The Golden Hour of Trauma Care: past, present and future

Gill Cryer MD
Man kicked by horse

- Complains of severe abdominal pain
- Horse shoe mark RUQ
- Taken to nearest hospital
- Evaluated by:
  - Triage nurse?
  - Family doctor?
  - EM physician?
Man kicked by horse

- Suspect internal bleeding
- General surgeon called
- Surgeon arrives 2 hours later
- Takes patient to operation
Man kicked by horse

- Lots of bleeding
  - ran out of blood
- Surgeon not used to operating on liver
- No help
- Patient died!
Trimodal distribution of death from Trauma
Immediately life threatening injuries

• Brain injury (50% of mortality)
• Bleeding/shock (35% of mortality)
• May have both
• Both are time sensitive, minutes count!
The Golden Hour

• The goal is to find immediately life threatening injuries and fix them.
• Trauma center high performance team always ready and waiting for the patient when they arrive
Trauma Center Commitment

• ALL departments
  – Trauma Surgeon
  – Other physicians
    • Emergency medicine
    • Critical care
    • Neurosurgery
    • Orthopedics
    • Cardiothoracic
    • Plastics and ENT
    • Anesthesia
    • Radiology
  – Nurses
  – Every other staff member
Trauma Center

- Open 24/7
- All resources available
  - Operating rooms
  - CT scan
  - Physician specialists
- They know you are coming
- The team is waiting for you ready to go!
Standards for Care of the Injured Patient
RESOURCES
FOR OPTIMAL CARE
OF THE INJURED PATIENT

2014

COMMITTEE ON TRAUMA
AMERICAN COLLEGE OF SURGEONS

AMERICAN COLLEGE OF SURGEONS
Inspiring Quality:
Highest Standards, Better Outcomes
100+ years
ACS COT prioritization strategy

ATLS course

• Airway
• Breathing
• Circulation
  – Free bleeding
  – Contained bleeding
• Disability
  – Space occupying lesion
  – prevent secondary injury
Initial strategy

• Rapid resuscitation
  – Blood not crystalloid
  – Restore perfusion
  – Buy time to use diagnostic tools

• Find the problem
  – Site of hemorrhage
  – Brain injury

• Fix the problem
Trauma induced coagulopathy
Blood clot

- Fibrin
- Red cells
- Platelets
Plasma
Packed red blood cells
Platelets
Mortality by FFP/PRBC
Population BA within 30 days of ED

R-Square = 0.12
P-Value = 0.20
Effect of FFP:RBC Ratio on Overall Mortality

Chi Square
RB: p=0.006
RG: p<0.001
BG: p=0.034

Mortality %

FFP:RBC Ratio

0:22 - 1:4
65%
n=31

1:3.9 - 1:2.1
34%
n=56

1:2 - 1:0.59
20%
n=165
- Transfuse universal RBC and plasma in a ratio between 1:1 and 1:2 (plasma to RBC).

- Transfuse one single donor apheresis or random donor platelet pool for each six units of RBC.

- Blood products should be automatically sent by the transfusion service in established ratios.

- Subsequent coolers should be delivered at 15-minute intervals until the MTP has been terminated.

- The goal is to keep at least one MTP cooler ahead for the duration of the MTP activation.
Damage control resuscitation

- Whole blood or 1:1:1 ratio PRBC, FFP and platelets
- Minimize crystalloid
- Arrest bleeding and contamination
- Restore perfusion
- Restore normal physiology
- Delayed or staged definitive repair
Damage control surgery

• Rapid initial control of hemorrhage and contamination and temporary closure
• ICU for physiologic resuscitation
• Reoperation for planned definitive repair once normal physiology has been restored.
• Avoid the lethal triad of hypothermia, acidosis and coagulopathy (bloody vicious cycle)
Golden hour of hemorrhagic shock

Monitoring
- Correct: Temperature, Ca^{2+}, K^+, p_aO_2, p_aCO_2. Shock Reversal: pH, Lactate

Antifibrinolytics*
- Tranexamic acid according to CRASH2 and/or VHA

Transfusion therapy
- Ratio 1:1:1
- RBC according to Hb.

Hemorrhage dynamics
- Uncontrolled hemorrhage

Increasing control of hemorrhage

Time
- 30 min
- 60 min
- Hemostasis
- VTE prophylaxis
Diagnostic tools: bed side ultrasound

Blood in the abdomen! She needs an operation!
Definitive diagnostic test: CAT SCAN
What operations/procedures are needed?

- Therapeutic lap 24%
- Craniotomy 6%
- Therapeutic angio 20%
- Thoracotomy 5%
Operating room (60%)
Extremity damage control

• GSW upper arm, no pulse at wrist
• Expedited exploration
  – Humerus fx, transected brachial artery and nerve
  – Hemostasis, Javid shunt, external fixator, forearm fasciotomy
  – Pulse restored
  – Stabilize for later definitive care
Damage control: 1st operation hemostasis, shunt, fasciotomy and external fixator
Damage control: first stage completed
2\textsuperscript{nd} operation: definitive repair artery, tagged median nerve
Adjusted fixator and VAC
Interventional Radiology (20%)
Selective Angiography and Trancatheter Embolization

Pre-embolization  Post-embolization
Endovascular stent of subclavian artery injury
Stenting the transected aorta

Zager et al. J Trauma, 2003
Surgical ICU (25%)
Impact of delayed transfer of critically ill patients from the emergency department to the intensive care unit

Donal B. Chalfin, MD, MS, FCCM; Stephen Trzeciak, MD, MPH; Antonios Likourezos, MA, MPH; Brigitte M. Baumann, MD, MSCE; R. Phillip Dellinger, MD, FCCM; for the DELAY-ED study group

National estimates of severe sepsis in United States emergency departments

Henry E. Wang, MD, MS; Nathan I. Shapiro, MD, MPH; Derek C. Angus, MD, MPH; Donald M. Yealy, MD

- 67 minute delay to ICU
- 3x↑mortality
Pathophysiology: Early Hematoma expansion

Zuzulía et al, Stroke 1999
Epidural Hematoma
Epidural Hematoma Treated Conservatively: When to Expect the Worst

Mohammed Basamh, Antony Robert, Julie Lamoureux, Rajeet Singh Saluja,


166 treated EDH

41 (24.7%) urgent evacuation

125 (75.3%) initial conservative treatment

In total 55 (33.1%) EDH surgically evacuated

14 (11.2%) surgery

111 (88.8%) no surgery
ACS TQIP
BEST PRACTICES IN THE MANAGEMENT OF TRAUMATIC BRAIN INJURY
TBI patients presenting to the ED in coma should be taken to surgery immediately upon arrival if a large hematoma is identified as the cause of the coma.
• A large traumatic hematoma should be evacuated before neurological deterioration develops, irrespective of the GCS
Close monitoring is required during general anesthesia to avoid high ICP, hypotension, hypoxia, and hypo- or hypercarbia.
ICP monitoring is indicated in comatose patients (GCS ≤ 8) and if there is evidence of structural brain damage on initial CT imaging.
ICP monitoring should be considered in patients with a GCS > 8 who have structural brain damage with high risk for progression (large/multiple contusions, coagulopathy)
ICP monitoring should be considered in patients who require urgent surgery for extracranial injuries, who need mechanical ventilation because of extracranial injuries, or who evidence progression of pathology on CT imaging or clinical deterioration.
If patients with TBI require orthopedic operations, these should ideally be delayed 24 to 48 hours for initial stabilization of intracranial hypertension.
Case presentation

- 25 yo woman is severely injured in a motor vehicle crash
Case presentation

- In ED BP 90/40, pulse 130, pale
- Right femur deformity
- Pelvic tenderness
Case presentation

- Blood pressure improves with resuscitation with PRBC, Plasma and Platelets
Pelvic fracture on X-ray

Vertical shear fracture

Angio is called immediately on seeing this X-ray
Ct-scan shows pelvic arterial bleeding

Angiographer there to see scan and team is setting up
In angio within 30 minutes

Blood pressure stabilized immediately after embolization
CT-scan negative for any other injuries
Patient stable for damage control operation on femur fracture and pelvic fracture
3 days later definitive open reduction and internal fixation

Back to work 6 weeks later and normal function at 6 months
Angiography Disadvantages

• 32 unstable patients with negative FAST went from ED to Angio
• 47% had therapeutic angio
• 41% required therapeutic laparotomy
• Some patients were in the wrong place
• Time consuming

What if the problem is in the belly, chest, or head?
So put it all together
Hybrid operating room

- C-arms
- CT-scan on rails
- MRI portable
- Robotics
- 3D-imaging
- Fusion imaging
- Overlay imaging
Needs a lot of room (70 sq meters)
Control Room, lead shielding
Lots of people (8-20): 24/7
Logistical problems for trauma

- Very expensive, who pays?
- Who uses it?
- Will it be available?
- Staffing 24 hours per day
- Speed of information transfer?
- Lots that can go wrong
- Coordination of multiple teams
ED thoracotomy to the OR
Ongoing blood product resuscitation
Trauma team in the abdomen
Angio and Ortho setting up
Ex fix going on
Trauma, ortho and angio
Multifunctional trauma OR: the future?
Summary of the “golden hour”

• Severely injured patient to trauma center
• Damage control resuscitation
• Injuries identified
• Damage control surgery
• Stabilization in the ICU
• In the future do it all in the same place
Time Sensitive Diagnoses & Mortality

- MISSED MI: <10%
- STROKE: 7%
- TRAUMA: 5%
- SEPSIS: 18-47%
Don’t let the golden hour sneak up on you!

Thank you
Next to the operating room
Advances: Skill and Technology