Trauma System Resource Optimization in Thirteen States

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Trauma in the United States

- 30 million annual ED visits, 2 million hospitalizations, 160,000 deaths
- Trauma centers reduce mortality risk by 25%
- Helicopter transport reduces mortality risk by 15%
- 35% of severely injured pts treated at non-trauma centers
- Healthy People 2020 Goal: improve access by 10%
  - Currently 87.1%
  - Goal 91.4%

1. CDC Injury Fact Book, 2006
3. Galvagno, JAMA 2012
System Design for Time-Critical Disease

• Unplanned critical illness requires population-based planning
• Patients seek/receive care in different manner than for other diseases
  • Time = medicine
  • Geographic access = time to treatment
  • EMS providers frequently decide destination
• Resource allocation to maximize population access to care
Objective

• Determine optimal placement of trauma centers and helicopter depots in order to maximize population access to trauma care
Methods

Data
- US Census Estimates
- American Hospital Association Annual Survey
- Trauma Information Exchange Program national trauma center inventory
- Atlas and Database of Air Medical Services national air ambulance inventory
- State Inpatient Databases
- National Center for Health Statistics’ Multiple Cause of Death data
- 13 states: CA, FL, CO, IA, MD, NC, NJ, NY, OK, OR, PA, UT, WA

Population
- Severely injured patients (Injury Severity Score > 15 or death from injury)
Calculating Access

• The Trauma Resource Allocation Model for Ambulances and Hospitals (TRAMAH)
  • Number of severely injured patients assigned to each ZIP code centroid
  • Time to Level I/II trauma center (TC) within 60 minutes by air or ground ambulance
Ground Ambulance Calculations

- Prehospital time intervals

- Ground ambulance estimates
  - Include prehospital intervals
  - Distance and driving speeds adjusted for urban/suburban/rural location
Air Ambulance Calculations

- Include activation, warm-up, response, on-scene, and transport intervals
- Cruise speeds of helicopters at each helicopter depot (HD)
- Ellipse-shaped access

![Diagram showing TC and HD with time intervals for TC to HD and HD to TC.]
Air or Ground Access

- Helipads
- Trauma Centers

Scale: 0 10 20 40 60 80 Miles
www.traumamaps.org
Location Optimization

• Enumeration Algorithm
  • Search all possible solutions to find the one best solution
  • TC candidate sites: acute care hospitals with 24/7 ED
  • HD candidate sites: existing airports, helipads, hospitals
  • Limit to 2 changes to current system (addition or relocation)
Add 1 Helipad

5.8% max gain in NC – 3.4% average gain in multiple states (60 min)
Results: Addition of Resources

![Graph showing state-wise access increase with different resource addition scenarios.](image-url)
Add 1 Helipad

5.8% max gain in NC – 3.4% average gain in multiple states (60 min)
Add 1 Trauma Center

7.8% max gain in MD – 6.4% average gain in multiple states (60 min)
Add 2 Trauma Centers

3.7% max gain in WA – 9.2% average gain in multiple states (60 min)
Add 1 Trauma Center, 1 Helipad

33.2% max gain in OK – 9.4% average gain in multiple states (60 min)
Results: Relocation

![Graph showing the percentage of access increase in different states for various relocation scenarios. The x-axis represents the states, and the y-axis represents the percentage increase. Different lines represent different relocation scenarios: Relocate 1 HD, Relocate 2 HD, Relocate 1 TC, Relocate 2 TC, and Relocate 1 HD/1TC.]
Diminishing Returns

Population Access to Trauma Care vs. System Investment

Branas, Socio-Economic Planning Sciences 2001
Trauma System Design is (Conceptually) Easy

1. Maximize access to trauma care
2. Minimize number of resources
In Reality, It’s Complicated

- Capacity
  - Trauma Centers
    - Number and size
  - EMS System
    - Vehicles and staff

- System Goals
  - Maximize population access
    - Overall population vs. at risk population
  - Reduce disparities
Conclusions and Next Steps

- Optimizing the location of resources can improve population access to care

Next Steps:

- Capacity considerations
- Cost and outcomes projections to compare effectiveness of different scenarios
- Other time-critical diseases
- Interactive website where policymakers can simulate their own scenarios (www.traumamaps.org)
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