Trauma in the Elderly

C M Ursic
St George Hospital
Sydney
I don't want to achieve immortality through my work...
I want to achieve it through not dying.

Woody Allen
WHO Classification

“Aging is the combination of a set of gradual physiologic, organic, and emotional alterations, or the gradual and irreversible organic deterioration to adapt to environmental alterations.”

Middle Age  45-59 yrs
Elderly      60-74 yrs
Aged         75-90 yrs
Very Old     >90 yrs
MEDIAN AGE:

2002: 35 yrs
2021: 40 yrs
2051: 45 yrs
POPULATION GROWTH BY AGE
AUSTRALIA

% Total Population

Age ≥ 65
Age ≥ 85

YEAR

2002 2021 2051 2101
POPULATION, Age and Sex
NEW ZEALAND

1996
90+
75-79
60-64
45-49
30-34
15-19
0-4
%

2051
90+
75-79
60-64
45-49
30-34
15-19
0-4
%

Male
Female
ST GEORGE HOSPITAL
2003

TRAUMA MORTALITY BY AGE

Mortality (%)

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-14</td>
<td>1.1</td>
</tr>
<tr>
<td>15-29</td>
<td>1.4</td>
</tr>
<tr>
<td>30-44</td>
<td>2.0</td>
</tr>
<tr>
<td>45-59</td>
<td>1.5</td>
</tr>
<tr>
<td>60-74</td>
<td>1.8</td>
</tr>
<tr>
<td>75-90</td>
<td>3.9</td>
</tr>
</tbody>
</table>
Geriatric Trauma Victims Have:

1. Higher Mortality Rate
2. Higher Complication Rate
3. Longer Hospital Stay

- For Equivalent Injury Severity

Champion, et al, AJPH 1989
Pre-existing Diseases and Mortality

# Increased Relative Risk of Death by Chronic Medical Condition and Injury Severity Score (ISS)

McGwin, et al  
*J Trauma* 2004

<table>
<thead>
<tr>
<th>Preexisting Condition</th>
<th>ISS 1-15</th>
<th>ISS 16-25</th>
<th>ISS 25+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renal</td>
<td>4.09</td>
<td>1.88</td>
<td></td>
</tr>
<tr>
<td>Cardiac</td>
<td>3.17</td>
<td>1.35</td>
<td></td>
</tr>
<tr>
<td>Hepatic</td>
<td>3.04</td>
<td>1.82</td>
<td></td>
</tr>
<tr>
<td>Respiratory</td>
<td>1.87</td>
<td>1.30</td>
<td></td>
</tr>
<tr>
<td>Hematologic</td>
<td>1.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imm.-compromised</td>
<td>1.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neurologic</td>
<td>1.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obesity</td>
<td></td>
<td>1.18</td>
<td>1.31</td>
</tr>
<tr>
<td>Immunologic</td>
<td></td>
<td>1.19</td>
<td></td>
</tr>
</tbody>
</table>

Source: National Trauma Data Bank
PHYSIOLOGY OF AGING

Myocardium
• Degeneration
• Fatty infiltration
• Stiffening, loss of elasticity

CO = SV x HR
PHYSIOLOGY OF AGING

Conduction
↓ Beta receptors
↓ Pacing myocytes
AV node atrophy
Bundle branch atrophy

Impaired ability to raise heart rate in response to stress
PHYSIOLOGY OF AGING

Atherosclerotic occlusive disease
Valvular thickening & calcification

Drugs
• Beta blockers
• Calcium channel blockers
• Afterload reducers

Pacemakers

Myocardia ischemia

Limited cardiac output
 PHYSIOLOGY OF AGING

- Alveolar elasticity
- Alveolar size

- Atelectasis
- Air trapping
PHYSIOLOGY OF AGING

- Cough & laryngeal reflexes
- Cough strength
- LES tone
- Mucociliary transport

↑ aspiration risk
## Physiology of Aging

<table>
<thead>
<tr>
<th>Problem</th>
<th>Age of Onset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest wall Stiffening</td>
<td>20</td>
</tr>
<tr>
<td>Loss of rib density/strength</td>
<td>30</td>
</tr>
</tbody>
</table>
PHYSIOLOGY OF AGING

Structural Changes
Cerebral atrophy: 10% loss of weight

greater movement of brain within skull

• Shearing / rotation

hematomas
PHYSIOLOGY OF AGING

Functional changes
Dendrite deterioration, accumulation of senile plaque, and atherosclerosis

• Memory
• Cognition
• Sensation
  ➢ Vision
  ➢ Hearing
  ➢ Vestibular

amyloid protein
PHYSIOLOGY OF AGING

Progressive fall in creatinine clearance by 80-90% over lifespan

Impaired thirst & ADH insensitivity: chronic dehydration

↑ Sensitivity to
- Contrast
- Aminoglycosides
- Hypovolemia

Acute ICU Renal Failure in elderly: 50% mortality
PHYSIOLOGY OF AGING

Others

↓ Bone density and strength ➔ susceptibility to fractures
↓ Muscle mass ➔ strength and coordination
Vitamin / mineral deficiencies ➔ poor wound healing
T & B cell dysfunction ➔ infections
Causes of Death: Age > 65

Zeitlow et al. J. Trauma 1994
Mechanisms of Injury

Champion HR, et al 1989
Mechanisms of Injury

FALL

MVC

Finelli et al – J Trauma, 1989
The Man-Killing Trees of Kogarah

DANGER
Falls

PREDISPOSING FACTORS

• Visual acuity
• Hearing
• Vestibular / proprioceptive functions
• Memory
• Cerebrovascular disease
• Cardiac dysrhythmias
• Dehydration
• Medications
Falls

• 75% of deaths occur in geriatric population

• 50% 1-year mortality if hospitalized for fall

Falls

Sterling, et al - 2001
## Injury Patterns for all Falls

<table>
<thead>
<tr>
<th>AIS REGION</th>
<th>Older (n=159) %</th>
<th>Younger (n=83) %</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head/neck</td>
<td>47</td>
<td>22</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Chest</td>
<td>23</td>
<td>8</td>
<td>&lt;0.003</td>
</tr>
<tr>
<td>Skin &amp; soft tissue</td>
<td>47</td>
<td>60</td>
<td>&lt;0.025</td>
</tr>
<tr>
<td>Abdomen</td>
<td>2</td>
<td>12</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Pelvis / extremity</td>
<td>27</td>
<td>14</td>
<td>&lt;0.021</td>
</tr>
</tbody>
</table>

Sterling, et al - 2001
Crashes

Leading mechanism of injury bringing elderly to trauma centers
Crashes

Leading cause of trauma death in ages 65-74
Crashes age 75+

- Incidence is second only to < 25 year-olds
- 50% due to driver error

Viano, et al. 1990
Crashes

Elderly more likely to be involved:

- Good weather
- Close to home
- In daylight hours
- At intersections
- Without alcohol use
Crashes

Predisposing factors

Old
- Dementia, memory loss
- Visual acuity
- Auditory acuity
- Arthritis, loss of strength
- Medications

Young
- High speed
- Alcohol
Auto vs. pedestrian: age 65+

64% occur within a crosswalk

20% of all fatalities occur in > 65 yrs age group (highest age group)
Auto vs. pedestrian incidence

Deaths Per 100,000

<table>
<thead>
<tr>
<th>Age</th>
<th>0-4</th>
<th>5-14</th>
<th>15-24</th>
<th>25-44</th>
<th>45-64</th>
<th>65-74</th>
<th>&gt;74</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaths</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>
Auto vs. pedestrian

Average U.S. cross-walk requires pedestrian speed

4 feet / second
Burns

Higher morb./ mort. for lesser burn severity

50% in-hospital mortality
Burns

Predispositions:
- Impaired sensorium
- Living alone
- Thinner dermis
- ↓ Epidermal proliferation

Poor prognosis:
- Lower extremity burns
- High fluid requirements
- Pneumonia

Anous, et al. 1986
Burns

Early Excision & Grafting

- Improved survival
- Fewer infections
- Shorter hospital stay

- Scott-Conner, et al. 1990
- Deitch, et al. 1983
Neurotrauma

Fall: most common mechanism
Mortality 4 X greater overall

<table>
<thead>
<tr>
<th>6-mo. mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>↑ ICP</td>
</tr>
<tr>
<td>Coma &gt; 72 hrs.</td>
</tr>
</tbody>
</table>

Ross. Et al. 1992
Neurotrauma

Chance of meaningful neurologic recovery after coma > 1 week

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Recovery Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;51 yrs.</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>20-50 yrs.</td>
<td>50%</td>
</tr>
<tr>
<td>0-19 yrs.</td>
<td>80-90%</td>
</tr>
</tbody>
</table>

Carlsson, et al. 1968
## Pre-Injury Warfarin & Head Injury Outcome

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Worse</th>
<th>Same</th>
</tr>
</thead>
<tbody>
<tr>
<td>'04</td>
<td>Lavoie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'03</td>
<td>Mina</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'03</td>
<td>Reynolds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'01</td>
<td>Karni</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'01</td>
<td>Li</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'01</td>
<td>Wojcik</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'00</td>
<td>Kennedy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'99</td>
<td>Garra</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'99</td>
<td>Ferrera</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Spine

Compared to 15-30 year-old age group:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia</td>
<td>2 X</td>
</tr>
<tr>
<td>GI hemorrhage</td>
<td>2 X</td>
</tr>
<tr>
<td>PE</td>
<td>7 X</td>
</tr>
<tr>
<td>D/C to chronic care</td>
<td>23 X</td>
</tr>
</tbody>
</table>

DeVivo, et al 1990
Spine

Lower survival for equal severity of injury

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Survival Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-30 y.o.</td>
<td>95%</td>
</tr>
<tr>
<td>&gt;60 y.o.</td>
<td>59%</td>
</tr>
</tbody>
</table>

DeVivo, et al 1990
### Rib Fractures

<table>
<thead>
<tr>
<th>age (yrs)</th>
<th>&gt; 65</th>
<th>&lt; 65</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilator days</td>
<td>4.3</td>
<td>3.1</td>
<td>0.16</td>
</tr>
<tr>
<td>ICU days</td>
<td>6.1</td>
<td>4.0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Hospital days</td>
<td>15.2</td>
<td>11.0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>22</td>
<td>10</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Rib Fractures

Mortality

Elderly

Young

Penetrating Injuries

Cook County Hospital 1983 – 1998
Age  64 – 90        N = 85

Compared to same-age blunt trauma:
• Lower mortality rate (20%)
• Lower complication (22%)

Penetrating Injuries

Cook County Hospital 1983 – 1998

<table>
<thead>
<tr>
<th></th>
<th>Young</th>
<th>Old</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>complication</td>
<td>17.6%</td>
<td>22.3%</td>
<td>NS</td>
</tr>
<tr>
<td>mortality</td>
<td>10%</td>
<td>10%</td>
<td>NS</td>
</tr>
<tr>
<td>ICU care</td>
<td>22%</td>
<td>32%</td>
<td>NS</td>
</tr>
<tr>
<td>ICU L.O.S.</td>
<td>3.4 d</td>
<td>7.4 d</td>
<td>0.047</td>
</tr>
<tr>
<td>D/C home</td>
<td>98.8%</td>
<td>79%</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Survival Probability (blunt trauma) vs. ISS by Age

Baker, et al. 1974
## Death Rate (%) v.s. ISS

3,883 patients from the MTOS

<table>
<thead>
<tr>
<th>ISS</th>
<th>&lt; 65</th>
<th>&gt; 65</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-8</td>
<td>0.3</td>
<td>3</td>
</tr>
<tr>
<td>9-15</td>
<td>2.7</td>
<td>6.9</td>
</tr>
<tr>
<td>16-24</td>
<td>10.5</td>
<td>28.9</td>
</tr>
<tr>
<td>25-40</td>
<td>29.3</td>
<td>51.4</td>
</tr>
<tr>
<td>41-49</td>
<td>50.0</td>
<td>73.7</td>
</tr>
<tr>
<td>50-74</td>
<td>65.2</td>
<td>90.5</td>
</tr>
<tr>
<td>75</td>
<td>89.9</td>
<td>94.4</td>
</tr>
</tbody>
</table>

Champion HR, et al. AJPH, 1989
Mortality vs. ISS

LD$_{50}$ after age 65

Predicting Mortality

<table>
<thead>
<tr>
<th></th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>*GCS &lt; 8</td>
<td>86</td>
</tr>
<tr>
<td>SBP &lt; 90</td>
<td>86</td>
</tr>
<tr>
<td>Inotropic / vent support</td>
<td>75</td>
</tr>
<tr>
<td>*Previous MI</td>
<td>78</td>
</tr>
</tbody>
</table>

* independent risk factor by multivariate logistic regression

Zeitlow et al. J. Trauma 1994
Predicting Mortality

- Shock (SBP < 80)
- Head injury
- Pneumonia

- Shock (SBP < 90)
- Head Injury (GCS = 3)
- RR < 10/min

Aggressive Treatment for Elderly Trauma Victims IS Warranted.

<table>
<thead>
<tr>
<th>AGE &gt; 70 and ISS &gt; 15</th>
<th>NO</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trauma Team Activation</strong></td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>N</td>
<td>260</td>
<td>76</td>
</tr>
<tr>
<td>Age</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Gender</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>ISS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Mechanism</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>54</td>
<td>34</td>
</tr>
</tbody>
</table>

No Immediate Miracles...

Looking for the Fountain of Youth?
Call 1-800-222-2225
FREE Fact Sheet
about "anti-aging" miracle drugs.

National Institute on Aging
National Institutes of Health
Prevention

- Home safety inspections
- Medication awareness
- Driver education
- Street / pedestrian safety
- Reduction of energy transfer
Prevention

- Vision and hearing changes
- Effects of medication
- Reaction time changes
- Left turns and other right-of-way situations
- New laws and how they affect you
- Hazardous driving situations
Prevention

Queens, N.Y.
Pedestrian safety programs

Outcomes
↓ 43% Fatalities
↓ 86% Injuries

Retting, et al. 1989
GENERAL APPROACH TO THE ELDERLY:
All the usual principles apply....

1. Suspect underlying chronic disease

2. Suspect head injury
   • Liberal use of CT scan

3. Resuscitate quickly
   • Avoid hypoxemia, hypotension

4. Anaemia to 80 g/L is usually well tolerated

5. Rehabilitation is usually mandatory
Summary

1. Different injury patterns (falls # 1)
2. Aging = ↓ physiologic reserve
3. Higher mortality for equal/lesser injury severity
4. Shock & CNS injury = poor prognosis
5. Prevention is the new frontier...
“You can live to be a hundred if you give up all the things that make you want to live to be a hundred.”
Woody Allen