Getting There:
The Right Place at the Right Time

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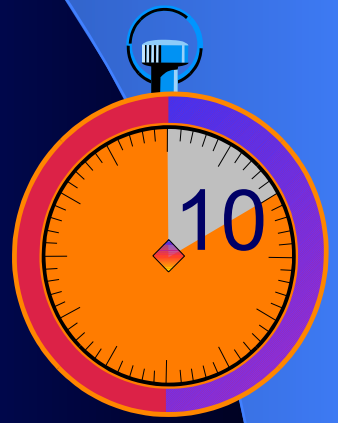
THE ROBERT W. WOODRUFF HEALTH SCIENCES CENTER | EMORY

Goal

Get the *right patient . . .*

. . . to the right place



. . . in the right amount of time.

Patient destination based upon <u>medical appropriateness</u>

Accessibility to Trauma Centers

Branas CC, et al; JAMA, 2005:

- Almost 90% of the US population lives in areas accessible to designated trauma care (Level I, II or III centers) within a one hour period of time

The Reality

Nathens AB, et al; J Trauma, 2000:

- Examined over 500,000 injured persons in 18 states
- Failed to receive care at designated trauma facilities:
  - 56% of all trauma patients
  - 36% of major trauma patients

The Right Place

Trauma Center

An institution *committed* to the care of injured patients, from acute care to rehabilitation

- Initial resuscitation
- Operative management
- Critical care
- Continuing care

Trauma Center

Immediate availability on a 24-hr basis:

- Specialized surgeons
- Physician specialists
- Nurses
- Allied Health Personnel
- Resuscitation and life support equipment

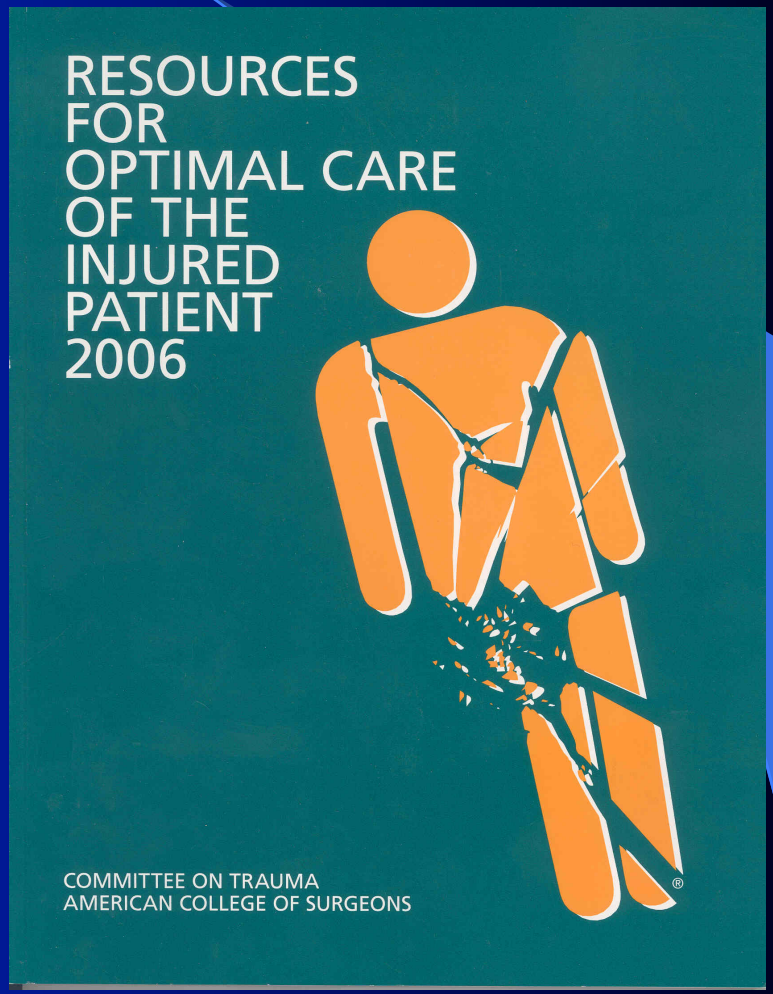
Teamwork

- **Physicians**:
  - Surgery
  - EM
  - Ortho
  - etc
- **Therapists**:
  - Respiratory
  - Physical
  - Occupational
- **Technologists**:
  - Lab
  - Xray
- **Nurses**:
  - ED
  - OR
  - ICU
  - Ward
  - Clinic

Trauma Center

Trauma program:

- Trauma service
- Trauma team
- Trauma medical director
- Coordinator / program manager
- Performance improvement/ registry



Trauma Centers

- Levels- established by ACS-COT:
  - Level IV
  - Level III
  - Level II
  - Level I
- “Designated”- state agency
- “Verified”- ACS-COT site visit

Level III

- General Surgery- immediately available*
- Available 24 hrs: EM, Orthopedics, Plastics, Radiology, Anesthesia
  - *Neurosurgery is **desirable***
- Required (24 hr) : Xray, CT, PACU
- Desirable (24 hr): Xray Tech, Resp Tech

* = *within 20 minutes of patients arrival in ED*

Level II

Level III Criteria, plus:

- Physicians*: Neurosurg, Hand, OB/GYN, Ophth, OMFS, Thoracic, CCM
- *24 hr OR is desirable*
- Injury Prevention outreach

**Inhouse trauma surgeons NOT required*

Level I

Level II criteria, plus:

- Physicians*: Cardiac surg, Microvascular
- Services: CPB, inhouse OR personnel, inhouse SICU service
- Teaching facility (Surg residency, ATLS)
- Research
- Admissions: 1,200/yr; 240 with ISS $\geq$ 15
- ***Tertiary referral / resource center***

**Inhouse trauma surgeons NOT required*

Level IV

- 24 hrs: ED, Lab
- Does not need 24 hr Emer Med
- Desirable: 24 hr Gen Surg, Anesth
- Initial resuscitation
  - Refer to higher level center

Lack of Trauma Centers

Hospitals that "lack a commitment to trauma care" have been associated with a higher incidence of *unacceptable care* and *poor outcomes*

- Moylan JA, et al., J Trauma, 1976
- Detmer DE, et al., J Trauma, 1977

Comparison of Trauma Systems

West JG, et al., Arch Surg, 1979

- Comparison of trauma patients who died after arrival at a hospital
  - Orange Co., closest facility (n = 90)
  - San Francisco, single trauma center (n = 92)
- "Preventable" deaths
  - Orange Co. 40 of 90 deaths (44%):
    - **20**/30 (66%) of non-CNS trauma
    - **20**/60 (33%) of CNS trauma pts
  - SF: only one (about 1%)

Trauma Centers

Transfer of trauma patients to designated trauma centers has also been shown to *improve outcomes*:

- West JG, et al., Arch Surg, 1983
  - Follow up to 1979 study
  - Significant reduction in mortality by regionalization: 6/29 (overall 20%, 9% at trauma center preventable)
- Shackford SR, et al., J Trauma, 1986
- Waddell TK, et al., J Trauma, 1991

Trauma Center vs Closest Hospital

Closest Hospital

- CRASH!
- 8 minute EMS response
- 10 min scene time
- 5 min transport time
- 10 min ED evaluation
- 30 min surgeon call-in
- 30 min OR call-in
- 5 min transfer to OR

Total Time, injury to OR= 98 mins

Trauma Center

- CRASH
- 8 minute EMS response
- 10 min scene time
- **15 min** transport time
- 10 min ED evaluation
- 5 min transfer to OR

Total Time, injury to OR= 48 mins

Effect of Trauma-Center Care on Mortality

- Outcomes of trauma patients managed at 18 Level I trauma centers compared to 51 non-trauma centers (14 states)
- Complete records available for:
  - 1104 patients who died
  - 4087 patients discharged alive
- CDC funded

MacKenzie EJ, et al, NEJM, 2006

Effect of Trauma-Center Care on Mortality

- In-hospital mortality :
  - **Trauma center: 7.6%; relative risk 0.80**
  - Non-trauma center: 9.5%
- One year mortality rate:
  - **Trauma center 10.4%, relative risk 0.75**
  - Non-trauma center: 13.8%
- Differences in mortality rates primarily confined to patients with ***more severe injuries***

Level I vs Level II

- Traditionally outcome between Level II and Level I centers viewed to be equivalent
  - Criteria for clinical care nearly identical
  - Level I primarily teaching / research facility

Superiority of Level I?

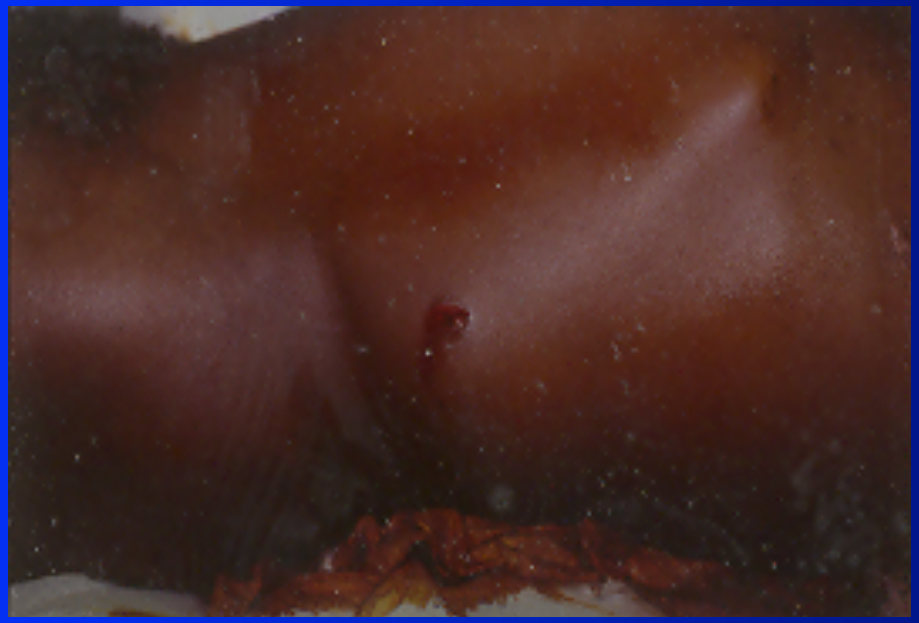
- Retrospective review using NTDB
  - pts > 14 yrs, ISS >15
  - One of the following injuries: aortic, vena cava, iliac vessels, cardiac, Grade IV/V liver injuries, quadriplegia or complex pelvic fx
  - Outcomes compared among Level I and II, and between centers of the same level but different volumes (< 240 vs $\geq$ 240 admissions of ISS >15/yr)

Demetriades D, et al., Ann Surg, Oct 2005

Superiority of Level I?

- Results
  - 12,254 pts met inclusion criteria
  - Level I centers had significantly:
    - **Lower mortality** (25.3% vs 29.3%, p = 0.004)
    - **Less severe disability** at D/C (20.3% vs 33.8%, p = 0.001)
    - **Higher functional outcome**
  - Volume of admissions with ISS>15 had no effect

The Right Patient



Overtriage

Transporting minimally injured trauma patients to a trauma center

- Overtriage rate of up to 50% considered acceptable
- Often a financial / resource issue

Undertriage

Failure to transport major trauma patients to a trauma center

- Undertriage rate of 5 – 10 % considered unavoidable, and is associated with an overtriage rate of 30 – 50%
- Often a political issue

What is a "Major Trauma Patient"?

Major Trauma Patient

- **Injury Severity Score (ISS) ≥ 15** frequently used

  Correlates well with mortality over a broad range of ages and injuries

  - Knudson MM, et al., Arch Surg, 1994
  - Buckley SL, et al., J Pediatr Orthop, 1994
  - Gustilo RB, et al., Orthop, 1985
  - Jones JM, et al., J Trauma, 1995
  - Shedden PM, et al., Pediatr Neurosurg, 1990
  - Chen RJ, et al., Eur J Surg, 1995

Can't be calculated in the prehospital setting

Injury Severity Score

Region	Injury Description	AIS	Square Top Three
Head & Neck	Cerebral Contusion	3	9
Face	No Injury	0	
Chest	Flail Chest	4	16
Abdomen	Minor Contusion of Liver	2	
	Complex Rupture Spleen	5	25
Extremity	Fractured femur	3	
External	No Injury	0	
		Injury Severity Score:	50

ISS - Issues

- *Based primarily on motor vehicle crash data*
  - *Not as useful in penetrating trauma*
- *Ignores multiple injuries in the same body region*

Other Trauma Scores

Trauma Index
- Kirkpatrick JR, Youmans RL, J Trauma, 1971

Trauma Score / Revised Trauma Score
- Champion HR, et al., Crit Care Med, 1981
- Champion HR, et al., J Trauma, 1989

CRAMS scale
- Gormican SP, Ann Emerg Med, 1982

Prehospital Index
- Koehler JJ, et al, Ann Emerg Med, 1986

Trauma Triage Rule
- Baxt WG, et al., Ann Emerg Med, 1990

Each with limitations, lacking clear superiority over others

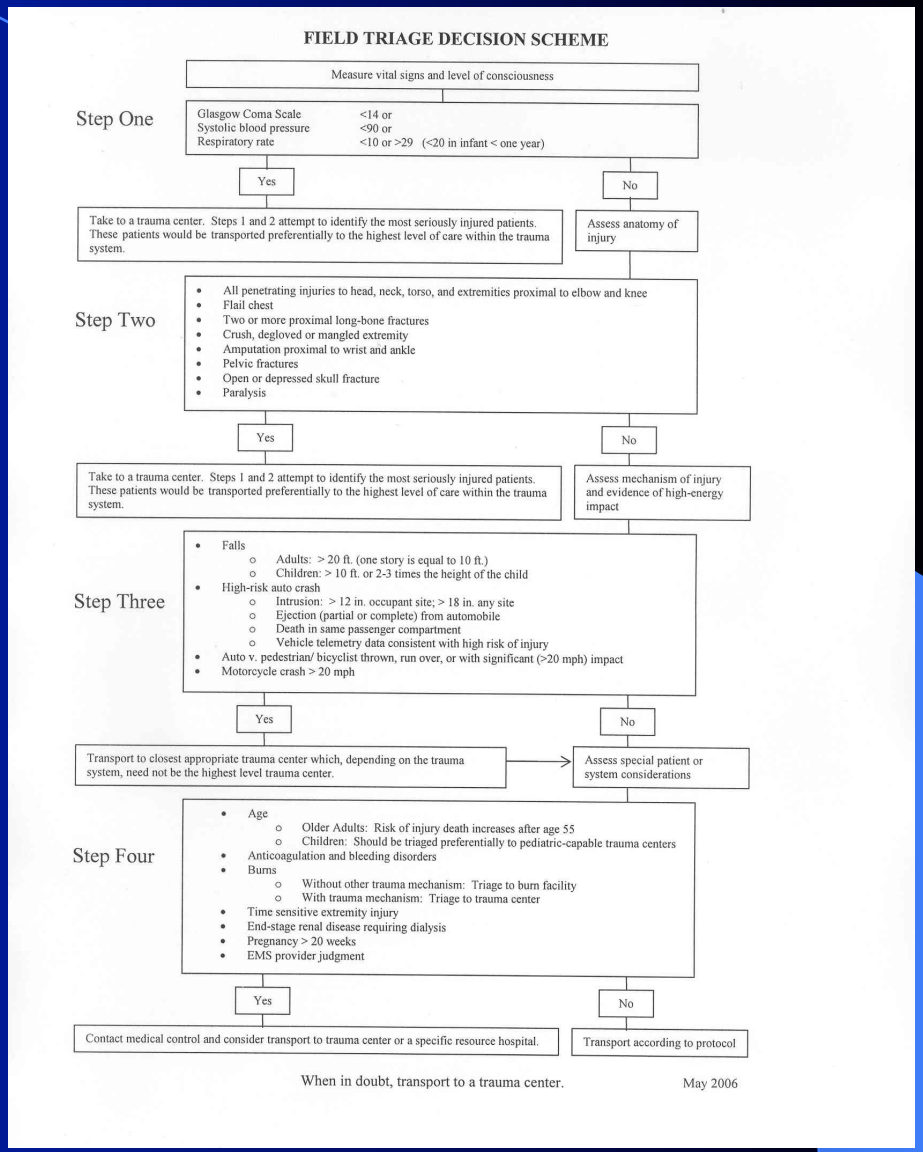
Alternatives to ISS

- Deaths in the ED or within 24 hrs of ED admission
- Resource utilization:
  - Massive blood transfusions
  - Rapid operative intervention
  - Cessation of bleeding by interventional angiography
  - Early intensive critical care

All difficult to determine in the field!

Field Triage

- Committee on Trauma, American College of Surgeons
- Components:
  - Physiologic
  - Anatomic
  - Mechanism of Injury
  - Special Considerations



FIELD TRIAGE DECISION SCHEME

Measure vital signs and level of consciousness

Step One

Glasgow Coma Scale <14 or
Systolic blood pressure <90 or
Respiratory rate <10 or >29 (<20 in infant < one year)

Yes → Take to a trauma center. Steps 1 and 2 attempt to identify the most seriously injured patients. These patients would be transported preferentially to the highest level of care within the trauma system.

No → Assess anatomy of injury

Step Two

- All penetrating injuries to head, neck, torso, and extremities proximal to elbow and knee
- Flail chest
- Two or more proximal long-bone fractures
- Crush, degloved or mangled extremity
- Amputation proximal to wrist and ankle
- Pelvic fractures
- Open or depressed skull fracture
- Paralysis

Yes → Take to a trauma center. Steps 1 and 2 attempt to identify the most seriously injured patients. These patients would be transported preferentially to the highest level of care within the trauma system.

No → Assess mechanism of injury and evidence of high-energy impact

Step Three

- Falls
  - Adults: > 20 ft. (one story is equal to 10 ft.)
  - Children: > 10 ft. or 2-3 times the height of the child
- High-risk auto crash
  - Intrusion: > 12 in. occupant site; > 18 in. any site
  - Ejection (partial or complete) from automobile
  - Death in same passenger compartment
  - Vehicle telemetry data consistent with high risk of injury
- Auto v. pedestrian/ bicyclist thrown, run over, or with significant (>20 mph) impact
- Motorcycle crash > 20 mph

Yes → Transport to closest appropriate trauma center which, depending on the trauma system, need not be the highest level trauma center.

No → Assess special patient or system considerations

Step Four

- Age
  - Older Adults: Risk of injury death increases after age 55
  - Children: Should be triaged preferentially to pediatric-capable trauma centers
- Anticoagulation and bleeding disorders
- Burns
  - Without other trauma mechanism: Triage to burn facility
  - With trauma mechanism: Triage to trauma center
- Time sensitive extremity injury
- End-stage renal disease requiring dialysis
- Pregnancy > 20 weeks
- EMS provider judgment

Yes → Contact medical control and consider transport to trauma center or a specific resource hospital.

No → Transport according to protocol

When in doubt, transport to a trauma center.

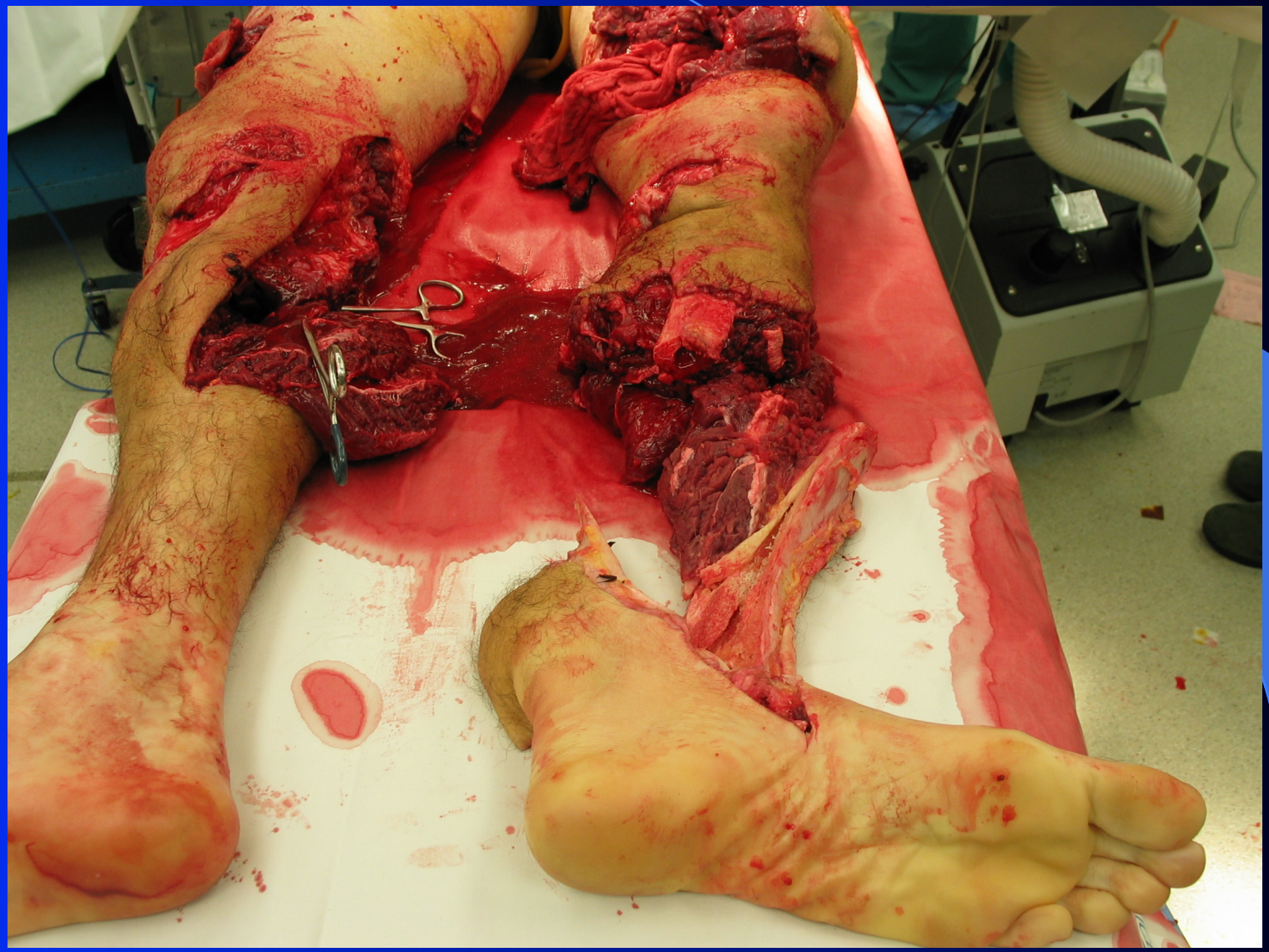
May 2006

Case

29 y/o male fishing in small boat at 1 AM. Boat run over by speedboat.

- Airway: Intact
- Breathing: shallow, 34/min, equal
- Circulation: no radial pulses, SBP 80 mm Hg, significant hemorrhage from lower extremities
- Disability: GCS 13 (E4, V4, M5)
- Expose: No injuries to torso, head, upper extremities

Speedboat vs Fisherman



Physiologic Criteria

Take to Trauma Center:

- Glasgow Coma Scale Score < 14
- Systolic blood pressure < 90 mm Hg
- Respiratory rate < 10 or > 29
  - <20 in infant (under one year of age)

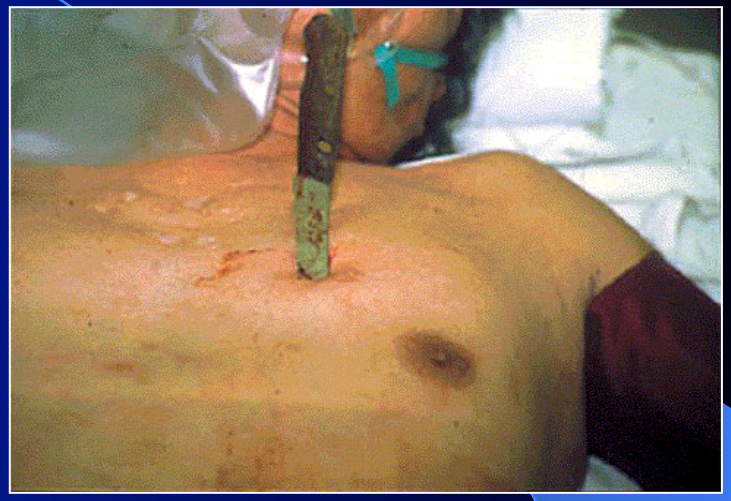
Physiologic Criteria

- Physiologic derangement correlates well with *severity of injury* and *can predict mortality*
  - Baxt WB, et al., Ann Emerg Med, 1989
- Patients with significant tachycardia and hypotension have typically lost 30 – 40% of their blood volume and often are in need of emergent transfusion and surgical intervention

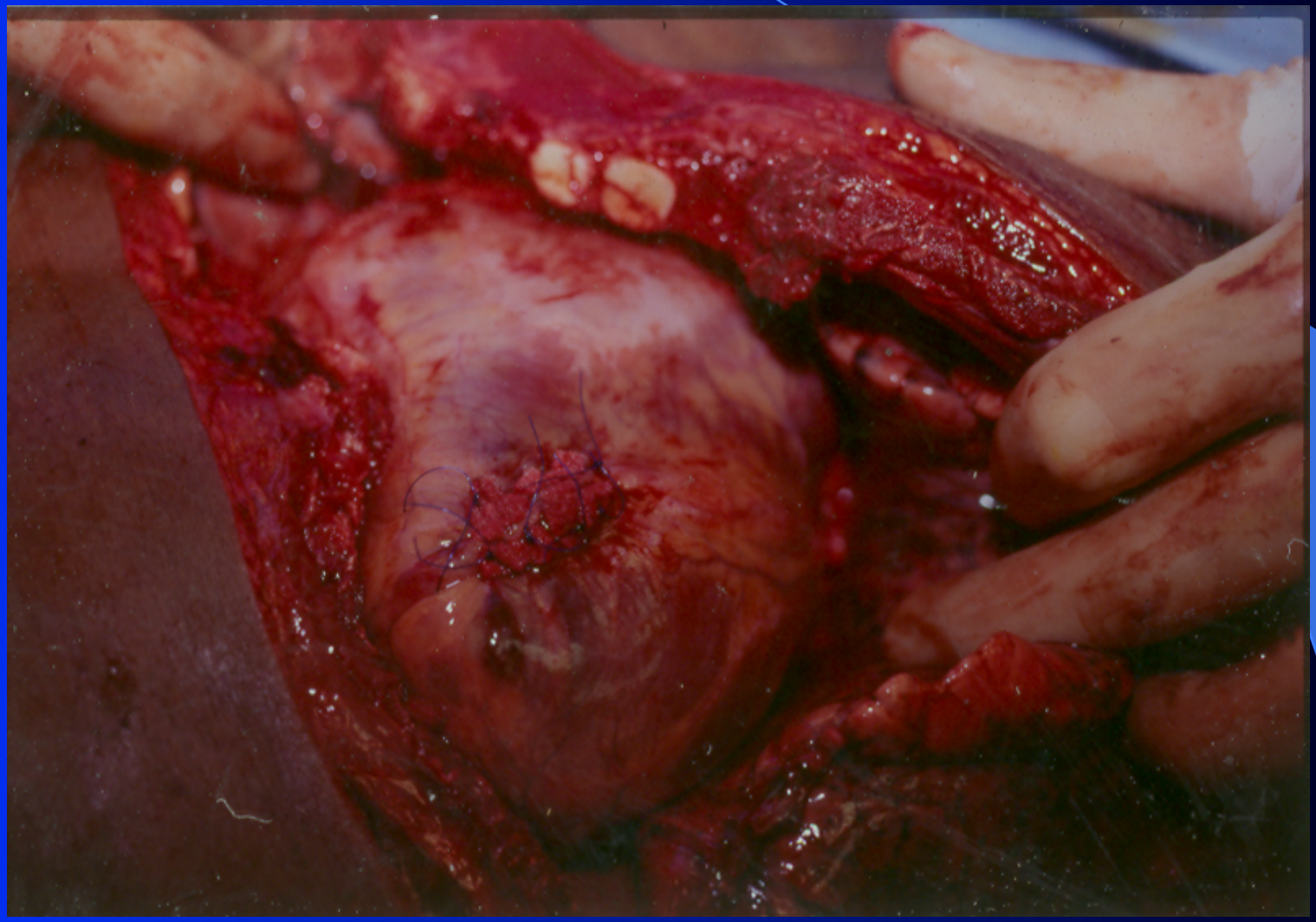
Case

55 y/o male, despondent over relationship, stabs self in left chest with kitchen steak knife

- Airway: intact
- Breathing: 24, equal BS
- Circulation: HR 58, BP 114/68
- Disability: GCS 14
- Exposure: No other injuries



Steak knife vs heart



Anatomic Criteria

Take to Trauma Center:

- All penetrating injuries to head, neck, torso and extremities proximal to elbow or knee
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- Crush, degloved or mangled extremity
- Pelvic fractures
- Open and depressed skull fractures
- Paralysis

Anatomic Criteria

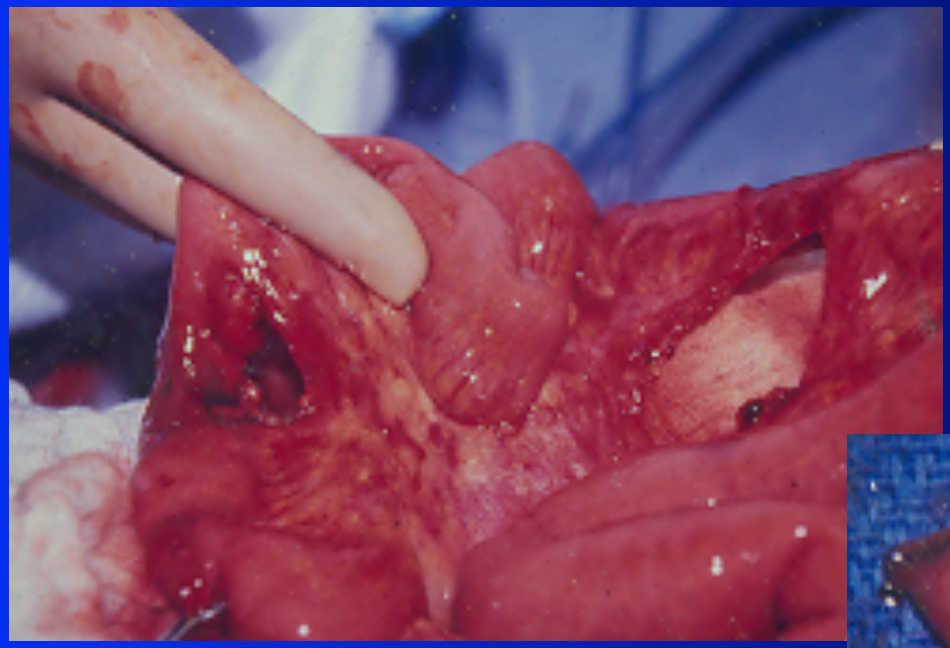
- Some patients with lethal injury may present with normal vital signs, especially if EMS response has been rapid
  - Reliance on only physiologic criteria may result in undertriage
- Perhaps anatomic criteria should be individualized to the community
  - Kane G, et al., J Trauma, 1985

Case

8 y/o male backseat passenger of vehicle involved in frontal collision. Significant intrusion to passenger compartment

- Airway: intact
- Breathing: RR 28, equal BS
- Circulation: Pulse 110
- Disability: GCS 15
- Expose: Seatbelt mark to abdomen, abdomen tender

Child in MVC



Mechanism of Injury

Take to Trauma Center:

- Falls
  - Adults > 20 ft (one story is equal to 10 ft)
  - Children: > 10 ft or 2-3 times the height of the child
- High-risk auto crash*
  - Intrusion: > 12” occupant site; > 18” any site
  - Ejection (partial or complete) from automobile
  - Death in same passenger compartment
  - Vehicle telemetry data consistent with high risk of injury
- Auto-pedestrian / auto-bicyclist thrown, run over, or with significant (> 20 mph) impact
- Motorcycle crash >20 mph

* Removed: rollover, deformation to vehicle

Mechanism of Injury Criteria

- MOI may aid in predicting serious injury
  - King AI, et al., J Trauma, 1995
  - Grande CM, et al., Crit Care Clin, 1990
  - Presswalla FB, Med Sci Law, 1978
- MOI correlates least well with the presence of significant injury
  - *Relying on these alone increases overtriage rate*