How Actual Practice of Emergency Medical Services Personnel Aligns with the Recommended National Scope of Practice in Rural Versus Urban Areas of the U.S.

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KEY FINDINGS

The 2019 *National EMS Scope of Practice Model* provides recommended guidelines for states to develop scopes of practice for emergency medical services (EMS) practitioners. This study had two main aims: (1) examine the extent to which EMS professionals perform skills that correspond to their credential levels as described in the national *Model* and (2) determine whether there are variations in adherence to *Model* guidelines between agencies serving rural versus urban populations and agencies with unpaid (volunteer) versus paid staffing models. This study used data from ESO Solutions, Inc., on EMS encounters in 2018 from 1,056 EMS agencies nationally. We examined the credentials (emergency medical responder [EMR], emergency medical technician [EMT], advanced EMT, and paramedic) of personnel performing any of nine airway, medical/cardiac, and trauma procedures. We documented instances when personnel did and did not have the minimum credential level recommended by the *Model*. Key study findings were as follows:

- EMS personnel exceeded the recommended scope most often when treating patients requiring advanced airway skills, such as supraglottic airway and gastric decompression procedures.
- EMRs or EMTs performed nearly one in five (18.6%) supraglottic airway procedures, which are recommended only for responders with more advanced training—AEMTs and paramedics.
- Though the *Model* recommends that paramedics perform gastric decompression procedures (nasogastric or orogastric tube), about one in twelve (8.3%) of these procedures were performed by personnel below the paramedic level.
- Very small percentages of cardiac and trauma procedures examined were performed by a credential level not recommended by the *Model*.
- In analyses controlling for various agency characteristics, EMS professionals were less likely to align with the *Model* in agencies that served isolated small rural areas, had unpaid or mixed paid/unpaid staffing models, or provided service at the EMT or AEMT level. Compared with urban, paid agencies, these types of agencies tend to have lower financial resources and few or no paramedics.

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KEY FINDINGS *continued*

Our findings suggest a potential mismatch between EMS workforce capabilities and population health needs. Personnel in rural and lower-resource agencies, often staffed by EMTs and volunteers, need enhanced training and oversight to allow them to respond to community health needs while ensuring high-quality care. Future revisions of the national *Model* would benefit by including perspectives from rural-serving and volunteer EMS agencies. Adapting scope of practice guidelines for emergency care to the needs of under-resourced communities could help reduce health inequities.

How Actual Practice of Emergency Medical Services Personnel Aligns with the Recommended National Scope of Practice in Rural Versus Urban Areas of the U.S

INTRODUCTION

The 2019 *National EMS Scope of Practice Model*[1] is a federally sponsored blueprint for states to develop scopes of practice for emergency medical services (EMS) practitioners. This approach is intended to reduce inconsistencies between states and provide a basis from which national standards of care and performance for each level of EMS practitioner can be developed with the expectation of reducing health disparities and improving outcomes. Out-of-hospital EMS credential levels recognized in the U.S., from least to most advanced, include emergency medical responders (EMRs), emergency medical technicians (EMTs), advanced EMTs (AEMTs), and paramedics. While international nomenclature refers to all these types of EMS practitioners as "paramedics" of one kind or another (and the field more broadly as "paramedicine"),[2] this report uses the U.S. nomenclature, where paramedics refer to the highest credential as distinct from the other levels.

Periodic updates to the *National EMS Scope of Practice Model* (hereafter referred to as "the *Model*") allow EMS experts to change the procedures recommended for each level of EMS practitioner based on identified needs. Varying models of EMS governance between states, however, introduce significant variability in what procedures are performed, which type of EMS professional performs them, and where they are performed.[3] In addition, some procedures are rarely performed but require significant investment to assure practitioner competency while other procedures are performed routinely with less oversight.

Past research has documented that the distribution of EMS personnel across rural and urban U.S. geographies varies by credential level and volunteer status, with proportionally more paramedics and paid staff in urban areas and more EMTs and volunteer staff in rural areas.[4,5] This uneven distribution of emergency responders raises fundamental questions about patient access to care and how personnel are deployed to meet community needs, particularly in locations where the most highly trained providers are scarce. While some studies have examined the distribution of procedures performed by EMS personnel,[6,7] few have considered how procedures in practice vary by authorized or recommended scopes of practice at each credential level. A 2008 survey in nine states about interventions that EMS agency directors authorized emergency responders to perform for cardiovascular and stroke patients found that scopes of practice varied according to multiple factors, including agency rurality, volunteer/non-volunteer status, medical director involvement, type of organization (fire department, hospital, or stand-alone EMS agency), and level of practitioner.[8] Rural EMTs were more likely than urban EMTs to be authorized to perform six of seven interventions, perhaps because of shorter transport times in urban areas to hospitals, where appropriate cardiovascular and stroke treatment could be provided. Volunteer EMTs and AEMTs generally had broader scopes of practice while volunteer paramedics had more restricted scopes compared with their paid staff counterparts. A more recent analysis examined AEMTs and paramedics, using 2016 data, and found relatively little differentiation in the content of their practice.[9]

Though past research has begun to examine how actual practice and scope of practice align, we do not know the extent to which providers perform skills that correspond to their credential levels as described in the national *Model* or whether there are systematic variations in adherence. This study's purpose was to examine the fit between the practices of EMS practitioners by credential level and scopes of practice recommended by the *Model* as well as determine whether practices vary between rural

and urban communities and between paid and volunteer responders. Understanding how actual practice aligns with recommended scopes of practice in different contexts can inform EMS quality improvement, education, and system governance. We focus on emergency (9-1-1) response using skills that require responders to exercise clinical judgment in three of seven main categories of interventions—airway and breathing, medical/cardiac, and trauma care—identified in the *Model*.

STUDY QUESTIONS

This study's key questions were as follows:

1. How frequently do EMS personnel at each credential level use select medications and procedures to provide airway and breathing, medical/cardiac, and trauma care?
2. How do the interventions used by EMS personnel at each credential level align with recommended scopes of practice in the 2019 *National EMS Scope of Practice Model*?
3. Does the extent to which actual practice aligns with recommended scopes vary between rural and urban agencies or between unpaid (volunteer) versus paid staffing models?

DATA AND METHODS

We obtained data on EMS encounters from ESO Solutions, Inc. (ESO), which provides electronic health records software to many EMS agencies. The data used for this study, derived from ESO's Research Data Collaborative dataset, contained de-identified records from EMS agencies across the U.S. that agreed to make their data available for research purposes. The dataset we received from ESO Solutions included records for 7,574,879 EMS encounters from January 1, 2018, through December 31, 2018, representing 1,288 EMS agencies from states across the U.S. The University of Washington Human Subjects Division determined that this study did not involve human subjects research.

SELECTION OF EMS ENCOUNTERS AND PROCEDURES

To select the EMS encounters that were most likely to involve direct patient care provided in response to a 9-1-1 emergency call, we excluded certain encounter types (e.g., medical transport, standby, home visit, etc.) and patient dispositions (cancelled calls, no treatment/no transport, etc.), as well as encounters with no documented procedures and records with missing data for key covariates described below. We also excluded procedures performed by personnel other than EMR, EMT, AEMT, or paramedic (e.g., nurses and physicians were excluded) or where the type of credential could not be determined.

We focused our descriptive analysis on a subset of airway, medical/cardiac, and trauma procedures identified in the *Model*. For regression models (described below), we further limited our analyses to procedures that were not recommended for at least one of the three credentials below the paramedic level (EMR, EMT, AEMT) to examine interventions that personnel performed that fell outside of the *Model* recommendations for their credential level. Finally, we excluded procedures with too few cases for meaningful analysis. See **Appendix A** for a full list of inclusion criteria.

OUTCOMES AND COVARIATES

The binary outcome of our analysis was whether each documented procedure was performed by a provider with a credential level that was recommended by the *Model*. For example, if an EMR or EMT performed a procedure that the *Model* only recommends for the more advanced credentials of AEMT or paramedic, we classified the procedure as occurring outside of the *Model's* scope of practice guidelines. Likewise, if an EMR, EMT, or AEMT performed a procedure that the *Model* only recommends for paramedics, we classified the procedure as occurring outside of the guidelines. When a provider had more than one credential listed, we used the highest credential (e.g., someone with both an AEMT and paramedic credential listed was assumed to be a paramedic). Some procedure names in the ESO data did not match those listed in the *Model*. The study's subject matter expert

(author Nudell) created a crosswalk between the two to ensure that the correct recommended credential level was assigned to each ESO procedure (See **Appendix A5**).

Our analysis included agency rural/urban geography and paid/unpaid status, our main characteristics of interest, as well as several agency-level variables as covariates, defined as follows:

- **Agency paid status** (paid, mixed paid and unpaid, unpaid). This variable was self-reported by each agency to indicate whether the agency paid all its personnel, relied on a mix of paid and unpaid (volunteer) personnel, or relied exclusively on unpaid personnel.
- **Agency service area rural/urban geography** (predominantly urban, predominantly large rural, predominantly small rural, predominantly isolated small rural). We created a measure of each agency's predominant type of geographic area served using the U.S. Department of Agriculture Economic Research Service ZIP code approximation (version 3.1) of the Rural-Urban Commuting Area (RUCA) Codes[10] to classify encounter ZIP codes as urban (codes 1 – 3), large rural (codes 4 – 6), small rural (codes 7 – 9) or isolated small rural (code 10). To do this, we calculated the percentage of each agency's encounters in 2018 that occurred in each geographic category. If 50% or more of the encounters occurred in an urban ZIP code, the agency was classified as predominantly urban. For agencies with fewer than 50% of encounters at an urban ZIP Code, we classified agency rural/urban geography according to the rural category with the highest percentage of encounters. For example, if an agency responded to encounters that were 20% urban, 10% large rural, 40% small rural, and 30% isolated small rural, the agency was classified as small rural.
- **Agency type** (community [non-profit], fire department based, government [non-fire], private [for profit], non-hospital). This variable was self-reported by each agency.
- **Agency level of service** (EMR, EMT, AEMT, paramedic, and nurse or physician [combined]). This is the level of care that an agency is authorized or licensed to provide, self-reported by each agency.
- **Agency volume**. We calculated each agency's total number of all types of encounters in 2018 (before applying exclusion criteria above).

STATISTICAL ANALYSIS

For each procedure included in this analysis, we calculated the percentage of documented procedures that were performed by each credential level (EMR, EMT, AEMT or paramedic) and summarized the percentage of procedures that were performed according to the *Model* guidelines.

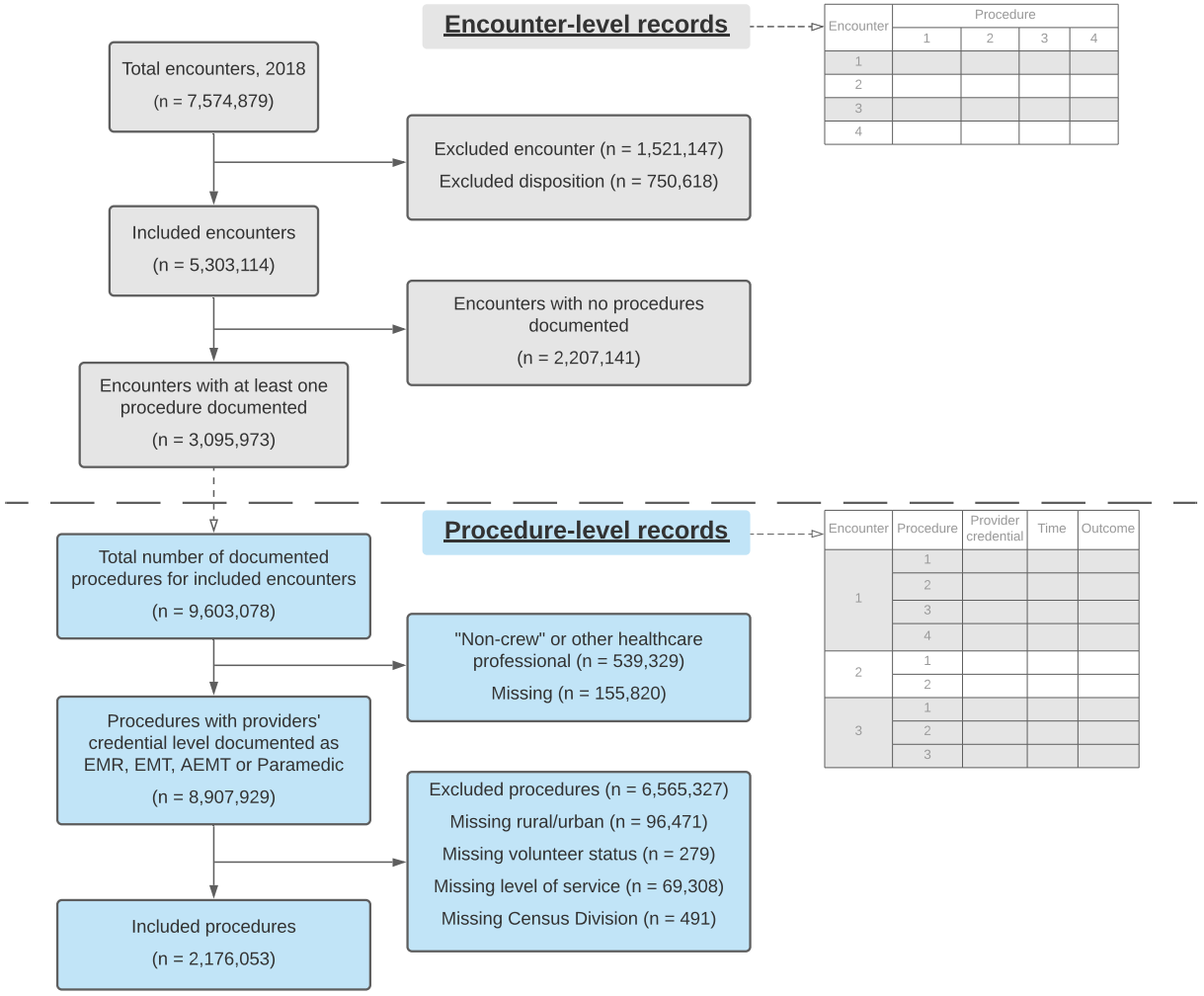
We then identified a subset of nine procedures that were not recommended for at least one of the EMS credential levels and where a high proportion of occurrences did not meet the recommended scope of practice guidelines. For this part of the analysis, we included six airway procedures, two cardiac procedures, and one trauma procedure.

Limiting our analyses to records for which these nine procedures were documented, we assessed the bivariate associations of agency paid/unpaid status, agency service area geography, agency type, agency level of service, and total number of agency encounters in 2018 with the binary outcome variable (whether or not the procedure was performed by a credential level as recommended by the guidelines). Bivariate analyses consisted of chi-square or Kruskal-Wallis rank sum tests as appropriate. We then created a mixed-effects logistic regression model to investigate the relationship between the fixed effect variables of interest and covariates (described above) and the likelihood that a procedure was performed according to the *Model* guidelines. We included state and agency identifiers as random effects to account for clustering within states, given that states set broad EMS policies that affect all agencies within states, and within agencies, because EMS responses occur in the context of agency cultures and practices. We used an alpha level of 0.05 for all statistical tests and performed all analyses using R software version 3.3.0 (R Core Team).[11]

RESULTS

After applying the exclusion criteria described above, the final analysis dataset included 2,176,053 documented procedures from 1,269,836 EMS encounters during 2018 by 1,056 EMS agencies in 36 U.S. states (see **Figure 1**).

Figure 1: Flowchart of EMS Encounter Records Included in the Final Analysis



EMR: emergency medical responder; EMT: emergency medical technician; AEMT: advanced EMT

We compared procedures that were included in our analysis to those that were excluded (see **Appendix B**, **Table B1**). The distributions of most agency characteristics for included and excluded procedures were fairly similar, but compared to excluded procedures, included procedures were more often from agencies providing paramedic-level service (96.7% vs. 92.5%) and less often EMT-level service (0.2% vs. 1.2%). In addition, all procedures from the New England Census Division were excluded due to missing ZIP codes that prevented rural/urban classification, though these represent just 1.1% of the total analytic sample. Some differences were also evident between included and excluded procedures in their geographic distribution across U.S. Census Divisions. **Table B2** in **Appendix B** shows the distribution of included and excluded agencies for these same variables. Compared

with excluded agencies, included agencies were less often unpaid (10.9% vs. 20.3%), urban (61.6% vs. 72.9%), or community non-profit (64.1% vs. 78.0%), and their agency level of service was less likely to be designated as EMT (10.3% vs. 31.5%). Included agencies had a higher median annual number of encounters (2,056 vs. 786).

Tables 1a – 1c show the EMS credential levels that performed each of the procedures included in this analysis and the credential level(s) recommended for each procedure. For the airway procedures we examined, EMRs or EMTs performed nearly one in five (18.6%) supraglottic airway procedures, which are recommended only for the more advanced credential levels, AEMTs and paramedics. About one in twelve (8.3%) gastric decompression procedures (nasogastric [NG] or orogastric [OG] tube) were performed by personnel with a credential below paramedic, the recommended level. Fewer than 4% of the other airway procedures examined were performed by a credential level below what the *Model* recommended. Likewise, a small percentage of all cardiac and trauma procedures examined were performed by a credential level not recommended by the *Model*.

Table 1a: Percentage of Airway Procedures Performed Within or Outside of the 2019 *National EMS Scope of Practice Model*

		Procedures Performed by Each Credential Level (n, row %)			
Selected Airway Procedures	**Approved Credential Levels**	**EMR**	**EMT**	**AEMT**	**Paramedic**
Airway obstruction – manual dislodgement techniques	EMR, EMT, AEMT, Paramedic	0	19 (18.4%)	7 (6.8%)	77 (74.8%)
Chest seal	EMR, EMT, AEMT, Paramedic	1 (0.2%)	52 (9.2%)	23 (4.1%)	487 (86.5%)
CPAP	EMT, AEMT, Paramedic	0	791 (2.9%)	502 (1.9%)	25,834 (95.2%)
Inhaled – beta agonist/bronchodilator and anticholinergic for dyspnea and wheezing	EMT, AEMT, Paramedic	20 (0.0%)	10,684 (4.2%)	8,209 (3.2%)	234,110 (92.5%)
Use of epinephrine (auto-injector) for anaphylaxis (supplied and carried by the EMS agency)	EMT, AEMT, Paramedic	3 (0.0%)	512 (5.7%)	238 (2.7%)	8,223 (91.6%)
Airway – supraglottic*	AEMT, Paramedic	5 (0.0%)	2,652 (18.6%)	755 (5.3%)	10,876 (76.1%)
Ventilator*	Paramedic	0	152 (3.0%)	15 (0.3%)	4,972 (96.8%)
Chest decompression - needle	Paramedic	0	25 (1.8%)	13 (0.9%)	1,359 (97.3%)
Chest tube placement – assist only	Paramedic	0	0	0	43 (100.0%)
Cricothyrotomy	Paramedic	0	0	0	141 (100.0%)
Endotracheal intubation*	Paramedic	0	673 (1.7%)	463 (1.1%)	39,267 (97.2%)
Gastric decompression – NG Tube*	Paramedic	0	48 (6.5%)	12 (1.6%)	681 (91.9%)
Gastric decompression – OG Tube*	Paramedic	0	43 (7.3%)	7 (1.2%)	541 (91.5%)
Included airway medication*	Paramedic	0	237 (2.4%)	29 (0.3%)	9,610 (97.3%)

*Procedure included in regression model.
EMR: emergency medical responder; EMT: emergency medical technician; AEMT: advanced EMT; CPAP: continuous positive airway pressure; NG: nasogastric; OG: orogastric.

Legend

= Procedure performed outside of scope of practice guidelines

= Procedure performed within of scope of practice guidelines

Table 1b: Percentage of Cardiac Procedures Performed Within or Outside 2019 *National EMS Scope of Practice Model*

		Procedures Performed by Each Credential Level (n, row %)			
Selected Cardiac Procedures	**Approved Credential Levels**	**EMR**	**EMT**	**AEMT**	**Paramedic**
Defibrillation – automated / semi- automated	EMR, EMT, AEMT, Paramedic	6 (0.2%)	909 (32.3%)	248 (8.8%)	1,649 (58.6%)
Cardiac monitoring – 12-lead ECG acquisition and transmission	EMT, AEMT, Paramedic	249 (0.0%)	70,432 (4.6%)	27,178 (1.8%)	1,449,053 (93.7%)
Oral aspirin for chest pain of suspected ischemic origin	EMT, AEMT, Paramedic	42 (0.0%)	11,208 (8.3%)	3,634 (2.7%)	120,473 (89.0%)
STEMI alert	EMT, AEMT, Paramedic	7 (0.1%)	123 (2.2%)	71 (1.3%)	5,295 (96.3%)
Cardioversion – electrical	Paramedic	0	35 (2.4%)	7 (0.5%)	1,416 (97.1%)
Defibrillation – manual*	Paramedic	0	527 (1.9%)	253 (0.9%)	27,482 (97.2%)
Included cardiac medication*	Paramedic	0	296 (2.0%)	65 (0.4%)	14,209 (97.5%)
Pacing - transcutaneous or transvenous	Paramedic	0	70 (1.3%)	22 (0.4%)	5,485 (98.4%)
Pericardiocentesis	Paramedic	0	2 (12.5%)	0	14 (87.5%)

*Procedure included in regression model.
EMR: emergency medical responder; EMT: emergency medical technician; AEMT advanced EMT; ECG: electrocardiogram; STEMI: ST elevation myocardial infarction.

Legend

= Procedure performed outside of scope of practice guidelines

= Procedure performed within of scope of practice guidelines

Table 1c: Percentage of Trauma Procedures Performed Within or Outside 2019 *National EMS Scope of Practice Model*

		Procedures Performed by Each Credential Level (n, row %)			
Selected Trauma Procedures	**Approved Credential Levels**	**EMR**	**EMT**	**AEMT**	**Paramedic**
Hemorrhage control – tourniquet	EMR, EMT, AEMT, Paramedic	1 (0.1%)	213 (15.5%)	77 (5.6%)	1,084 (78.8%)
Anti-coagulant alert	EMT, AEMT, Paramedic	0	0	0	1 (100.0%)
C-spine clearance	EMT, AEMT, Paramedic	12 (0.0%)	5,148 (10.4%)	1,226 (2.5%)	43,256 (87.1%)
Splint – traction	EMT, AEMT, Paramedic	0	159 (16.4%)	32 (3.3%)	780 (80.3%)
Trauma alert or notification	EMT, AEMT, Paramedic	14 (0.1%)	1,127 (5.7%)	512 (2.6%)	18,027 (91.6%)
Included trauma medication	Paramedic	0	17 (1.5%)	9 (0.8%)	1,110 (97.7%)
Joint reduction	Paramedic	0	3 (20.0%)	1 (6.7%)	11 (73.3%)
Maintain an infusion of blood or blood products*	Paramedic	0	4 (1.2%)	2 (0.6%)	314 (98.1%)
Ultrasound	Paramedic	0	0	0	42 (100.0%)

*Procedure included in regression model.
EMR: emergency medical responder; EMT: emergency medical technician; AEMT: advanced EMT.

Legend

= Procedure performed outside of scope of practice guidelines

= Procedure performed within of scope of practice guidelines

In bivariate analysis, all agency-level variables were significantly associated with the likelihood of a procedure being performed according to the scope of practice *Model* for the nine procedures we analyzed (supraglottic airway, endotracheal intubation, bag-valve-mask, gastric decompression - NG tube, gastric decompression - OG tube, manual defibrillation, maintain an infusion of blood or blood products, airway medications, or cardiac medications; see **Table 2**). Agencies that were less likely to perform procedures according to the *Model* had the following characteristics: unpaid or mixed staffing models; small rural or isolated small rural patient population; community, non-profit status; EMT or AEMT level of service; and a higher patient volume (number of annual responses).

Table 2: Predictors of Performing a Procedure Within the 2019 *National EMS Scope of Practice Model*

	Bivariate Analysis			Logistic Regression with Mixed Effects
	Outside of SoP (N=5,483)	Within SoP (N=108,707)	p-value	Odds Ratio (95% CI)
Agency paid status				
Unpaid	124 (2.3%)	350 (0.3%)	< 0.001	**0.21 (0.10 - 0.42)**
Mixed	1,211 (22.1%)	21,491 (19.8%)		**0.67 (0.48 - 0.93)**
Paid	4,148 (75.7%)	86,866 (79.9%)		Ref
Agency service area geography				
Predominantly urban	4,091 (74.6%)	83,423 (76.7%)	< 0.001	Ref
Predominantly large rural	595 (10.9%)	16,401 (15.1%)		0.93 (0.64 - 1.37)
Predominantly small rural	677 (12.3%)	7,453 (6.9%)		0.81 (0.53 - 1.26)
Predominantly isolated small rural	120 (2.2%)	1430 (1.3%)		**0.48 (0.27 - 0.84)**
Agency type				
Community, non-profit	3,689 (67.3%)	65,796 (60.5%)	< 0.001	Ref
Fire department	651 (11.9%)	15,238 (14.0%)		1.06 (0.73 - 1.53)
Governmental, non-fire	843 (15.4%)	20,763 (19.1%)		1.10 (0.69 - 1.74)
Private, non-hospital	300 (5.5%)	6,910 (6.4%)		0.61 (0.32 - 1.17)
Agency level of service				
EMR	1 (0.0%)	6 (0.0%)	< 0.001	0.06 (0.0 - 133.1)
EMT	118 (2.2%)	115 (0.1%)		**0.02 (0.01 - 0.04)**
AEMT	70 (1.3%)	149 (0.1%)		**0.09 (0.03 - 0.22)**
Paramedic	4,905 (89.5%)	105,106 (96.7%)		Ref
Nurse or physician	389 (7.1%)	3,331 (3.1%)		1.01 (0.37 - 2.77)
Number of agency encounters				
Median (25th percentile, 75th percentile)	3,007 (1,203, 7,990)	2,509 (998, 6,015)	0.007	**0.99 (0.99 - 0.99)**

SoP: scope of practice; EMR: emergency medical responder; EMT: emergency medical technician; AEMT: advanced EMT.
Notes: (1) All variables shown in the table were included in the logistic regression model as fixed effects. State and agency were included as random effects. (2) An odds ratio < 1 indicates a lower likelihood of performing one of the included procedures within the scope of practice guidelines. Numbers in bold indicate a statistically significant association. (3) Included procedures: Supraglottic airway, endotracheal intubation, bag-valve-mask, gastric decompression - NG tube, gastric decompression - OG tube, manual defibrillation, maintain an infusion of blood or blood products, airway medications, cardiac medications, or trauma medications. (4) We excluded procedures administered by nurses or physicians, but some agencies listed this as their level of service.

In the adjusted model, agency service area geography, paid/unpaid status, agency level of service, and median number of agency encounters remained significant predictors of performing procedures according to the *Model*. Agency type (e.g., community, non-profit status or fire department) was no longer a statistically significant predictor. Controlling for the other variables in the model and accounting for clustering at the state and agency level, agencies serving predominantly isolated small rural areas were less likely than other agencies to perform procedures according to the *Model*. Agencies with unpaid and mixed staffing models were less likely than agencies with a paid staffing model to align with the *Model*, as were EMT- and AEMT-level agencies when compared with paramedic-level agencies.

DISCUSSION

This study found variations in alignment with the *National EMS Scope of Practice Model* according to agency staffing configurations and service area geography. All other things being equal, EMS professionals were less likely to align with the *Model* in agencies that had unpaid or mixed paid/unpaid staffing models, provided service at the EMT or AEMT level, or served isolated small rural areas. Compared with urban, paid agencies, these types of agencies tend to have lower financial resources and few or no paramedics. EMS personnel exceeded the recommended scope most often when treating patients requiring advanced airway skills, such as supraglottic airway and gastric decompression procedures.

Limitations of this study include that the data may not be fully representative of small, rural, volunteer EMS agencies or the largest ambulance providers, and agencies in the New England Census Division were not included. Inaccuracies in patient record documentation can happen, but we were not able to assess the extent to which this occurred. Our designation of EMS professional credentials was based on the credential level documented as administering each procedure, but we do not know whether responders may have been supervised by paramedics or others. Because this analysis was cross-sectional, causality cannot be determined. Finally, because our data used coded state identifiers that allowed us to identify all cases from the same state but not the name of each state, we were not able to examine specific state EMS policy and system factors.

Despite these limitations, the data used in this study included an immense variety of EMS agency sizes and types as well as ample numbers of both rural and urban patients from most parts of the country. Our multivariate analysis allowed us to account for a range of agency factors and control for state-level clustering that could influence implementation of and adherence to scope of practice guidelines.

This study's findings have implications for EMS policy, practice, and future directions for research. Newly published guidance from the National Association of EMS Physicians indicates that airway skill proficiency is the result of a combination of initial training, ongoing experience, and a provider's desire to improve their clinical decision-making. More advanced skills require a greater level of reflection and systemic support for improvement through deliberate practice that includes abundant opportunities for skill repetition.[12] The fact that personnel performed interventions that exceeded the recommended scope could indicate a potential mismatch between workforce skills and population health needs that the national *Model* was not designed to address. Patients in need of life-saving care may live in communities that lack EMS professionals with appropriate advanced skills. Scope of practice guidelines that do not consider the implications of scope recommendations for under-resourced populations and do not promote flexibility in scope to meet community needs may further contribute to health inequities. The COVID-19 pandemic has further underscored the need for enhanced and flexible scopes of practice for EMS professionals to meet emerging needs and also demonstrated the limitations of a standard, one-size-fits-all approach that can inhibit our ability to respond during times of health system stress.[13] Future revisions of the national *Model* should include perspectives from rural-serving and volunteer EMS agencies and consider whether updates are needed to account for practices that reflect the needs of more remote and lower-resource contexts.

The national *Model* is a set of recommendations with no regulatory force; state and local regulations supersede national guidelines. A critical consideration in developing and implementing guidelines for scope of practice is whether model recommendations should be viewed as a floor or a ceiling. Viewing these recommendations as a floor—the minimum skills required at each credential level—can allow local EMS directors to determine what is best for their communities and when and where enhanced scopes are needed. Our study findings suggest that this is what some agencies may be doing by enabling EMTs and AEMTs to perform more advanced skills. Personnel in lower-resource agencies, often EMTs and volunteers, and often serving rural patients farther from definitive care may need enhanced training and oversight to allow them to respond to regular community health needs. More robust and targeted resources for initial training followed by reflective practice, and supported by an agency culture of self-improvement, would also help to ensure that personnel who need enhanced skills can provide needed care that is safe and of high quality. To do so successfully also requires active and involved real-time emergency medical direction, less available in rural communities,[14] which rely disproportionately on primary care physicians instead of board-certified emergency medicine physicians.[15] Rural EMS medical directors who play multiple health care roles in their communities also may have less access to—let alone time and resources to implement—the latest guidance and evidence.

Further research is warranted to understand the extent to which these practice scope and training challenges affect medical directors and the EMS agencies they serve in rural and other under-resourced settings and how better to meet their needs. Other extensions of this research should examine how rural EMS professionals perform deliberate and reflective practice[12] despite reduced procedural volumes, how state and local EMS policies and system factors related to scope of practice affect actual practices, as well as how the patterns we identified affect patient outcomes. A better understanding of the impacts of national guidelines on real-world practice, and how to support EMS medical directors and practitioners who care for less-resourced communities, can help promote health equity in emergency care for both rural and urban communities.

APPENDIX A. EMS ENCOUNTERS AND DOCUMENTED PROCEDURES INCLUDED IN THE ANALYSIS

A1. Run Type

Included codes	Excluded Codes
• 911 Response • Mutual Aid • Emergency Interfacility Transfer	• Unknown • Medical Transport • Standby • APP – Home Visit/MIH Visit • APP – Emergency Response • Public Assistance/Other not listed • Urgent Interfacility Transport • Non-Emergency Interfacility Transfer • Intercept • Law Enforcement Assist • Missing

A2. Incident Disposition

Included codes	Excluded Codes

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

A3. Credential level documented as providing a procedure

Included codes	Excluded Codes
• EMR • EMT • AEMT • Paramedic	• Non-crew • Nurse • Physician • Physician Assistant • Instructor • Driver • Respiratory Therapist • Other healthcare professional • Missing

A4. Procedure-level records were excluded if any of the following variables were missing data:

- rural/urban status of the response ZIP code
- agency volunteer status
- agency level of service
- agency Census Division

A5. Skill names from 2019 *National EMS Scope of Practice Model* and corresponding ESO Research Dataset Procedure names that were included in the analysis.

Model Skills Included in the Analysis	Corresponding Procedures in ESO Data Included in the Analysis
Airway Skills	
Airway Obstruction – manual dislodgement techniques	Heimlich Maneuver
Chest Seal	Chest Seal
Continuous positive airway pressure (CPAP)	Bi-level positive airway pressure/Variable positive airway pressure or continuous positive airway pressure (BiPAP/VPAP, CPAP)
Inhaled – beta agonist/bronchodilator and anticholinergic for dyspnea and wheezing	Albuterol, Alupent, Atrovent, Combivent, Duoneb, Ipratropium, Terbutaline
Use of epinephrine (auto-injector) for anaphylaxis (supplied and carried by the EMS agency)	Epi Pen, Epi Pen Jr, Epinephrine 1:1
Airway – supraglottic	Combitube, EasyTube Airway, iGEL, King Airway, Laryngeal Mask Airway, SALT Airway
Bag-valve-mask (BVM)	Ventilator
Chest decompression - needle	Pleural Decompression, Flutter Valve
Chest tube placement – assist only	Chest Tube
Cricothyrotomy	Needle Cricothyroidotomy, Pertrach, QuickTrach (Adult), QuickTrach (Child), Surgical Cricothyroidotomy
Endotracheal intubation (ETI)	ETI Verification, Nasotracheal Intubation, Orotracheal Intubation, Rapid Sequence Intubation (RSI), Retrograde Intubation, Sedation Assist Intubation(SAI), Video Laryngoscopy
Gastric decompression – Nasogastric (NG) Tube	Nasogastric Tube
Gastric decompression – Orogastric (OG) Tube	Orogastric Tube
Included Medication	Diprivan, Diprivan Infusion, Etomidate, Nimbex, Norcuron, Propofol, Rocuronium, Succinylcholine, Vecuronium, Zemuron
Cardiac Skills	
Defibrillation – automated / semi- automated	Automated external defibrillator (AED) Defibrillation
Cardiac monitoring – 12 lead electrocardiogram (ECG) acquisition and transmission	12-Lead ECG, 15-Lead ECG, 3-Lead ECG
Oral aspirin for chest pain of suspected ischemic origin	Aspirin
ST-elevation myocardial infarction (STEMI) Alert	ST-elevation myocardial infarction (STEMI) Alert
Cardioversion – electrical	Cardioversion
Defibrillation – manual	Dual Sequence Defibrillation (DSD), Manual Defibrillation
Included Medication	Brilinta, Digoxin, Diltiazem, Dobutamine, Dopamine, Enalapril, Enalaprilat, Heparin Bolus, Heparin Infusion, Integrilin, Labetalol, Labetalol Infusion, Lasix, Levophed, Lidocaine, Lidocaine Infusion, Lopressor, Lovenox, Metoprolol, Neosynephrine, Nicardipine, Nitro Infusion, Norepinephrine, Plavix, Potassium, Potassium Chloride, Procainamide, Procardia, Propranolol, Retavase, tissue plasminogen activator (t-PA), Tenecteplase, Vasopressin, Vasotec, Verapamil
Pacing - transcutaneous or transvenous	Pacing, Pacing Discontinued
Pericardiocentesis	Pericardiocentesis
Trauma Skills	
Hemorrhage control – tourniquet	Tourniquet
Anti-Coagulant Alert	Anti-Coagulant Alert
Cervical spine (C-spine) Clearance	Cervical spine (C-spine) Clearance
Splint – traction	Traction Splint
Trauma Alert or Notification	Trauma Alert, Trauma Notification - Full, Trauma Notification - Limited
Included Medication	Lidocaine 2%, Mannitol, Mannitol Infusion, Tranexamic Acid (TXA)
Joint Reduction	Joint Reduction
Maintain an infusion of blood or blood products	Blood, Fresh Frozen Plasma (FFP), Packed Red Blood Cells (PRBC), Whole Blood
Ultrasound	Ultrasound

APPENDIX B. SUPPLEMENTAL TABLES

Table B1: Characteristics of Procedures Included in the Analysis Compared with Excluded Procedures

	Included Procedures (N=2,176,053)	Excluded Procedures (N=8,485,931)	Total Documented Procedures (N=10,661,984)
Agency paid status			
Unpaid	10,683 (0.5%)	50,627 (0.6%)	61,310 (0.6%)
Mixed	450,990 (20.7%)	1,567,691 (18.5%)	2,018,681 (18.9%)
Paid	1,714,380 (78.8%)	6,865,050 (80.9%)	8,579,430 (80.5%)
Agency service area geography			
Predominantly urban	1,728,450 (79.4%)	6,139,395 (77.0%)	7,867,845 (77.5%)
Predominantly large rural	304,845 (14.0%)	1,152,441 (14.4%)	1,457,286 (14.4%)
Predominantly small rural	116,002 (5.3%)	514,098 (6.4%)	630,100 (6.2%)
Predominantly isolated small rural	26,756 (1.2%)	170,382 (2.1%)	197,138 (1.9%)
Agency type			
Community, non-profit	1,382,709 (63.5%)	5,576,245 (65.7%)	6,958,954 (65.3%)
Fire department	277,848 (12.8%)	916,674 (10.8%)	1,194,522 (11.2%)
Governmental, non-fire	437,737 (20.1%)	1,261,801 (14.9%)	1,699,538 (15.9%)
Private, non-hospital	77,759 (3.6%)	731,134 (8.6%)	808,893 (7.6%)
Agency level of service			
EMR	59 (0.0%)	769 (0.0%)	828 (0.0%)
EMT	5,375 (0.2%)	99,517 (1.2%)	104,892 (1.0%)
AEMT	5,017 (0.2%)	21,924 (0.3%)	26,941 (0.3%)
Paramedic	2,104,351 (96.7%)	7,476,393 (92.5%)	9,580,744 (93.4%)
Nurse or Physician	61,251 (2.8%)	488,250 (6.0%)	549,501 (5.4%)
Number of agency encounters in 2018			
Median (25th percentile, 75th percentile)	2,056 (689, 5,407)	1,914 (602, 5,142)	1,914 (600, 5,140)
U.S. Census Division for agency's home state			
New England	0 (0.0%)	118,840 (1.4%)	118,840 (1.1%)
Middle Atlantic	78,630 (3.6%)	391,332 (4.6%)	469,962 (4.4%)
South Atlantic	778,172 (35.8%)	2,366,836 (27.9%)	3,145,008 (29.5%)
East South Central	257,244 (11.8%)	1,184,474 (14.0%)	1,441,718 (13.5%)
West South Central	414,315 (19.0%)	1,454,809 (17.2%)	1,869,124 (17.5%)
East North Central	309,958 (14.2%)	1,078,302 (12.7%)	1,388,260 (13.0%)
West North Central	178,746 (8.2%)	675,714 (8.0%)	854,460 (8.0%)
Mountain	45,387 (2.1%)	460,069 (5.4%)	505,456 (4.7%)
Pacific	113,601 (5.2%)	749,907 (8.8%)	863,508 (8.1%)
Credential level of provider performing each procedure			
EMR	360 (0.0%)	2,907 (0.0%)	3,267 (0.0%)
EMT	106,161 (4.9%)	889,394 (10.7%)	995,555 (9.3%)
AEMT	43,610 (2.0%)	367,800 (4.4%)	411,410 (3.9%)
Paramedic	2,025,922 (93.1%)	6,346,988 (76.4%)	8,372,910 (78.5%)
Non-crew or other healthcare professional	0 (0.0%)	704,503 (8.3%)	704,503 (6.6%)

EMR: emergency medical responder; EMT: emergency medical technician; AEMT: advanced EMT.
Missing data: agency paid status - 2,563 (0.0%); agency service area geography - 509,615 (4.8%); agency type - 77 (0.0%); agency level of service - 399,078 (3.7%); Census Division - 5,648 (0.1%); credential level - 174,339 (1.6%)

Table B2: Characteristics of EMS Agencies Included in the Analysis Compared with Excluded Agencies

	Agency for which at least one procedure was included in the analysis (N = 1,056)	Agency for which all procedures were excluded from the analysis (N = 232)	Total (N=1,288)
Agency paid status			
Unpaid	115 (10.9%)	41 (20.3%)	156 (12.4%)
Mixed	369 (34.9%)	57 (28.2%)	426 (33.9%)
Paid	572 (54.2%)	104 (51.5%)	676 (53.7%)
Agency service area geography			
Predominantly urban	650 (61.6%)	94 (72.9%)	744 (62.8%)
Predominantly large rural	179 (17.0%)	17 (13.2%)	196 (16.5%)
Predominantly small rural	136 (12.9%)	8 (6.2%)	144 (12.2%)
Predominantly isolated small rural	91 (8.6%)	10 (7.8%)	101 (8.5%)
Agency type			
Community, non-profit	677 (64.1%)	181 (78.0%)	858 (66.6%)
Fire department	224 (21.2%)	25 (10.8%)	249 (19.3%)
Governmental, non-fire	107 (10.1%)	13 (5.6%)	120 (9.3%)
Private, non-hospital	48 (4.5%)	13 (5.6%)	61 (4.7%)
Agency level of service			
EMR	4 (0.4%)	5 (3.0%)	9 (0.7%)
EMT	109 (10.3%)	53 (31.5%)	162 (13.2%)
AEMT	28 (2.7%)	9 (5.4%)	37 (3.0%)
Paramedic	895 (84.8%)	93 (55.4%)	988 (80.7%)
Nurse or Physician	20 (1.9%)	8 (4.8%)	28 (2.3%)
Number of agency encounters in 2018			
Median (25th percentile, 75th percentile)	2,056 (689, 5,407)	786 (192, 3,785)	1,858 (556, 5,126)
U.S. Census Division for agency's home state			
New England	0 (0.0%)	42 (22.6%)	42 (3.4%)
Middle Atlantic	98 (9.3%)	21 (11.3%)	119 (9.6%)
South Atlantic	162 (15.3%)	34 (18.3%)	196 (15.8%)
East South Central	114 (10.8%)	13 (7.0%)	127 (10.2%)
West South Central	217 (20.5%)	19 (10.2%)	236 (19.0%)
East North Central	259 (24.5%)	23 (12.4%)	282 (22.7%)
West North Central	92 (8.7%)	8 (4.3%)	100 (8.1%)
Mountain	38 (3.6%)	11 (5.9%)	49 (3.9%)
Pacific	76 (7.2%)	15 (8.1%)	91 (7.3%)

EMR: emergency medical responder; EMT: emergency medical technician; AEMT: advanced EMT.
Missing data: agency paid status - 30 (2.3%); agency service area geography - 103 (8.0%); agency level of service 64 - (5.0%); Census Division - 43 (3.6%)

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