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Analysis of the Proximity of Fatal Motor Vehicle Crash Locations to the Availability of Helicopter Emergency Medical Service Response

Summary

Emergency medical service (EMS) response combined with the increasing availability and usage of advanced automatic collision notification (AACN) systems in motor vehicles are important components in the effort to reduce fatalities and serious injuries suffered in motor vehicle crashes. This research note examines fatal motor vehicle crash locations in relation to the coverage area of helicopter-based EMS and is a first step towards a better understanding of the contributions of EMS and AACN to reducing the injury severity outcome of motor vehicle crashes. This analysis could not determine the type of EMS response (if at all), only whether a crash occurred where helicopter-based EMS was available. Key results of this analysis show:

- About 80 percent of motor vehicle crash fatalities from 2005 to 2009 occurred within the 20-minute helicopter coverage area serving level I or II trauma centers.
- In 2005 to 2009 about 64 percent of fatally injured people outside the coverage area died at the crash scene, compared to 55 percent inside the coverage area.

Introduction and Objective

In 2009, 33,808 people were killed in an estimated 5,505,000 police-reported motor vehicle traffic crashes that also resulted in an estimated 2,217,000 people injured.¹ One of the first steps to understanding the impact of EMS on the injury outcomes of motor vehicle crashes is to determine the extent of the coverage area of EMS transport to the highest level of trauma care facilities. EMS transport can be either land-based or air-based.² For this report only helicopter EMS coverage was used because geographic positional information for exclusively land-based EMS was not available

in electronic format at the time of writing. Having said that, most land-based EMS coverage is contained within the helicopter coverage and therefore the helicopter coverage closely approximates the total coverage for all forms of EMS response. Based on the helicopter EMS coverage, the National Highway Traffic Safety Administration performed a geospatial analysis of fatal motor vehicle crash locations and their relationship to the availability of helicopter EMS.

Data and Methodology

A geospatial analysis of the proximity of fatal motor vehicle crashes to the availability of 20-minute-fly-circle helicopter EMS was performed. The following data was used in this analysis:

- Fatality Analysis Reporting System (FARS) (see Appendix); and
- Atlas & Database of Air Medical Services (ADAMS) (see Appendix).

Trauma Centers

A trauma center is a hospital that has additional resources and equipment to help care for severely injured patients. Trauma centers are classified as level I, II, III, or IV. A level I trauma center is designed and organized in order to provide the highest level of surgical care to trauma patients, and level II trauma centers are designed and organized to work in collaboration with the level I centers. Level III and below trauma centers do not have the capability to offer the full comprehensive care that is usually needed to handle the results of severe motor vehicle crashes. Research by the Centers for Disease Control and Prevention³ shows that access to a level I or II trauma center within 60 minutes—the

so-called “golden hour”—greatly reduces the chance of a fatal outcome for a patient. Data from the American Trauma Society² show that approximately 82 percent of the U.S. population (which represents about 28% coverage of the land) has access to helicopter transport within one hour of a level I or II trauma center.

Analysis of EMS Air Medical Coverage and Fatal Crash Locations

The ADAMS database helicopter EMS fly circle information was analyzed to look for spatial relationships with fatal motor vehicle crashes as collected in FARS. For the purpose of this analysis, fatal crashes were

analyzed based on proximity to 20-minute helicopter fly circles that had access to level I or II trauma centers. A 20-minute fly circle equates to areas that can be reached within a 20 minute from take-off. This was added to 20-minute return flying time, plus any additional time needed for flight preparation, to approximate to the 60-minute response time discussed above.

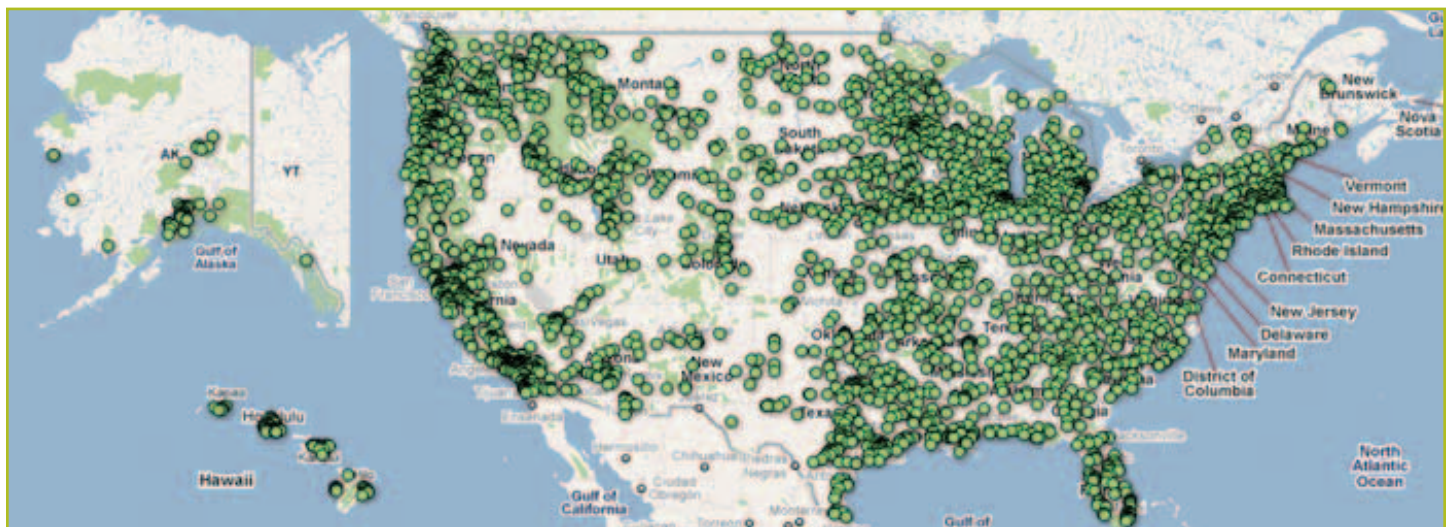
Figure 1 below shows 20-minute helicopter EMS fly circle coverage with access to a level I or II trauma center in the United States. (Note: Hawaii has no air coverage coded in the database but does have land-based coverage). Figure 2 below shows fatal motor vehicle crash locations in 2009.

Figure 1
Location of 20-Minute Helicopter Fly Circles With Access to Level I or II Trauma Centers



Data Source: Atlas and Database of Air Medical Services (ADAMS)

Figure 2
Location of Fatal Motor Vehicle Crashes in Year 2009



Data Source: The Fatality Analysis Reporting System (FARS)

Table 1 below displays the percent of fatalities, by State, shown in Figure 2 that occurred within the fly circles shown in Figure 1. Currently there is no information in FARS on the type of EMS response, so there is no way to know

exactly whether air medical services were called to a crash scene or not. It is only known that the crash was within the 20-minute helicopter coverage and therefore was a potential candidate for receiving EMS air medical service.

Table 1

Percent of Motor Vehicle Crash Fatalities Inside 20-Minute Helicopter Fly Circles of Level I or II Trauma Centers by Year and State

State	Trauma Center Level I Only					Trauma Center Level I or II				
	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
Alabama	26	30	32	31	32	43	46	47	47	45
Alaska ²						73	66	51	58	66
Arizona	67	71	68	66	69	82	85	81	79	81
Arkansas	11	12	12	10	11	54	57	56	54	53
California	89	88	89	89	88	97	96	96	96	97
Colorado	66	61	61	67	62	73	69	71	76	71
Connecticut	100	100	100	100	100	100	100	100	100	100
Delaware	100	99	100	98	100	100	99	100	98	100
Dist of Columbia	100	100	100	100	100	100	100	100	100	100
Florida	83	85	85	85	84	95	95	96	95	94
Georgia	73	73	72	71	73	79	78	77	77	77
Hawaii ¹										
Idaho	11	6	10	13	9	37	43	44	44	39
Illinois	89	88	90	89	90	93	93	94	94	94
Indiana	78	78	78	77	75	96	95	94	95	94
Iowa	41	46	43	50	42	81	80	77	86	81
Kansas	52	56	52	52	50	60	64	60	60	58
Kentucky	81	80	79	80	79	85	84	86	84	84
Louisiana	10	9	11	10	10	13	14	13	15	13
Maine	8	5	5	10	8	8	5	5	10	8
Maryland	99	100	100	99	99	99	100	100	99	99
Massachusetts	100	100	100	100	100	100	100	100	100	100
Michigan	86	85	85	83	86	86	85	86	84	86
Minnesota	68	65	61	63	60	82	76	75	76	79
Mississippi	48	50	51	46	50	65	61	67	65	63
Missouri	73	71	69	71	70	81	81	79	81	79
Montana ²						37	28	36	31	33
Nebraska ²						76	79	73	72	69
Nevada	66	68	67	66	59	84	83	84	83	75
New Hampshire	95	93	95	90	85	95	93	95	90	85
New Jersey	100	100	100	100	100	100	100	100	100	100
New Mexico	47	44	39	40	45	47	44	39	40	45
New York	95	95	92	95	94	97	97	97	97	97
North Carolina	83	79	80	81	80	90	87	88	90	89
North Dakota ²						24	23	19	27	29
Ohio	95	95	96	95	94	96	97	98	96	96
Oklahoma	42	42	46	44	46	47	45	47	47	50
Oregon	47	42	47	43	42	80	80	80	77	77
Pennsylvania	98	98	98	97	97	100	100	100	100	100
Rhode Island	100	100	100	100	100	100	100	100	100	100
South Carolina	87	85	85	88	85	87	85	85	88	85
South Dakota ²						25	23	20	24	22
Tennessee	86	85	86	88	87	93	93	93	95	94
Texas	70	69	70	71	72	73	72	74	74	75
Utah	61	62	60	64	61	61	62	60	64	61
Vermont	56	54	58	59	65	56	54	58	59	65
Virginia	97	98	97	95	96	97	98	97	95	96
Washington	51	52	44	44	49	53	53	46	48	51
West Virginia	96	96	97	98	99	97	98	98	98	99
Wisconsin	53	51	54	53	54	92	90	91	91	92
Wyoming	4	2	2	3	4	13	12	13	18	19
U.S. Total	72	71	72	72	71	81	80	80	81	80

¹ State has no EMS fly circles connected with level 1 or 2 trauma center.

² State has no EMS fly circles connected with level 1 trauma center.

Data Source: FARS and ADAMS

Figure 3 below shows the State-by-State variation on the percent of motor vehicle crash fatalities inside 20-minute helicopter fly circles of level I or II trauma centers as seen in Table 1. Figure 3 is sorted by State (from the smallest to the largest percentage) for 2009.

Location of a Person’s Death

The FARS database codes information on the location of a person’s fatality. The possible outcomes are (1) died away from the crash scene (hospital, nursing home, place of residence, etc.), (2) died at the crash scene, (3) died en route to medical facility, or (4) unknown location.

Figure 3
The Percent of Motor Vehicle Crash Fatalities Inside the 20-Minute Helicopter Fly Circles of Level I or II Trauma Centers By State (Smallest to Largest Percentage), 2009



Data Source: FARS and ADAMS

Table 2
Percentage of Motor Vehicle Crash Fatalities by Location of Fatality, 20-Minute Helicopter Fly Circle of a Level I or II Trauma Center and by Year

Crash Location	Year	Location of Fatality				Total
		Died Other (Hospital, etc.)	Dead at Scene	Died on Route	Unknown	
Within a 20-Minute Helicopter Fly Circle of a Level I or II Trauma Center	2005	44	55	1	1	100
	2006	43	56	1	0	100
	2007	43	56	2	0	100
	2008	41	55	3	0	100
	2009	43	53	2	1	100
Outside a 20-Minute Helicopter Fly Circle of a Level I and II Trauma Center	2005	34	64	1	0	100
	2006	34	65	1	0	100
	2007	33	64	2	0	100
	2008	32	65	3	0	100
	2009	34	63	3	1	100

Data Source: FARS and ADAMS

Table 2 below shows the percentage of fatalities by location of fatality in relation to the 20-minute helicopter fly circles.

Results

As shown in Table 1 above, there is a large variation by State, from 2005 through 2009, in the percentage of fatal crashes that were located within the coverage area of air medical services associated with level I or II trauma centers. The State-by-State variation for 2009 is shown in Figure 3. Although the average percentage of motor vehicle crash fatalities inside the 20-minute fly circles of level I or II trauma centers for the United

States was 80 percent, the percentage coverage across all States ranges from a low of 8 percent in Maine up to a high of 100 percent in six States (Connecticut, Delaware, Massachusetts, New Jersey, Pennsylvania and Rhode Island) and the District of Columbia. Table 2 shows that from 2005 through 2009, there was on average around a 10-percentage-point difference between the percentage of people who died at the scene of the crashes when the crashes occurred within the level I or II fly circles, compared to the percentage who died at the scene when the crashes occurred outside the level I and II fly circles (53 and 63% respectively for 2009).

Future Research and Data Limitations

FARS does not currently record whether the EMS response was air-based or ground-based, only that EMS was notified. This information will become available beginning with the release of FARS 2010. The FARS database also codes the following times: Crash, EMS notification, EMS arrival at the crash scene, and medical facility arrival. Future research will analyze and compare the characteristics of motor vehicle crashes both inside and outside the air medical coverage (rural/urban, speeding, crash type, vehicle type, etc.) in relation to the type of EMS response and the associated EMS times.

Appendix:

Fatality Analysis Reporting System

The FARS is a database maintained by NHTSA that contains data on a census of fatal traffic crashes within the 50 States, the District of Columbia, and Puerto Rico. To be included in FARS, a crash must involve a motor vehicle traveling on a trafficway customarily open to the public, and must result in the fatality of an occupant of a vehicle or a nonoccupant within 30 days of the crash.

Atlas & Database of Air Medical Services

The Center for Transportation Injury Research is located in Buffalo, New York, and teamed up with the Association of Air Medical Services to create ADAMS, the Atlas & Database of Air Medical Services. ADAMS was developed with support from the Federal Highway

Administration. The database is implemented in a Web-based geographic information system to provide a map context for data query and analysis. Specifically, ADAMS includes descriptive and geographic information on air medical service providers, their communication centers, base helipads, rotor and fixed-wing aircraft, and receiving hospitals. The need for such a data resource is driven by newly emerging automatic crash notification technologies that are changing both the content and the manner in which motor vehicle crash emergency messages are routed. In addition, ADAMS has attracted interest from homeland security and disaster response agencies. The ADAMS database contains the following information:

- Emergency air medical services in the United States:
 - ◆ Fixed wing (FW),
 - ◆ Rotor wing (RW) (helicopter),
 - 10-, 20-, and 30-minute fly circles.
- Main and satellite base locations,
- Communication centers, and
- Receiving hospitals.

This database contains information on more than 300 air medical service providers operating at approximately 900 air bases, with around 1,200 aircraft. The rotor-wing fly circles are calculated using the nominal cruise speed for the make and model of aircraft operating at a particular base.

References:

1. NCSA. (2010). Traffic Safety Facts 2009 – Overview. (Fact Sheet. Report No. DOT HS 811 392). Washington, DC: National Highway Traffic Safety Administration. Available at www-nrd.nhtsa.dot.gov/Pubs/811392.pdf.
2. American Trauma Society – 2009 Trauma Center Maps. <http://tramah.cml.upenn.edu/CML.TraumaCenters.Web/Default.aspx>.
3. Centers for Disease Control and Prevention. – Injury Prevention & Control: Access to Trauma Care: http://www.cdc.gov/traumacare/access_trauma.html.



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