The Impact of Rural Hospital Closures on Emergency Medical Services Transport Times

Todd Brenton Smith, PhD, MSHA, MBA, BSN, NEA-BC[1]

Thomas MacAndrew English, PhD[2]

Marilyn Whitman, PhD[3]

Dwight Lewis, PhD[4]

Abbey Gregg, PhD[5]

[1] Assistant Professor, University of Alabama, Capstone College of Nursing, tbsmith3@ua.edu

[2] Assistant Professor, University of Alabama, Management, tmenglish1@cba.ua.edu

[3] Professor and HealthSouth Endowed Chair in Healthcare Management, University of Alabama, Management, mwhitman@cba.ua.edu

[4] Assistant Professor, University of Alabama, Management, lewis060@cba.ua.edu

[5] Assistant Professor, University of Alabama, College of Community Health Sciences, algregg1@ua.edu

Abstract

Purpose: Previous studies have found disparities in emergency medical service (EMS) transports for rural residents including double the average response time and lower patient survival rates when compared with their urban counterparts. Since 2012, the rate of rural hospitals closures has risen alarmingly from previous years. Previous studies have linked the closure of rural hospitals to increased EMS transport and total activation time. However, data and methods used in previous studies have not included facility-level characteristics, which limits the ability to tease out the nuances of each closure. Thus, the purpose of this study is to examine the impact of rural hospital closures on EMS travel time, as well as the characteristics of the closed hospitals.

Sample: Data sources for the study came from a state-level EMS database, the CMS Provider of Service files, and state-level hospital data reports.

Methods: Geographic information system software was used to geocode hospital locations and generate service areas based on drive times. We identified rural hospitals that closed in Alabama between 2010-2018 and then identified the 911 call data from the state's EMS database that occurred within close proximity of each of the hospitals of interest, resulting in a sample of 120,802 EMS calls.

Findings: We identified five hospital closures within our time period. For one of the five closures, EMS transport time to the emergency department increased by thirteen minutes post-closure. In two of the five closures, transport time increased by five minutes or less. In two instances, however, transport time decreased.

Conclusions: Our findings suggest that not all rural hospital closures result in increased EMS transport times as rural patients may have already been routinely transported to alternate hospitals. Additionally, specific characteristics of a hospital pre-closure may be related to changes in EMS travel times that occur post-closure.

Keywords: Rural health, emergency medical services, access, hospital closure, travel distance

The Impact of Rural Hospital Closures on Emergency Medical Services Transport Times

Emergency Medical Services (EMS) are an intricate system of coordinated response that provides emergency medical care (National Highway Traffic Safety Administration, n.d.). For rural communities in particular, EMS plays a vital role in providing pre-hospital services for individuals suffering from trauma, sudden injuries, or acute illnesses (Rural Health Information Hub, n.d.). Yet, rural EMS must contend with the challenges of serving a geographically large area

that may negatively impact response or transport times. Previous studies have found a number of disparities in trauma care for rural residents (Carr et al., 2017), including double the average response time as their urban counterparts (Mell et al., 2017) and lower patient survival rates (English, 2008).

Since 2012, however, physical access to acute care facilities in rural communities across the nation has decreased significantly as rural hospital closures have increased at an alarming rate. Undoubtedly, the term *rural* remains inexact. The U.S. Census Bureau offers the only official federal definition of rural consisting of all territory, population, and housing units that are located outside of urbanized areas and urban clusters (U.S. Census Bureau, n.d.). Rural hospitals that are located either in a nonmetropolitan country or in an area within a metropolitan county that has a Rural Urban Community Area (RUCA) code of 4 or greater (Freeman et al., 2015). Between 2013 and 2017, U.S. rural hospital closures doubled from the prior five-year period (Cosgrove, 2018), leaving approximately 1.7 million rural residents without access to nearby acute medical services (Kaufman et al., 2016). To date, the total number of rural hospital closures since 2010 now stands at 137, with well over half of all closures occurring in southern states (Sheps Center for Health Services Research [Sheps Center], 2019). The consequences stemming from closures are often severe for the communities they serve (Kaufman et al., 2016; Thomas et al., 2016). Unlike urban hospital closures, in which residents are still left with alternative hospitals in the immediate area, rural hospital closures often leave communities without proximal acute medical services (Kaufman et al., 2016). Already faced with long EMS response times (Mell et al., 2017), rural residents may also face longer EMS transport times as a result of rural hospital closures.

Recent studies on the impact of rural hospital closures on EMS times have been linked to increased transport and total activation time (Miller et al., 2020; Troske & Davis, 2019).

Specifically, Troske and Davis (2019) estimate that rural patients in the U.S. spend an additional 11 minutes in EMS transport a year after the closure of a hospital. In Miller et al. (2020), the authors found that rural hospital closures resulted in greater transport and activation times. Although these two studies offer valuable insights on the impact of rural hospital closures on EMS times, there are a number of limitations that may influence their findings. For example, these studies relied on secondary data from the National EMS Information System (NEMSIS), a national database to which states voluntarily submit EMS data. NEMSIS is considered a convenience sample as not all states participate and/or submit complete data. Also, NEMSIS does not release geographic information such as street addresses or the name of the destination hospital, but rather only zip codes, leaving researchers to make a number of assumptions related to travel distance. Furthermore, these two studies relied on average transport time for all rural closure areas and Euclidean distances rather than driving distances, respectively, which in certain cases may significantly alter conclusions. Therefore, the methods in these two studies do not offer an opportunity to tease out the nuances of each rural hospital closure and may result in an inaccurate or oversimplification of the impact of hospital closures.

The present study aims to address these limitations. Using data from the state of Alabama, we offer a more in-depth, and possibly more accurate, investigation of the impact of rural hospital closures on EMS transport times. Alabama has witnessed a substantial number of closures (Sheps Center, 2019) and has recently been reported to have the highest percentage of financially distressed rural hospitals in the country (Kacik, 2019). Moreover, our study addresses an important factor that is often overlooked in studies examining the impact of closures on EMS transport times – the utilization patterns of a hospital facility prior to that hospital's closing. That is, were EMS routinely transporting patients to these rural hospitals prior to their closure? To answer this

question, our study uses several data sources to highlight variations in EMS transport times to alternate hospitals as compared with a pre-closure hospital, how closed hospitals varied based on certain characteristics pre-closure, and how these factors may be related.

Methods

We used data from the Alabama Department of Public Health's EMS database to examine the impact of rural hospital closures on EMS transport times. Approval for use of the data for this study was through the University of Alabama's Institutional Review Board (18-01-872, FWA # 00004939). The database contains full details of all EMS calls to 911 centers in Alabama including the location of each event and the transport destination location. According to the University of North Carolina Sheps Center (2019), five rural hospitals in Alabama closed between 2010 and 2018. We extracted 911 calls data from the state EMS department that occurred in a zip code within 15 minutes of drive time of each of the five hospitals of interest. We limited our analysis to Advanced Life Support or Basic Life Support services ground transports and excluded transfer calls to capture only unplanned ambulance transports. This resulted in a final sample of 120,802 non-planned EMS calls.

The amount of time between dispatch notification of a 911 call to the hospital arrival time was considered to be the total transport time. Average transport times were then calculated for each of the now closed five rural hospitals one-year pre-closure and one-year post-closure. We used ESRI ArcGIS Pro v2.1 and StreetMap Premium data from HERE© to geocode hospital locations and generate service areas based on drive times. We then spatially joined zip codes that intersected with generated service areas to determine areas potentially affected by a hospital's closure.

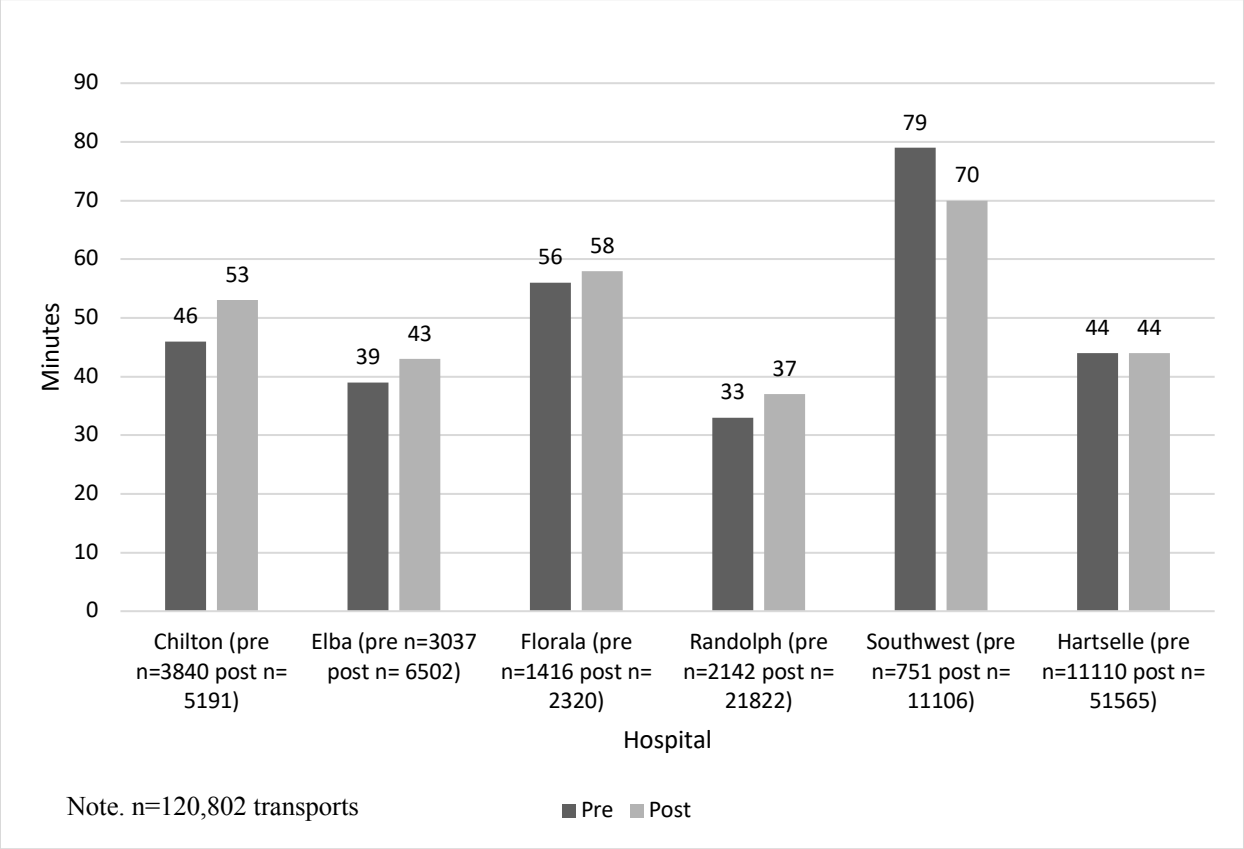
Next, we built a linear regression model using SPSS v27 to look at the impact of hospital closure on EMS response times in zip codes within 15 minutes of each hospital that closed. We included direct effects of each hospital, pre- and post-hospital closure, and interactions for each hospital with pre- and post. We used Hartselle Medical Center as a comparison for the dummy variables. Hartselle Medical Center did close but is not considered to be located in a rural area.

Results

Figure 1 shows the average time from dispatch notification of an event to the arrival time of the ambulance to each hospital one-year pre-closure and one-year post-closure. Findings reveal that transport time changed in an inconsistent manner after hospital closure across the six closed hospitals. In the case of three hospitals, transport times to an alternate hospital increased post-closure by 3, 4, and 13 minutes respectively. The hospital with the largest increase in transport time post-closure (13 minutes) had the highest rate of EMS transports pre-closure (61.2%). In two closure cases, transport times decreased post-closure by four and five minutes, respectively. In each of these situations, there were relatively low rates of pre-closure EMS transports (0.8% and 27.7%).

Figure 1

Pre- and Post-Closure EMS Transport Time in Minutes by Hospital



Our findings suggest that the impact of closure varied based on the hospital. As shown in Table 1, the pre/post closure variable was not statistically significant. However, all of the interactions of each hospital. and pre/post times, were statistically significant with only one exception. Four of the areas showed a significant increase in transport times post hospital closure. However, the area surrounding Southwest Alabama Medical Center did see a decrease in overall transport time.

Table 1

Difference in Difference Analysis Summary

	B	Std. Error	t	*p*-Value
(Constant)	43.772	0.242	180.51	<0.001
Area Effect				
Chilton	2.348	0.478	4.908	<0.001
Elba	-4.859	0.523	-9.284	<0.001
Florala	12.139	0.721	16.832	<0.001
Randolph	-10.896	0.603	-18.066	<0.001
Southwest	34.819	0.964	36.132	<0.001
Time Effect				
Post Closure	0.426	0.267	1.593	0.111
Interaction of Area and Time				
Chiltonpost	7.382	0.606	12.178	<0.001
Elbapost	3.484	0.622	5.601	<0.001
Floralapost	1.392	0.902	1.543	0.123
Randolphpost	3.641	0.637	5.712	<0.001
Southwestpost	-8.968	1	-8.967	<0.001

Data from the Centers for Medicare and Medicaid Services (CMS, n.d.) Provider of Service files and the Alabama State Health Planning and Development Agency (n.d.) indicates that four of the five closed hospitals had low occupancy rates pre-closure. Only Randolph Medical Center, the closure that resulted in the largest increase in transport time, had a relatively high occupancy rate (54.51%). Randolph was also the only hospital with a comprehensive emergency department offering physician coverage for medical, surgical, obstetric, and anesthesiology services 24 hours a day. One hospital had a substantially higher number of emergency department visits compared to the other four, but its services were limited. And, only one of these hospitals was designated as a trauma center. With the exception of just one hospital, all reported Medicare as constituting half or more of their principal source of payment. Finally, the nearest alternative hospitals for two of

the five hospitals were located over 30 miles away. The other three hospitals have alternate hospitals ranging between 11 to 17 miles away.

Additionally, we compared the characteristics and services of each closed hospital to the alternate hospital that saw the largest increase in EMS transport rates from the service destination area post-closure (see Table 2). Overall, these alternate hospitals had greater mean occupancy rates and mean emergency departments visits. Offering obstetrics services and operating an intensive care unit (ICU) for medical and surgical purposes seemed to be the key differences between most alternate and closed hospitals. And finally, none of the five closed hospitals offered obstetrics or ICU services pre-closure.

Table 2

Characteristics of and Services Offered by Closed Hospitals

	Chilton Medical Center	**Elba General Hospital**	**Florala Memorial Hospital**	**Randolph Medical Center**	**Southwest Alabama Medical Center**
Alternative Hospital Distance via Google Maps	30.8 Miles, 32 Minutes	16.9 Miles, 22 Minutes	31.4 Miles, 39 Minutes	11.6 Miles, 13 Minutes	17.3 Miles, 20 Minutes
Hospital Characteristics					
Ownership	LLC	Healthcare Authority	Corporation	Healthcare Authority	LLC
Occupancy Rate	12.4%	22%	15.4%	54.5%	14.1%
Licensed Capacity	60	20	23	35	49
Type of ED	Limited	Essentially Prompt	Essentially Prompt	Comprehens ive	Essentially prompt
Number of ED visits	14,051	4,984	2,413	5,041	7,087
Designated Trauma Center	no	no	no	no	yes
Percent of Discharges by Principal Source of Payment					
% Medicare	68.6%	44.8%	73.3%	61.7%	50.5%
% Medicaid	8.9%	25.4%	2.9%	12.4%	19.5%
Hospital Services					

	Chilton Medical Center	Elba General Hospital	Florala Memorial Hospital	Randolph Medical Center	Southwest Alabama Medical Center
Obstetrics	no	no	no	no	no
Cardiac Catheterization	no	no	no	no	no
Inpatient Surgery	yes	no	no	yes	yes
Psychiatric (Inpatient)	no	no	no	yes	no
Psychiatric (Emergency)	no	no	no	no	no
ICU Medical/Surgical	no	no	no	no	no
Neurological	no	no	no	no	no

Note. Type of ED definitions: Comprehensive - comprehensive 24 hour hours a day, including in hospital physician coverage for medical, surgical, obstetric, and anesthesiology services; Limited - limited by lack of immediate coverage in some major specialties, but a physician is always present in the emergency area and a surgeon is immediately available for consultation, other specialists are on call with 5-30 minutes; Essentially prompt - essentially prompt emergency care available at all times with basic medical and surgical service usually supplied within 30 minutes or less. Certain clinical problems are always immediately transferred to another facility, while others may require specific assessment before transfer.

Discussion

Although a number of studies have examined the impact of hospital closures on travel times to emergency department services (Buchmueller et al., 2006; Hsia & Shen, 2011; Kaufman et al., 2016), few have used data that identifies the address from which the 911 call originated and the destination hospital, allowing for the accurate driving distance calculation. Thus, our study offers a more detailed and accurate assessment of actual EMS travel times.

We believe that in most health policy arenas, the general consensus considers rural hospital closures as detrimental to the residents in the communities they serve, potentially increasing mortality rates from lack of proximal access to emergency services. Indeed, in many communities a rural hospital closure may result in residents having to travel greater distances for care. Also, greater travel times for EMS have been linked to increased deaths from heart attacks and unintentional injuries (Sheps Center, 2019). Accordingly, a recent study investigating rural and urban emergency department (ED) utilization patterns between 2005 and 2016 found a substantial

increase in rural ED utilization, accounting for nearly one-fifth of all U.S. ED visits (Greenwood-Ericksen & Kocher, 2019). However, our analysis of the impact of rural hospital closures on EMS transport times in Alabama suggests this may not be the case for every rural hospital. Some areas may have alternate hospitals within the same distance, or closer, as revealed in the data from two hospitals in our sample. Additionally, a recent study examining the impact of hospital closures on geographic access in the Southeast U.S. suggests that it is possible to mitigate the adverse effects of hospital closures (Burkey et al., 2017). Using optimization modeling techniques, the authors analyzed the potential impact of hospital closures and found that using a strategic approach, a limited number of hospital closures in a given state may not adversely affect geographical access or quality of care.

Our findings also suggest that the impact of rural hospital closures on EMS transport times may be related to hospital utilization patterns prior to closure. Given this consideration, prospective patients may have preferred to utilize the services of alternative hospitals prior to their local hospital's closure. Only one of the hospitals in our sample had a high rate of EMS transports to it pre-closure, and this was the hospital service area that saw a high increase in transport time post-closure. As financial challenges continue to plague rural hospitals, few are able to offer a full array of services (Escarce & Kapur, 2009), especially compared with larger facilities in more populated areas. Consequently, rural residents may prefer to receive care at other facilities, including those at a greater distance to their homes. Thus, it is important to consider the types and breadth of services offered by a rural hospital and the EMS transfer patterns pre-closure to accurately assess the impact a rural hospital closure may have on future EMS transfer times.

While our analysis focused on EMS transport times, rural hospital closures may impact other EMS outcome measures, such as increased demand for transports, changes in waiting times, the

time spent waiting to transfer care from the ambulance to the ED staff, or the time from the arrival of the ambulance to the hospital to when it leaves to resume service (El Sayed, 2012). These time points may be critical to EMS agencies as they optimally staff their organizations to provide the timeliest response to patients. Therefore, we believe that an in-depth analysis of EMS data is critical to providing high quality care to communities. Policymakers, planners, and researchers advocating for rural hospitals should consider using EMS data, whether from their state (which in our case had richer data) or from the NEMSIS database, to prioritize efforts to save rural hospitals at risk for closure that are providing emergency care to their communities. EMS data could also be used to identify rural hospitals that may need additional support in order to provide emergency care to their communities.

As with most studies, ours is not without limitations. First, as with any spatial analysis of this nature, we cannot infer causation. It is possible that other factors coincided with the hospital closures that could have influenced the results generated. Second, the service area generated for each hospital was based on the zip code. Thus, we were limited by zip code centroid. The area of some zip codes extended beyond the 15-minute service area in analyses due to missing data. Data submitted to the state varies a great deal by time and by EMS provider, thus, it is unclear how missing data could impact the findings. Finally, our findings are limited to rural hospital closures in one state, and thus may not be generalizable to other states, and our sample size was rather small, with only six hospitals under consideration.

Conclusion

For most health emergencies, timely access to medical care is a critical factor in the successful resolution of the medical event. Rural hospital closures are often detrimental to the communities they serve, resulting in some residents having to travel greater distances for care.

With an estimated 700 rural hospitals at a high risk of closure (Seigel, 2019), the need to understand the impact that these closures may have on EMS transport times to an alternate facility is critical. Using optimization modeling techniques, the present study suggests that not all rural hospital closures result in adverse effects to the community or its residents. Our findings indicate that some rural hospital closures may actually result in a decrease in post-closure EMS transport time. Thus, the impact that a rural hospital closure may have on its community may depend on several factors, including utilization and EMS travel patterns prior to closure. That said, in some communities where a rural hospital has closed, that hospital may not have been a facility of choice pre-closure for many in the community. Policymakers should consider the inclusion of this particular factor when determining the effects of hospital closures on the medical and economic well-being of the rural communities they serve.

References

Alabama State Health Planning and Development Agency. (n.d.). *Certificate of Need Review Board*. http://www.shpda.state.al.us/datadivision/pricing.aspx

Buchmueller, T. C., Jacobson, M., & Wold, C. (2006). How far to the hospital?: The effect of hospital closures on access to care. *Journal of Health Economics, 25*(4), 740-761. https://doi.org/10.1016/j.jhealeco.2005.10.006

Burkey, M. L., Bhadury, J., Eiselt, H. A., & Toyoglu, H. (2017). The impact of hospital closures on geographical access: Evidence from four southeastern states of the United States. *Operations Research Perspectives, 4*, 56-66. https://doi.org/10.1016/j.orp.2017.03.003

Carr, B. G., Bowman, A. J., Wolff, C. S., Mullen, M. T., Holena, D. N., Branas, C. C., & Wiebe, D. J. (2017). Disparities in access to trauma care in the United States: A population-based analysis. *Injury, 48*(2), 332-338. https://doi.org/10.1016/j.injury.2017.01.008

Centers for Medicare and Medicaid Services. (n.d.). *Provider of services current files*. https://www.cms.gov/Research-Statistics-Data-and-Systems/Downloadable-Public-Use-Files/Provider-of-Services/

Cosgrove, J. (2018). Rural hospital closures: Number and characteristics of affected hospitals and contributing factors. *GAO Reports*. https://www.gao.gov/products/gao-18-634

El Sayed, M. J. (2012). Measuring quality in emergency medical services: A review of clinical performance indicators. *Emergency Medicine International, 2012*. Article 16. https://doi.org/10.1155/2012/161630

English, F. (2008). Improving cardiac survival rates in rural communities by ownership of health: What the evidence shows. *Journal of Emergency Primary Health Care, 6*(3). https://ajp.paramedics.org/index.php/ajp/article/download/465/465/0

Escarce, J. J., & Kapur, K. (2009). Do patients bypass rural hospitals?: Determinants of inpatient hospital choice in rural California. *Journal of Health Care for the Poor and Underserved, 20*(3), 625-644. https://doi.org/10.1353/hpu.0.0178

Freeman, V. A,, Thompson, K., Howard, H. A., Randolph, R., & Holmes, G. M. (2015). The 21st century rural hospital. North Carolina Rural Health Research Program, Cecil G. Sheps Center for Health Services Research. https://www.shepscenter.unc.edu/wp-content/uploads/2015/02/21stCenturyRuralHospitalsChartBook.pdf

Greenwood-Ericksen, M. B., & Kocher, K. (2019). Trends in emergency department use by rural and urban populations in the United States. *JAMA Network Open, 2*(4). Article e191919. https://doi.org/10.1001/jamanetworkopen.2019.1919

Hsia, R. Y., & Shen, Y. C. (2011). Rising closures of hospital trauma centers disproportionately burden vulnerable populations. *Health Affairs, 30*(10), 1912-1920. https://doi.org/10.1377/hlthaff.2011.0510

Kacik, A. (2019). Nearly a quarter of rural hospital are on the brink of closure. *Modern Healthcare*. https://www.modernhealthcare.com/article/20190220/NEWS/190229999/nearly-a-quarter-of-rural-hospitals-are-on-the-brink-of-closure

Kaufman, B. G., Thomas, S. R., Randolph, R. K., Perry, J. R., Thompson, K. W., Holmes, G. M. & Pink, G. H. (2016). The rising rate of rural hospital closures. *The Journal of Rural Health, 32*(1), 35-43. https://doi.org/10.1111/jrh.12128

Mell, H. K., Mumma, S. N., Hiestand, B., Carr, B. G., Holland, T. & Stopyra, J. (2017). Emergency medical services response times in rural, suburban, and urban areas. *JAMA Surgery, 152*(10), 983-984. https://doi.org/10.1001/jamasurg.2017.2230

Miller, K. E., James, H. J., Holmes, G. M., & Van Houtven, C. H. (2020). The effect of rural hospital closures on emergency medical service response and transport times. *Health Services Research, 55*(2), 288-300. https://doi.org/10.1111/1475-6773.13254

National Highway Traffic Safety Administration. (n.d.). *What is EMS?* https://www.ems.gov/whatisems.html

Rural Health Information Hub. (n.d.). *Rural emergency medical services (EMS) and trauma*. Retrieved April 16, 2021 from https://www.ruralhealthinfo.org/topics/emergency-medical-services

Seigel, J. (2019). *Rural hospital closures rise to ninety-eight*. National Rural Health Association. https://www.ruralhealthweb.org/blogs/ruralhealthvoices/february-2019/rural-hospital-closures-rise-to-ninety-seven

Sheps Center for Health Services Research. (2019). *Rural hospital closures since January, 2005*. University of North Carolina. https://www.shepscenter.unc.edu/programs-projects/rural-health/rural-hospital-closures/

Thomas, S. R., Holmes, G. M., & Pink, G. H. (2016). To what extent do community characteristics explain differences in closure among financially distressed rural hospitals? *Journal of Health Care for the Poor and Underserved, 27*(4), 194-203. https://doi.org/10.1353/hpu.2016.0176

Troske, S., & Davis, A. (2019). Do hospital closures affect patient time in an ambulance? *Rural & Underserved Health Research Center Publications, 8*. https://uknowledge.uky.edu/ruhrc_reports/8

U.S. Census Bureau. (n.d.). Rural America. https://mtgis-portal.geo.census.gov/arcgis/apps/MapSeries/index.html?appid=49cd4bc9c8eb444ab51218c1d5001ef6