International Journal of Paramedicine

Published by the National EMS Management Association (USA)

RESEARCH REPORTS

A CROSS-SECTIONAL ANALYSIS OF ALS/BLS CARE IN LOW ACUITY 9-1-1 RESPONSE BY GEOGRAPHY AND INSURANCE STATUS UTILIZING THE 2019 NEMSIS DATASET

Jeffrey Pesarsick, MPH, NRP*[1]; Ruchi Bhandari, PhD, MPA, MBA[1]; Caroline P. Groth, PhD[1]; Scott Findley, MD[2]; Brian Hendricks, PhD[3,4]

Author Affiliations: 1. West Virginia University Department of Epidemiology and Biostatistics; Morgantown WV, USA; 2. Department of Emergency Medicine, School of Medicine, West Virginia University, Morgantown, West Virginia, USA; 3. West Virginia School of Osteopathic Medicine, Center for Rural and Community Health, Lewisburg, WV, USA. 4. West Virginia Clinical and Translational Sciences Institute; Morgantown, WV, USA.

**Corresponding Author*: jap0036@mix.wvu.edu

Recommended Citation: Pesarsick, J., Bhandari, R., Groth, C.P., Findley, S., & Hendricks, B. (2024). A cross-sectional analysis of ALS/BLS care in low acuity 9-1-1 response by geography and insurance status utilizing the 2019 NEMSIS dataset. *International Journal of Paramedicine*. (8), 80-88. https://doi.org/10.56068/NOTY5781. Retrieved from https://internationaljournalofparamedicine.com/index.php/ijop/article/view/2996

Keywords: patient acuity, EMS, advanced life support, basic life support, community paramedicine, NEMSIS, emergency medical services, EMS, paramedicine

Received: November 27, 2023
Revised: July 1, 2024
Accepted: July 1, 2024
Published: October 8, 2024

Funding: BH effort was supported by NIH NIGMS award 2U54GM104942-02 and NIH NIMHD award 5U01MD017419-02.

Declaration of Interests: None.

ABSTRACT

Purpose: The objective of this study was to examine the relationship between patient acuity and level of EMS care (ALS/BLS) adjusting for rurality and insurance.

Methods: Data were obtained from the National Emergency Medical Services Information System (NEMSIS) dataset for 2019. EMS responses (n = 4,375,568) were analyzed comparing patient acuity and CMS service level, advanced life support (ALS) vs basic life support (BLS), to assess for associations in acuity and CMS service level using logistic regression.

Results: Overall, there was a decreased odds of advanced life support service use at low acuity EMS responses (aOR = 0.457, 95% CI [0.454, 0.460]). Analysis exploring the interaction between CMS service level and rurality demonstrates an overall trend of decreasing odds of low acuity EMS responses among rural areas and BLS care (aOR = 0.492, 95% CI [0.486, 0.498]) and ALS care (aOR = 0.208, 95% CI [0.206, 0.210]). When analyzing trends among public versus all other insurance and rural versus urban settings, there were decreases in low acuity ALS care in the rural setting; ALS and public insurance (aOR = 0.469, 95% CI [0.465-0.472], $p < 0.001$), ALS and rural (aOR = 0.208, 95% CI [0.206, 0.210], $p < 0.001$) among low acuity responses. The results indicate that acuity and service level vary according to insurance and rurality. In the low acuity call type, we see decreased odds of ALS use compared to BLS use in those with public insurance compared to other insurance. There is also a geographic component to these results where the use of advance life support services declined with decreases in urbanicity.

Discussion: These results potentially highlight that rural areas utilize less emergency medical response resources in low acuity responses. As such, EMS programs like community paramedicine, could be potentially effective interventions to close gaps in access to care for rural residents.

INTRODUCTION

Emergency medical care has a critical role in providing access to health care. Historically, emergency medical services (EMS) in the United States were created to transport ill or injured pa-

tients to the nearest hospital facility and were poorly organized, unregulated, and rooted in businesses such as the funeral industry (West Virginia Department of Education, n.d. However, over time their role developed, and by the late 19th century, EMS were equipped with compact medical equipment to provide prehospital care and improve patient outcomes (Shah, 2006). In the 1960s, legislative action oversaw the standardization of emergency medical services by geography, resulting in the development of the first statewide EMS program in Maryland (Shah, 2006). EMS responses now consist of six main areas, which are early detection, early reporting, early response, on scene care, care in transit, and transfer to definitive care (PFEMS, 2022). Taken together, these actions are meant to provide critically ill or injured patients with immediate medical care to prolong life.

Patient acuity in EMS response is as diverse as it is complex, representing the perceived severity measured subjectively by the responder (Shekhar & Blumen, 2021). The National EMS Core Content provides a framework of the knowledge and skills required for EMS clinicians to assess, diagnose, and manage patients (National Highway Traffic Safety Administration, 2005). Its guidelines divide severity of patient scenarios into three categories, based on the Model of Clinical Practice of Emergency Medicine: Critical, Emergent, and Lower Acuity (Beeson et al., 2020; NHTSA, 2005). Acuity is determined by the responder based upon signs and symptoms of the illness or injury at the time of assessment. Critical patients, according to this framework, have a high probability of mortality if immediate lifesaving intervention is not initiated, while those categorized as emergent have conditions which could progress with further complications without treatment, whereas lower acuity have a low probability of progression to more serious disease or complications (Beeson et al., 2020). While some conditions are easy to categorize as critical, for instance, an unresponsive patient, others are more subjective to responder biases and experience, and while acuity can dictate level of care, this relationship is not exclusive (Shekhar & Blumen, 2021).

Importantly, not all EMS are equally credentialed to provide the same level of life support to communities. The differentiation of BLS and ALS services is vital, as access to these resources differs, even within the United States (McLaughlin et al., 2021). This is of serious public health concern, as an EMS response involving ALS services may permit use of tools or medications to improve patient-centered outcomes or care not available to BLS services. It is important to note that some states' EMS agencies are required to license at the highest level of care they can guarantee to provide, which may understate the actual care able to be provided. Consequently, whether ALS services are used at a response or not does not accurately reflect on their availability (National Association of State EMS Officials, 2020).

In comparing settings, geographic differences typically result in urban EMS having shorter response, on scene, and transport times, higher survival rates, decreased morbidity, and more clinicians and resources (Alanazy et al., 2019; Lerner & Moscati, 2001; Newgard et al., 2017). Disparity in the availability of resources could result in critically ill or injured patients within rural areas being transported to a hospital by EMS with only BLS credentialing, while EMS with ALS certification may respond in urban areas to low acuity situations. Previous research has examined disparities in the use of EMS in low acuity situations and found increasing use in vulnerable populations (Durant & Fahimi, 2012). However, they did not examine level of EMS support utilized within low acuity re-

sponses. There is a scarcity in the literature regarding disparities in frequency of basic or advanced life support services by EMS within differing levels of response acuity. Gaps in available research are further exacerbated when attempting to locate geographic differences in inequities in BLS and ALS services.

Previous studies have utilized prehospital databases such as the National Hospital Ambulatory Care Survey (NHAMCS) or the National Emergency Medical Services Information System (NEMSIS) to better understand emergency department visits for low acuity EMS responses, reimbursement for low acuity EMS response, and disparities in use of EMS services among older adults (Alpert et al., 2017; Duong et al., 2017; Durant & Fahimi, 2012). However, no study to our knowledge has described disparities in level of support provided during low versus all other acuity calls, or attempted to understand how they differ by rurality. This study has the potential to better inform policy and resource allocation for placement of EMS services within differing regions of the U.S. The purpose of this study is to fill the gap in research surrounding use of ALS versus BLS services during EMS response at low acuity versus emergent and critical acuity responses.

METHODS

Data Source and Management

Data were obtained from the National Emergency Medical Services Information System (NEMSIS) 2019 data files. Briefly, NEMSIS is sponsored by the National Highway Traffic Safety Administration's (NHTSA) Office of EMS which collects EMS data from 48 states and three U.S. territories to improve standardization, aggregation, and utilization of EMS events (National Emergency Medical Services Information System, 2020). In the 2019 data set, these data are de-identified, contain no protected health information, and are made up of reports from 34,302,737 EMS activations.

Study inclusion criteria consisted of 9-1-1 response to scenes from patients who were treated and/or transported as well as those who refused treatment and/or transport. Exclusion criteria comprised responses for interfacility, routine transfer, mutual aid, standby events, and public assistance. Exclusion criteria also included incidents which did not have a patient, for example "no patient found" entries and responses where the CMS service level (ALS/BLS), insurance, or initial acuity indicators were missing. CMS service level was used to elucidate level of care provided by EMS responders (ALS/BLS) and is defined in the NEMSIS extended data definitions as the service level provided for the encounter (NASEMSO, 2016). Lastly, a response was excluded if initial acuity was categorized as dead without resuscitation efforts, as they were inherently different and likely did not have a treatment or transport component.

The outcome for the study was the odds of a low acuity response compared to all other initial acuities among our study sample. Initial acuity is indicative of the severity of the EMS encounter and is defined by the Model of Clinical Practice of Emergency Medicine and reported in the National EMS Core Content (NHTSA, 2005). Initial acuity is stratified into four categories (low, emergent, critical, and dead without resuscitation efforts). Low acuity calls have a low probability of progression to more serious disease, emergent may progress in severity or complication with a high probability for mortality, and critical involves life threatening illness or injury with a high probability of mortality if

immediate intervention is not begun (NHTSA, 2005). Initial acuity was dichotomized as low initial acuity and all other acuities.

Covariates included CMS service level (level of treatment ALS or BLS), unit level (license level of responding unit ALS or BLS) age, sex at birth, insurance coverage, and urbanicity. Age was colinear with insurance and so was excluded from the analysis. Insurance coverage was dichotomized to patients with or without public insurance. Race was not included in our analysis given it was missing in greater than 50% of the EMS responses in our analytic sample. Urbanicity of EMS response was captured to characterize geographic differences between acuity of calls and CMS services provided. Urbanicity in the NEMSIS dataset is based on the 2013 United States Department of Agriculture (USDA) influence codes which are divided into four categories: urban, suburban, rural, and wilderness (U.S. Department of Agriculture Economic Research Service, n.d.). These four categories were further dichotomized in our study to rural and non-rural.

Statistical Analysis

Logistic regression was conducted to identify differences in the odds of a low acuity call by CMS service level, adjusting for covariates in the model. Regression analyses were also conducted to investigate effect modification in CMS service level by rurality, patient insurance coverage by rurality, and CMS service by patient insurance coverage. Statistical significance was evaluated using 95% confidence intervals around estimated odds ratios. All data management and statistical analyses were conducted in R Studio (Version 1.3.959).

RESULTS

Overall, there were 2,821,072 low acuity events and 1,434,956 emergent and critical events within our NEMSIS study sample. Among low acuity events, 72% received ALS care while 28% received a BLS level of care. Among low acuity events the responding unit's license level was BLS in 9% of responses and ALS in 91% of responses.

	Low Acuity N=2,812,072	Emergency and Critical Acuities N=1,434,956
Sex		
Female	1502075 (53.4%)	730831 (50.9%)
Male	1309997 (46.6%)	704125 (49.1%)
Unit Level		
BLS	395458 (14.1%)	131851 (9.2%)
ALS	2416614 (85.9%)	1303105 (90.8%)
Level of Care		
BLS	782323 (27.8%)	216578 (15.1%)
ALS	2029749 (72.2%)	1218378 (84.9%)
Insurance		
Non-Public Insurance	1927049 (68.5%)	972191 (67.8%)
Public Insurance	885023 (31.5%)	462765 (32.2%)
Rural		
Non-Rural	2577529 (91.7%)	1216835 (84.8%)
Rural	234543 (8.3%)	218121 (15.2%)
Rural and Insurance		
Non-Rural & Non-Public Insurance	1792869 (63.8%)	855353 (59.6%)
Non-Rural & Public Insurance	784660 (27.9%)	361482 (25.2%)
Rural & Non-Public Insurance	134180 (4.8%)	116838 (8.1%)
Rural & Public Insurance	100363 (3.6%)	101283 (7.1%)
Level of Care and Rural		
BLS & Non-Rural	684857 (24.4%)	168008 (11.7%)
BLS & Rural	97466 (3.5%)	48570 (3.4%)
ALS & Non-Rural	1892672 (67.3%)	1048827 (73.1%)
ALS & Rural	137077 (4.9%)	169551 (11.8%)
Level of Care and Insurance		
BLS & Non-Public Insurance	540944 (19.2%)	148989 (10.4%)
BLS & Public Insurance	241379 (8.6%)	67589 (4.7%)
ALS & Non-Public Insurance	1386105 (49.3%)	823202 (57.4%)
ALS & Public Insurance	643644 (22.9%)	395176 (27.5%)

Table 1. Characteristics of study population (NEMSIS, 2019).

Among low acuity events, 32% involved patients with public insurance classifications (n = 885,023), 53% were female (n = 1,502,075), and 92% were among urban geographic localities (n = 2,577,529). Low acuity complaints were identified to have statistically different distributions of insurance, service level, gender, and urbanicity compared to emergent and critical acuity complaints. A comprehensive breakdown is presented in Table 1.

Covariate	Odds Ratios	CI	p
Sex			
Female	1		
Male	0.909 ***	[0.905, 0.912]	< 0.001
Service Level			
BLS	1		
ALS	0.457 ***	[0.454, 0.460]	< 0.001
Unit Level			
BLS	1		
ALS	0.819 ***	[0.813, 0.824]	< 0.001
Insurance			
Non-Public Insurance	1		
Public Insurance	1.015 ***	[1.010, 1.019]	< 0.001
Rural			
Not Rural	1		
Rural	0.459 ***	[0.457, 0.462]	< 0.001

Table 2. Multivariable logistic regression for all acuity calls. Results display the odds ratios for probability of Low Acuity responses within different subgroups within the analysis.

Multivariable logistic regression results are presented in Table 2. There was a significantly lower odds of involvement in low acuity events for ALS services compared to BLS services (aOR = 0.457, 95% CI [0.454, 0.460]). Low acuity events had a statistically lower odds of the responding unit being ALS licensed (aOR = 0.819, 95% CI [0.813, 0.824]) compared to those which were licensed BLS. Low acuity events had a statistically lower odds of occurring in rural areas compared to emergent and critical acuity events (aOR = 0.459, 95% CI [0.457, 0.462]). Males had a statistically lower odds involvement in low acuity events than females (aOR = 0.909, 95% CI [0.905, 0.912]). Lastly, there was a statistically higher odds of a low acuity event involving someone with public insurance compared to all other insurance types (aOR = 1.015, 95% CI = [1.010,1.019]).

Interaction specific model results are displayed in Table 3. All models included adjustment for patient sex at birth and responding unit level. There was a significantly lower odds of a low acuity event involving patients living in rural areas who had public insurance compared to those in non-rural areas without public insurance (aOR = 0.466, 95% CI [0.462, 0.471]). Similarly, there were statistically lower odds of a low acuity event involving patients living in rural areas without public insurance compared to those in non-rural areas without public insurance (aOR = 0.542, 95% CI [0.538, 0.547]). Alternatively, there was a statistically higher odds of a low acuity event involving a patient living in a non-rural area with public insurance compared to those in non-rural areas without public insurance (aOR = 1.029, 95% CI [1.025, 1.034]). When examining the interaction between CMS service level and insurance status, responses involving BLS care and patients with public insurance had statistically lower odds of involvement in low acuity events compared to those receiving BLS care without public insurance (aOR = 0.978, 95% CI [0.968, 0.988]). Similarly, responses involving ALS services had statistically lower odds of involvement in low acuity events for patients with public insurance (aOR = 0.469, 95% CI [0.465, 0.472]) and for those without public insurance (aOR = 0.488, 95% CI [0.484, 0.491]) compared to those receiving BLS care without public insurance. Lastly, for CMS service within rural versus non-rural areas, BLS service in rural areas had statistically lower odds of involvement in a low acuity event compared to BLS care in non-rural areas

(aOR = 0.492, 95% CI [0.486, 0.498]). Likewise, there was statistically lower odds of involvement in a low acuity event for ALS care among rural (aOR = 0.208, 95% CI [0.206, 0.210]) and non-rural (aOR = 0.464, 95% CI [0.461, 0.467]) compared to BLS care in non-rural areas.

Covariate	Odds Ratios	CI	p
Gender			
Female	1		
Male	0.901 ***	[0.897, 0.904]	< 0.001
Unit Level			
BLS	1		
ALS	0.611 ***	[0.606, 0.615]	< 0.001
Rural & Insurance			
Non-Rural & Non-Public Insurance	1		
Non-Rural & Public Insurance	1.029 ***	[1.025, 1.034]	< 0.001
Rural & Non-Public Insurance	0.542 ***	[0.538, 0.547]	< 0.001
Rural & Public Insurance	0.466 ***	[0.462, 0.471]	< 0.001
Gender			
Female	1		
Male	0.908 ***	[0.904, 0.912]	< 0.001
Unit Level			
BLS	1		
ALS	0.819 ***	[0.813, 0.825]	< 0.001
EMS & Rural			
BLS & Not Rural	1		
BLS & Rural	0.492 ***	[0.486, 0.498]	< 0.001
ALS & Not Rural	0.464 ***	[0.461, 0.467]	< 0.001
ALS & Rural	0.208 ***	[0.206, 0.210]	< 0.001
Gender			
Female	1		
Male	0.909 ***	[0.905, 0.913]	< 0.001
Unit Level			
Female	1		
Male	0.811 ***	[0.805, 0.817]	< 0.001
EMS & Public Insurance			
BLS & Not Pub Ins	1		
BLS & Pub Ins	0.978 ***	[0.968. 0.988]	< 0.001
ALS & Not Pub Ins	0.488 ***	[0.484, 0.491]	< 0.001
ALS & Pub Ins	0.469 ***	[0.465, 0.472]	< 0.001

Table 3. Interaction logistic regression model results for odds of low acuity event by insurance, EMS and rurality.

DISCUSSION

The results indicate that patient acuity level, low acuity versus emergent and critical acuities, varied across insurance status and geography. Importantly, odds of low acuity involvement were lower for rural areas, among patients with public insurance, and responses involving ALS services. This study also highlights key interactions between these covariates which complicates direct inferences which can be drawn from the main effects. Importantly, we found that regardless of insurance status, there was a lower odds of a low acuity event in rural areas. This was not true for non-rural areas, where non-rural areas with public insurance had higher odds of low acuity events. This may be due to variation in socio-economic status levels among non-rural versus rural areas. Previous studies have found differing impact of socio-economic status and vulnerability across rural and urban communities (Deziel et al., 2023; Eberhardt et al., 2002). This study highlights an important disparity among rural communities, who also experience longer than average travel times for primary care and limited access to medical specialties and hospitals (Iglehart, 2018).

Conversely, urban areas that likely have greater access to healthcare resources and public transportation, and probably have more ALS EMS resources available displayed increased odds of low acuity events. One potential explanation of our results is that with greater access to ALS care there could be over triage of care in the urban environment whereas in the rural environment there is less access to ALS services. Interestingly, in the urban setting those without public insurance exhibited a lower odds of low acuity response than those with public insurance whereas in the rural setting those with public insurance had a higher odds of low acuity events.

While the cross-sectional nature of these data prohibits a causal inference, the disparity in ALS vs BLS services and acuity of calls in rural areas could speak to the disparities in access to health care in rural versus urban settings. This is key as educational interventions or additional studies could be designed to better understand disparities in EMS utilization.

These findings, though not causative, provide contextual support for additional research to elucidate the mechanisms for the disparities across the geographic and socioeconomic spectrum. Studies aimed at evaluating resource availability, allocation, and potential alternatives would be appropriate. Potential outcomes include supporting programs aimed at reducing disparities in access to healthcare. These could include community paramedicine programs targeted to communities with reduced access to care and or assisting the reduction of EMS calls and hospital crowding in the urban environment. Finding ways to share resources in those areas with reduced access to care could also be a strategy to increase access to care and address rural disparities. One example may be for local hospitals to partner with EMS agencies to bridge gaps in care.

Several limitations to our approach exist. First, while NEMSIS is a nationally representative sample of EMS responses, not every EMS agency or state participates. This bias has the potential to influence relationships found by geography as EMS responses are not evenly distributed within space (NASEMSO, 2020). Next, responses did not include a unique identifier for individual patients, which could result in a single patient having more than one entry. However, we attempted to mitigate this through our inclusion/exclusion criteria. For example, exclusion of inter-facility transport reduces instances in which a patient is transported multiple times by EMS for the same encounter. It is important to keep in mind that NEMSIS is an encounter-based surveillance system and was not intended to be used for patient level analyses. Though defined in the National EMS Core Content, patient acuity is subjective to classification by the EMS practitioner which creates the potential of information bias such as over or under triage of patient acuity. This could also influence ALS versus BLS care where for example in an urban setting with only ALS providers, a low acuity response that may typically be completed with BLS resources was treated with ALS care. Though this is a limitation in our results, it also supports the possible disparity of EMS resources in these settings. Unit level is defined by the NEMSIS data dictionary as the level an EMS unit/crew can provide regardless of patient need (NASEMSO, 2016). There may be instances where a unit is licensed as ALS but staffed by a BLS crew providing BLS care; however this situation is not discernable within this data set. Despite these limitations our study had several strengths. With 4,247,028 EMS events our sample size was robust and is adequately powered. Our inclusion of unit level, though with limitations, does hint at the potential availability of ALS resources within a response area. Importantly, this is the first nationally representative analysis of patient insurance status, geography, and EMS service level involvement by acuity of event in EMS response data.

CONCLUSIONS

This research provides a national overview of the frequency of involvement for different insurance statuses, geographies, and patient demographics in low acuity events for 9-1-1 responses. While we are unable to examine local neighborhood context for the relationships we observed, our study does address major gaps in the current public health

literature concerning urban-rural disparities in prehospital health care. In particular, this study addresses uncertainties with regard to how EMS service level availability is distributed within different geographic contexts and for a variety of patient populations. Future research is warranted to focus specifically on how the relationships identified here vary in geographic space and to examine resource utilization in differing EMS models. Methods, such as those applied within spatial epidemiology, could be particularly useful in elucidating how these factors impact provision of care for patients across the United States rural-urban gradient.

REFERENCES

Alanazy, A. R. M., Wark, S., Fraser, J., & Nagle, A. (2019). Factors impacting patient outcomes associated with use of emergency medical services operating in urban versus rural areas: A systematic review. *International Journal of Environmental Research and Public Health, 16*(10). https://doi.org/10.3390/ijerph16101728

Alpert, A., Morganti, K. G., Margolis, G. S., Wasserman, J., & Kellermann, A. L. (2017). Giving EMS flexibility in transporting low-acuity patients could generate substantial Medicare savings. *Health Affairs, 32*(12), 2142–2148. https://doi.org/10.1377/hlthaff.2013.0741

Beeson, M. S., Ankel, F., Bhat, R., Broder, J. S., Dimeo, S. P., Gorgas, D. L., Jones, J. S., Patel, V., Schiller, E., Ufberg, J. W., & Keehbauch, J. N. (2020). The 2019 model of the clinical practice of emergency medicine. *Journal of Emergency Medicine, 59*(1), 96–120. https://doi.org/10.1016/j.jemermed.2020.03.018

Deziel, N. C., Warren, J. L., Bravo, M. A., Macalintal, F., Kimbro, R. T., & Bell, M. L. (2023). Assessing community-level exposure to social vulnerability and isolation: Spatial patterning and urban-rural differences. *Journal of Exposure Science & Environmental Epidemiology, 33*(2). https://doi.org/10.1038/S41370-022-00435-8

Duong, H. V., Herrera, L. N., Moore, J. X., Donnelly, J., Jacobson, K. E., Carlson, J. N., Mann, N. C., & Wang, H. E. (2017). National characteristics of emergency medical services responses for older adults in the United States. *Prehospital Emergency Care, 22*(1), 7–14. https://doi.org/10.1080/10903127.2017.1347223

Durant, E. & Fahimi, J. (2012). Factors associated with ambulance use among patients with low-acuity conditions. *Prehospital Emergency Care, 16*(3), 329–337. https://doi.org/10.3109/10903127.2012.670688

Eberhardt, M. S., Ingram, D. D., & Makuc, D. M. (2002). The effects of socioeconomic status on health in rural and urban america. *JAMA, 287*(1), 109–109. https://doi.org/10.1001/jama.287.1.109-JMS0102-3-1

Iglehart, J. K. (2018). The challenging quest to improve rural health care. *New England Journal of Medicine*, (378)5. https://doi.10.1056/NEJMhpr1707176

Lerner, E. B., & Moscati, R. M. (2001). The golden hour: Scientific fact or medical "urban legend"? *Academic Emergency Medicine, 8*(7), 758–760. https://doi.org/10.1111/J.1553-2712.2001.TB00201.X

McLaughlin, C., Riutta, O., & Busko, J. (2021). *Rural EMS workforce: A call to action*.

National Association of State EMS Officials (NASEMSO). (2016). *Extended data definitions*.

National Association of State EMS Officials (NASEMSO). (2020). *2020 national emergency medical services assessment*.

National Emergency Medical Services Information System (NEMSIS). (2020). *History of NEMSIS*. https://nemsis.org/what-is-nemsis/history-of-nemsis/

National Highway Traffic Safety Administration (NHTSA). (2005). *National EMS core content* (Publication DOT HS 809 898). https://www.ems.gov/pdf/education/EMS-Education-for-the-Future-A-Systems-Approach/National_EMS_Core_Content.pdf

Newgard, C. D., Fu, R., Bulger, E., Hedges, J. R., Mann, N. C., Wright, D. A., Lehrfeld, D. P., Shields, C., Hoskins, G., Warden, C., Wittwer, L., Cook, J. N. B., Verkest, M., Conway, W., Somerville, S., & Hansen, M. (2017). Evaluation of rural vs urban trauma patients served by 9-1-1 emergency medical services. *JAMA Surgery, 152*(1), 11. https://doi.org/10.1001/JAMASURG.2016.3329

PFEMS. (2022). *Purpose of EMS* (emergency medical services). https://fcems.org/EMS-purpose.html

Shah, M. N. (2006). The formation of the emergency medical services system. *American Journal of Public Health, 96*(3), 414–423. https://doi.org/10.2105/AJPH.2004.048793

Shekhar, A. C. & Blumen, I. (2021). Evaluating emergency medical services provider perceptions about patient acuity across various transport vehicles. *Air Medical Journal*, (40)2, 139-140. https://doi.org/10.1016/j.amj.2020.11.011

U.S. Department of Agriculture Economic Research Service. (n.d.) *Urban Influence Codes*. Retrieved April 20, 2021, from https://www.ers.usda.gov/data-products/urban-influence-codes.aspx

West Virginia Department of Education. (n.d.). *History of EMS*. Retrieved March 8, 2022, from https://wvde.state.wv.us/abe/Public%20Service%20Personnel/HistoryofEMS.html