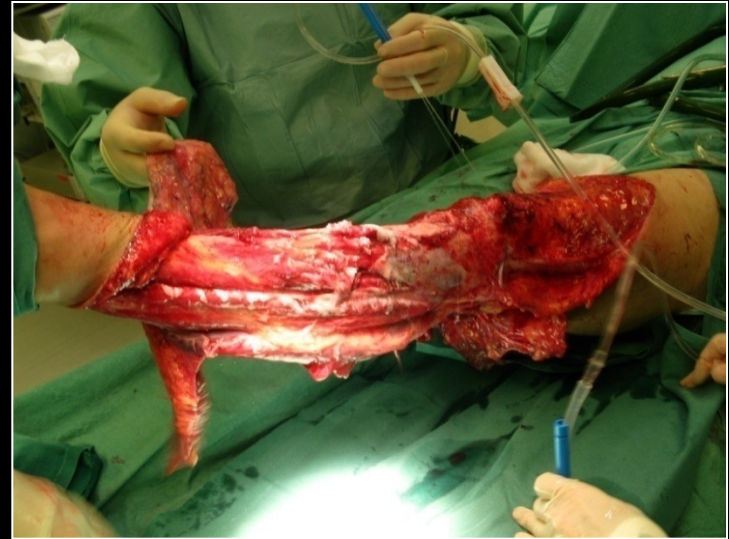
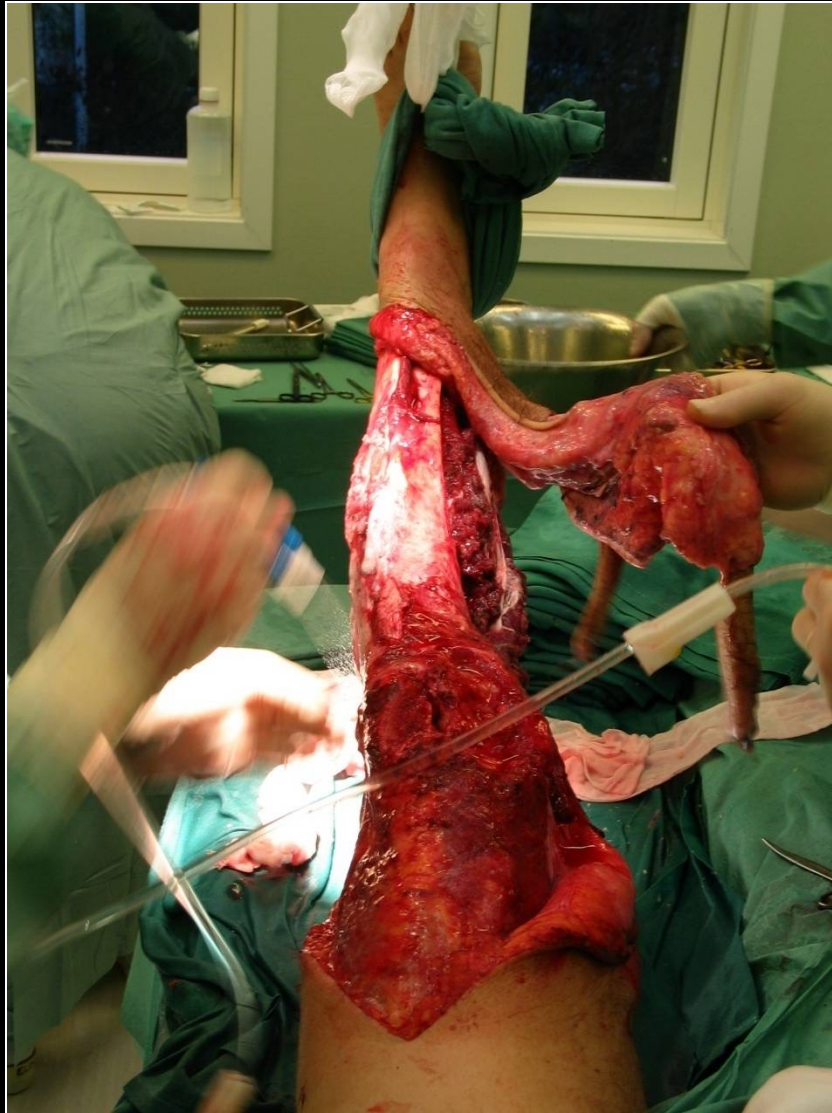
AO trauma course

Advanced principles of fracture management

24-26/4-2024

Jeppe Barckman

# Amputation or reconstruction?

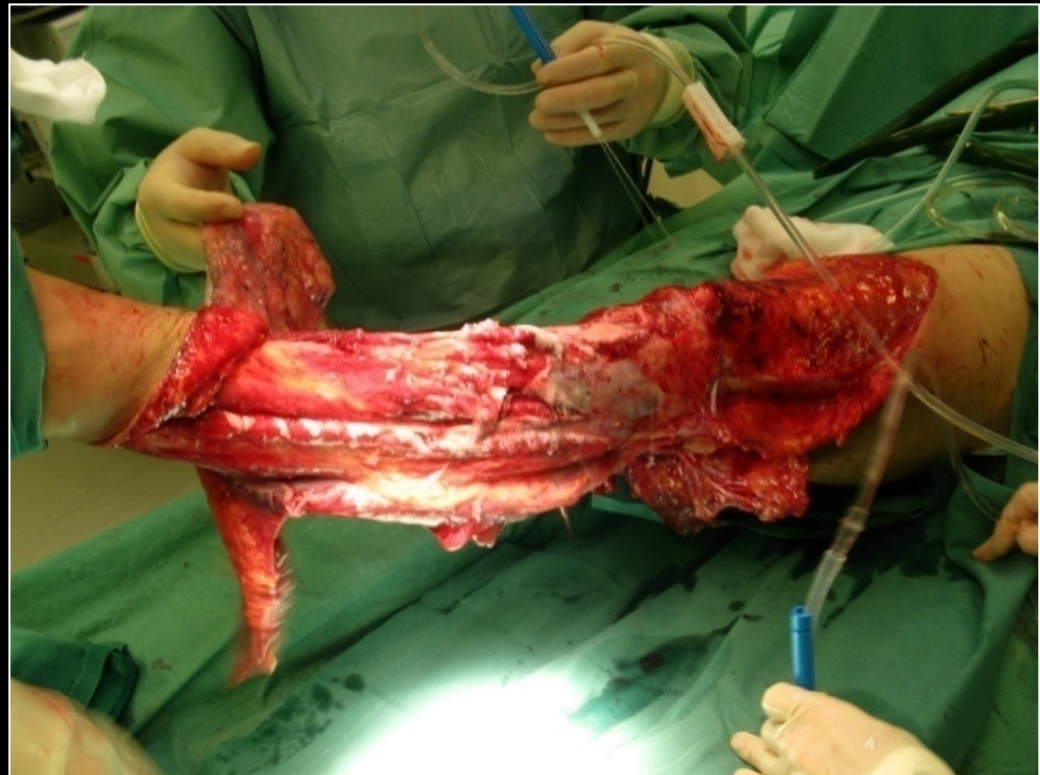


Mangled extremity

# 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
- Fall from height



## High energy trauma

- Explosion
- Blast injuries sustained in military



# 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 EJ<sup>1</sup>, Bosse MJ, Kellam JF, Burgess AR, Webb LX, Swiontkowski MF, Sanders RW, Jones AL, McAndrew MP, Patterson TM, McCarthy ML.

Mangled extremity

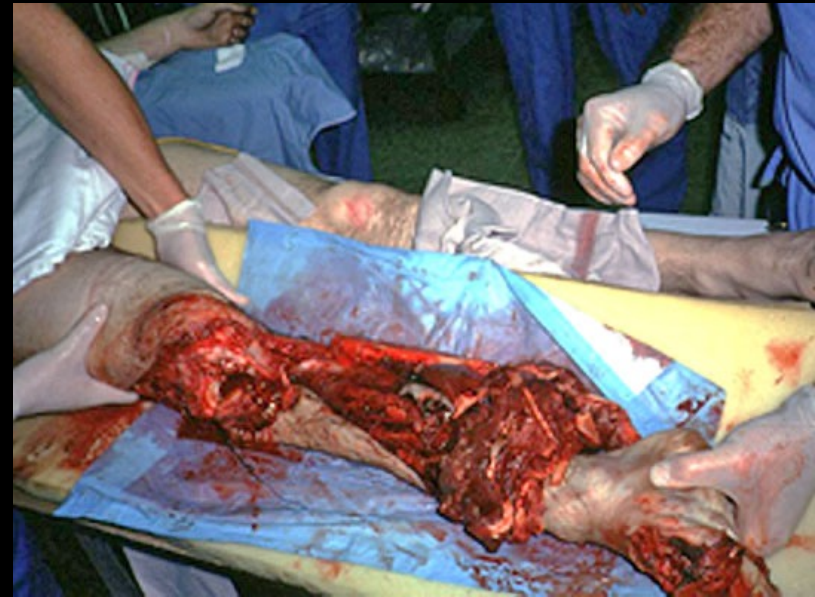
# Initial management

## 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



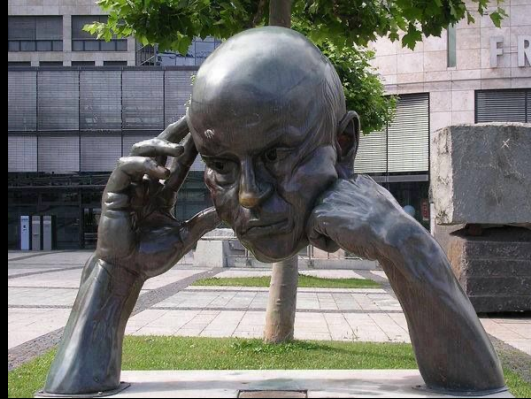
# orthopedic treatment in the ER



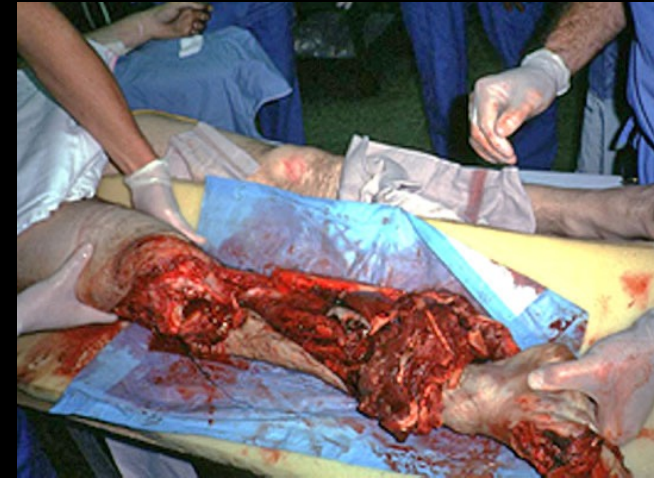
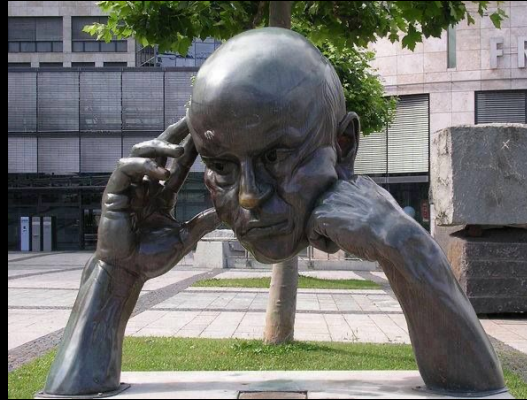
# orthopedic treatment in the ER

1. Antibiotic and Tetanus prophylaxis
  - 1. generation Cephalosporin + Gentamicin
2. Reduction of fracture/joint dislocation
  - motor-, sensory and perfusion examination is repeated after reduction
3. Removal of any gross contamination and gently irrigation
4. Immobilize the extremity
  - splint or cast
5. Apply sterile dressing

# then what?



# Plan?



## Acute amputation (< 24h)?

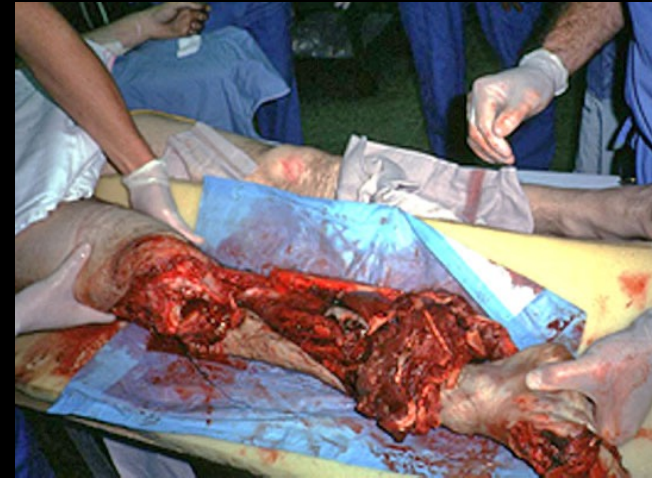


# Acute amputation

## indications

- **Absolute criteria:**

- Ischemia time > 6 hours lower extremity  
> 8 (10) hours upper extremity



- **Relative criteria:**

- Serious associated injuries (ISS>40)
- Severe ipsilateral foot trauma
- Soft tissue loss beyond free flap reconstruction
- Muscle loss involving > 2 lower leg compartments
- Bone loss involving > 1/3 of the tibia

# Acute amputation

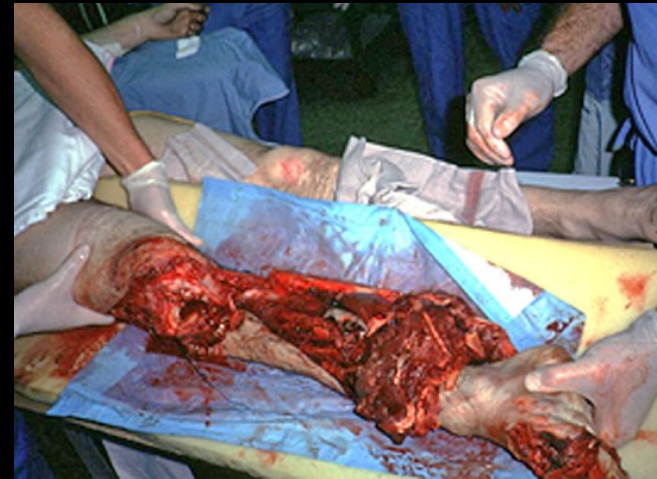
of the mangle extremity



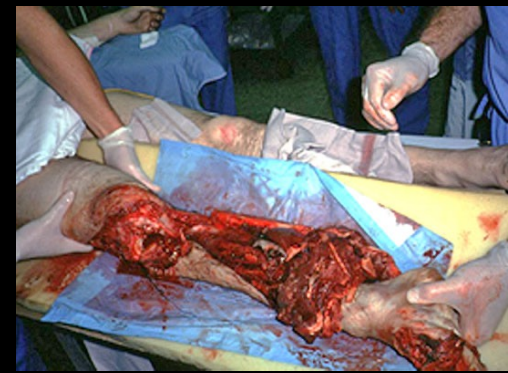
- Most distal level possible (not giliotine)
- Serial irrigation and debridements
- Closure of the stump

# Primary operation

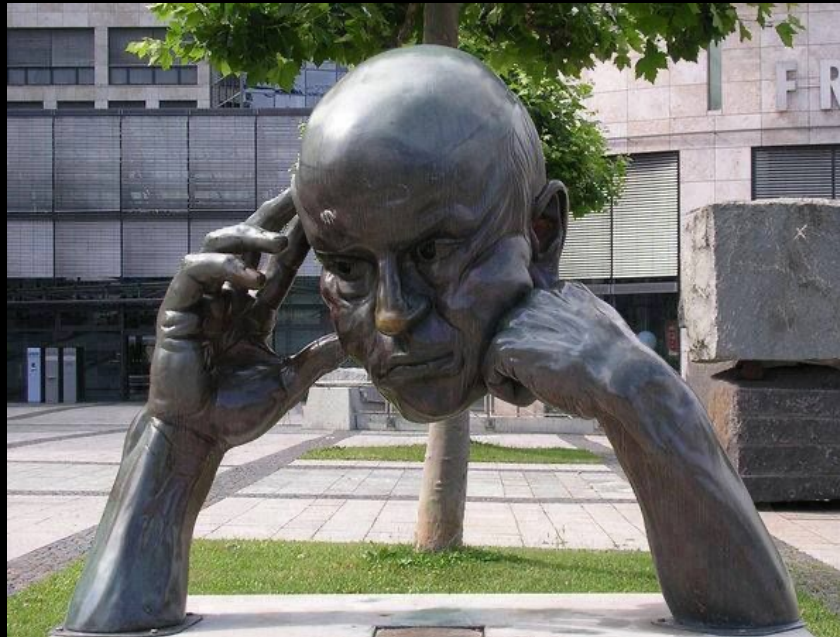
- 1) Sterile tourniquet (not inflated)
- 2) Remove splint and dressing
- 3) Re-examine for perfusion
  - Vascular repair if needed
- 4) Thorough debridement
- 5) Skeletal stabilization



# plan?

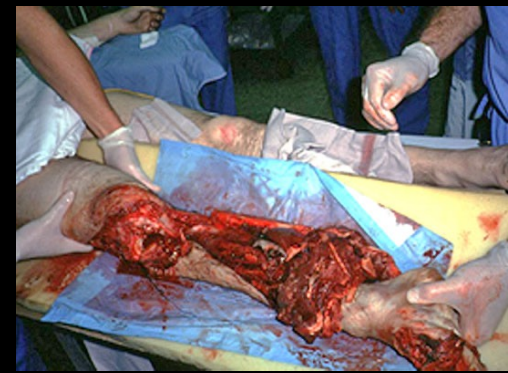


## Salvage or primary amputation ( $< 30$ days)

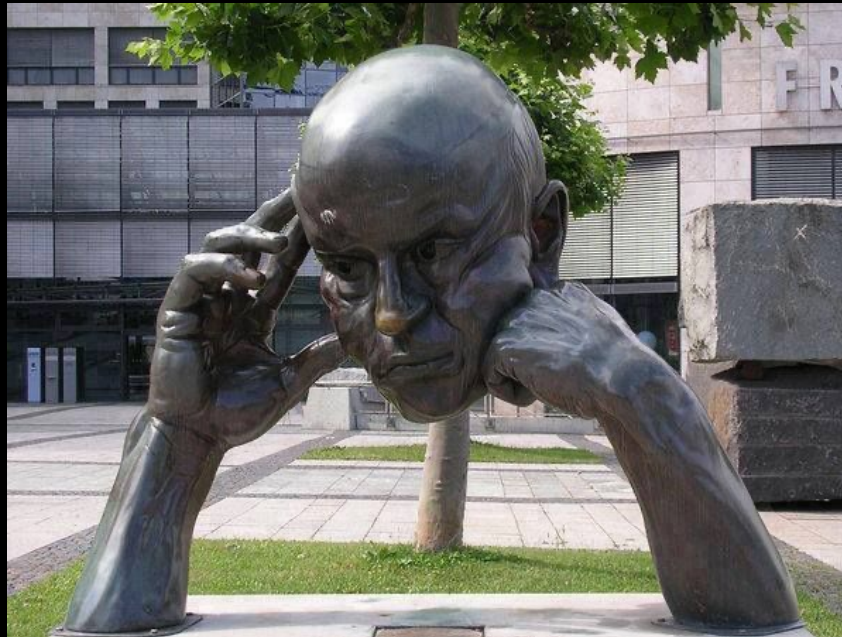


1. Is the limb salvable?
2. Does salvage give the best functional outcome

# 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 Severety Score                                               | Johansen K | 1990 |
| LSI - Limb Salvage Index                                                              | Russel WL  | 1991 |
| NISSA - Nerve injury, Ischemia, Soft tissue injury,<br>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; parasthesia, 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 MJ<sup>1</sup>, MacKenzie EJ, Kellam JF, Burgess AR, Webb LX, Swiontkowski MF, Sanders RW, Jones AL, McAndrew MP, Patterson BM, McCarthy ML, Cyril JK.

Prospective      n = 556

MESS, LSI, PSI, NISSA & HFS

«The low sensitivity, **failed** to support the validity of the **high** scores as **predictors of amputation.**»

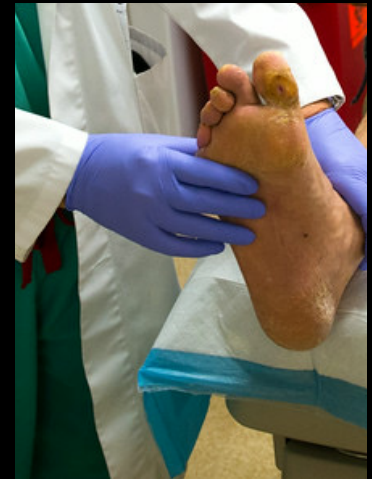
“The high specificity of the scores in all of the patient subgroups did confirm that **low scores could be used to predict limb-salvage potential.**”

# 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

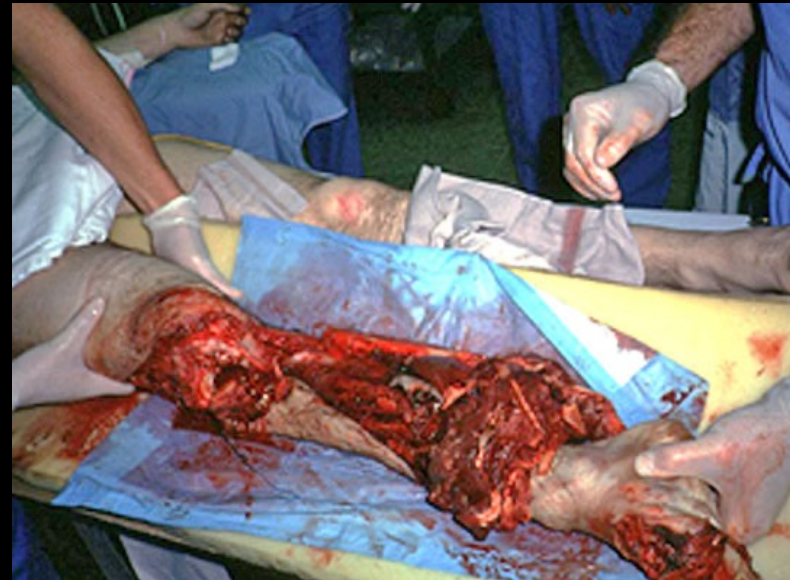
## CONCLUSION:

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

# My decision making

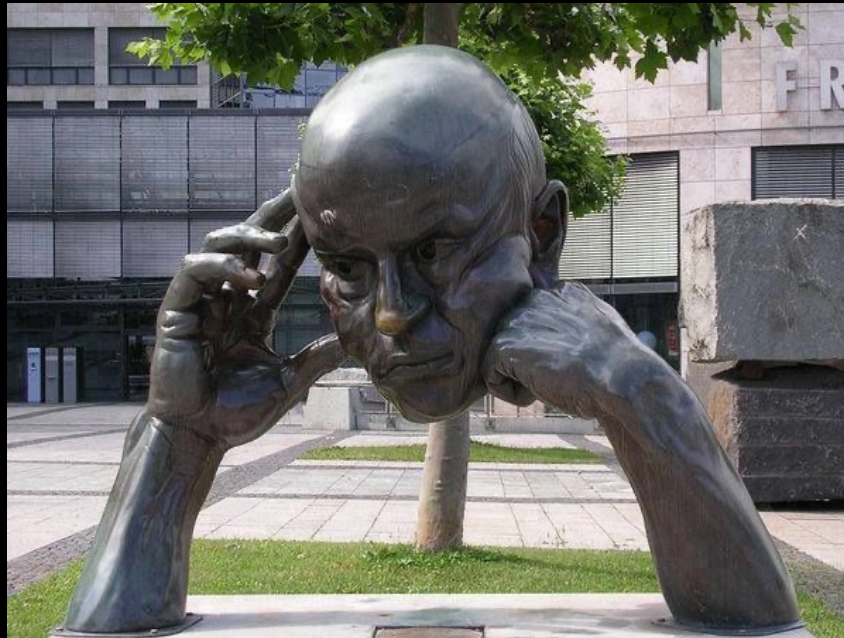
*If uncertain, or unknowns, then ALWAYS:*

- state probably need for early or delayed primary amputation
- don't spoil amputation stump length
- don't risk life for limb
- get a second opinion



# plan?

## **Salvage or primary amputation** ( $< 30$ days)



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

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 JW<sup>1</sup>, Jacobs CL, Swiontkowski 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**



# Outcome LEAP studies Amputation or reconstruction?

- No "right answer"

*"Limbs treated with reconstruction can achieve outcomes equivalent to amputees at 2 years."*

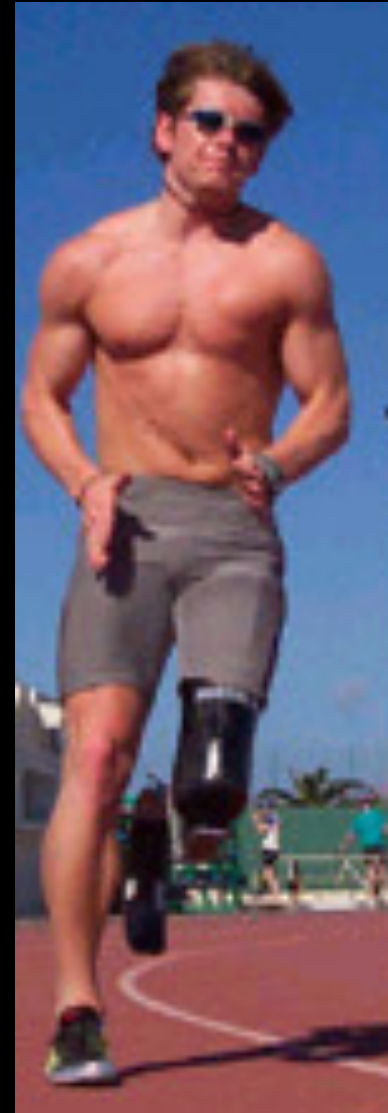
# What are the financial costs?

Lifetime costs:

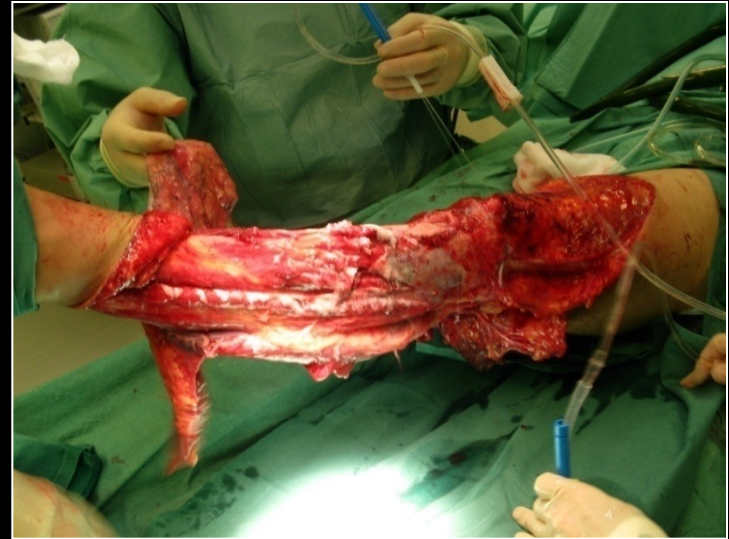
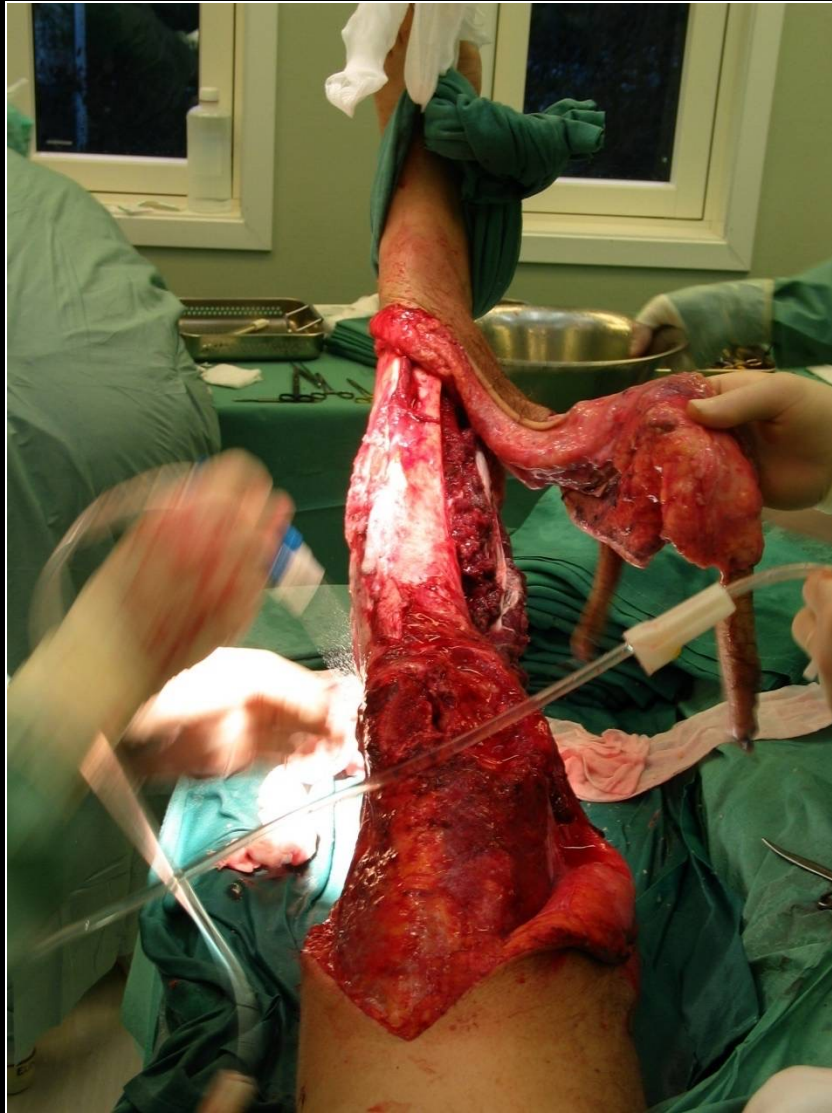
***Salvage:***                      **\$ 163 000**

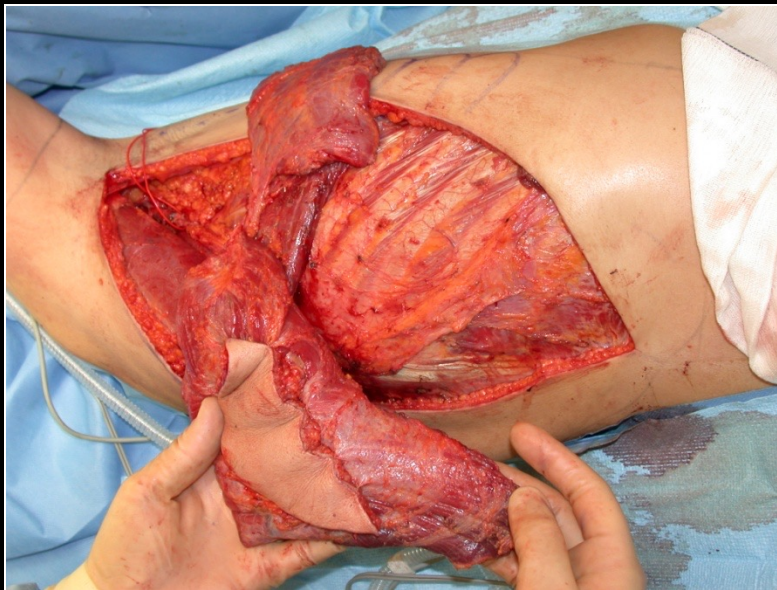
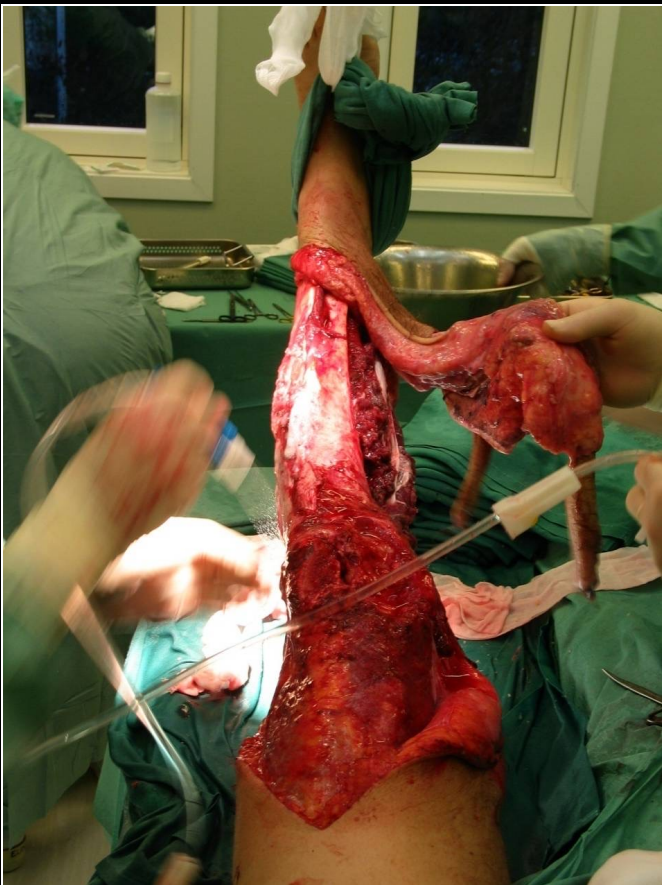
***Amputations:***                **\$ 509 000**

MacKenzie et al (*J Bone Joint Surg Am.*  
2007;89:685–1692)



# Amputation or reconstruction?





# Take home messages

- Life before limb
- Salvage or amputation?
- A (sensitive) good shaped foot is critical
- Scores are of limited use and not sensitive
- Reconstruction is much slower and complex
- Amputation is a good option
- No difference in self-reported outcomes

*....never decide alone*

# Outcome LEAP studies



*Amputation.....*

*is not a therapeutic failure*





*Thank you.....*