GERIATRIC TRAUMA: EVOLVING CONCEPTS IN A RAPIDLY GROWING POPULATION

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“THERE ARE THREE SIGNS OF OLD AGE. THE FIRST IS YOUR LOSS OF MEMORY AND THE OTHER TWO I FORGET.”

Unknown
Geriatric Trauma: An emerging public health issue

- Geriatric population – Age 65 and older?
  - Problem 1 – Definition of “Geriatric” depends on what you read!
  - Range 55 – 70 years old; Minor, Moderate, Severe Trauma
  - For each 1 year beyond 65, odds of dying after GT ↑ 6.8%
  - Overall mortality for all GT patient age > 65yo – 7 to 10%
  - Odds of death are 34% less – female
  - GT is 5th leading cause of death

- Elderly – 10% population but 23% of all trauma admissions

- Account for 1/3rd trauma expenditures
  - 9 billion dollars per year for geriatric trauma in the U.S.
    - Weir S et al., Expert Rev Pharmacoecon Outcomes Res 2010: 10(2);187-97
  - Currently, 1/3 of geriatric population is a fall risk
    - Each fall costs ~ $18,000 per episode
2050 - 90 million people > age 65 and will represent 1/5 of the US population. Currently, 65yo account for 23% of all trauma admissions – projected to 40%

The Gray Tsunami!!!
Numerous studies describe the ways in which 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 and suffer more injury severity than younger patients.
Physiologic Reserve

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

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

- Young & Healthy
- Age
- Underlying Disease

Host Factors
Physiologic Reserve
Injury Severity Determines Slope

Physiologic Exhaustion

Time

Pre-existing Conditions

Injury Related

High ISS

Moderate ISS
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
Triage of the Geriatric Patient

- Accidents occur where medical personnel are readily available – attempt “onsite” treatment
- Degree of injury – underestimated
  - Undertriage rate – 40 to 70% (Young – 15 -20%)
  - Age > 65 is independent risk factor for undertriage
- Outcomes improved when GT is taken directly to a Level 1 Center
  - Still Problematic
    - “Normal” field vital signs lead to transfer to lower level centers
    - “Normal” vitals ➔ incorrect triage at the trauma center
- Age alone should be a criterion for triage/trauma team activation
Chang et al. 2008: 10 year retrospective review in Maryland
- 25,565 patients

Risk of under-triage in age group ≥ 65 was significantly greater than younger group
- 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

Demetriades et al.

- Standard physiological and anatomic triage criteria failed to identify severely injured GT
  - 63% of severely injured (ISS>15)
  - 23% of those critically injures (ISS>30)
  - Didn’t meet standard hemodynamic activation criteria

- 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 a Trauma Center (Level I/II)
  - Less likely experience preventable adverse events
  - More likely have lower risk-adjusted mortality
  - If treated Trauma Center and/or hospitals with dedicated surgeon-intensivists
    - ↓ Mortality 25%
    - In a study of severely injured 80yo, TC survival 56% v. 8% NTC
    - Instituting a state trauma system increased survival 5%

- Survey of Current Practice - Maxwell, Miller et al.:
  - 43% of elderly patients are being 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

Common Mechanisms of Injury
Falls

- Most common mechanism of injury elderly
  - Account 75% of all geriatric trauma
    - MVC’s, Pedestrian v. MV
  - 90% are “simple” falls – ground level
- 5-10x more EMS calls due to Falls than MVCs
- 30% > age 65 fall each year
- 6% result in fracture
- 10-30% multiple injuries
- Leading cause non-fatal injuries in GT
- Overall Fall Mortality: 7%
Ground Level Falls (GLF)

- Retrospective review NTDB
- 32,320 elderly GLF (\(>70\) y/o)
- Mortality 4.4%
- More likely to sustain injury
- GCS \(<15\) significantly predicts mortality
- GT patients – 5x > chance dying from GLF than younger population

Spaniolas, J. Trauma 2010; 69:821-825
Unique Physiology
How do Geriatric trauma patients behave differently?

- Heffernan et al. demonstrated that “normal” presenting vital signs are unreliable in the geriatric trauma patient

- Positive Shock Index: HR > 100 and SBP < 90 mmHg

- Suggested for GT: HR > 90 or a SBP < 110 mmHg should be considered indicative of under-resuscitation
Studies suggest that geriatric patients suffer “occult hypoperfusion”

Normal vital signs mask inadequate tissue perfusion
- Rate of occult hypoperfusion ranges 16-70%
- In fact, 42% of patients with occult hypoperfusion had normal vital signs

Outcomes similar to those who present in frank shock
- OH lasting longer than 12 hours ↑ mortality 12 – 35%
- OH was associated with a 2 fold ↑ odds of mortality

Identifying these patients using modalities other than physical examination and vital signs critical for optimizing their resuscitation
Identifying geriatric patients with occult hypoperfusion

- Lactate and base deficit have been identified as one risk stratification tool

- Others have even advocated for all geriatric trauma patients to 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
~80% GT patients have at least 1 PEC, 50% ≥ 2

Most Common:
- HTN - >50% of GT
- Arthritis
- Heart - >30%, CHF/β-blocker/AC: ↑ RD 3.4x (Impact LATE)
- Pulmonary – COPD: ↑RD 3x
- Diabetes - ↑ RD 1.2x
- Stroke
- Dementia
- Hepatic – worst (↑ RD 5x) – (Impact EARLY)
- Renal Disease (↑ RD 3x)
- Cancer (↑ RD 2x)
**Co-morbidities/PECs**

Important to remember:

- PEC’s often initiating event for trauma
- Poor pre-injury functional status leading predictor of poor outcome
- PECs substantially increase incidence complications
- Probability of mortality increases as number of co-morbidities increase
  - Most prevalent with low and moderate trauma
Evaluation
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
Meds that affect initial evaluation/care
- Anticoagulants
- Beta blockers – 20% of patients with CAD, 10% of patients with HTN
- ACE inhibitors

Acute, non-traumatic events that may have precipitated 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
- Coagulation profile and TEG – thromboelastography
- ABG/VBG – 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, and arthritis
  - Spinal canal stenosis, decrease cervical spine mobility
Breathing

- Aging - myriad of effects on pulmonary function
- Osteoporosis
  - Decreased rib durability
  - Increased incidence rib/sternal fxs
  - Pulmonary contusion even from low energy trauma
- Weakened respiratory muscles/degenerative changes
  - Decrease chest wall compliance
  - Decrease pulmonary function - VC, FRC, I/E force
  - Limited ability to compensate
- Blunted responses to hypoxia, hypercarbia and acidosis - delay onset signs impending distress
- Early ABG/lactate
Circulation/Resuscitation

- IV, 02, monitor
- “Normal” BP- frank hypotension
- Shock and Occult hypoperfusion (OH) predicts mortality in GT
- Judicious fluids, blood and blood products early
- ABG (VBG)/lactate/base deficit
  - Important in triage and resuscitation
  - Correlates with systemic hypoperfusion and shock
- Early angiographic embolization playing increasing role in non-op management GT
  - 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 and significant mortality in all trauma patients but especially in the elderly:
  - Base deficit -5 mEq/L or higher $\rightarrow$ less than 23% mortality
  - Base deficit -6 mEq/L or worse $\rightarrow$ 60% mortality

- **Lactate > 2.5 is considered severe**
  - Independent predictor of severe injury and mortality
    - Lactate > 2.5 led to a 2.6 fold $\uparrow$ odds of mortality
  - Better predictor of hypoperfusion/outcome than vital signs
  - Correlates with:
    - Total oxygen debt
    - Degree of hypoperfusion
    - Severity of shock
ICU Care/Resuscitation

- Elevated lactate (>2.5)/base deficit (> -6) → ICU
  - Goal: within 1 hour of presentation
- Invasive hemodynamic optimization → Swan
  - Study from Scalea
- Goal directed therapy:
  - Cardiac Index ≥ 4L/min/m2
  - Oxygen Consumption ≥ 170ml/min/m2
- Several studies now show equivalence of Swan to Vigileo/Flotrac system (noninvasive method of fluid optimization)
Disability/Exposure

- Elderly trauma risks for hypothermia and pressure sores
  - Poor nutrition
  - Loss of lean muscle mass
  - Microvascular changes
  - Blunted hypothalamic function
- Rectal temperature and rewarming methods
  - Bair hugger
  - Increase ambient temperature
  - Humidifier on vent
  - Level 1 infuser
- Reduce incidence of 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
- Prevention of Nephropathy
  - Volume
  - bicarbonate/N-acetyl-cysteine (out of favor)
  - Low-osmolar, non-ionic contrast
Patterns of Injury
Cervical Spine Injuries

- Increased cervical stenosis/degenerative spine disease
  - Fractures often 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
  - 1-3: 11% Mortality
  - 4-6: 14%
  - >6: 31%
- EACH rib fx ↑ risk pneumonia 27% and mortality 19%
- Rib fracture(s) are an indication for admission
- Pain management essential ↓ morbidity/mortality
  - Epidural
  - PCA
  - Rib blocks, Lidocaine patches
  - Comprehensive pain service
  - 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.
  - Any instability should warrant evaluation/exploration/IR intervention
  - 17 GT nonop management – 3 failed; 2/3 died
  - 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 fxs
- Higher rates hemorrhage – 3x more likely to get blood
  - Binder/sheet
  - Transfusion
  - Angio-embolization
  - ICU admission
  - Surgical intervention is about timing!
- Look for other fracture
  - Hip ➔ wrist/shoulder fractures
  - Pelvic fx w/long bone fractures are associated with occult bleeding
Early diagnosis and treatment critical to outcome

>65 yo 2-5x mortality of younger groups with matched GCS/intra-cranial pathology

Linear relationship between 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 – due to tearing of bridging veins
  - Larger, more midline shift, mortality rate 4x greater
- Epidurals are relatively rare – dura adheres to skull
Study of Mild Head Trauma (GCS 13 - 15)

- 14% had evidence of head injury on CT
- 20% of those → neurosurgical intervention
- No clinical predictors identified that could distinguish those with (+) CT and those (-) CT

Recommendations:

- CT all GT with signs of head injury/altered GCS
- Serial neurologic examination
Traumatic Brain Injury on AC

77 AC Patients/Mild Head Trauma (GCS 13-15)

- Often supratherapeutic – average INR 4.4
- Mortality 80.6%
- 54/77 admitted for observation (NO reversal)
  - 70% of these had a “normal” initial CT head
  - 80% deteriorated within 12 hours to a GCS < 10 and had significant intracranial hemorrhage
- Mandatory admission for AC patients!
  - Reversal of Anticoagulation if supratherapeutic
  - Frequent neurologic exam
  - Liberal use of CT (initial CT / repeat CT in 6 hours)
TBI and Anticoagulants

- Dramatically increase morbidity and mortality associated with elderly TBI
- Coumadin:
  - Independent predictor mortality TBI
  - Elderly more likely present with supra-therapeutic INR
  - Remove TBI – Coumadin is not associated with worse outcomes

- No good reversal strategies for anti-platelet agents (prasugrel/Effient, clopidogrel/Plavix)
  - Adenosine di-phosphate Inhibitors
  - Platelet transfusion, desmopressin (DDAVP) and rFVIIa MAY offset some bleeding
  - P2Y12 Level – platelet activation = ADP + P2Y12 receptor
    - P2Y12 receptor is blocked by Plavix/Effient
    - Result: less than 194 PRU means receptor blockade and platelets don’t function

Head Imaging should be done EARLY! (Goal CT w/i 15min)
Antiplatelet drugs

- Cyclooxygenase inhibitors
  - Aspirin
- Adenocine di phosphate (ADP) receptor inhibitors
  - Clopidogrel (Plavix)
  - Ticlopidine (Ticlid)
- Phosphodiesterase inhibitors
  - Cilostazol (Pletal)
- Glycoprotein IIb/IIIA inhibitors (intravenous use only)
  - Abciximab (ReoPro)
  - Eptifibatide (Integrilin)
  - Tirofiban (Aggrastat)
  - Defibrotide
- Adenocine reuptake inhibitors
  - Dipyridamole (Persantine)
~ 15% of Geriatrics pts taking it (65% cardiac)

If not reversed, GT have 10 fold ↑ mortality
  - GT/Coumadin/ICH – 48% v. GT/ICH – 10%

Reversal
  - FFP – issues: volume required (10ml/kg)/frozen
    - GT 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
    - 1/10 cost of VIIa, ½ Life ~ 20 hours
    - Low risk of thrombotic events - < 2%
    - Dosing: INR > 5 – 30 IU/kg; INR < 5 – 15 IU/kg (50cc)
How should coagulation-based coagulopathy be treated?

- Ivascu et al.: Posttraumatic intracranial hemorrhage in elderly patients with Coumadin-related coagulopathy:

  - Protocol:
    1. Rapid head computed tomography
    2. Initiation of INR-correcting therapy within 1.9 hours
    3. Full correction of coagulopathy within 4 hours of admission
      - 75% decrease in mortality


TBI and Direct Factor Inhibitors

- Dabigatran- direct thrombin inhibitor
  - Praxbind – reversal agent
- Rivaroxaban/Apixaban /Edoxaban
  - Direct Xa inhibitors
  - Currently: NO MEANS OF REVERSAL
    - Andexanet alfa – recombinant gene
  - Investigational studies on dialysis and PCC
- Thromboelastogram(TEG) useful to ID presence of these drugs and platelet inhibitors
Treatment: Dabigatran (Pradaxa)

bullet Idarucizumab (Praxbind) – new approved reversal agent ($3500.00)
  bullet 5g (2 - 2.5g vials) of intravenous idarucizumab as consecutive infusions
  bullet Can be given with saline
  bullet Kept refrigerated and once removed from vial given within one hour
  bullet Only useful for Dabigatran

bullet Administration of activated charcoal if ingested within two to three hours of presentation.

bullet Emergent hemodialysis to correct Thromboelastogram or ACT to < 150sec may be considered. (this would now be considered second line therapy)

bullet A normal aPTT in a patient receiving dabigatran is sufficient evidence to eliminate a significant dabigatran effect. A normal TT (thrombin time) in a patient receiving dabigatran is sufficient evidence to exclude dabigatran as a potential cause of bleeding. The TT is extremely sensitive to the effects of dabigatran and can be prolonged even by trivial amounts of the drug.
IV Thrombin Inhibitors: Argatroban, Bivalirudin (Angiomax)

There is no specific reversal agent or pharmacologic antidote. Due to the short half-life of these agents (Argatroban 40-50 min; Bivalirudin 25 min), management of hemorrhagic complications is primarily supportive and interruption of treatment will be sufficient to reverse the anticoagulant effect.

Consider any of the following based on bleeding severity:

- Symptomatic treatment
- Mechanical compression
- Surgical intervention
- Fluid replacement and hemodynamic support
- Blood product transfusion – RBCs for severe or symptomatic anemia, platelets if thrombocytopenia

If hemostasis is not achieved with the strategies outlined above, consider the administration of 2-4 units of fresh frozen plasma (FFP).

For severe, life-threatening bleeding

No agent has been shown to successfully reverse the anticoagulant effects of intravenous DTIs or treat DTI-related bleeding events. However, the interventions below may be considered.

1. Administer Kcentra® (4-factor PCC)
   a. 50 units/kg IV (max dose 5000 units) x 1
   b. STOCKED IN PHARMACY – call with STAT order 686-6221
2. For persistent refractory bleeding, consider pursuing formal Hematology consult
3. To investigate potential causes of the bleeding event, obtain the following: serum creatinine, PT, aPTT, TT, CBC (platelets).
Severe Traumatic Brain Injury Outcomes

Elderly patients with severe traumatic brain injury
- GCS ≤ 8 for 72 hours or more
- At least 80% mortality or long term placement disposition
- Justifies discussion regarding goals of care after initial phase of care and withdrawal of all sedatives

Complications

- GT complication rate 33%
- Preventable complications contribute to over 30% of all GT deaths
- Rest of complications related to pre-existing conditions and age-related physiologic changes
- Infection risk ~ 40% for nosocomial infections
  - COPD independent predictor of infection
Principles in Management of GT patient toward improved function

- Treat individual, not just the injuries
- Align team resources
- Avoid AGEISM- stereotyping older patients
- Emphasize respect/sense that GT patient viewed as an 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
  - Optimize mobility
  - Mitigate delirium
- Use elderly-appropriate meds and doses
- Avoid benzodiazepines
- Monitor use narcotics
- Epidural analgesia especially with multiple rib fractures
- Consider non-narcotics
  - NSAIDS
  - Tramadol
Multi-disciplinary Treatment Plan

- Early mobilization/ambulation
  - Standard care bundles
  - 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
Summary

- Elderly population (≥65) fastest growing age group
- Will account for majority of trauma admissions over the 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 risk of occult hypo-perfusion
- Measure ABG/base deficit/lactate
Summary

- Low threshold for CT scan
- Rapid Head CT and correction of coagulopathy with ICH and anticoagulants
- GCS ≤8 associated with poor outcome
- Create multi-disciplinary team and treatment plan to reduce complications and improve outcome
- GT patients eventually can return to productive lifestyle and independence