A GIS Evaluation of Emergency Medical System (EMS) Response to Alaskan Car Crashes

Marie Flanigan, Kevin Majka, Alan Blatt
CUBRC

and

Ron Perkins, Beth Schuerman
Alaska Injury Prevention Center

For Presentation Tuesday, Aug 15, 2006
at
Rural ITS Conference
Big Sky, Montana

Distribution: NHTSA permission granted to show (at conference) but not release maps of geocoded FARS data.
Acknowledgements

- Louis Lombardo and Barry Eisemann (NHTSA)
- Mary Russell (CUBRC)
- Association of Air Medical Services (AAMS)

This material is based in part upon work supported by the Federal Highway Administration (FHWA) under Grant No. DTFH61-98-X-00103 to the Center for Transportation Injury Research.
Response to Car Crashes in Alaska

Introduction
• There were 327 motor vehicle crash (MVC) deaths & over 25,000 MVC injuries (2001-2004).
• CUBRC & AIPC are working on a project to:
  – Improve EMS response to car crashes (especially in rural areas)
  – Develop metrics to measure these improvements.

This Paper
• Uses Geographic Information System (GIS) tools to study access to trauma care in Alaska considering locations of:
  – Fatal motor vehicle crashes (over 4 year period)
  – Ground ambulance depots & air medical rotor wing (RW) bases
  – Hospitals and trauma centers

Objective
• Develop metrics to model & analyze emergency medical response to MVCs.
  – Examine ‘computed’ travel times from Ambulance Base to Scene to Hospital
EMS Has Come a Long Way...
Center for Transportation Injury Research

Background Literature

• Patients with serious injuries benefit from receiving definitive surgical care at a trauma center

• Previous studies looked at access to trauma care by state based on trauma center locations & population distributions
  • Number & type of trauma centers by state
  • Calculated travel time by ground or air (from census blocks) to trauma centers

Maps Adapted from Branas, 2005

Theoretical study presented here will look at travel times to the hospital relative to fatal crash injury location in the State of Alaska.
Data Sources

Scene Locations

• Crash Locations
  – Future studies will include serious injury crashes as well as fatal crashes

Infrastructure Locations & Attributes

• Hospitals & Trauma Centers
  – Alaska Injury Prevention Center (AIPC), Alaska Community Health & Emergency Medical Services (CHEMS), Alaska State Sources
• Ground Ambulance Depots
  – Alaska Injury Prevention Center (AIPC) & Alaska Community Health & Emergency Medical Services (CHEMS)
• Air Medical Rotor Wing Base Helipads
  – Atlas & Database of Air Medical Services (ADAMS) 2004. Developed by CenTIR / Association of Air Medical Services / USDOT
Methodology

Emergency Response Infrastructure

- Pre-Hospital Emergency Medical Services
  - Geocoded ADAMS’ Air Medical Bases
  - Ground Ambulance Depots
- Public Safety
  - PSAPS, Police, Fire
- Hospital
  - Hospitals & Trauma Centers

*ESRI ArcGIS StreetMaps USA 8.3

Geocode ESRI ArcGIS 9.1*

Geodatabase

Modeling and Analysis

Alaska Crash Data

Geocoded FARS Data

Crash Scene
Alaska Geocoded Emergency Medical Infrastructure Locations

Legend

Air Medical Base (9)
10, 20, 30 minute Fly Circles around Helipad

Ground Ambulance Depot (131)
Advanced Life Support (ALS) (36)
Basic Life Support (BLS) (45)
All Other (50)

Hospital (27)
Level 2 Trauma Center (1)
Level 4 Trauma Center (2)
Acute Care Hospitals (24)
Crash Event Timeline and Time Budgets¹
To Reach Surgery in ‘Golden Hour’

1 min
Time From Crash to EMS Notification

<10 min
Time From EMS Notification To Scene Arrival

<15 min
Time To Triage, Treat and Package

<20 min
Time To Transport to Hospital

~45 min  ~60 min
Surgery

Crash Event Timeline and Time Budgets

To Reach Surgery in ‘Golden Hour’

1 min

Time From Crash to EMS Notification

<10 min

Time From EMS Notification To Scene Arrival

<15 min

Time To Triage, Treat and Package

<20 min

Time To Transport to Hospital

Leg 1 Transport Base to Scene

Leg 2 Transport Scene to Hospital

~45 min 60 min

Surgery

Crash Event

9-1-1 PSAP Notification EMS Dispatch

EMS Arrival at Scene

Prehospital Triage Treatment

EMS Departing Scene

EMS Arrival at Hospital ER

Air Ambulance Travel Times
Fatal Crash Locations Color Coded by ‘Computed’ Air Medical Transport Times for Leg 1

Helipad Base to Scene

**Approach**
- Distance (as crow flies) from Helipad Base to Crash Scene.
- Flight distance converted to time using average speed in ADAMS (129 knots).

**Legend**
Dots show locations of 307 fatal crashes. Colors indicate flight times.

- Blue: 0 - 5 minutes
- Black: 6 - 10 minutes
- Green: 11 - 30 minutes
- Yellow: 31 - 60 minutes
- Red: > 60 minutes

Distribution: NHTSA permission granted to show (at conference) but not release maps of geocoded FARS data.
Cumulative Percent of Crashes with ‘Computed’ Flight Time ≤ ‘X’ for Transport Leg 1

64% of the crashes have base-to-crash scene flight times ≤ 15 minutes.

Total Travel Budget (Legs 1+2) limited to 30 minutes to meet ‘Golden Hour’ goal.
**Flight Time ‘Computed’ from Nearest Rotor Wing Base → Crash Scene → Level 2 Trauma Center**

**Legend**
Dots indicate locations of 307 fatal crashes. Colors indicate travel times.
(129 knots average speed)

- 0 - 10
- 11 - 30
- 31 – 60
- 61 - 150
- > 150 minutes

Distribution: NHTSA permission granted to show (at conference) but not release maps of geocoded FARS data.
Legend

Dots indicate locations of 307 fatal crashes. Colors indicate travel times.

- **0 - 10**
- **11 - 30**
- **31 – 60**
- **61 - 150**
- **> 150 minutes**

Distribution: NHTSA permission granted to show (at conference) but not release maps of geocoded FARS data.
Cumulative Percent of Crashes with ‘Computed’ Flight Time \( \leq \) ‘\( X \)’ for Transport Legs 1 + 2

Flying at 129 knots
48% could reach L2 Trauma Center
67% could reach Closest Hospital within 30 min Travel Budget

Flight Time from Closest Rotor Wing Base \( \rightarrow \) Crash Scene \( \rightarrow \) Closest Specified Medical Facility (mins)
Ground Ambulance Computed Travel Distances & Times
Determine Driving Distance via Ground Ambulance

**Legend**

- **Ground Ambulance Depots**
  - Advanced Life Support (ALS)
  - Basic Life Support (BLS)
  - All Other
- **Hospitals**
  - Level 2 Trauma Center
  - Acute Care Hospitals
- **Crash Site**

**Distribution:** NHTSA permission granted to show (at conference) but not release maps of geocoded FARS data.

**Computational Approach**

- Create network from street line file.
  - Compute topography & calculate distances.

- Add ground ambulance & hospital locations.
  - Create connectors to roadway network.

- Calculate all points *along network* that are within specified distances (5, 10, 15 miles) of ambulance bases or hospitals. Create polygon ‘bins’.

- Identify crashes in each polygon & assign them to 5, 10, 15 mile polygon ‘bin’
'Computed' Driving Distance from Nearest State Certified Ground Ambulance Depot to Crash Scene

Legend

- Dots indicate locations of 307 fatal crashes. Colors indicate travel dist.
  - 0 - 5 miles
  - 6 - 10 miles
  - 11 – 15 miles
  - > 15 miles

- ALS + BLS Ambulance Depot

At 45 mph, a 15 mile drive takes 20 min

Geocoded FARS data provided by NHTSA/NCSA

Distribution: NHTSA permission granted to show (at conference) but not release maps of geocoded FARS data.

307 (of 327) fatal crashes over 4 year period geocoded
'Computed' Driving **Distance** from Nearest State Certified Ground Ambulance Depot to Crash Scene to Closest Hospital.

Legend

- Dots indicate locations of fatal crashes. Colors indicate travel distance.
  - **0 - 10**
  - **11 - 15**
  - **16 - 20**
  - **21 - 25**
  - **26 - 30**
  - **> 30 miles**

**Distribution:** NHTSA permission granted to show (at conference) but not release maps of geocoded FARS data.

1 Geocoded FARS data provided by NHTSA/NCSA
Cumulative Percent of Crashes with ‘Computed’ Driving Time $\leq \ ‘X’$
for Transport Legs 1 & Legs 1+2

State Certified Ground Ambulances (ALS + BLS)

Driving at 35 mph
24% could reach L2 Trauma Center
45% could reach Closest Hospital
within 30 min Travel Budget
State Certified Ground Ambulances (ALS + BLS)

Speeds Examined
- 35 mph
- 45 mph
- 50 mph

Driving at 50 mph
- 28% could reach L2 Trauma Center
- 57% could reach Closest Hospital within 30 min Travel Budget
Summary & Concluding Remarks

• First steps in study completed:
  – Infrastructure identified and geocoded
  – Computational techniques developed
  – Initial metrics investigated

• Next Steps
  – Implement enhanced Alaska EMS data collection system
  – Refine models and analyze actual event time data
  – Utilize injury crashes in addition to fatal crashes
  – Explore additional metrics to support evaluations of new technologies for emergency notification, dispatch and response.