Trauma system development in Ontario: Getting the right patient to the right place at the right time

Avery B. Nathens MD MPH, Professor
Departments of Surgery & Health Policy, Management, and Evaluation, University of Toronto &
Medical Director of Trauma, St. Michael’s Hospital
In the event of a life threatening injury, how important is it to be treated at a trauma centre?

A. Very important
B. Moderately Important
C. Unimportant
How important is it for an ambulance to take you to a trauma centre, even if it is not the closest hospital?

A. Very important
B. Moderately Important
C. Unimportant
Do you believe that you would be taken to a hospital that is best equipped to handle your injury within the golden hour?

A. Absolutely
B. Depends on weather
C. Come on - you are joking?
American Civil War: 1861
Mortality: 25%
Transport time: 72 hrs
Factors: +/- ambulance

WW I: 1914
Mortality: 8.6%
Transport time: 8 hrs
Factors: ambulance (motorized)
World War II: 1939
Mortality: 4.5%
Transport time: 4 hrs
Factors: Ambulance, Medics, Plasma, Antibiotics
Korean War: 1951
Mortality: 2.5%
Transport time: 1.25 hrs
Factors: Helicopter, MASH
Viet Nam War: 1965-1972
Mortality 1.9%
Transport time: 27 minutes
Factors: Helicopter, Medics, Fixed wing
circa 1947
A tale of two counties
West & Trunkey, 1979

- Orange County
  - Trauma patients transported to nearest of 39 facilities
  - Preventable deaths: 43%

- San Francisco County
  - Trauma patients transported to 1 centrally located trauma facility
  - Preventable deaths: 1%
A National Evaluation of the Effect of Trauma-Center Care on Mortality

Ellen J. MacKenzie, Ph.D., Frederick P. Rivara, M.D., M.P.H.,
Gregory J. Jurkovich, M.D., Avery B. Nathens, M.D., Ph.D.,
Katherine P. Frey, M.P.H., Brian L. Egleston, M.P.P., David S. Salkever, Ph.D.,
and Daniel O. Scharfstein, Sc.D.
NSCOT – National Study of Cost and Outcomes in Trauma Care

- Prospective cohort study
- 18 level I trauma centers and 51 large non-designated centers in 15 urban
- Extensive data collection to allow for risk adjustment
  - Follow-up x 1 year
National Evaluation of the Effect of Trauma Center Care on Mortality


25% lower risk of death at one year in trauma centers

N = 15,000 patients

<table>
<thead>
<tr>
<th>Time from injury</th>
<th>NTC</th>
<th>TC</th>
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<tbody>
<tr>
<td>In hospital</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 d</td>
<td></td>
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<tr>
<td>90 d</td>
<td></td>
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<tr>
<td>365 d</td>
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Mortality (%)
Do trauma centers improve outcomes among survivors?
- SF-36, functional capacity, return to work
- Modest improvement in SF-36 scores only among those with severe lower extremity trauma (J Bone Joint Surgery, 2008)

Are trauma centers cost effective?
- One year costs: $80,232 in trauma centers vs $58,320 in non-trauma centers
- $36,319 per life–year gained or $790,931 per life saved
  - 50-100k per life year gained is considered acceptable
“Get the right patient to the right place at the right time”
Effect of regional trauma systems

**Figure.** Crash Mortality as a Function of Time From First Trauma Center Designation

10% reduction in mortality
# Effect of trauma systems on motor vehicle crash mortality

Nathens, *JAMA*, 2000

<table>
<thead>
<tr>
<th>Legislation</th>
<th>Effect on crash mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional trauma system</td>
<td>↓ 9%</td>
</tr>
<tr>
<td>Primary restraint laws</td>
<td>↓ 13%</td>
</tr>
<tr>
<td>Secondary restraint laws</td>
<td>↓ 3%</td>
</tr>
<tr>
<td>65 mph (vs 55 mph) speed limit</td>
<td>↑ 7%</td>
</tr>
<tr>
<td>Administrative revocation laws</td>
<td>↓ 5%</td>
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Trauma System Components

- Pre-hospital triage protocols
  - Bypass of nearer, non-designated centers
- Trauma center designation process
- Interfacility transfer agreements
- System-wide quality assurance
- Region-wide trauma center coverage
- Number of trauma centers based on need
- Supported by legislation
- High speed rollover
- 35 yo restrained driver
- Awake alert, VSS
- No obvious injuries
Ideal Triage

- Direct patients with serious injuries to centers with available resources and personnel

- Direct those with less serious injuries to all other centers within same geographic area
Field triage goals – a balance

- **Undertriage** – major trauma patient triaged to center with inadequate resources
  - Patient incurs risk

- **Overtriage** – minimally injured trauma patient triaged to regional trauma center
  - System incurs risk
    - Utilization of limited material, financial and human resources
    - Inconveniences family/patient
Field Triage Tools - Overview

- Physiologic criteria
- Anatomic criteria
- Mechanism of injury
- Modifiers
Physiologic criteria - ACS field triage

Pros
- Objective, quantifiable
- Easily assessed
- Predictive of death

Cons
- Time dependent

- GCS < 14
- SBP < 90
- RR < 10 or > 29
Anatomic criteria - ACS field triage

- Penetrating injury proximal to elbow or knee
- Flail Chest
- Trauma with burns
- ≥2 proximal long-bone #
- Pelvic #
- Open & depressed skull #
- Paralysis
- Amputation proximal to wrist or ankle
- Major burns

- Pros
  - Accurate if injury obvious

- Cons
  - Physical exam not predictive of injuries
  - Time consuming exam
Mechanism of injury - ACS field triage

- Falls >20 ft
- High risk crash
  - Ejection
  - Death in same compartment
  - Intrusion > 12 in occupant compartment
  - Intrusion > 18 in anywhere
- Auto-pedestrian/cyclist >20 mph
- Motorcycle crash > 20mph

- Pros
  - Estimate of type, amount, direction of force applied
  - Readily assessed by EMS personnel

- Cons
  - Estimate of potential, not actual injury
  - Limited value when used alone
Modifiers: permissive criteria - ACS field triage

- Age <5 or >55
- Anticoagulation
- Burns
- Pregnancy

Pros
- Good predictor of bad outcomes

Cons
- Cannot be determined in field
- Underutilized
Field Triage Decision Scheme:
ACS COT, Resources for Optimal Care, 2007

Physiologic criteria

Anatomic criteria

Consider transport to a trauma center

Mechanism

Modifiers (Permissive)

Transport to highest level of trauma care available: alert trauma team
ACS Trauma Triage Criteria

*Norcross, JACS, 1995*

Goal: Identify those with ISS>15

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<tr>
<th></th>
<th>Physiologic</th>
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</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>65%</td>
</tr>
<tr>
<td>Overtriage</td>
<td>58%</td>
</tr>
<tr>
<td>Undertriage</td>
<td>8%</td>
</tr>
<tr>
<td>Accuracy</td>
<td>80%</td>
</tr>
</tbody>
</table>
Compliance with protocols: 
*Ma, J Trauma, 1999*

- Response to therapy
- Concern for deterioration
- Patient preference
- Ageism

- Physiologic: 34%, 23%
- Anatomic: 89%, 86%, 83%
- Mechanism: 69%, 65%, 46%, 38%

Age > 55
Predictors of undertriage

- Advanced age - single most important predictor of undertriage
  - Zimmer-Gembeck, J Trauma, 1995
Undertriage in the Elderly

*Scheetz, J Emerg Nurs, 2003*

- Triage tools insensitive in the elderly

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<thead>
<tr>
<th></th>
<th>Age&lt;65</th>
<th>Age≥65</th>
</tr>
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<tbody>
<tr>
<td>Sensitivity</td>
<td>91%</td>
<td>83%</td>
</tr>
<tr>
<td>Undertriage</td>
<td>6%</td>
<td>9%</td>
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Toronto Field Trauma Triage Guidelines: Physiologic criteria

- GCS\(\leq\) 10 OR
- Two or more of
  - Any alteration in level of consciousness.
  - A pulse rate less than 50 or more than 120.
  - A blood pressure less than 80 or an absent radial pulse
  - A respiratory rate less than 10 or greater than 24
Anatomic

- Spinal Cord injury with paraplegia or quadriplegia.
- Penetrating injury to head, neck, trunk or groin, OR
- Amputation above the wrist or ankle
Divert if anticipate won’t survive
- Complete airway obstruction
- Absence of spontaneous respirations
- Absence of a palpable carotid pulse

Estimated transport time > 30 minutes
Trauma Center Designation Levels

- **Level I/II**
  - Provides definitive care - urban
  - Exclusive system

- **Level III/IV/V**
  - Initial care of major trauma – rural
  - All centers involved in quality assurance
  - Easier identification of need to transfer to higher level center
  - Decentralized in case of disasters

Inclusive system
Inclusive Trauma Systems: Do They Improve Triage or Outcomes of the Severely Injured?

Garth H. Utter, MD, MSc, Ronald V. Maier, MD, Frederick P. Rivara, MD, MPH, Charles N. Mock, MD, PhD, Gregory J. Jurkovich, MD, and Avery B. Nathens, MD, PhD, MPH

Mortality reduction: 7%

Mortality reduction: 23%
Geographic variations in MVC-mortality: *Baker et al, 1987*

Population density (persons/sq mile)  
MVC mortality (per 100,000 persons)

Esmerelda, NV versus Manhattan, NY
Twice the size of Texas: 416,000 sq mi
13 million people
90% rural
- 15% of the population >60 miles from a specialist

Exclusive system
- 9 adult trauma centers
- No standards for ED’s & no lower level centers
- No system PI
Do we have a problem?

- Everyone says
  - “No problem”
  - “Everything works fine”
  - “No one is dying”
- No data = no problem
Leg break equals Buffalo wings

Toronto Sun, June 25th, 2009
Access to trauma centre care in Ontario

Proportion of severely injured patients who receive definitive care at non-trauma centres

Source: NACRS/DAD (2002-2008)
Projection: Canada Albers Equal Conic
Produced by: David Gomez

No realized access:
- 3% - 25%
- 26% - 50%
- 51% - 75%
- 76% - 100%

H: Trauma Centres
Transfer Patients

Overall pre-hospital time (min)

Mean – 6 hrs
90% percentile - 11 hrs

Mean – 6 hrs
90% percentile - 11 hrs
~20% of all deaths occur in ED’s before transfer
Summary

- Trauma centres save lives
- There is opportunity for significant trauma system development in Ontario
  - Identifying level 3 or 4 centres
  - Improving identification of severely injured patients and facilitating rapid transport
- There is a plan to get you to the right place
  - It just might take a while
  - ...and bring your passport