EMS and CEMSIS Working Paper

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ABSTRACT

This study examines data from the California EMS Information System (CEMSIS) to identify factors that influence prehospital time for EMS events related to motor vehicle collisions (MVCs). While only 19 percent of the United States population resides in rural areas, over half of all traffic fatalities involve rural motor vehicle collisions. Rural and urban MVCs result in similar injury severities, however relative inaccessibility of trauma centers and prehospital EMS time (activation, response, and transport time) likely contribute to the generally higher mortality rate in rural areas. For the present study, 24 CEMSIS data variables were requested, many of which involved missing data, which severely restricted the potential analysis of the impact of EMS response times. However, the findings did show that average overall EMS time (including response, scene and transport time) were approximately twice as long for collisions in rural zip codes compared with urban zip codes. Several limitations influence the interpretation of these results. Data on prehospital EMS times is missing for much of the state—even for zip codes with records of EMS events, data is likely incomplete. In addition, zip code level location data is insufficient for adequate study of the effects of the built environment and road network on prehospital time. Furthermore, according to the National EMS Information System (NEMSIS) User Manual, the national dataset suffers from selection and information bias, which are likely also present in the CEMSIS data. Although the present study cannot analyze the effect of longer prehospital times on patient outcome, other research has found that longer prehospital times may negatively impact patient health. Recommendations for reducing time from injury to appropriate medical care in rural areas include improving cell phone coverage, compliance of rural 911 center with FCC wireless, use of GPS technology, and integration of automatic vehicle location and computer aided navigation technologies into all computer-aided dispatch systems. In addition, CEMSIS should improve the coverage of their dataset and ensure that all EMS activities are recorded. To expand the type of analyses that can be conducted using CEMSIS data, EMS records must include fields that allow them to be linked to hospital and police datasets. When such data becomes available, research must be conducted to determine whether prehospital time is significantly related to patient outcome following motor vehicle collisions.

INTRODUCTION

This study examines data from the California EMS Information System (CEMSIS) to identify the factors that influence prehospital time for EMS events related to motor vehicle collisions (MVCs).

LITERATURE REVIEW

There is widespread belief in the significance of the 'golden hour' immediately following an injury, during which time resuscitation, stabilization and transport to a medical facility offer the greatest chance of survival for the patient.[1] By reducing prehospital time, more advanced medical care can be provided sooner, resulting in reduced mortality.

While only 19 percent of the United States population resides in rural areas, over half of all traffic fatalities involve rural motor vehicle collisions. In 2011, a total of 75 percent of drivers who were injured in MVCs and died during transport to the hospital were in rural areas.[2]

Rural motor vehicle collisions are not intrinsically more deadly—one study found that rural and urban motor vehicle crashes result in similar injury severities.[3] Mortality rates are similar for severely injured patients regardless of whether the incident occurred in an urban or a rural setting—this indicates that patients with lower injury severity contribute to the generally higher mortality rate in rural areas.[3]

This discrepancy could be caused by the relative inaccessibility of trauma centers in rural areas. Although patients who are treated at Level 1 trauma centers within one hour of injury are 25 percent less likely to die as a result, more than 45 million U.S. citizens live over an hour away from a Level 1 or 2 trauma center.[2] In a study of motor vehicle collisions in Texas, the authors found that activation time, response time, and transport time were significantly longer for fatal motor vehicle collisions in rural areas than in urban areas.[4]

According to a study of urban sprawl and ambulance arrival delays, urban sprawl was significantly associated with longer EMS response times and a greater likelihood of delayed ambulance arrival.[5] Counties exhibiting characteristics of sprawl—including low density construction, limited street connectivity, and separation of residential development from commercial areas—had a higher probability of delayed ambulance arrival than counties with smart growth features. The authors surmised that the "integration of more comprehensive land-

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[1] Harmsen, A. M. K., G. F. Giannakopoulos, P. R. Moerbeek, E. P. Jansma, H. J. Bonjer, and F. W. Bloemers. The Influence of Prehospital Time on Trauma Patients Outcome: A Systematic Review. *Injury*, Vol. 46, No. 4, 2015, pp. 602–609. https://doi.org/10.1016/j.injury.2015.01.008.

[2] Towards Zero Deaths Steering Committee. *Toward Zero Deaths: A National Strategy on Highway Safety*. 2014.

[3] Gonzalez, R. P., G. R. Cummings, H. A. Phelan, M. S. Mulekar, and C. B. Rodning. Does Increased Emergency Medical Services Prehospital Time Affect Patient Mortality in Rural Motor Vehicle Crashes? A Statewide Analysis. *The American Journal of Surgery*, Vol. 197, No. 1, 2009, pp. 30–34. https://doi.org/10.1016/j.amjsurg.2007.11.018.

[4] Lu, Y., and A. Davidson. Fatal Motor Vehicle Crashes in Texas: Needs for and Access to Emergency Medical Services. *Annals of GIS*, Vol. 23, No. 1, 2017, pp. 41–54. https://doi.org/10.1080/19475683.2016.1276102.

use metrics, such as measures of urban sprawl, into EMS dispatch algorithms may improve resource utilization and potentially response reliability."[5]

METHODOLOGY

Background on CEMSIS

The California EMS Information System CEMSIS is a secure, consolidated data system that collects information about emergency medical service calls, patients treated at hospitals, and EMS providers.[6] Data are collected according to National Emergency Medical Services Information System (NEMSIS) standards. Prior to 2017, data was collected according to version 2.2.1 of the standards, and subsequently, local EMS agencies have gradually transitioned to using the current 3.4 version.

Eventually, CEMSIS data will be used to develop and coordinate high quality emergency medical care across the state via programs that link treatments to patient care outcomes, enhancing agency collaboration across jurisdictions, and increasing public awareness of EMS services in California.[7] However, CEMSIS is currently a demonstration project and is not yet fully implemented throughout the state. Table A1 in the appendix illustrates the timeline of CEMSIS participation by each local EMS agency (LEMSA) in California.

CEMSIS uses the NEMSIS data dictionary, although not all variables listed in the NEMSIS dictionary are populated—even partially—in the CEMSIS dataset.

Based on the data requested from CEMSIS, variables designated as national elements are generally populated in the CEMSIS dataset. These elements are required to be collected by the local EMS agencies and submitted to NEMSIS by each state.[8] The current version of NEMSIS (3.4) has definitions for 165 national elements, as well as 420 recommended and optional elements.

Data Description

For the present study, 24 variables were requested, including the zip code in which the incident occurred, the time at which an EMS unit was notified of the incident, the time at which the EMS unit was en route to the patient, the arrival and departure times to and from the scene, and the time when the EMS unit reached their hospital or trauma center destination. Demographic variables, such as patient gender and ethnicity, were requested but were not released due to privacy concerns. Only records that listed the cause of injury as a motor vehicle traffic accident were included in the present study.

Many of the variables that were requested involved missing data. For example, 97 percent of the records for 2013 were missing data on the condition of the patient at the hospital or trauma

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[5] Trowbridge, M. J., Gurka, M. J., & O'Connor, R. E. (2009). Urban Sprawl and Delayed Ambulance Arrival in the U.S. *American Journal of Preventive Medicine*, 37(5), 428–432. https://doi.org/10.1016/j.amepre.2009.06.016

[6] https://emsa.ca.gov/cemsis/

[7] ibid.

[8] https://nemsis.org/media/nemsis_v3/3.3.4.140328/DataDictionary/PDFHTML/DEMEMS/NEMSISDataDictionary.pdf

center destination. For the present study, the prevalence of missing data severely restricted the potential analysis of the impact of EMS response times.

Table 1: CEMSIS Dataset Description

Year	Number of Records	Number of Distinct Zip Codes for which there are records	Number of Distinct Counties for which there are records
2013	9083	131	11
2014	27211	330	34
2015	39834	509	40

Figures A1-A3 in the Appendix illustrate the geographic coverage of the CEMSIS dataset. While coverage has been expanded over the years, CEMSIS is still not receiving information from a large part of the state.

Analysis at the Zip Code Level

Because data on EMS events were available only at the zip code level, it was necessary to conduct the present analyses at that scale. There are 843 urban and 876 rural zip codes in California. Demographic variables were aggregated from the census block group level to the zip code level, using 2016 ACS data. If a block group fell into more than one zip code, it was assumed that the population was evenly distributed and a fraction of that demographic was added to the zip code proportional to how much of the block group fell inside the zip code.

Zip codes were classified as urban or rural based on the location of their centroid. If the centroid fell within an urbanized area (as defined by the Census, shown in Figure A4 in the Appendix), then the zip code was classified as urban, otherwise the zip code was classified as rural. The average size of a rural zip code in the state is 170 square miles, while the average size of an urban zip code is 11 square miles.

The Euclidean distance between the zip code centroid and the nearest trauma center location was calculated using ArcGIS's Near tool.

For the present study, the average duration of various segments of prehospital time were calculated according to characteristics of the zip code in which the scene was located. The prehospital segments included response time, the time from the notification of the EMS vehicle and the arrival of the vehicle at the scene; scene time, the time between the arrival of the EMS vehicle at the scene and the departure of the vehicle from the scene; and transport time, the time between the departure of the vehicle from the scene and its arrival at the emergency room or trauma center destination. Overall time is comprised of these three components of prehospital time.

RESULTS

Table 2: Rural/Urban Difference in Response Time—Scene Time, Transport Time, and Overall Time

Year:	2013		2014		2015	
Collision Location:	Rural Zip Code	Urban Zip Code	Rural Zip Code	Urban Zip Code	Rural Zip Code	Urban Zip Code
Average Response Time (min)	21.2	6.8	21.4	6.8	17.9	7.2
Average Scene Time (min)	27.6	19.1	26.8	18.3	23.1	17.4
Average Transport Time (min)	26.2	15.1	35.2	14.6	31.3	14.9
Average Overall Time (min)	73.3	40.9	85.0	39.9	79.7	39.8

The CEMSIS dataset included 57 urban zip codes and 74 rural zip codes in 2013, 118 urban zip codes and 212 rural zip codes in 2014, and 246 urban zip codes and 263 rural zip codes in 2015.

As shown in Table 2, the average EMS response time to a motor vehicle collision is substantially longer when the collision occurs in a rural zip code rather than in an urban zip code. This was true for each study year, although the difference appeared to be slightly smaller in 2015. This difference was statistically significant each year (p=0.000).

Average scene time was also longer in rural zip codes than in urban zip codes for all study years. However, the difference was not as dramatic as it was for response times. The difference in scene time was not statistically significant in 2013, but was statistically significant in 2014 (p=0.015) and in 2015 (p=0.000).

Average transport time was approximately twice as long in rural zip codes as in urban zip codes for all study years. The difference was statistically significant for all years (p=0.000).

Average overall time was also approximately twice as long in rural zip codes than in urban zip codes for all study years, although the difference appeared to be the smallest in 2013. The difference was statistically significant for all years (p=0.000).

As shown in Table 3, the difference in prehospital times is not as substantial when comparing zip codes with and without trauma centers as it is when comparing urban and rural zip codes. Average response time is approximately one minute shorter in zip codes with trauma centers than in zip codes without them. The difference is statistically significant in 2013 (p=0.009) and 2014 (p=0.001), but not in 2015.

Table 3. Differences in Times Based on Presence of Trauma Centers in Zip Code

Year:	2013		2014		2015	
Collision Location:	No Trauma Center in Zip Code	At least one Trauma Center in Zip Code	No Trauma Center in Zip Code	At least one Trauma Center in Zip Code	No Trauma Center in Zip Code	At least one Trauma Center in Zip Code
Average Response Time (min)	7.8	6.8	7.9	6.6	7.8	6.7
Average Scene Time (min)	19.6	19.6	19.1	18.2	17.7	18.4
Average Transport Time (min)	16.2	11.1	16.7	10.5	16.3	10.6
Average Overall Time (min)	43.3	37.4	44.1	35.5	42.6	36.0

Average transport time is approximately 5 to 6 minutes shorter in zip codes with trauma centers than in zip codes without them. The difference is statistically significant in all years (p=0.000).

Average overall time is shorter in zip codes with trauma centers than in those without them. The difference is statistically significant in all years (p=0.007 in 2013, p=0.000 in 2014 and 2015).

Table 4. Differences in Times Based on Presence of ERs in Zip Code

Year:	2013		2014		2015	
Collision Location:	No Emergency Room in Zip Code	At least one Emergency Room in Zip Code	No Emergency Room in Zip Code	At least one Emergency Room in Zip Code	No Emergency Room in Zip Code	At least one Emergency Room in Zip Code
Average Response Time (min)	8.4	6.6	8.4	6.8	8.0	7.2
Average Scene Time (min)	19.5	19.7	19.5	18.1	17.9	17.5
Average Transport Time (min)	17.2	13.5	18.3	12.6	17.1	13.5
Average Overall Time (min)	44.8	39.7	46.8	37.4	44.1	38.4

As shown in Table 4, there is some difference in prehospital times between zip codes with emergency rooms and zip codes without ERs. In zip codes with no emergency rooms, average response times are approximately 1 minute longer than in those with emergency rooms. This difference is statistically significant for all years (p=0.000).

Average transport times are approximately 4 minutes longer for zip codes without ERs than for those with them. This difference is statistically significant for all years (p=0.000).

Average overall prehospital time is longer in zip codes without ERs than it is in zip codes with ERs. This difference is statistically significant for all years (p=0.018 in 2013, p=0.000 in 2014 and 2015).

Regression Results

Regression models were generated for each year using the distance from the zip code centroid to the nearest trauma center and a dummy variable signifying its rural status as independent variables (both alone and together) and using either response time, scene time, transport time, or overall time as the dependent variable. All models were statistically significant, though the R-squared value varied.

Table 5: Regression Results for Response Time (minutes)

Year	2013	2014	2015
Model A: Distance only			
Constant	4.985***	4.943***	5.666***
Miles to nearest Trauma Center	0.473***	0.588***	0.469***
R-squared	0.1419	0.1909	0.1124
Adjusted R-squared	0.1418	0.1909	0.1124
No. observations	8,793	25,585	38,531
Model B: Rural Status only			
Constant	6.800***	6.844***	7.202***
Rural	14.426***	14.517***	10.718***
R-squared	0.2313	0.2577	0.1217
Adjusted R-squared	0.2312	0.2577	0.1217
No. observations	8,793	25,585	38,531
Model C: Distance and Rural Status			
Constant	5.633***	5.409***	5.962***
Miles to nearest Trauma Center	0.233***	0.341***	0.316***
Rural	11.698***	11.086***	7.674***
R-squared	0.2575	0.3074	0.1627
Adjusted R-squared	0.2574	0.3074	0.1627
No. observations	8,793	25,585	38,531

*,**,*** indicates significance at the 90%, 95%, 99% level, respectively

As shown in Table 5, Model A demonstrates that distance to the nearest trauma center has a small but significant impact on the average response time for a zip code. When rural status is controlled for in Model C, the impact of distance is reduced but is still significant.

On its own, as shown by Model B, rural status has a large impact on response time, although it is smaller in 2015 than in 2013 and 2014. When distance to the nearest trauma center is controlled for in Model C, the impact of rural status is slightly reduced.

In each year, Model C accounts for more of the variation in response time than Model A and B.

Table 6: Regression Results for Scene Time (minutes)

Year	2013	2014	2015
Model A: Distance only			
Constant	17.745***	16.918***	16.587***
Miles to nearest Trauma Center	0.322***	0.401***	0.248***
R-squared	0.0292	0.0442	0.0130
Adjusted R-squared	0.0290	0.0442	0.0130
No. observations	6,570	17,382	25,666
Model B: Rural Status only			
Constant	19.074***	18.344***	17.418***
Rural	8.558***	8.490***	5.670***
R-squared	0.0346	0.0441	0.0140
Adjusted R-squared	0.0344	0.0440	0.0140
No. observations	6,570	17,382	25,666
Model C: Distance and Rural Status			
Constant	18.047***	17.154***	16.741***
Miles to nearest Trauma Center	0.203***	0.271***	0.166***
Rural	6.263***	5.707***	4.036***
R-squared	0.0437	0.0594	0.0187
Adjusted R-squared	0.0434	0.0593	0.0186
No. observations	6,570	17,382	25,666

*,**,*** indicates significance at the 90%, 95%, 99% level, respectively

The regression for scene time does not explain much of its variation. Distance to the nearest trauma center has a small but significant impact on the average scene time for a zip code. The rural status of the zip code has a larger impact on scene time.

Table 7: Regression Results for Transport Time (minutes)

Year	2013	2014	2015
Model A: Distance only			
Constant	13.355***	11.848***	12.217***
Miles to nearest Trauma Center	0.413***	0.838***	0.776***
R-squared	0.0435	0.1251	0.1027
Adjusted R-squared	0.0433	0.1250	0.1026
No. observations	6,449	17,136	24,456
Model B: Rural Status only			
Constant	15.076***	14.611***	14.912***
Rural	11.130***	20.605***	16.371***
R-squared	0.0502	0.1678	0.0954
Adjusted R-squared	0.0500	0.1678	0.0954
No. observations	6,449	17,136	24,456
Model C: Distance and Rural Status			
Constant	13.760***	12.485***	12.637***
Miles to nearest Trauma Center	0.262***	0.482***	0.552***
Rural	8.028***	15.668***	10.964***
R-squared	0.0638	0.1995	0.1369
Adjusted R-squared	0.0635	0.1994	0.1368
No. observations	6,449	17,136	24,456

*,**,*** indicates significance at the 90%, 95%, 99% level, respectively

The regression for transport time does not explain much of its variation. Distance to the nearest trauma center has a small but significant impact on the average transport time for a zip code. The impact was higher in 2014 and 2015 than in 2013. The rural status of the zip code has a much larger impact on response time. Rural status had the largest effect in 2014.

Table 8: Regression Results for Overall Time (minutes)

Year	2013	2014	2015
Model A: Distance only			
Constant	36.337***	33.748***	34.519***
Miles to nearest Trauma Center	1.119***	1.860***	1.620***
R-squared	0.0884	0.1951	0.0955
Adjusted R-squared	0.0883	0.1950	0.0955
No. observations	6,498	17,263	24,649
Model B: Rural Status only			
Constant	40.889***	39.881***	39.806***
Rural	32.366***	45.123***	39.942***
R-squared	0.1180	0.2589	0.1218
Adjusted R-squared	0.1179	0.2588	0.1218
No. observations	6,498	17,263	24,649
Model C: Distance and Rural Status			
Constant	37.589***	35.157***	35.682***
Miles to nearest Trauma Center	0.654***	1.073***	1.000***
Rural	24.628***	34.160***	30.137***
R-squared	0.1415	0.3086	0.1509
Adjusted R-squared	0.1412	0.3085	0.1509
No. observations	6,498	17,263	24,649

*,**,*** indicates significance at the 90%, 95%, 99% level, respectively

The regression for overall time explains a little of the variation in 2013 and 2015, but explains more in the 2014 dataset. Distance to the nearest trauma center has a small but significant impact on the average overall time for a zip code. The rural status of the zip code has a much larger impact on overall time.

DISCUSSION

The data shows that there are substantial differences in response, scene, and transport times between collisions that occur in urban and rural zip codes. However, there are several limitations influencing interpretation of the results.

Limitations

Data on EMS response, scene, and transport times are missing for much of the state (see Fig A1-3 in Appendix). Even for zip codes that have records of EMS events, the dataset is likely incomplete (i.e., not all EMS responses to motor vehicle collisions in a zip code are recorded).

Therefore, the data recorded in CEMSIS may not be representative of EMS events throughout California.

Additionally, zip code level location data is insufficient for adequate study of the effects of the built environment and road network on prehospital time.

The analyses that can be conducted using zip code level data are limited by missing data. Fields such as patient condition are not populated, thus analyses for such factors cannot be completed. For example, without data on patient condition, the effect of response time on health outcomes cannot be determined.

CEMSIS, like NEMSIS, is a convenience sample, in which data are submitted voluntarily by local EMS agencies. According to the NEMSIS User Manual, the dataset suffers from selection bias, which occurs when a perceptible difference between two groups is caused by different criteria being included. The dataset also suffers from information bias, which is a difference between two groups that is due to differences in the data available for comparison.[9] The problems that the national database experiences are likely also present in CEMSIS data.

Possible Implications of Urban/Rural Differences

Despite the study limitations, it is possible that there is a significant difference for EMS response and transport times between urban and rural zip codes.

Although the present study cannot analyze the effect of longer prehospital times on patient outcome, previous research has found that longer prehospital times may negatively impact patient health. According to one study, fatality rates resulting from rural traffic collisions are nearly twice as high as those involving urban collisions. The study also found that increases in EMS prehospital time appear to be associated with higher mortality rates for injuries resulting from traffic collisions in rural areas.[10]

Another study found that severely injured trauma patients from urban-area collisions exhibited higher 30-day mortality rates compared with patients injured in rural areas, however length of ICU stays were similar for both groups. The study also found that more pre-hospital deaths occurred as a result of collisions in rural areas, suggesting that time prior to mobile ICU arrival is critical to trauma patient survival, particularly in rural areas.[11]

A survey of 29 EMS personnel in eastern SD was conducted to identify existing issues related to roads and traffic controls. Among the responses, one outstanding issue was motorists' lack of

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[9] https://nemsis.org/wp-content/uploads/2017/10/NEMSIS-RDS-221-2016-User-Manual.pdf

[10] Gonzalez, R. P., G. R. Cummings, H. A. Phelan, M. S. Mulekar, and C. B. Rodning. Does Increased Emergency Medical Services Prehospital Time Affect Patient Mortality in Rural Motor Vehicle Crashes? A Statewide Analysis. *The American Journal of Surgery*, Vol. 197, No. 1, 2009, pp. 30–34. https://doi.org/10.1016/j.amjsurg.2007.11.018.

[11] Raatiniemi, Lasse, Janne Liisanantti, Suvi Niemi, Heini Nal, Pasi Ohtonen, Harri Antikainen, Matti Martikainen, and Seppo Alahuhta. 2015. Short-Term Outcome and Differences between Rural and Urban Trauma Patients Treated by Mobile Intensive Care Units in Northern Finland: A Retrospective Analysis. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine* 23 (1). https://doi.org/10.1186/s13049-015-0175-2.

compliance to emergency vehicles. All respondents considered the failure of other drivers to pull over as a major safety concern.[12]

According to a statewide analysis of MVCs in Alabama, increased EMS prehospital time appears to be associated with higher mortality rates in rural areas. For the study, prehospital data from a two-year period were analyzed to determine EMS response scene and transport time in rural and urban areas. When mortalities occurred, the mean EMS transport time for rural areas was 12.45 minutes, and 7.43 minutes in urban areas ($P < .0001$). When mortalities occurred, the overall mean prehospital time in rural areas was 42.0 minutes, and 24.8 minutes in urban areas ($P < .0001$). The mean EMS response time for rural MVCs with survivors was 8.54 minutes compared with a mean of 10.67 minutes with mortalities ($P < .0001$). The mean EMS scene time for rural MVCs with survivors was 14.81 minutes compared with 18.87 minutes with mortalities (patients who were declared dead at the scene and extrication patients were excluded) ($P = .0014$).[13]

RECOMMENDATIONS AND FUTURE WORK

Improvements to EMS Response Time in Rural Areas

The National Cooperative Highway Research Program (NCHRP) recommends the following strategies for reducing time from injury to appropriate medical care in rural areas:[14]

- Improve cellular telephone coverage in rural areas
- Improve compliance of rural 9-1-1 centers with FCC wireless
- "Phase II" automatic location capability
- Utilize GPS technology to improve response time
- Integrate automatic vehicle location (AVL) and computer aided navigation (CAN) technologies into all computer-aided dispatch (CAD) systems
- Equip EMS vehicles with multi-service and/or satellite capable telephones

To create a comprehensive approach to reducing EMS response time in rural areas, NCHRP further recommends these related strategies:[15]

- Public information and education (PI&E) programs
- Enforcement of traffic laws
- Strategies directed at improving the safety management system

Local EMS systems should evaluate ambulance patient offload time at the hospital as a key indicator of efficient EMS system function. Those that have identified negative system impacts

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[12] Samra, Haifa, Xiao Qin, and Zhaoxiang He. 2014. *Improving Rural Emergency Medical Services (EMS) through Transportation System Enhancements*. Mountain Plains Consortium. https://www.ugpti.org/resources/reports/downloads/mpc14-267.pdf

[13] Gonzalez RP[1], Cummings GR, Phelan HA, Mulekar MS, Rodning CB. Does increased emergency medical services prehospital time affect patient mortality in rural motor vehicle crashes? A statewide analysis. *Am J Surg*. 2009 Jan;197(1):30-4. doi: 10.1016/j.amjsurg.2007.11.018. Epub 2008 Jun 16. DOI:10.1016/j.amjsurg.2007.11.018

[14] National Cooperative Highway Research Program (NCHRP), 2005. *Guidance for Implementation of the AASHTO Strategic Highway Safety Plan: A Guide for Enhancing Rural Emergency Medical Services.* NCHRP) Report 500, Vol. 15.

[15] Ibid.

due to offload delays should use common language and metrics to define and measure delays in developing action plans to decrease or eliminate delays. Local EMS systems should establish ambulance patient offload time interval standards between 15-30 minutes that define when delay occurs.[16]

In a survey of hospitals and local emergency medical services in California, those that did not report transportation delays listed three factors that contributed to their success:

1. Optimizing the ED intake process
2. Successful hospital process improvement strategies
3. Hospital and LEMSA collaboration and ongoing process improvement strategies[17]

The first step to reducing offload delays in California involves establishing standardized definitions for data collection to address the significant variability in obtaining data from the state's 33 local agencies, hundreds of EMS provider agencies, and 320 acute care hospital emergency departments that receive 911 dispatched ambulances.[18]

Improvements to CEMSIS Data

CEMSIS should improve the coverage of their dataset and ensure that all EMS activities are recorded in its database. This will eliminate potential selection bias that is introduced by using the incomplete dataset. CEMSIS should also ensure that important fields such as patient outcome are populated with as little missing data as possible to reduce the information bias that occurs when one area populates a field more accurately than another. To expand the type of analyses that can be conducted using CEMSIS data, EMS records need to include fields that allow them to be linked to hospital and police datasets.

When this data becomes available, new research must be conducted to determine whether prehospital time is significantly related to patient outcome following motor vehicle collisions.

APPENDIX

Table A1. Timeline of CEMSIS Participation by Local EMS Agencies in California

LEMSA	2013	2014	2015	2016	2017	2018
Alameda County			X	X	X	X
Central California*		X	X	X	X	X
Coastal Valleys**					X	X
Contra Costa County		X	X	X	X	X
El Dorado County	X	X	X	X	X	X
Imperial County	Not Participating					
Inland Counties***	X	X	X	X	X	X
Kern County					X	X
Los Angeles County	Not Participating					
Marin County		X	X	X	Not Participating	X
Merced County					X	X
Monterey County	X	X	X	X	X	X
Mountain Valley^	X	X	X	X	X	X
Napa County	X	X	X	X	X	X
North Coast^^	X	X	X	X	X	X
Northern California^^^	X	X	X	X	X	X
Orange County				X	X	X
Riverside County					X	X
Sacramento County			X	X	X	X
San Benito County		X	X	X	X	X
San Diego County					X	X
San Francisco County	X	X	X	X	X	X
San Joaquin County					X	X
San Luis Obispo County	X	X	X	X	X	X
San Mateo County	Not Participating					X
Santa Barbara County			X	X	X	X
Santa Clara County					X	x
Santa Cruz County		X	X	X	X	X
Sierra-Sacramento Valley#		X	X	X	X	X
Solano County	Not Participating					X
Tuolumne County					X	X
Ventura County		X	X	X	X	X
Yolo County		X	X	X	X	X

*Fresno, Kings, Madea, and Tulare Counties

**Sonoma and Mendocino County

***Inyo, Mono, and San Bernardino Counties

^Alpine, Amador, Calaveras, Mariposa, Stanislaus

^^Del Norte, Humboldt, and Lake Counties

^^^Lassen, Modoc, Plumas, Sierra, and Trinity Counties

#Butte, Colusa, Glenn, Nevada, Placer, Shasta, Siskiyou, Sutter, Tehama, and Yuba County

Figure A1. CEMSIS 2013 Dataset

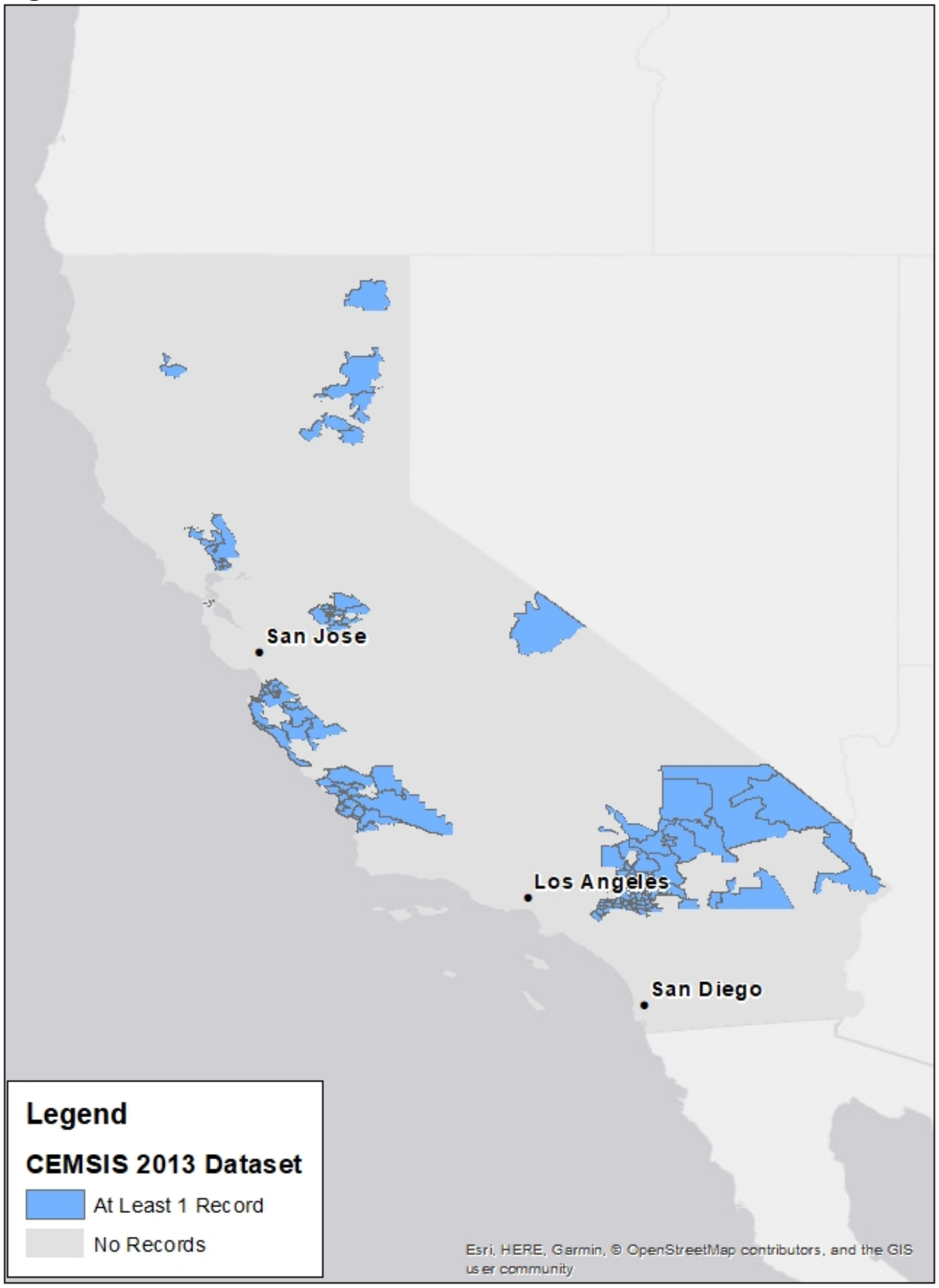

Figure A2. CEMSIS 2014 Dataset

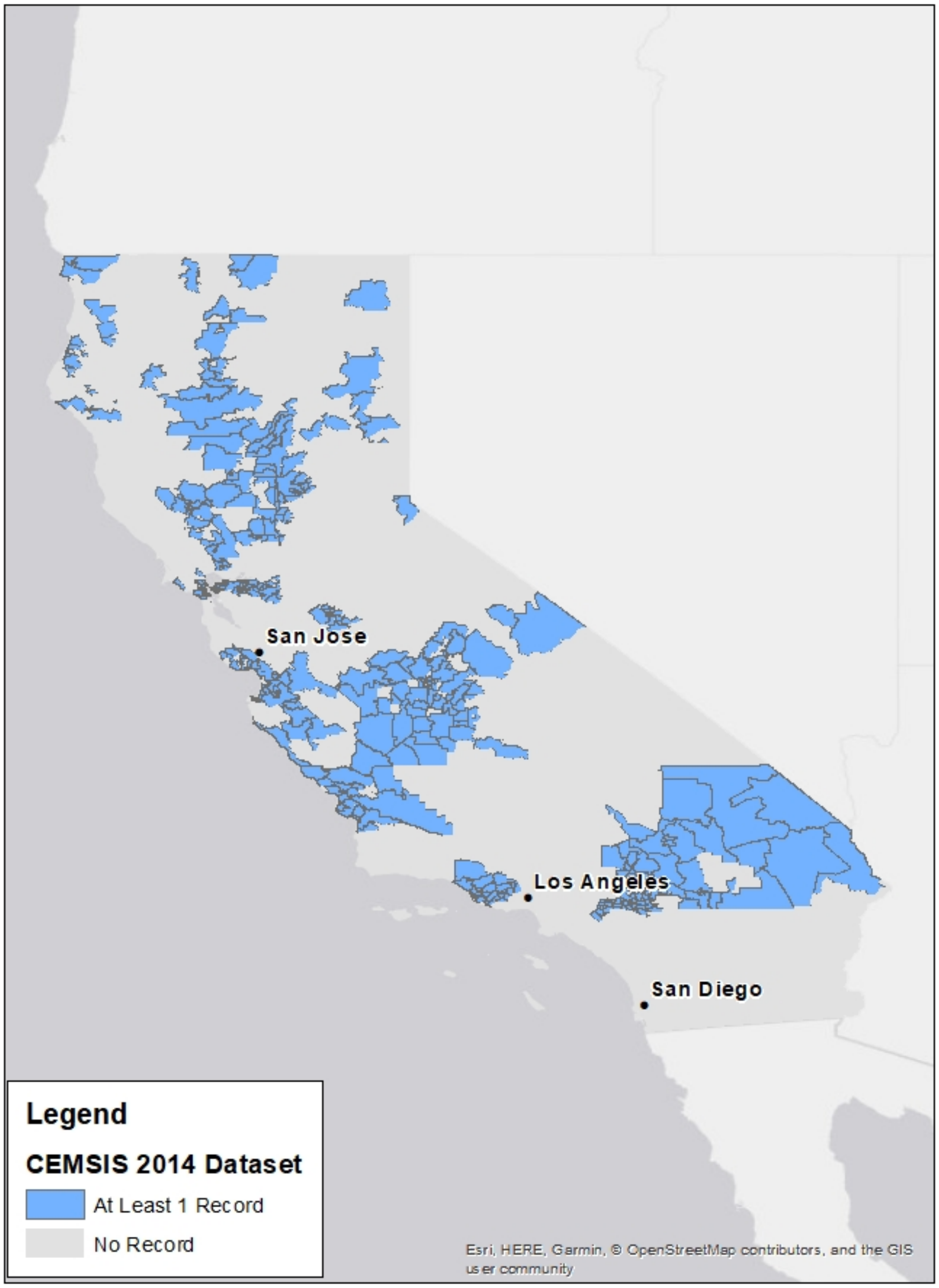

Figure A3. CEMSIS 2015 Dataset

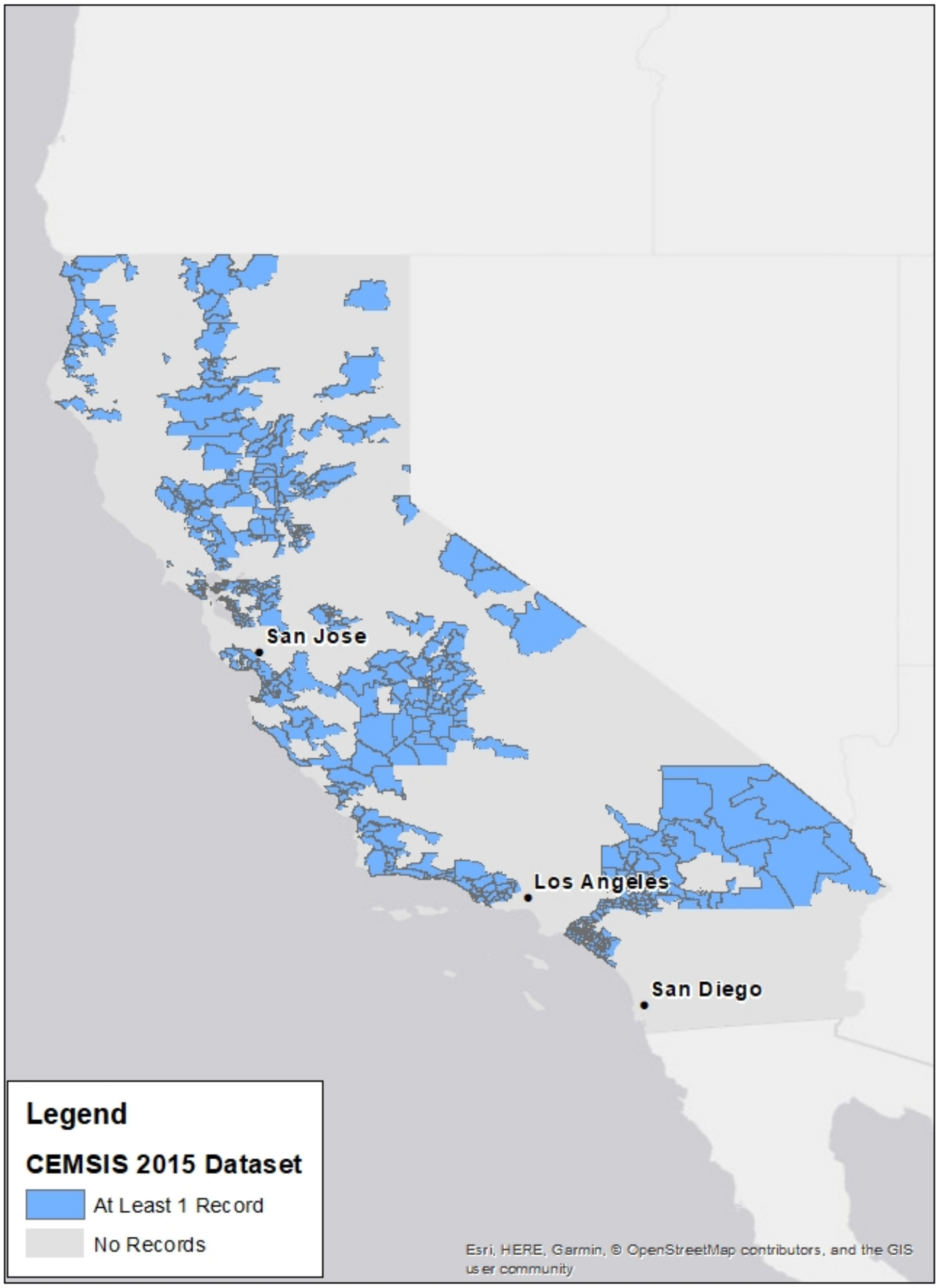

Figure A4. California Census Urban Areas

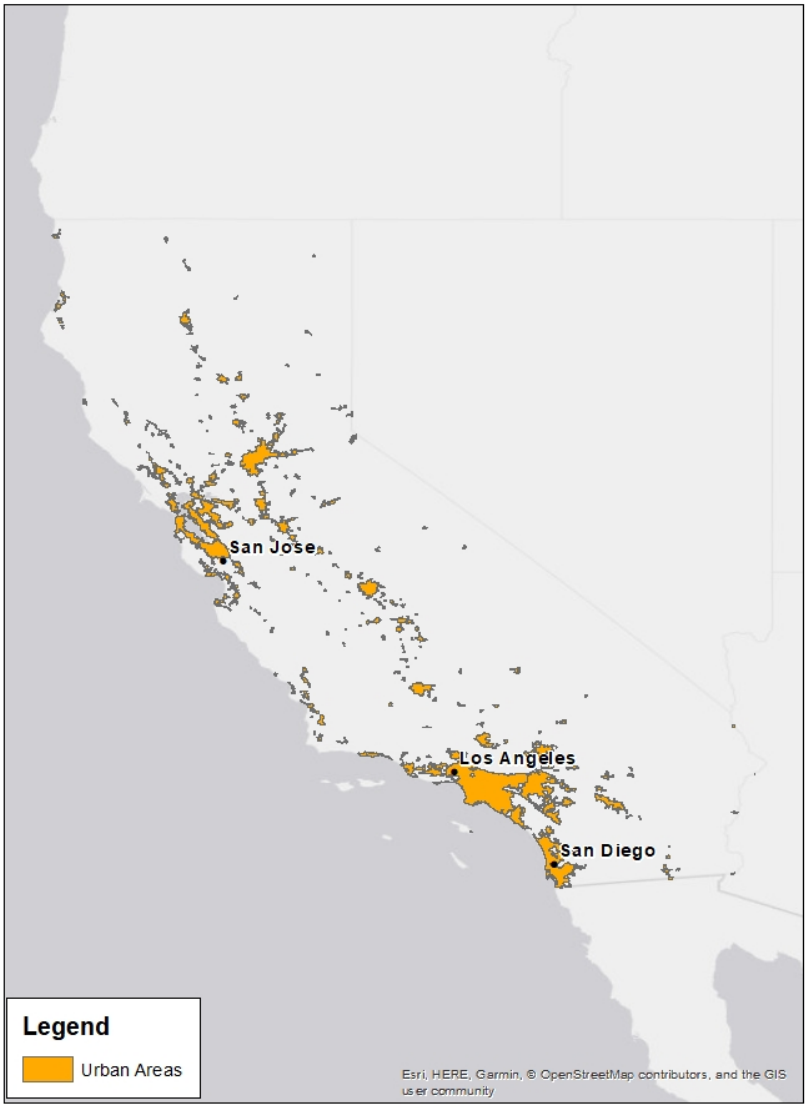

Table A2-9. Demographic Differences (or lack of) at Zip Code Level

Year:	2013		2014		2015	
Collision Location:	% White Population at or above State Average	% White Population Below State Average	% White Population at or above State Average	% White Population Below State Average	% White Population at or above State Average	% White Population Below State Average
Average Response Time (min)	9.7	6.3	8.8	6.7	8.6	7.0
Average Scene Time (min)	20.2	19.2	19.5	18.5	17.9	17.6
Average Transport Time (min)	16.9	14.9	17.1	15.3	16.1	15.6
Average Overall Time (min)	46.1	40.5	46.1	40.6	44.1	40.3

Year:	2013		2014		2015	
Collision Location:	% Black Population at or above State Average	% Black Population Below State Average	% Black Population at or above State Average	% Black Population Below State Average	% Black Population at or above State Average	% Black Population Below State Average
Average Response Time (min)	7.3	8.3	6.8	8.6	7.2	8.1
Average Scene Time (min)	20.2	18.7	18.5	19.4	18.1	17.5
Average Transport Time (min)	15.6	15.9	15.0	17.2	15.9	15.8
Average Overall Time (min)	43.1	42.2	40.4	45.8	41.5	42.6

Year:	2013		2014		2015	
Collision Location:	% Native American Population at or above State Average	% Native American Population Below State Average	% Native American Population at or above State Average	% Native American Population Below State Average	% Native American Population at or above State Average	% Native American Population Below State Average
Average Response Time (min)	10.0	7.5	9.0	7.5	9.4	7.4
Average Scene Time (min)	22.6	19.3	19.4	18.9	19.4	17.4
Average Transport Time (min)	18.0	15.5	18.0	15.8	18.0	15.4
Average Overall Time (min)	49.6	42.1	46.9	42.6	46.9	41.1

Year:	2013		2014		2015	
Collision Location:	% Asian Population at or above State Average	% Asian Population Below State Average	% Asian Population at or above State Average	% Asian Population Below State Average	% Asian Population at or above State Average	% Asian Population Below State Average
Average Response Time (min)	6.2	8.0	6.4	8.2	6.9	8.2
Average Scene Time (min)	19.3	19.6	18.5	19.1	16.9	18.2
Average Transport Time (min)	15.2	15.8	14.3	16.8	14.3	16.6
Average Overall Time (min)	40.5	43.1	39.1	44.7	38.0	44.1

Year:	2013		2014		2015	
Collision Location:	% Hispanic Population at or above State Average	% Hispanic Population Below State Average	% Hispanic Population at or above State Average	% Hispanic Population Below State Average	% Hispanic Population at or above State Average	% Hispanic Population Below State Average
Average Response Time (min)	6.9	10.2	7.1	9.3	7.4	8.3
Average Scene Time (min)	19.2	20.9	18.6	19.9	18.0	17.3
Average Transport Time (min)	15.2	17.4	15.9	16.9	15.6	16.2
Average Overall Time (min)	41.2	47.8	41.9	46.7	41.3	43.5

Year:	2013		2014		2015	
Collision Location:	% Population Below Poverty Line at or above State Average	% Population Below Poverty Line below State Average	% Population Below Poverty Line at or above State Average	% Population Below Poverty Line below State Average	% Population Below Poverty Line at or above State Average	% Population Below Poverty Line below State Average
Average Response Time (min)	7.9	7.3	9.2	7.0	7.7	7.8
Average Scene Time (min)	20.1	18.8	20.1	18.3	18.2	17.1
Average Transport Time (min)	15.5	16.1	18.0	15.1	15.9	15.8
Average Overall Time (min)	43.2	42.1	48.0	40.7	42.2	42.0

Year:	2013		2014		2015	
Collision Location:	% Homeowners Population at or above State Average	% Homeowners Population Below State Average	% Homeowners Population at or above State Average	% Homeowners Population Below State Average	% Homeowners Population at or above State Average	% Homeowners Population Below State Average
Average Response Time (min)	9.1	6.6	9.2	7.0	8.7	7.1
Average Scene Time (min)	19.8	19.4	20.1	18.3	17.9	17.6
Average Transport Time (min)	17.5	14.3	18.0	15.1	17.4	14.9
Average Overall Time (min)	46.1	40.0	48.0	40.7	45.8	39.9

Year:	2013		2014		2015	
Collision Location:	% Uninsured Population at or above State Average	% Uninsured Population Below State Average	% Uninsured Population at or above State Average	% Uninsured Population Below State Average	% Uninsured Population at or above State Average	% Uninsured Population Below State Average
Average Response Time (min)	7.6	7.9	8.1	7.3	7.7	7.8
Average Scene Time (min)	19.4	19.9	19.4	18.4	18.1	17.3
Average Transport Time (min)	16.0	15.2	17.2	14.6	16.3	15.2
Average Overall Time (min)	42.9	42.4	45.3	40.4	42.6	41.5