GERIATRIC TRAUMA:
OLD DOG
NEW TRICKS

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Geriatric Trauma:
An emerging public health issue

- Geriatric population – Age 65 and older?
  - “Geriatric” depends on what you read...
    - Range 55 – 70 years old
    - Relates to Minor, Moderate, Severe Trauma

- Elderly • 10% general population but 25% trauma admissions

- Account for 1/3rd trauma expenditures
  - 9 billion dollars per year for geriatric trauma in the U.S.

Geriatric Trauma:
An emerging public health issue

- Geriatric Generalities:
  - For each 1 year beyond 65, risks of dying after GT ↑ 7%
  - Overall mortality GT age > 65yo – 7 to 10%
  - Risk of death are 34% less – female
  - GT is 4th leading cause of death
Total number of persons 65 or older, by age group, 1900 to 2050, in millions

2050: 90 million people = age 65 and will represent 1/6 of the US population. Currently, 25% of all trauma admissions, 2050 projected to be 40%.

The Gray Tsunami!!!
Geriatric trauma patients behave differently

- Geriatric trauma patients behave differently than their younger counterparts
- "Normal" appearing vitals signs mask their physiologic derangement
  - "Occult Hypoperfusion"
- With a similar traumatic insult, GT higher risk of death/suffer more injury severity than younger patients

Geriatric Trauma

- Physiologic Reserve
- Physiologic/Anatomic Changes
- Triage/Activation of GT
- Occult Hypoperfusion
- Pre-existing Conditions (PECs)
- Treatment of GT
- Unique Mechanisms and Patterns of Injury

Physiologic Reserve

- Defined As:
  - Individual's Ability To Tolerate Injury

- Function Of Unique Host Factors:
  - Age
  - Gender
  - Preexisting Disease
  - Immuno-competence
Physiologic Reserve

- Diminished response to hypovolemia:
  - Cardiac Index decreases 1% per year
  - Maximal heart rate is reduced with advancing age
  - Effect of adrenergic stimulation reduced

- Geriatric trauma patients have:
  - Lower cardiac index
  - Lower oxygen delivery
  - Lower oxygen consumption

- Suffer worse outcomes from hypoperfusion

Host Factors Define Physiologic Reserve

![Graph showing physiologic reserve affected by age, underlying disease, and host factors.]

Physiologic Reserve
Injury Severity Determines Slope

![Graph showing physiologic reserve affected by injury severity and pre-existing conditions.]

Young & Healthy
Age
Underlying Disease
Host Factors

Physiologic Reserve
Pre-existing Conditions
High ISS
Moderate ISS
Physiologic Exhaustion
Death

Time
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Decline in Function with Age

- Brain mass
- Eye disease
- Discrimination of colors
- Respiratory vital capacity
- Renal function
  - 2- to 3-inch loss in height
  - Impaired blood flow to lower leg(s)
- Degeneration of the joints
- Total body water
  - Nerve damage (peripheral neuropathy)
- Stroke
- Diminished hearing
- Sense of smell and taste
- Saliva production
- Esophageal activity
- Cardiac stroke volume and rate
- Heart disease and high blood pressure
- Kidney disease
- Gastric secretions
- Number of body cells
- Elasticity of skin, thinning of epidermis
- 15 – 30% body fat

Aging Impact on Function

- Decreased vision and hearing
- Slower reflexes
- Poorer balance
- Impaired motor/cognitive function
- Decreased muscle mass/strength
- Decreased bone density
- Less joint flexibility
- Impaired sensation – especially pain
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Triage of the Geriatric Patient

- “Onsite” treatment

- Undertriage:
  - Rate – 40 to 70% (Young – 15 to 20%)
  - Age > 65 is independent risk factor for undertriage

- Best Outcomes when GT Level 1 Center; however:
  - “Normal” field vital signs:
    - lead to transfer to lower level centers
    - incorrect triage at the trauma center
Is advanced age a triage criterion for trauma center referral and activation?

- Chang et al. 2008: 10 year retrospective review
  - 25,565 patients
  - Risk of undertriage in age ≥ 65 was significantly greater
    - 49.9% vs. 17.8%
  - Multivariate analysis
    - controlling for year, sex, physiology, injury, mechanism, EMS provider level training, presence or absence of specific injuries
  - Age ≥ 65 is an independent risk factor for under-triage


Age as a criteria for activation?

Demetriades et al.

- Standard physiological/anatomic triage criteria FAILED to identify severely injured GT
  - Failed to meet hemodynamic activation criteria
    - 63% of severely injured (ISS>15)
    - 23% of those critically injures (ISS>30)
  - Conclusion: Age 70yo or older should be a criteria for trauma team activation

- Follow-up study – Mortality/Disability

Geriatric Trauma Patients: Care in Designated vs. Non-designated Trauma Centers

- Elderly patients treated at Level I Trauma Center
  - Lower preventable adverse events/lower risk-adjusted mortality
  - If treated by dedicated surgeon-intensivists
    - Mortality 25%
    - Study of severely injured 80yo TC survival 56% v. 8% NTC
  - Survey of Current Practice - Maxwell, Miller et al.:
    - 43% of elderly admitted to non-designated trauma centers.
    - Non trauma centers are admitting highest percentages:
      - Older age groups/co-morbidities
      - Falls
      - Femoral neck fractures
      - Major OR procedures

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How do Geriatric trauma patients behave differently?

- Heffernan et al.: *“Normal” presenting vital signs are unreliable*
  - Positive shock index: HR > 100 and SBP < 90 mmHg
  - For GT: HR > 90 or a SBP < 110 mmHg
  - Indicative of under-resuscitation

- Studies suggest that geriatric patients suffer “occult hypoperfusion”
- Rate of OH ranges 16-30%
- In fact, 42% of patients with OH had normal vital signs

- Outcomes: Occult hypoperfusion = frank shock
  - Longer than 52 hours, mortality 32 – 35%
  - OH leads to 2 fold risk of mortality

- Identifying patients with OH – mission critical
  - Physical examination/vital signs don’t work


Identifying occult hypoperfusion
“2 Schools of Thought”

All geriatric trauma patients receive the highest level activation

- Full trauma resuscitation team comprised: attending trauma surgeon, an attending emergency medicine physician, resident physicians in teaching institutions, and multiple dedicated nurses and technicians.


Lactate/base deficit identified as risk stratification tool


Physiologic Reserve

Physiologic/Anatomic Changes

Triage/Activation of GT

Occult Hypoperfusion

Pre-existing Conditions (PECs)

Treatment of GT

Unique Mechanisms and Patterns of Injury

Geriatric Trauma

~80% GT patients have at least 1 PEC, 50% ≥ 2

Most Common:
- HTN – >50% of GT
- Hepatic – worst (RD 5x) – (Impact EARLY)
- Heart – >30%, RD 3.4x (Impact LATE)
- Pulmonary – COPD, RD 3x
- Diabetes – RD 1.2x
- Renal Disease (RD 3x)
- Cancer (RD 2x)
- Stroke
- Dementia
- Arthritis

Co-morbidities or Pre-existing Conditions (PECs)
Co-morbidities/PECs

Important to remember:

- PEC’s often initiating event for trauma
- Poor pre-injury function = poor outcome
- PECs substantially increase complications
- Mortality increases as number of PECs increase
  - Most prevalent with low/moderate trauma

Is advanced age a triage criterion for trauma center referral and activation?

- Doom & Gloom!
- A "large proportion" of elderly patients return to independent living
- And therefore:
  - Age alone should not be used as the sole criterion for limiting care!

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References:
Primary Survey

- Adults/pediatrics/pregnant/elderly – priorities are all the same!
  
  A Airway with C-spine protection
  B Breathing
  C Circulation with hemorrhage control
  D Disability
  E Exposure/Environment

History – “AMPLE”

- Meds that affect initial evaluation/care
  - Anticoagulants
  - Beta blockers
    - 20% of patients with CAD, 10% of patients with HTN

- Consider acute, non-traumatic events led to injury
  - Acute coronary syndrome
  - Hypovolemia/dehydration
  - UTI
  - Pneumonia
  - Acute renal failure
  - Cerebrovascular events
  - Syncope

- Labs
  - CBC, lytes, BUN/creatinine – all done as rapidly as possible – i-stat
  - ROTEM or TEG – thromboelastography
  - ABG/VEG - determination of base deficit or lactate (serial test)
  - Type/Cross

Airway

- Inspect oral cavity
  - Poorly fitting, loose dental appliances
  - Bag-valve mask difficult with edentulous airway

- When in doubt - INTUBATE, especially with
  - Shock
  - Chest trauma
  - Mental status changes

- Beware
  - Loss of kyphotic curve
  - Spinal canal stenosis
  - Decrease cervical spine mobility
Breathing
- Myriad of effects on pulmonary function
- Osteoporosis
  - ↓ rib durability
  - ↑ incidence rib/sternal fxs
  - Pulmonary contusion even low energy trauma
- Weak respiratory muscles/age related changes
  - ↓ chest wall compliance
  - ↓ pulmonary function- VC, FRC, I/E force
- Blunted response hypoxia, hypercarbia, acidosis
- Limited ability to compensate

Circulation/Resuscitation
- IV, O2, monitor
- “Normal” BP = frank hypotension
  - Shock and Occult hypoperfusion (OH) predicts mortality
- Judicious fluids, blood and blood products early
- Lactate/Base Deficit ASAP
  - Important in triage and resuscitation
  - Correlates with systemic hypoperfusion and shock
- Early angiographic embolization
  - Complex pelvic fractures
  - Splenic, liver, kidney lacerations

Use of Base Deficit/Lactate in evaluating resuscitation in Geriatric Trauma
- Base deficit values of -6 mEq/L or worse
  - marker of severe injury/significant mortality in all trauma patients but especially in the elderly:
    - Base deficit -5 mEq/L or higher → less than 25% mortality
    - Base deficit -6 mEq/L or worse → 60% mortality
- Lactate > 2.5 is considered severe
  - Independent predictor of severe injury/mortality
    - 2.6 times vs. risk of mortality
  - Better predictor of hypoperfusion/outcome than vital signs
  - Correlates with:
    - Total oxygen debt/degree of hypoperfusion/severity of shock
Disability/Exposure

- Risk for hypothermia and pressure sores
  - Poor nutrition
  - Loss of lean muscle mass
  - Microvascular changes
  - Blunted hypothalamic function
- Rectal temperature and rewarming methods
  - Bair hugger/warm blankets
  - Increase ambient temperature
  - Level 1 infuser
- Decrease hypothermic-induced coagulopathy
  - Deadly Triad
- Off back board, clear cervical collar, spine ASAP

Diagnostic Imaging

- CXR- standard yet fails ID 50% rib fractures
- Pelvis X-ray- rules out major pelvic fractures
- CT scan
  - Primary mode evaluation in elderly
  - Low threshold
  - Radiation exposure not important issue
- Contrast-induced nephropathy risk factors:
  - CRI, DM, dehydration, CHF, Age > 75
  - Cr 4 or less – IV contrast ok

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Falls

- Most common mechanism of injury
  - 75% of all geriatric trauma
  - 90% ground level
- 5-10x more EMS calls due to Falls than MVCs
- 30% 65yo and older fall each year
  - 6% result in fracture
  - 10-30% multiple injuries
  - Leading cause non-fatal injuries in GT
- Overall Fall Mortality: 7%
- Each fall costs ~ $18,000 per episode

Ground Level Falls (GLF)

- Retrospective review NTDB
- 32,320 elderly GLF (>70 y/o)
- Mortality 4.4%
- GCS <15 significantly predicts mortality
- GT patients – 5x ↑ risk dying from GLF than younger population

NTDB = National Trauma Data Bank
Spaniolas, J. Trauma 2010; 69:821-825

- NTDB database study – 589,830 patients
- Geriatric: 183,209 (31%)
- Nongeriatric: 406,621 (69%)
- Presentation Vital Signs - Geriatric Trauma
  - Lower heart rate
  - Higher systolic blood pressure
  - Less often hypotensive
  - Presented more often GCS < 9
  - Higher Overall Crude Mortality: 4.6% v 1.9%
Geriatric Physiology

- GT more likely:
  - HTN, cardiac disease, cerebrovascular disease, CRF
- Overall, GT more likely presented with:
  - Lower HR/higher SBP
- GT more likely to be hypotensive:
  - after MVC, pedestrian vs auto, assault, MCC
  - Impact of falls
- Overall, GT presents with:
  - Lower ISS (Injury Severity Score)
  - But more often suffered severe TBI/LE fractures

Falls

- Most common mechanism of injury 55% vs 29%
- Mortality: 4.4% vs 1.9%
- Injury Pattern:
  - 31% - lower extremity fracture
  - 23% - TBI
  - 23% - hip fracture
- More likely than younger to suffer:
  - TBI
  - UE/LE fractures
  - Rib fractures
  - Hip fractures/Pelvic fractures

Motor Vehicle Collisions

- 21,145 (15%) vs 119,618 (85%)
- GT more often hypotensive (4.5% vs 3.1%)
- GT mortality higher (5.6% vs 1.9%)
- Injury Pattern:
  - 43% - thoracic injury
  - 41% rib fractures
  - 22% - spine fracture
  - 18% - TBI
**Pedestrian v Auto**

- 5552 (14%) v 35,185 (86%)
- GT more often hypotensive (5.5% v 4.6%)
- GT mortality higher (7.8% v 3.3%)
- Injury Patterns
  - 35% - lower extremity fractures
  - 29% - thoracic injuries
  - 24% - TBI
- GT more likely to suffer:
  - Pelvic fracture/Hip fracture
  - Lower extremity fracture

**Most Important...**

- Age > 65 independently associated with mortality across ALL mechanisms of injury

**Cervical Spine Injuries**

- Cervical stenosis/degenerative spine disease
  - Fractures involve more than 1 level
  - Often clinically unstable
  - C1/C2 fractures are common
  - GLF tend to produce high C-spine injury
  - C-spine injury is twice more frequent than young pts
- Predictors of C-spine Injury:
  - Focal neurologic deficits
  - Concomitant head injury
  - High energy mechanism
**Rib Fractures**

- Bulger et al- 277 patients over 65 with rib fractures
- Mortality: 1-3: 11%  4-6: 14%  >6: 31%
- EACH rib fx ↑ risk pneumonia 27% and mortality 19%
- Rib fracture(s) are an indication for admission
- Triage to Floor/ICU • Incentive Spirometry
- Pain management essential • morbidity/mortality
  • Epidural
  • PCA, Rib catheters/blocks, Lidocaine patches
  • Good pulmonary toilet
  • Rib fixation when indicated

**Abdominal Injury**

- Doesn’t differ significantly from younger pts
- FAST – still mainstay for early diagnosis
- Over age 55 – more likely to fail non-operative management of solid organ injury
  - Stable patient – reasonable to attempt nonop mngmt.
  - BUT, any instability should warrant exploration/IR
    - 17 GT nonop management – 3 failed; 2/3 died
  - BUT, presence of “arterial blush” on initial CT should warrant urgent exploration or IR intervention
  - Attempt at non-operative management warrants an ICU admission

**Pelvic Fractures**

- Most common after fall
- Lateral compression fractures (Unique)
  - Pubic rami /Acetabulum /Ischium
  - > 50% multiple fx’s
- Increased hemorrhage: 3x more likely to get blood
  - Binder / Transfusion /Angio-embolization
  - ICU admission
  - Surgical intervention is about timing!
- Look for other fracture/other injuries
  - Hip ➔ wrist/shoulder fractures
  - Pelvic fx w/long bone fractures are associated with occult bleeding
Traumatic Brain Injury (TBI)

- Early diagnosis/treatment critical to outcome
- >65 yo 2-5x mortality of younger groups
- Linear relationship: Age and Mortality
- Overall mortality TBI with ICH: 30-85%
- Brain weight decreases by 10% between ages 30-70
  - Cerebral atrophy → Increase intracranial space
  - Mask ongoing bleed, subtle presentations, delay dx
  - Liberal early use of CT
  - Subdural hematoma common – tearing of bridging veins
    - Larger, more midline shift, mortality rate 4x greater
  - Epidurals are rare – dura adheres to skull

Traumatic Brain Injury

Study of Mild Head Trauma (GCS 13 – 15)

- 14% had evidence of head injury on CT
- 20% of those → neurosurgical intervention
- NO CLINICAL PREDICTORS
  - Couldn’t distinguish (+) CT and those (-) CT
- Recommendations:
  - CT all GT with signs of head injury/altered GCS
  - Serial neurologic examination

TBI and Anticoagulants

- Dramatically ↑ morbidity/mortality with elderly TBI

- Antiplatelet Agents
  - No good reversal strategies for anti-platelet agents
    - Prasugrel/Effient, clopidogrel/Plavix = ADP Inhibitors
    - P2Y12 Level
      - Platelet activation = ADP + P2Y12 receptor
      - Plavix/Effient = block P2Y12 receptor
      - Result: less than 194 PRU means receptor blockade
    - Platelet Activation Function
      - Other anti-platelet agents
    - Platelet transfusion, desmopressin (DDAVP) and rFVIIa MAY offset some bleeding
**Coumadin**
- ~15% of Geriatric pts taking it (65% cardiac)
- Independent predictor mortality TBI – 10x ↑
- Remove TBI – not associated worse outcomes
- Reversal
  - FFP – issues: volume required (10ml/kg)/frozen
  - VIIa have increased risk of transfusion related ALI
  - VIIa – cost, indication and short DofA (2 hours)
  - PCC – Prothrombin Concentrate Complex (Kcentra)
    - Factors IX, X, II, (VII) ~ 25x ↑ concentration plasma
    - 1/2 Life ~ 20 hours; cost 1/10th of VIIa
    - Low risk of thrombotic events - < 2%
    - Dosing: based upon INR/ROTEM

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**How should coagulation-based coagulopathy be treated?**
- Level 1: Insufficient CLASS I and CLASS II data
- Level 2: Insufficient CLASS I and CLASS II data
- Level 3:
  1. Patients on AC: coagulation profile on admission
  2. Suspected head injury: immediate CT of the head
  3. Patients on Warfarin with ICB
     correction of coagulopathy to < 1.6x normal within 2hrs

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**Direct Factor Inhibitors**
- Dabigatran (Pradaxa)
  - Direct thrombin inhibitor
  - Idarucizumab (Praxbind) – reversal agent ($3500.00)
- Rivaroxaban/Apixaban /Edoxaban
  - Direct Xa inhibitors
    - Andexanet alfa (AndexXa) – recombinant gene
    - Investigational studies on dialysis/PCC
    - In doubt – give PCC
- TEG/ROTEM useful to ID presence of these drugs and platelet inhibitors
Severe TBI Outcomes

BUT:

Elderly patients with severe traumatic brain injury
- GCS ≤ 8 for at least 72 hours (off sedation)
- At least 80% mortality or long term placement disposition
- Justifies discussion of goals of care


Complications/Infections

- GT complication rate: 33%
- Preventable complications
  - Contribute to 30% of all GT deaths
- Other complications:
  - Pre-existing conditions
  - Age-related physiologic changes
- Infection risk ~ 40%
  - Nosocomial infections
  - COPD independent predictor of infection

Direct transport of geriatric trauma patients with pelvic fractures to a Level I trauma center within an organized trauma system: impact of two-week incidence of in-hospital complications.

- 87 GT patients with unstable pelvic fractures
  - 39% (34/87) transported to nontertiary trauma centers (NTC)
  - 61% (43/87) transported to a Level I center
- Adjusting for comorbidity and ISS
- 2 week incidence of complications 54% higher in NTC
- Complications:
  - Pneumonia/Sepsis/Myocardial infarction
- Majority of complications occurred within 7 days

Garwe et al; American Journal of Surgery (2012) 204, 921-26
Global Management Principles

- Treat individual, not just the injuries
- Align team resources
- Avoid AGEISM—stereotyping older patients
- Emphasize respect/sense of individual
- Recovery highly individualized process
- Understand unique capacities and limitations
- Preserve as much independence and dignity as possible

Pain Management Strategies

- Effective pain management central determinant of success in drive to improve:
  - Pulmonary function/Mobility/Mitigate delirium
- Use elderly-appropriate meds and doses
- Avoid benzodiazepines
- Monitor use narcotics
- Epidural analgesia with multiple rib fractures
- Consider non-narcotics
  - NSAIDS
  - Tramadol

Multi-disciplinary Treatment Plan

- Early mobilization/ambulation
  - Within 24-48 hours
- Assess fall risk
- Aspiration precautions
  - Elevate HOB at all time with repositioning
  - Sit upright while eating and 2 hrs after
  - Evaluate for swallowing deficits
- Chest PT-IS/deep breathing exercises
- Early enteral nutrition
- Pain control
- Bowel regimen, especially with opiate use
- Screen for presence of pressure ulcers
- Assessment of cognition/sleep disturbances
Geriatric Trauma Service: A one year experience

- G-60 Geriatric Trauma Unit in Level II
- Worked on collaboration
  - Medical hospitalist
  - Physiatrist
  - PT/OT/RT
  - Nursing supervisor with geriatric experience
  - Palliative care specialist
- Compared before/after G-60 - 280pts/393pts
  - Decreased time to OR
  - Decreased ICU and hospital LOS
  - Decreased complications
  - Decreased mortality rate

Mangram et al, J. Trauma 2012;72:119-122

EAST PMG: Conclusions

1. Elderly trauma patients should be treated at centers that have resources and have attained excellence in care.

2. In patients with ICB and Warfarin-induced coagulopathy, coagulation profile should be immediately assessed.

3. Base deficit of -6 mEq/L should be used as a marker for severe injury and admission to ICU should be considered.

4. Glasgow Coma Score of ≤ 8, which remains low after 72 hrs warrants discussion regarding goals of care.
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- Triage/Activation of GT
- Unique Mechanisms of GT
- Occult Hypoperfusion
- Pre-existing Conditions (PECs)
- Treatment of GT
- Prevention

Future Directions
- Risk Stratification – 65 ≠ 65 ≠ 65
- Frailty Index – 18 different ones
- Prognosis Calculators
  - PALLIATE = Prognostic Assessment of Life and Limitations After Trauma in the Elderly consortium
  - Geriatric Trauma Outcome Score (GTOS)
    - As reliable as TRISS (Trauma Injury Severity Score)
    - \[ \text{GTOS} = \text{Age} + (2.5 \times \text{ISS}) + (22 \times \text{PRBC}) \]
    - PRBC: Yes = 1, No = 0

Summary
- Elderly (≥65) fastest growing age group
- Majority of trauma admissions over next 20 years
- GT patients behave differently
- Age, Injury Severity, PEC’s all indep. predict death
- Limited physiologic reserve
- Ground level falls are NOT benign
- Consider triage to designated trauma centers
- Do not rely on “normal” vital signs
- Pulse > 90, SBP< 110 = SHOCK
- Measure base deficit/lactate
Summary
- Low threshold for CT scan
- Rapid Head CT and correction of coagulopathy
- GCS ≤ 8 associated with poor outcome
- Create multi-disciplinary team
- Reduce complications and improve outcomes
- GT patients CAN return to productive lifestyle