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Prehospital Emergency Medical Services Personnel: Comparing Rural and Urban Professional Experience and Provision of Evidence-Based Care

KEY FINDINGS

- Compared with emergency medical services (EMS) agencies serving predominantly rural patient populations, urban-serving agencies more often provided evidence-based care according to performance measures for stroke, hypoglycemia, and trauma. The rural/urban difference was more pronounced with increasing rurality. For seizures, EMS agencies serving predominantly large rural and isolated small rural patients provided evidence-based care more often than urban-serving agencies.
- EMS professionals at predominantly urban-serving agencies responded to a higher mean number of daily 911 encounters in 2018 and spent more total time on 911 responses during that year than those at rural-serving agencies. EMS professionals' experience, as measured by numbers of 911 encounters and total time spent on 911 responses in 2018, decreased as agency rurality increased.
- In analyses controlling for multiple agency characteristics, agencies that served predominantly small rural areas were less likely to provide evidence-based care than urban-serving agencies across the board for seizure, stroke, hypoglycemia, and trauma. Agencies serving isolated small rural areas also were less likely than urban agencies to provide evidence-based care for stroke and trauma.
- Patients were more likely to receive evidence-based care for seizure and trauma when the lead EMS professional at the encounter had accumulated more total time spent responding to 911 encounters. Measures of experience were not statistically significant for stroke or hypoglycemia.
- Agency staffing models—paid, unpaid, or mixed paid/unpaid—generally did not influence the provision of evidence-based care except for hypoglycemia, where agencies with mixed paid and unpaid staff performed better than those with strictly paid staff.

BACKGROUND

The use of evidence-based guidelines in medicine generally and emergency medical services (EMS) specifically has been the focus of increasing attention.[1-3] Numerous measures of quality and performance have arisen across the healthcare industry, even being mandated by federal payers for certain organizations. A landmark paper by the U.S. Metropolitan Municipalities'

EMS Medical Directors Symposium proposed evidence-based guidelines and performance measure benchmarks for EMS but provided guidance only for the largest suburban and urban EMS systems.[4] Due to their distinct attributes and unique challenges, rural EMS systems remain at risk of being left behind in the transition toward evidence-based care.[5] Indeed, a study of EMS quality programs found that rural agencies were less likely than urban to follow clinical quality metrics.[6]

Rural EMS systems differ greatly from urban systems in workforce characteristics and care provided. Longer distances to definitive care mean that rural EMS professionals often require greater skill levels than their urban counterparts.[7] For example, rural professionals have been shown to be more likely than urban professionals to exercise a wider scope of practice for acute cardiovascular events.[8] Yet paradoxically, rural EMS systems tend to have fewer resources and personnel with less training and experience.[7] A WWAMI Rural Health Research Center study documented heavy reliance on volunteers and fewer personnel trained at the paramedic level in rural agencies, with variation across different types of rural geographies.[9]

Supplementing rural response with urban expertise does not always result in positive outcomes: a study of rural patients with acute ST-elevation myocardial infarction (STEMI) in Nebraska found that they did not receive the standard of care when that care was directed by cardiologists in urban centers because the urban physicians did not understand rural processes of care.[10] The impacts of rural-urban variations in training, experience, and practices on patient care and outcomes are not well understood, and findings from past research are somewhat inconsistent. For example, an early study of intubation found that intermediate-level professionals (corresponding to today's Advanced Emergency Medical Technicians [AEMTs]) in rural areas did not differ significantly from urban and suburban paramedics in their outcomes,[11] suggesting that at least in some circumstances, rural professionals with less training could provide comparable care.

As might be expected, accumulated experience on the job matters both for EMS professionals' level of comfort providing care and for patient outcomes. A threshold volume of experiences may be needed to overcome "reality shock" as new practitioners gain real-world experience.[12] An Australian study found that the more professionals responded to cardiac arrests, the higher the survival rate but that both urban and especially rural paramedics had insufficient exposure to cardiac arrest to maintain proficiency.[13] For an urban paramedic to maintain proficiency at endotracheal intubation, a notably difficult skill, one estimate is that a single ambulance with dual paramedic staffing must respond to 10,000 total calls per year to provide enough intubation experiences for both paramedics (20 each),[14] an unrealistic number in rural counties that do not have enough residents to generate 10,000 calls. However, staff can be deployed to maximize the experience of the most highly trained professionals. One study found that agencies with higher average annual rates of trauma intubations per paramedic tended to have a smaller number of paramedics relative to the total number of EMS professionals.[15] Together these findings support the notion that configuring an agency's workforce to match appropriately trained professionals with patient volume and case mix is necessary to maintain complex skills and high-quality patient care.

The growing emphasis on evidence-based care coincides with greater availability of electronic prehospital EMS patient encounter records for billing and patient care. Records standardized according to National EMS Information System (NEMSIS) specifications are yielding a robust new source of data to compare practices and understand the causes of variability across EMS systems for research and quality improvement. The EMS Compass Initiative,[6,16] a two-year project funded by the National Highway Traffic Safety Administration (NHTSA), developed standardized, evidence-based EMS performance measures that are based on NEMSIS data elements. These measures were the result of an extensive design process to identify indicators that are important and feasible, based on widespread industry input. They were also considered likely candidates for eventual value-based EMS reimbursement. At the conclusion of the initiative, industry organizations formed the National EMS Quality

Alliance to continue its work.[17] These converging developments have provided an unprecedented opportunity to assess the extent to which rural and urban EMS personnel provide evidence-based care for critical time-sensitive conditions, as measured by standardized quality or performance measures, leading to the following study questions:

- Do EMS personnel in rural-serving agencies respond to fewer encounters and spend less total time providing 911 response on average than personnel in urban agencies, and if so, are differences more pronounced with increasingly rurality?
- What are the effects of individual accumulated experience and agency rurality on the provision of care measured according to evidence-based guidelines, controlling for other agency characteristics (organization type, staffing model, and agency level of service)?

METHODS

DATA SOURCES

We used a research data set of patient care records from ESO Solutions, Inc. (ESO), an EMS software vendor, that included data collected during the 7,574,879 prehospital EMS encounters by 1,288 rural and urban EMS agencies across the United States occurring from January 1 through December 31, 2018. Our analysis included the 4,963,913 EMS encounters classified as 911 response that involved patient care. We excluded encounters classified as emergency interfacility transfer (n=85,065; e.g., a patient at an urgent care center experiencing chest pain who is transported to a hospital), mutual aid (n=11,533), and 911 encounters that did not involve patient care (n=993,221). We classified 911 encounters that involved patient care as transport or non-transport based on the disposition code (see the Appendix for details). We used the U.S. Department of Agriculture Economic Research Service ZIP code approximation (version 3.1) of the 2010 Rural-Urban Commuting Area (RUCA) codes to categorize rural and urban locations.[18]

MEASURES

Agency characteristics. ESO classified each EMS encounter location ZIP code as urban (codes 1-3), large rural (codes 4-6), small rural (codes 7-9), or isolated small rural (code 10) using the primary digit of the 2010 RUCA codes (see Table 1). We assigned all agencies to one of two service area categories, predominantly urban or predominantly rural, using the above geographic classification of all EMS encounters linked to each agency based on the majority of encounters (i.e., more than 50% urban vs. more than 50% rural). We assigned all agencies with a predominantly rural service area to one of three rural categories (large rural, small rural, isolated small rural) based on the rural category with the highest percentage of encounters. For example, an agency with 19% large rural encounters, 53% small rural encounters, and 3% isolated small rural encounters was classified as a predominantly small rural-serving agency. We could not categorize the service areas of 61 agencies, primarily in the New England Census Division, due to missing RUCA codes for all or most of their EMS encounters. Our analytic file included the 1,085 agencies that had 911 encounters in at least one of the four Compass Measure analytic files (described below).

Table 1. Primary Rural-Urban Commuting Area Codes (RUCAs), 2010[18]

Code	Description
Urban	
1	Metropolitan area core: primary flow within urbanized area (UA)
2	Metropolitan area high commuting: primary flow 30% or more to UA
3	Metropolitan area low commuting: primary flow 10% to 30% to UA
Large Rural	
4	Micropolitan area core: primary flow within an urban cluster of 10,000 to 49,999 (large UC)
5	Micropolitan area high commuting: primary flow 30% or more to a large UC
6	Micropolitan area low commuting: primary flow 10% to 30% to a large UC
Small Rural	
7	Small town core: primary flow within an urban cluster of 2,500 to 9,999 (small UC)
8	Small town high commuting: primary flow 30% or more to a small UC
9	Small town low commuting: primary flow 10% to 30% to a small UC
Isolated Small Rural	
10	Rural areas: primary flow to ZIP outside a UA or UC

Other agency characteristics included organization type (community non-profit, fire department, government [non-fire], and private for-profit non-hospital), staffing model (paid, unpaid [volunteer], and mixed paid and unpaid), and agency level of service (Emergency Medical Technician [EMT], Advanced Emergency Medical Technician [AEMT], and Paramedic), which is the level of care that an agency is authorized or licensed to provide.

Individual accumulated experience. We calculated two measures of individual EMT and paramedic experience for the lead EMS professional at each encounter (based on four specified roles: lead, driver, none, and other): the mean daily number of 911 encounters and the mean daily number of hours spent responding to 911 encounters in 2018. We standardized both measures according to the number of days an EMS professional was "in service" (on the job) during 2018. For transport 911 encounters we calculated the difference between the time EMS personnel first made contact with the patient and the time of arrival at the emergency department to measure the time spent responding to an encounter. For non-transport 911 encounters we calculated the difference between the time EMS personnel first made contact with the patient and the time the incident was closed (the end of the call) as our measure of the time spent responding to an encounter. If the time of contact with patient was missing, we used the time the ambulance arrived at the address to which it was dispatched.

For each encounter we identified the highest credential level for the EMS professionals at the encounter focusing on the three main credential levels in 911 response: EMT, AEMT, and paramedic. We excluded physicians, nurses, and other healthcare professionals as well as individuals with expired and/or missing credentials. We compared recorded credential levels with these commonly known equivalent levels and categorized them according to the *National EMS Scope of Practice Model*.[19] For those with multiple active credentials, we selected the highest level. Minor local variations that are not equivalent to national scopes of practice are possible, but these few instances are unlikely to affect the results in any significant way.

Evidence-based care. We selected four measures of evidence-based care using the EMS Compass performance measures[20] summarized in Table 2 that target seizure, stroke, hypoglycemia, and trauma.

Seizure. The seizure measure ("seizure-02") is defined as the percentage of EMS responses originating from a 911 request for patients with status epilepticus who received a benzodiazepine aimed at terminating their status seizure during the EMS response.[21] There were 5,150 encounters that met the criteria of this measure, with a primary or secondary impression code of seizures with status epilepticus. Encounters during which a benzodiazepine was administered to the patient were classified as having received the Compass Measure treatment.

Stroke. The stroke measure ("stroke-01") is the percentage of EMS responses originating from a 911 request for patients suffering from a suspected stroke who had a stroke assessment performed during the EMS response.[22] There were 67,849 encounters that met the criteria of this measure, with a primary or secondary impression code of stroke/cerebrovascular accident (CVA), suspected transient ischemic attack (TIA), or TIA. Encounters were excluded (n=2,990) if the patient had a value of unresponsive for the AVPU (alert, verbal, pain, unresponsive) scale score. Encounters during which the prehospital stroke assessment was administered to the patient were classified as having received the Compass Measure treatment.

Table 2. EMS Compass Measures for Seizure, Stroke, Hypoglycemia, and Trauma

Measure	Definition	Inclusion Criteria	Exclusion Criteria
Seizure-02	The percentage of EMS responses originating from a 911 request for patients with status epilepticus who received a benzodiazepine aimed at terminating their status seizure during the EMS response.	911 encounters with a primary or secondary impression code of seizures with status epilepticus.	None
Stroke-01	The percentage of EMS responses originating from a 911 request for patients suffering from a suspected stroke who had a stroke assessment performed during the EMS response.	911 encounters with a primary or secondary impression code of stroke/cerebrovascular accident (CVA), suspected transient ischemic attack (TIA), or TIA.	Encounters where a patient had a value of unresponsive for the AVPU (alert, verbal, pain, unresponsive) scale score. (n=2,990)
Hypoglycemia-01	The percentage of EMS responses originating from a 911 request for patients who received treatment to correct their hypoglycemia.	911 encounters with a primary or secondary impression code of diabetic hypoglycemia or hypoglycemia/not diabetic and a first Glasgow Coma Scale (GCS) of less than 15 or an AVPU scale score of unresponsive, AND 911 encounters with a primary or secondary impression code of altered level of consciousness and a first glucose of less than 60.	Encounters where a patient was less than 24 hours old. (n=0)
Trauma-04	The percentage of EMS responses originating from a 911 request for patients who met CDC criteria for trauma and were transported to a trauma center.	911 encounters where patients met step one, two, or three of the Centers for Disease Control and Prevention: Guidelines for Field Triage of Injured Patients.	None

Hypoglycemia. The hypoglycemia measure ("hypoglycemia-01") is the percentage of EMS responses originating from a 911 request for patients who received treatment to correct their hypoglycemia.[23] There were 36,902 encounters that met the criteria of this measure, with a primary or secondary impression code of diabetic hypoglycemia or hypoglycemia/not diabetic and a first Glasgow Coma Scale (GCS) of less than 15 or an AVPU scale score of unresponsive. Encounters with a primary or secondary impression code of altered level of consciousness and a first glucose of less than 60 were also included. The only exclusion criterion was patients less than 24 hours old. Encounters during which patients received some form of glucose, dextrose, or food were classified as having received the Compass Measure treatment.

Trauma. The trauma measure ("trauma-04") is the percentage of EMS responses originating from a 911 request for patients who met CDC criteria for trauma and were transported to a trauma center.[24] There were 28,986 encounters that met the criteria of this measure, that is, where patients met step one, two, or three of the *Centers for Disease Control and Prevention: Guidelines for Field Triage of Injured Patients.*[25] Encounters during which these patients were transported to a trauma center (level 1 through 5) were classified as having received the Compass Measure treatment.

ANALYSES

We used standard statistical methods to examine relationships between EMS professionals' experience (mean daily 911 encounters and hours spent responding to 911 encounters in 2018), rurality, staffing models, and organization type with the provision of evidence-based care. We then examined whether the rurality of an agency's service area and the amount of an EMS professional's experience predicted whether patients received evidence-based care (yes/no), as defined by each of the four Compass Measures, controlling for all other agency characteristics. More methods details can be found in the Appendix. The University of Washington Human Subjects Division determined that this study was not human subjects research.

RESULTS

Table 3 shows agency characteristics overall and by rural-urban categories. The distribution of agencies by service area rurality was as follows: predominantly urban, 61.0%; predominantly large rural, 16.9%; predominantly small rural, 13.1%; and predominantly isolated small rural, 9.0%. For simplicity, we refer to these as "urban" and "rural" agencies (i.e., large rural, small rural, and isolated small rural agencies). Overall, most agencies were either community (non-profit) (63.8%) or fire department-based (21.3%) with a paid (53.0%) or mixed (paid and volunteer) staffing model (34.8%). Similar proportions of rural and urban agencies were authorized to provide care at the paramedic agency level of service (85.0% of urban and 86.0% of rural agencies). The lead EMS professionals at urban agencies had a higher mean number of 911 encounters per day in service in 2018 (1.0) than at rural agencies (0.7) and spent more time, on average, responding to 911 encounters in 2018 (0.4 hours per day in service for urban vs. 0.3 hours for rural agencies). These rural-urban differences were more pronounced with increasing rurality. The mean number of daily 911 encounters that personnel responded to was 0.8 for large rural, 0.6 for small rural, and 0.4 for isolated small rural agencies ($p < .001$). Similarly, the mean daily hours in 911 response per day were 0.3 for large rural, 0.3 for small rural, and 0.2 for isolated small rural agencies ($p < .001$).

Table 3. EMS Agency Sample Characteristics,[1] 2018

Characteristic	All Agencies (n=1,085)	Urban Agencies (n=662)	Rural Agencies (n=423)
Service Area Rurality, n (%)			
Predominantly Urban	662 (61.0%)	662 (100.0%)	-
Predominantly Large Rural	183 (16.9%)	-	183 (43.3%)
Predominantly Small Rural	142 (13.1%)	-	142 (33.6%)
Predominantly Isolated Small Rural	98 (9.0%)	-	98 (23.2%)
Agency Type, n (%)			
Community (Non-Profit)	692 (63.8%)	402 (60.7%)	290 (68.6%)
Fire Department Based	231 (21.3%)	182 (27.5%)	49 (11.6%)
Government (Non-Fire)	114 (10.5%)	45 (6.8%)	69 (16.3%)
Private (For Profit) Non-Hospital	48 (4.4%)	33 (5.0%)	15 (3.5%)
Staffing Model, n (%)			
Paid	575 (53.0%)	345 (52.1%)	230 (54.4%)
Mixed	378 (34.8%)	253 (38.2%)	125 (29.5%)
Unpaid (Volunteer)	132 (12.2%)	64 (9.7%)	68 (16.1%)
Agency Level of Service, n (%)[2]			
EMT	125 (11.5%)	82 (12.4%)	43 (10.2%)
Advanced EMT	33 (3.0%)	17 (2.6%)	16 (3.8%)
Paramedic	927 (85.4%)	563 (85.0%)	364 (86.0%)
Daily 911 Encounters per Person, mean (SD)[3,4]	1.0 (0.8)	1.0 (0.9)	0.7 (0.5)
Daily Time (Hours) Spent Responding to 911 Encounters per Person, mean (SD)[3,4]	0.4 (0.3)	0.4 (0.3)	0.3 (0.2)

[1]Agencies with encounters in at least one of the four analytic files (seizure, stroke, hypoglycemia, trauma).
[2]EMT is emergency medical technician. The data source used the older terminology of EMT-Basic, EMT-Intermediate, and EMT-Paramedic to refer to these three levels.
[3]Totals for the 29,747 lead EMS professionals (6,952 rural and 22,795 urban) at each of the encounters across all four analyses.
[4]Standardized based on the number of days the lead EMS professional on the encounter was "in service" during 2018.

Table 4 shows agency characteristics by Compass Measure, which showed similar patterns to the distribution of characteristics for the total sample. Table 5 shows results for each logistic regression model. All results described here are significant at $p < 0.05$ (see Tables 4 and 5 for details).

Seizure. Over half of patients served by large rural agencies (52.9%) and isolated small rural agencies (51.2%) received evidence-based care as defined in the Seizure-02 Compass Measure,[21] compared with slightly less than half of patients served by urban agencies (48.1%) and 40.1% of the patients served by small rural agencies. Encounters where patients received evidence-based care were staffed by lead EMS professionals who had a higher mean number of 911 encounters in 2018 (1.6) and who spent, on average, more time responding to 911 encounters in 2018 (0.7 hours) than encounters during which patients did not receive evidence-based care (1.4 encounters and 0.5 hours, not tabled).

Table 4. EMS Agency Provision of Evidence-Based Care According to EMS Compass Measures for Seizure, Stroke, Hypoglycemia, and Trauma by Agency Characteristics, 2018

	EMS Compass Measures			
	Seizure-02 Total=5,150	Stroke-01 Total=67,849	Hypoglycemia-01 Total=36,902	Trauma-04 Total=28,986
	Evidence-based care provided n=2,489 (48.3% of Total)	Evidence-based care provided n=46,292 (68.2% of Total)	Evidence-based care provided n=30,796 (83.5% of Total)	Evidence-based care provided n=6,684 (23.1% of Total)
Service Area Rurality, n (%)	**	***	***	***
Predominantly Urban	2,033 (48.1%)	37,798 (69.7%)	24,101 (83.5%)	5,433 (25.8%)
Predominantly Large Rural	315 (52.9%)	5,795 (66.8%)	4,840 (85.5%)	875 (18.8%)
Predominantly Small Rural	99 (40.1%)	2,074 (55.2%)	1,485 (78.4%)	315 (14.1%)
Predominantly Isolated Small Rural	42 (51.2%)	625 (50.7%)	370 (78.6%)	61 (6.0%)
Agency Type, n (%)	***	***	***	***
Community (Non-Profit)	1,543 (45.6%)	26,752 (65.3%)	18,369 (83.5%)	4,012 (23.8%)
Fire Department Based	389 (45.1%)	7,657 (73.1%)	4,698 (84.2%)	895 (18.9%)
Government (Non-Fire)	420 (63.6%)	9,046 (76.3%)	5,825 (84.8%)	1,161 (24.0%)
Private (For Profit) Non-Hospital	137 (55.7%)	2,837 (62.2%)	1,904 (78.0%)	616 (23.8%)
Staffing Model, n (%)	**	***	***	***
Paid	1,998 (48.5%)	36,346 (68.9%)	24,632 (82.9%)	4,875 (22.6%)
Mixed	483 (48.5%)	9,572 (66.7%)	6,006 (86.3%)	1,723 (25.0%)
Unpaid (Volunteer)	8 (21.6%)	374 (48.7%)	158 (65.0%)	86 (15.7%)
Agency Level of Service[1], n (%)[2]	***	***	***	***
EMT	4 (1.2%)	1,689 (61.8%)	170 (26.0%)	74 (8.9%)
Advanced EMT	4 (11.4%)	164 (50.6%)	106 (68.8%)	43 (14.7%)
Paramedic	2,481 (51.9%)	44,439 (68.6%)	30,520 (84.6%)	6,567 (23.6%)
Type of 911 Encounter, n (%)	***	***	***	***
Transport	2,407 (57.4%)	41,245 (68.7%)	15,481 (84.8%)	6,116 (25.5%)
Non-Transport	82 (8.5%)	5,047 (64.9%)	15,315 (82.2%)	568 (11.4%)
Total 911 Encounters[2], mean (SD)	1.6 (1.1)	1.5 (1.0)	1.5 (1.0)	1.5 (1.1)
Total Time (hours) Spent Responding to 911 Encounters[2], mean (SD)	0.7 (0.4)	0.6 (0.4)	0.6 (0.4)	0.6 (0.5)

[1]EMT is emergency medical technician. The data source used the older terminology of EMT-Basic, EMT-Intermediate, and EMT-Paramedic to refer to these three levels.
[2]Totals are for the lead EMS professional at each encounter. Standardized based on the number of days the lead EMS professional was "in service" during 2018.
Note: Statistically significant differences in provision of evidence-based care for each Compass Measure according to agency characteristics were determined using chi-square tests. Percentages indicate the proportion of agencies in each category within each characteristic that provided evidence-based care. Asterisks indicate that differences in the percentages of agencies providing evidence-based care were statistically significant for the categories within each characteristic reported in the column below the asterisks.
** p<.01
*** p<.001

Table 5. Logistic Regression Predictors of Evidence-Based EMS Care According to EMS Compass Measures for Seizure, Stroke, Hypoglycemia, and Trauma, 2018

Characteristics	Odds Ratio (95% CI[1])			
	Seizure-02	Stroke-01	Hypoglycemia-01	Trauma-04
Service Area Rurality				
Predominantly Urban	Ref	Ref	Ref	Ref
Predominantly Large Rural	0.96 (0.72 - 1.29)	0.81 (0.55 – 1.20)	1.11 (0.85 – 1.45)	0.75 (0.51 – 1.12)
Predominantly Small Rural	**0.64 (0.45 - 0.92)***	**0.61 (0.41 – 0.91)***	**0.69 (0.51 – 0.94)***	**0.55 (0.37 – 0.81)****
Predominantly Isolated Small Rural	1.31 (0.65 - 2.64)	**0.50 (0.30 – 0.82)****	0.85 (0.55 – 1.30)	**0.22 (0.12 – 0.38)*****
Agency Type				
Community (Non-Profit)	Ref	Ref	Ref	Ref
Fire Department Based	1.10 (0.84 – 1.44)	**1.86 (1.30 – 2.66)****	1.09 (0.82 – 1.44)	0.83 (0.57 – 1.22)
Government (Non-Fire)	**1.69 (1.11 – 2.58)***	**2.28 (1.17 – 4.44)***	1.09 (0.86 – 1.39)	0.89 (0.44 – 1.80)
Private (For Profit) Non-Hospital	1.10 (0.72 – 1.67)	0.79 (0.42 – 1.47)	0.63 (0.40 – 1.00)	0.97 (0.65 – 1.46)
Staffing Model				
Paid	Ref	Ref	Ref	Ref
Mixed	1.13 (0.86 – 1.48)	0.88 (0.61 – 1.27)	**1.44 (1.19 – 1.75)*****	1.33 (0.82 – 2.15)
Unpaid (Volunteer)	0.57 (0.17 – 1.94)	0.59 (0.35 – 1.01)	1.02 (0.68 – 1.55)	1.37 (0.85 – 2.21)
Agency Level of Service[2]				
EMT	**0.03 (0.01 – 0.09)*****	0.81 (0.35 – 1.87)	**0.07 (0.05 – 0.09)*****	**0.52 (0.32 – 0.83)****
Advanced EMT	**0.10 (0.03 – 0.36)*****	0.56 (0.24 – 1.30)	**0.42 (0.19 – 0.93)***	0.91 (0.42 – 1.98)
Paramedic	Ref	Ref	Ref	Ref
Type of 911 Encounter				
Transport	Ref	Ref	Ref	Ref
Non-Transport	**0.10 (0.06 – 0.15)*****	0.93 (0.62 – 1.38)	**0.81 (0.71 – 0.93)****	**0.45 (0.35 – 0.58)*****
Total 911 Encounters[3]	**0.71 (0.56 – 0.89)****	0.86 (0.51 – 1.44)	0.88 (0.69 – 1.14)	0.83 (0.58 – 1.18)
Total Time (hours) Spent Responding to 911 Encounters[2]	**3.07 (1.27 – 7.45)***	2.26 (0.51 – 9.96)	1.65 (0.79 – 3.48)	**3.66 (1.50 – 8.94)****

[1]CI is confidence interval.
[2]EMT is emergency medical technician. The data source used the older terminology of EMT-Basic, EMT-Intermediate, and EMT-Paramedic to refer to these three levels.
[3]Totals are for the lead EMS professional at each encounter. Standardized based on the number of days the lead EMS professional was "in service" during 2018.
*p<.05
** p<.01
*** p<.001

A logistic regression model showed that, after controlling for other factors, seizure patients served by small rural agencies were less likely to receive evidence-based care than patients served by urban agencies. As the lead EMS professional's total number of 911 encounters in 2018 increased, patients were less likely to receive evidence-based care. However, as

the lead EMS professional's total time spent responding to 911 encounters in 2018 increased, patients were more likely to receive evidence-based care. Agencies that did not transport the patient were less likely to provide evidence-based care than those that transported the patient. Government (non-fire) agencies were more likely than community (non-profit) agencies to provide evidence-based seizure treatment to patients. Paramedic-level agencies were more likely to provide evidence-based care than EMT- and AEMT-level agencies.

Stroke. Urban agencies were the most likely to provide evidenced-based care as defined in the Stroke-01 Compass Measure[22] (to 69.7% of patients), followed closely by large rural agencies (66.8%). Over half (55.2%) of the patients served by small rural agencies received evidence-based care, compared with just about half (50.7%) of the patients served by isolated small rural agencies. Encounters where patients received evidence-based care for stroke were staffed by lead EMS professionals who had a higher mean number of 911 encounters in 2018 (1.5) and who, on average, spent more time responding to 911 encounters in 2018 (0.6 hours) than encounters during which patients did not receive evidence-based care (1.3 encounters, 0.5 hours, not tabled).

A logistic regression analysis found that urban agencies were more likely than small rural agencies and isolated small rural agencies to provide evidence-based stroke treatment. Fire department-based and government (non-fire) agencies were more likely than community (non-profit) agencies to provide evidence-based care.

Hypoglycemia. Large rural agencies were the most likely to provide evidence-based care (85.5%) as defined by the Hypoglycemia-01 Compass Measure,[23] followed closely by urban agencies (83.5%), and then by isolated small rural (78.6%) and small rural agencies (78.4%). Encounters where patients received evidence-based hypoglycemia treatment were staffed by lead EMS professionals who had a higher mean number of 911 encounters in 2018 (1.5) and who, on average, spent more time (0.6 hours) responding to 911 encounters in 2018 than encounters during which patients did not receive evidence-based care (1.4 encounters, 0.5 hours, not tabled).

In a logistic regression analysis, patients served by small rural agencies were less likely to receive evidence-based hypoglycemia treatment than patients served by urban agencies. Agencies with a mixed staffing model were more likely than agencies with a paid staffing model to provide evidence-based care. Paramedic-level agencies were more likely to provide evidence-based care than EMT- and AEMT-level agencies. Evidence-based care was more likely during transport than non-transport encounters.

Trauma. Urban agencies provided evidence-based care, as defined in the Trauma-04 Compass Measure,[24] to about a quarter of patients (25.8%), followed by large rural (18.8%), small rural (14.1%), and isolated small rural agencies (6.0%). Encounters where patients received evidence-based trauma treatment were staffed by lead EMS professionals who had a higher mean number of 911 encounters in 2018 (1.5) and who, on average, spent more time (0.6 hours) responding to 911 encounters in 2018 than encounters during which patients did not receive evidence-based care (1.1 encounters, 0.5 hours, not tabled).

A logistic regression model found that urban agencies were more likely than small rural or isolated small rural agencies to provide evidence-based trauma treatment. Paramedic-level agencies were more likely than EMT-level agencies to provide evidence-based care. Once again, evidence-based care was more likely during transport than non-transport encounters. More time spent responding to 911 encounters in 2018 by the lead EMS professional was associated with a higher likelihood of evidence-based trauma treatment.

The results of a sensitivity analysis recategorizing service area rurality, where predominantly small rural and predominantly isolated small rural were combined into one category, were substantially similar.

DISCUSSION AND IMPLICATIONS

Our analysis of all EMS responses in 2018 (including the four conditions of interest and all other responses) found that individual personnel had accumulated more experience in urban agencies than rural agencies both in terms of the daily average numbers of encounters and hours spent in 911 response, and these differences were more pronounced with increasing rurality of the agency's service area. Examining the four EMS Compass measures, more than four fifths (83.5%) and more than two thirds (68.2%) of all EMS agencies provided evidence-based care for hypoglycemia and stroke, respectively. Only about half (51.7%) of all agencies provided evidence-based care for seizure and less than a quarter (23.1%) for trauma. Multivariate analyses found that accumulated experience had statistically significant effects for some measures and not others. The likelihood of patients receiving evidence-based care for seizure encounters was higher when the lead EMS professional at the encounter had accumulated fewer average daily 911 encounters or more average daily hours responding to 911 encounters, controlling for all other factors examined. Greater time spent responding to 911 encounters, but not number of encounters, predicted higher likelihood of patients receiving evidence-based care for trauma. These measures of experience were not statistically significant for stroke or hypoglycemia.

Agency rurality, however, was a significant predictor for all four measures when controlling for all other factors in our analysis: agencies that predominantly served small rural areas were less likely to provide evidence-based care than urban agencies across the board for seizure, stroke, hypoglycemia, and trauma. Agencies serving isolated small rural areas also were less likely than urban agencies to provide evidence-based care for stroke and trauma. Differences between large rural and urban agencies were not statistically significant.

Perhaps not surprisingly, evidence-based care was less likely for all conditions, except stroke, when the agency level of service was EMT or AEMT as compared to a paramedic level of service. Evidence-based care was less likely to occur in non-transport encounters for all conditions except stroke, possibly because another agency on the scene may have provided care according to the measure (this could not be determined from the data). We also found isolated effects of agency type on some measures, where non-fire department-based government agencies (for seizure and stroke) and fire-department-based agencies (for stroke) performed better on the measures than community non-profit agencies. Finally, after controlling for all other factors, agency staffing models generally did not have an effect on evidence-based care except for hypoglycemia, where agencies with mixed paid and unpaid staff performed better than those with strictly paid staff.

Study limitations include that causality cannot be definitively determined because this analysis was correlational. Though the data included EMS agencies from most of the country, New England states were underrepresented. The fact that very similar proportions of rural and urban agencies were paramedic-level services suggests that the study sample may overrepresent rural agencies with greater capabilities, since paramedic services are less common in rural areas.[9] Documentation of actions performed may not have been thorough or consistent for some measures. For example, some professionals may not have documented alternative treatments, such as giving food to the patient for hypoglycemia. Though we did control for the effect of state-level variation, our data did not allow us to examine the role of specific state EMS policies and systems in promoting evidence-based care, an area for further research.

These limitations notwithstanding, our findings suggest that spending more time responding to encounters each day on the job was associated with better care for two of the four conditions examined. The direction of this relationship was the same for the other two measures, but the differences were not statistically significant. The effects of experience as measured by time in service versus numbers of encounters deserves further investigation. Response time for a given call is likely to be longer in rural areas simply due to longer travel times, raising a question as to whether longer rural call times provide valuable experience as personnel continue providing care during transport even as rural agencies, with lower call volumes, have fewer patients on average for practicing skills. Whether or not this is the case, we found that even controlling for level of experience and other factors, the performance of agencies on these four measures declined with increasing rurality, indicating a need for training that is more robust or more appropriate for a rural or low-resource context,[5] improved medical direction, or EMS system development and integration with other systems of care.

For example, areas with well-developed stroke and trauma systems, with active outreach programs, can support greater stroke awareness among EMS professionals, while less developed systems in rural areas with less organizational support for evidence-based care may have limited access to clinical guidelines or opportunities to maintain skills. Simulation can be an effective training modality where real-world practice with patients is lacking.[26,27] The fact that paramedics are typically the only level of EMS professional authorized to administer benzodiazepine for patients experiencing seizure may explain why EMT- and AEMT-level agencies—as well as rural agencies, which are less likely to have paramedics—performed more poorly on this measure.

This study evaluated performance measures that were based entirely on primary documentation reported by the provider and no other data sources. Improving the quality of rural (and urban) EMS care will depend on improved documentation of patient encounters and data integration across the continuum of care that will enable more rigorous research linking EMS practices to patient outcomes. Further research is needed on how to improve the quality of documentation, the care that patients receive when evidence-based guidelines are not followed, and the downstream consequences of that care.

The processes of developing, testing, and implementing evidence-based guidelines must also consider whether measures for use in urban or more-resourced environments need to be adapted for rural contexts and lower-resource contexts with input from EMS professionals who provide rural care.[5] Performance measures may need to be modified or measures that are more appropriate for these settings might need to be created.

This study's findings can inform future efforts to establish appropriate response benchmarks for rural EMS agencies as well as help educators, planners, and policymakers devise solutions to address gaps in rural EMS workforce skills and systems of care. Improving rural EMS systems to implement evidence-based practices will require engagement and action of multiple stakeholders from the community to the national level. Rural community-informed self-determination has been promoted as a process to engage community members in understanding the EMS care available and playing an active role in deciding the level and quality of care desired.[28] Local EMS agencies need dedicated resources that can support better training, greater access to real-time medical direction, and improved quality through better documentation practices, implementation of performance measures, and routine use of performance data to guide practice. State EMS offices play a key role in developing regional systems of EMS education and care that address the needs of rural areas where EMS resources are stretched thin. Finally, federal government agencies as well as national EMS and rural health organizations can both lead and support these efforts to ensure rural patients have access to timely, safe, and effective emergency care.

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APPENDIX

Encounter Inclusion and Exclusion Criteria

Encounters were included or excluded from the analysis based on the following disposition codes:

Included in Analytic Data Sets	Excluded from Analytic Data Sets
Transported No Lights/Siren	No treatment, No Transport
Transported Lights/Siren	Cancelled (No Patient Contact)/Call Cancelled
Transported No Lights/Siren, Upgraded	Disregarded Enroute/Cancelled (Prior to Arrival at Scene)
Transported Lights/Siren, Downgraded	Cancelled on Scene/No Patient Found
Dead on Scene, Transport	False Alarm (No Incident Occurred)
Personnel Aiding in Transport	Wheelchair Transport
Patient Refused Evaluation/Care (With Transport)	Dead on Scene, No Transport
Patient Dead on Scene - Resuscitation Attempted (With Transport)	Patient Dead on Scene - No Resuscitation Attempted (With Transport
Treatment, No Transport	Patient Dead on Scene - No Resuscitation Attempted (Without Transport)
Patient Care Transferred/Patient Treated, Transferred Care to Another EMS Professional	Assist, Agency
Treated, Transported by Law Enforcement/Patient Treated, Transported by Law Enforcement	Assist, Public
Treated, Transported by Private Vehicle/Patient Treated, Transported by Private Vehicle	Assist, Unit
Patient Evaluated, No Treatment/Transport Required	Standby - No Service or Support Provided
Patient Refused Evaluation/Care (Without Transport)	Transport Non-Patient, Organs, etc.
Patient Treated, Released (AMA)	Standby - Public Safety, Fire, or EMS Operational Support Provided
Patient Treated, Released (per protocol)	Assist
Patient Dead on Scene - Resuscitation Attempted (Without Transport)	Standby

ANALYSIS

We performed chi-square and analysis of variance (ANOVA) to test bivariate relationships of individual accumulated experience (mean daily 911 encounters and hours spent responding to 911 encounters), rurality, staffing models, and organization type with provision of evidence-based care. We conducted a logistic regression to identify the effects of agency rurality and individual accumulated experience on performance according to each measure, controlling for all other

agency characteristics. The dependent variable for each of the four measures was whether care was provided (yes/no) as specified in the Compass Measure. We used general estimating equation methods to account for encounter clustering by agency and state in all logistic regression models. We also performed a sensitivity analysis by running the same regression models with a recategorization of service area rurality where predominantly small rural and predominantly isolated small rural were combined into one category. We used SAS software, Version 9.4 of the SAS System for Windows to conduct analyses.

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