The Association Between Out-of-Hospital Drug-Assisted Airway Management Approach and Intubation First-Pass Success

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Study objective: Achieving first-pass success during endotracheal intubation has been identified as an area for emergency medical services improvement efforts. Evidence on the effect of out-of-hospital drug-assisted airway management, including rapid sequence intubation, sedation-only intubation, and paralytic-only intubation on first-pass success, is limited. Our objective was to determine the association between out-of-hospital drug-assisted airway management approach and first-pass success, without evaluating the appropriateness of the procedure or the association with complications.

Methods: Using a large national emergency medical services data set, we performed an observational analysis of patients treated during a 911 response who underwent at least one intubation attempt. We excluded patients who experienced cardiac arrest at any time. We then categorized drug-assisted airway management approach according to the medications they received before the initial endotracheal intubation attempt. We characterized the data set with descriptive statistics and calculated adjusted odds ratios with 95% confidence intervals to assess the association between drug-assisted airway management approach and first-pass success.

Results: We identified 12,713 patients intubated who were not in cardiac arrest. As many as 7,396 (58.4%) were male patients and 3,081 (24.2%) were intubated for traumatic conditions. The median age was 60 (interquartile range 40 to 73) years and 42.6% patients were intubated with a video laryngoscope. Drug-assisted airway management approaches included rapid sequence intubation (51.2%), no medications (29.6%), sedation-only intubation (17.9%), and paralytic-only intubation (1.3%). Overall, first-pass success was 75.1%. Compared with no medication, the adjusted odds ratios (95% confidence interval) for achieving first-pass success were higher for rapid sequence intubation, 2.23 (2.00 to 2.50), and paralytic-only intubation, 2.11 (1.38 to 3.24), and similar for sedation-only intubation, 1.04 (0.92 to 1.19). Rapid sequence intubation was also associated with higher first-pass success when compared with sedation-only intubation (2.14 [1.88 to 2.43]).

Conclusion: The use of rapid sequence intubation in patients undergoing endotracheal intubation outside of cardiac arrest was associated with higher odds of first-pass success than patients undergoing either no-medication or sedation-only approaches. Future work is needed to evaluate the association between drug-assisted airway management approach and peri-intubation adverse events and clinical outcomes. [Ann Emerg Med. 2025;86:521-530.]

Please see page 522 for the Editor's Capsule Summary of this article.

Keywords: EMS, Airway management, Rapid sequence intubation, First-pass success.

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INTRODUCTION

Endotracheal intubation is a core component of paramedic scope of practice in the United States. Emergency medical services (EMS) medical directors are responsible for assuring the quality of intubation practice in their systems and often focus on improving the system's first-pass success.[1-3] Several evidenced-based guidelines and professional association recommendations address optimization of intubation.[1,4,5] These documents make a recommendation for the use of rapid sequence intubation techniques based on the suggestion of improved success but emphasize the limited and low certainty of evidence supporting these recommendations. Existing evidence is either indirect, looking at hospital or helicopter EMS–based practice, based on small sample sizes, or direct, looking only at ultimate procedural success instead of the

Editor's Capsule Summary

What is already known on this topic

First-pass success rate during out-of-hospital endotracheal intubation is a common quality metric.

What question this study addressed

Does medication use alter EMS intubation first-pass success rates?

What this study adds to our knowledge

In a data set of 12,713 subjects, first-pass success was lower for those who received no medications (66.8%) or sedation only (67.6%) versus those receiving rapid sequence intubation or a paralytic only (82.9 and 82%), although the groups varied in many characteristics.

How this is relevant to clinical practice

These observations support out-of-hospital paralytic and rapid sequence intubation use but underscore the need for better data to ensure safety and outcome beliefs.

initial success.[6-11] To date, there has been no direct evaluation based on large populations of ground-based EMS drug-assisted airway management approaches and their association with intubation first-pass success.

Drug-assisted airway management approaches use different combinations of medications, including sedatives and paralytics, to facilitate intubation. The potential combinations include rapid sequence intubation, a procedure that involves the administration of a neuromuscular blocking agent, otherwise referred to as a paralytic, to inhibit protective airway reflexes that make laryngoscopy more difficult, combined with a sedative agent to decrease awareness during paralysis.[12] Other approaches, with varying arguments in support and opposition, include sedation-only intubation (sedation-only) and, in contrast to recommendations against the practice, paralytic-only intubation (paralytic-only).[5,8,13] Finally, some patients are intubated without any medications (no medications).

The most recent out-of-hospital airway management evidenced-based guidelines call for additional research to clarify the optimal approach to drug-assisted airway management, highlighting the need to understand its effect on first-pass success, adverse events, and clinical outcomes. In response, we sought to investigate one of these questions, the association between drug-assisted airway management approach and first-pass success, while acknowledging the importance of remaining questions concerning adverse events and clinical outcomes.

Objective

We aimed to directly assess the association between first-pass success and drug-assisted airway management approach compared with the no-medication approach using a large national out-of-hospital data set. In this analysis, we did not attempt to determine the appropriateness of the procedure, any adverse events associated with either the procedure or the medication selection, or the clinical outcome of the procedure or medication selection. Our hypothesis was that first-pass success would be higher with rapid sequence intubation when compared with sedation-only or no-medication approaches.

MATERIALS AND METHODS

Study Design and Setting

We performed a retrospective observational analysis of electronic medical records using the 2022 ESO Data Collaborative data set (ESO, Austin, Texas). ESO is a leading provider of electronic medical records services to EMS systems in the United States. They produce an annual deidentified data set for research purposes. In 2022, the data set contained records on 12,803,160 responses from 2,705 distinct EMS agencies. The data elements collected adhere to version 3.5 of the National EMS Information System data standard.[14] ESO operates as a software as a service model in which each user sees the same data entry form. This uniform approach to data entry increases the conformity of the data captured across multiple agencies.

The ESO data set includes elements on patient and agency demographics, event characteristics such as response dates and times, as well as uniformly collected procedure and vital sign details, each with time stamps. During data entry for an intubation attempt, the electronic medical record forces each procedure to be documented on a single attempt basis, ie, it is not possible to document multiple attempts with a single outcome. This increases the granularity of the data set and allows us to determine the success or failure of each procedural attempt and the time it occurred. The outcome of each procedure is self-reported by the documenting clinician. We adhered to the Strengthening the Reporting of Observational Epidemiology guidelines while designing this study and preparing this manuscript.[15] This study was approved by the Baylor Scott & White Hospital Institutional Review Board (project #397795).

Population

We included all records resulting from a 911 emergency response that resulted in at least one endotracheal intubation attempt, whether successful or not. We excluded responses to a hospital or medical facility for an interfacility transfer. Because patients who are typically intubated with medications are distinct from those intubated for cardiac arrest in several important ways, including presence or absence of airway reflexes, the level of soilage in the airway, patient position, and the presence of ongoing compressions, we also excluded records with a cardiac arrest occurring at any time during the event (either before or after EMS arrival) as well as all patients with the only endotracheal intubation attempt made prior to EMS arrival. We attempted to differentiate cardiac arrests occurring after EMS arrival between those that occurred before the intubation attempt or medication administration and those that occurred after but were unable to do so reliably owing to a lack of granularity in the data set concerning the specific time the arrest occurred in relation to the time of the intubation attempt. We do, however, describe the available data in Table E1 (available at http://www.annemergmed.com). Finally, because of the potential for statistical clustering by agency, we excluded records missing an EMS agency identifier.

Measurements

We extracted the following variables from the data set: patient age, race and ethnicity, sex, whether the incident was medical, traumatic, or medical and traumatic, laryngoscope used (direct or video laryngoscopy), outcome of the attempt (success or failure), date/time of the attempt, medications given, date/time of medication administration, initial vital signs including systolic blood pressure, pulse rate, respiratory rate, pulse oximeter value, CO_2 level, and Glasgow Coma Scale (GCS), as well as agency characteristics such as urbanicity, service type, and service level. The data set includes distinct values for both race and ethnicity, which we combined into categories as follows: if race or ethnicity was Hispanic, we coded race as Hispanic. Records with multiple races selected were coded as multiracial. We have no information available as to how the clinician determined which race to enter into the record. We then limited race values to the races comprising more than 95% of the data set with the remaining 5% collapsed into an "Other" category. We report on the frequency of all races in Table E2 (available at http://www.annemergmed.com). We created the following 2 summarizing variables for each patient: GCS_low was True when the initial GCS was less than 8 and Hypoxemia was True when the initial pulse oximeter value was less than 90%.

We reviewed each distinct medication in the data set and categorized each as a sedative, a paralytic, or neither. We considered a medication a drug-assisted airway management medication if it was a sedative or paralytic and was administered before the initial endotracheal intubation attempt. We only evaluated the initial endotracheal intubation attempt because our primary outcome was first-pass success. We then categorized drug-assisted airway management approaches as follows: rapid sequence intubation included both a sedative and a paralytic; sedation-only included only a sedative, paralytic-only included only a paralytic, and finally "no medications" included neither a sedative nor a paralytic prior to the initial endotracheal intubation attempt. We selected these categories because they are the 4 potential combinations of the following 2 drug classes: both classes, only one or the other, or neither. These combinations also have been reported in the literature as being part of common pratice.[10]

Outcome

Our primary outcome was first-pass success. Success was self-reported in the data set. It was not possible to determine if a standardized definition of an intubation attempt (such as the blade passing the teeth or alveolar ridge) was used or whether agencies required the use of waveform capnography for successful placement confirmation.

Analysis

We described the patients and agencies with medians and interquartile ranges for continuous variables and absolute counts and proportions for categorical variables. Based on previous publications addressing EMS intubation success, we used patient age, sex, race, and indication for intubation (medical or trauma) as covariates.[16] Because of prior work indicating an association between type of laryngoscope blade (video laryngoscopy or direct laryngoscopy), we included this as well.[17-21] Although hypoxemia and hypotension may affect the choice of drug-assisted airway management approach, they were not included as their association with first-pass success was not clear. We include a directed acyclic graph describing the relationship between these variables, the exposure (drug-assisted airway management approach), and outcome (first-pass success) in Figure E1 (available at http://www.annemergmed.com). We performed multiple imputation using predictive mean matching for continuous variables and logistic regression for categorical variables (R package: mice) to address missing data among the included covariates.[22] There was no missing data among intubation success or drug-assisted airway management approach. We then used general linear mixed-methods regression (R

package: lme4), adjusting for identified covariates and including EMS agency as a random intercept to account for clustering by agency, to calculate adjusted odds ratio (aOR) and 95% confidence interval (95% CI) for the association between first-pass success and approach to drug-assisted airway management using no medication as the reference.[23] We used normalized age (R command: scale[Age]) rather than age to stabilize the model. We assessed the model predictors for multicollinearity using the generalized variance inflation factor method (R package: car).[24] A generalized variance inflation factor above 2 was used as the threshold for potential multicollinearity. We repeated the regression with sedation-only approach as the reference to further describe the comparison between 2 common approaches to drug-assisted airway management: rapid sequence intubation and sedation only. Finally, we repeated the adjusted analysis with missing data to assess the effect of multiple imputations. Analysis was completed in R 4.4 2 (R Core Team).[25]

RESULTS

Characteristics of Studied Population

From the entire 2022 data set of 12,803,160 records, there were 12,713 unique patients with at least one endotracheal intubation attempt for a patient not in cardiac arrest that resulted from a 911 response by 1,228 unique EMS agencies. These 12,713 patients made up our final

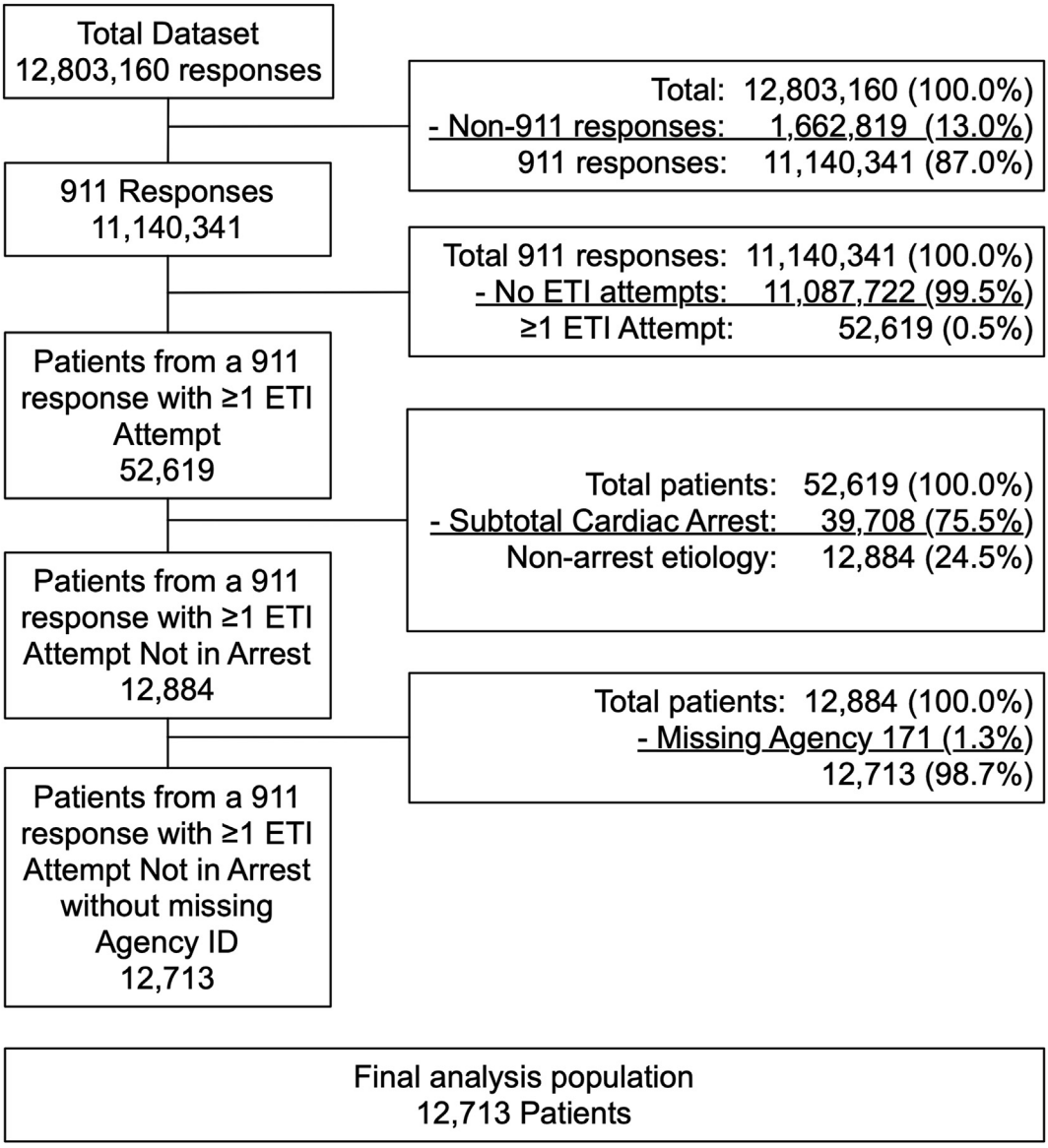

Figure 1. Diagram of patient inclusion and exclusion. *ETI*, endotracheal intubation.

Table 1. Patient and agency characteristics.

Variable	N	N=12,713*
Age	12,680	60 (40-73)
Missing		33
Sex	12,666	
Female		5,265 (41.6)
Male		7,396 (58.4)
Unknown (unable to determine)		5 (0.0)
Missing		47 (0.4)
Race	12,713	
Hispanic		875 (6.9)
Missing		1,838 (14.5)
Non-Hispanic Black		1,442 (11.3)
Non-Hispanic White		8,314 (65.4)
Other		244 (1.9)
Intubation indication	12,713	
Medical		8,867 (69.7)
Medical and trauma		704 (5.5)
Missing		61 (0.5)
Trauma		3,081 (24.2)
Laryngoscope blade type	12,713	
Direct		7,293 (57.4)
Video		5,420 (42.6)
First-pass success	12,713	9,552 (75.1)
Agency type	12,713	
Fire based		3,627 (28.5)
Hospital based		430 (3.4)
Other		44 (0.3)
Private		495 (3.9)
Third service		8,117 (63.8)
Agency level	12,713	
Critical care paramedic		611 (4.8)
EMT		58 (0.5)
Other		429 (3.4)
Paramedic		11,615 (91.4)
Agency status	12,713	
Mixed		2,579 (20.3)
Paid		10,070 (79.2)
Volunteer		64 (0.5)
Agency primary service	12,713	
911 Ground		12,475 (98.1)
Critical care ground		90 (0.7)
Other		137 (1.1)
Transfer		11 (0.1)
Drug-assisted airway management approach	12,713	
No medication		3,763 (29.6)
Paralytic alone		167 (1.3)
Rapid sequence intubation		6,513 (51.2)
Sedation alone		2,270 (17.9)
Initial SBP	12,080	135 (104, 162)
Missing		633 (5.0)
Initial SpO_2	11,842	90 (78, 97)
Missing		871 (6.9)
Initial respiratory rate	12,518	15 (10, 24)
Missing		195 (1.5)
Initial GCS	11,693	3.0 (3.0, 8.0)
Missing		1,020 (8.0)
Initial $EtCO_2$	11,620	33 (20, 45)
Missing		1,093 (8.6)

EMT, emergency medical technician; *$EtCO_2$*, CO_2 level; *SBP*, systolic blood pressure; *SpO_2*, pulse oximeter value.
*Median (Q1, Q3); n (%).

analysis data set (Figure 1). Among the analysis set, 51.2% of initial intubations were performed with rapid sequence intubation, 29.6% with no medications, 17.9% with sedation only, and 1.3% received a paralytic alone. Table 1 describes the patient and agency characteristics in more detail, including the proportion of missing data before imputation.

Main Results

First-pass success was highest with rapid sequence intubation (82.4%) and paralytic only (82.0%) and lowest with sedation only (67.6%) and no medications (66.8%). Compared with no medications, the unadjusted OR for first-pass success with rapid sequence intubation was 2.31 (95% CI 2.07 to 2.58), paralytic only was 1.99 (95% CI 1.30 to 3.03), and sedation only was 1.08 (95% CI 0.95 to 1.23). After adjusting for normalized age (interpreted as OR per SD of age), sex, race, reason for intubation (medical/trauma/medical and trauma), laryngoscope type (direct laryngoscopy versus video laryngoscopy), and GCS < 8, the aOR for first-pass success with rapid sequence intubation compared with no medication was 2.23 (95% CI 2.00 to 2.50) (Table 2). First-pass success was also higher compared with no medication for paralytic only: aOR 2.11 (95% CI 1.38 to 3.24). There was no difference between sedation-only and no-medication approaches: aOR 1.04 (95% CI 0.92 to 1.19) (Figure 2). When using sedation only as the reference, rapid sequence intubation and paralytic only both had higher first-pass success; aOR 2.14 (95% CI 1.88 to 2.43) and 2.01 (95% CI 1.31 to 3.10), respectively. Again, there was no difference between no medications and sedation only: aOR 0.96 (0.84 to 1.09). These findings were maintained in the sensitivity

analysis without imputed data (Table E3, available at http://www.annemergmed.com). The generalized variance inflation factor for all predictors included in the model was less than our threshold of 2, limiting concerns about multicollinearity.

LIMITATIONS

As with all studies, this one is limited by the specific clinical question investigated. We only evaluated the association between drug combination and first-pass success. We did not attempt to determine if the procedure was indicated, nor did we look for associations with either drug approach or first-pass success with adverse events, nor outcomes. These are clearly clinically important questions and should be investigated further with additional research. In addition, this was a retrospective analysis that limits our results to describing only the association with drug-assisted airway management approach and first-pass success; it cannot establish causation. A well-done prospective trial would be required to establish causation. Although the data set is uniform across all agencies, EMS treatment protocols are not. Our results, therefore, describe national system characteristics of endotracheal intubation practice, which include protocol differences as well as treatment deviation from protocols. The data set does not have information on clinician experience with intubation, and it is possible that some agencies have a higher proportion of experienced clinicians than others, which could influence our results. It is likely that there is variation between agencies that have comprehensive quality improvement and continuing education efforts to improve airway management and those that do not. We attempted to control for these potential confounders by accounting for clustering by agency in our model. Lack of access to agency protocols limits our ability to know what definition, if any, clinicians used for an intubation attempt, as well as what criteria they used for confirming successful placement. While using self-reported

Table 2. Association between drug-assisted airway management approach and intubation first-pass success.

Characteristic	First-Pass Success	Unadjusted Model OR (95% CI)	Adjusted Model aOR (95% CI)
Drug-assisted airway management approach			
No medication	66.8%	—	—
Paralytic alone	82.0%	1.99 (1.30-3.03)	2.11 (1.38-3.24)
Rapid sequence intubation	82.4%	2.31 (2.07-2.58)	2.23 (2.00-2.50)
Sedation alone	67.6%	1.08 (0.95-1.23)	1.04 (0.92-1.19)
Normalized age*			1.09 (1.04-1.14)
Sex			
Female	77.2%		—
Male	74.0%		0.90 (0.82-0.98)
Unknown/unable to determine	60.0%		0.33 (0.05-2.22)
Race			
Hispanic	71.9%		—
Missing	81.0%		1.08 (0.86-1.36)
Non-Hispanic Black	71.5%		0.99 (0.81-1.22)
Non-Hispanic White	75.2%		1.01 (0.85-1.20)
Other	72.5%		0.87 (0.62-1.22)
Laryngoscope blade type			
Direct laryngoscopy	72.0%		—
Video laryngoscopy	79.8%		1.56 (1.41-1.73)
Intubation indication			
Medical	77.1%		—
Medical and trauma	71.7%		0.81 (0.67-0.97)
Missing	73.8%		1.33 (0.72-2.48)
Trauma	71.1%		0.76 (0.68-0.85)

Odds ratios adjusted for age, race, sex, laryngoscope type, indication, and low GCS.
*Normalized to units of 1 SD.

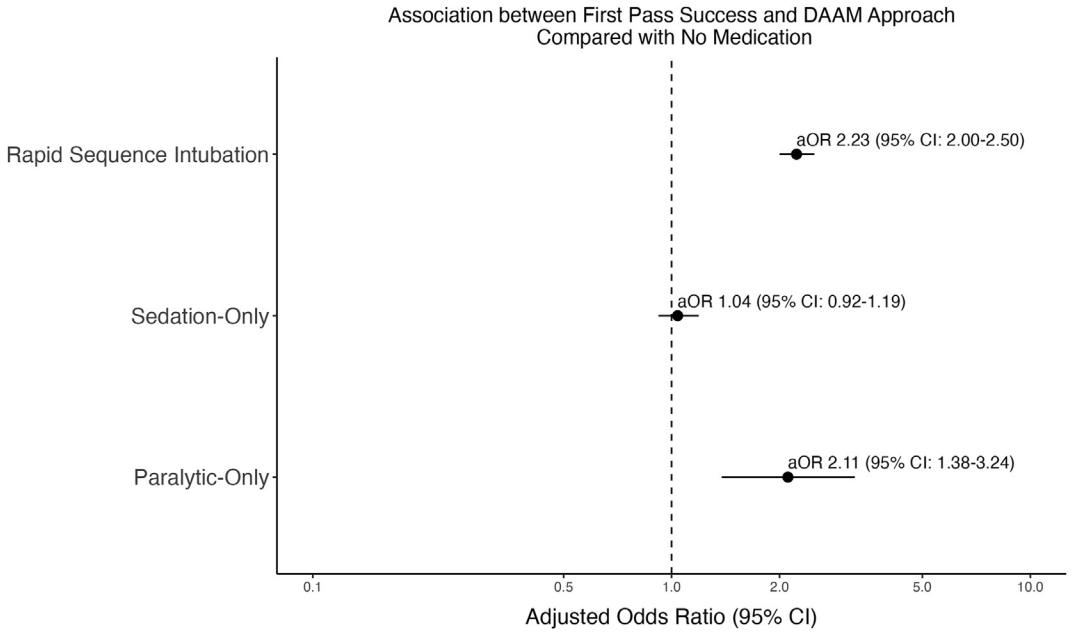

Figure 2. Association between first-pass success and drug-assisted airway management approach compared with no medication. *DAAM*, drug-assisted airway management.

data limits certainty in the accuracy of the reported first-pass success, it is an inherent limitation to studies using anonymized national data sets. Multiple observational and randomized studies, both in and out of hospital, have used self-reported success data, comprising much of the knowledge base on intubation success.[10,11,17,18,26-30] Future work on the differences between self-reported intubation success and waveform capnography confirmation would allow a better assessment of the validity of using self-reported success.

All research conducted using medical charts is subject to data entry errors. For example, we found that 167 (1.3%) of all patients in the analysis set received only a paralytic prior to intubation. It is possible that this reflects actual practice, but it could also represent data entry errors in which the clinician documented the paralytic in the discrete data element that is available for analysis while only documenting sedation in the narrative that was not available for this analysis. Likewise, the clinician may have documented the inverse, with sedation in the discrete data element but the paralytic only in the narrative. Future work should further analyze the population of patients reportedly receiving only a paralytic. This is particularly important given the recommendations against such practice. In addition, some timestamps might have been entered after the event, which might have subjected them to recall bias and potential error in which a drug might have been given prior to the intubation but documented as after intubation or vice versa. Because there is no way to identify documentation errors, all medications were analyzed as documented. With a sample size of more than 12,000 cases, it is unlikely that there was a systemic documentation error sufficient to significantly influence these results; however, the potential cannot be excluded. Although our results showed similar first-pass success rates with rapid sequence intubation and paralytic-only approaches, our data set did not include elements related to peri-intubation patient awareness, so we were unable to detect an important adverse event associated with a paralytic-only approach.

We specifically limited our analysis to the important outcome of first-pass success. We did not evaluate other important outcomes such as peri-intubation hypoxemia or hypotension, leaving that for a separate analysis currently underway.

There was missing data for some of the predictors included in our model. We addressed this with multiple imputations, which may have affected the results; however, this is unlikely given the sensitivity analysis showing similar results without imputation. Finally, although the overall data set we analyzed was large, there were few (1.3%) cases of paralytic-only intubations. Because of this small subset of cases, CIs were wide-limiting interpretation of estimates for this stratum.

DISCUSSION

In our analysis of a large national EMS data set, we found that the use of paralytic medications, whether through rapid sequence intubation or paralytic-only

approaches, was associated with 2-fold increases in first-pass success compared with no-medication or sedation-only approaches. Interestingly, we found no significant difference in sedation-only when compared with a no-medication approach.

These results are consistent with studies in the ICU and emergency department in which first-pass success was found to be higher with the use of paralytic approaches compared with nonparalytic ones.[6,7,31] EMS-focused data, however, were less robust. There are 2 small helicopter EMS quality improvement studies, both demonstrating increased overall intubation success with rapid sequence intubation compared with a nonparalytic approach.[8,9] Among ground-based EMS systems, we found no published studies directly comparing rapid sequence intubation versus nonrapid sequence intubation approaches. There are 2 indirect studies that used earlier releases of the ESO data set, both showing lower procedural success without paralytics in both adults and children.[10,11]

Interestingly, we found a small group of patients apparently receiving paralytic-only approaches to drug-assisted airway management. This contrasts with professional association recommendations to use sedation with paralysis to avoid awareness.[1,5] It is possible that this small group represents a systematic documentation error, something that should be further investigated in future work. It is also possible that this practice is intentional and driven by protocols. We also found that ~4% of patients in cardiac arrest, either before or after EMS arrival, were intubated using some combination of paralytics and sedation (Table E1). The situations under which airway medications might be used in cardiac arrest and the implications of such practice are unclear and worthy of further study. It might be that an increased airway tone leading to the use of paralytics may be a marker for better prognosis or the use of sedation might be a marker for intra-arrest consciousness.[32-34]

Although we found similar rates of first-pass success with both approaches that used paralytic-assisted intubation (rapid sequence intubation and paralytic only), it is important to remember the function of both classes of medications. Paralytics allow for complete relaxation of airway protective reflexes allowing for better laryngoscopic visualization of the airway and higher airway grades.[7] There are concerns associated with paralysis, however, including increased hypoxemia as a result of apnea and patient awareness when given in the absence of sedation. Awareness during paralysis occurs in up to 3% of paralytic-induced intubations in the ED and is associated with increased rates of posttraumatic stress disorder.[35,36] Sedatives are included with paralytics in rapid sequence intubation specifically to mitigate this awareness.[5] The rationale for these 2 approaches and the dangers of paralysis awareness should be kept in mind when considering either a rapid sequence intubation or a paralytic-only approach.

Although intubation first-pass success is an important measure, it is only one component of safe intubation. Avoidance of peri-intubation hypoxemia and hypotension is important, and composite outcome measures, such as first-pass success without hypoxemia or hypotension, are critical. First-pass success is necessary for safe intubation but not sufficient. It is possible that without specific and careful preparation and patient selection, the use of paralytics, although it improves first-pass success, may worsen physiologic adverse events. Future work should focus on the effect of drug-assisted airway management approach on peri-intubation hypoxemia and hypotension.

Our results are the first to directly evaluate the association between drug-assisted airway management approach and first-pass success among a large population of ground-based EMS. Although these data may provide additional data to assist EMS medical directors in their efforts to improve intubation practices in their systems, they should remain aware that procedural success is just one component of safe and effective airway management.

In conclusion, in this analysis of a large national EMS data set of noncardiac arrest patients undergoing endotracheal intubation, rapid sequence intubation was associated with 2-fold higher odds of first-pass success compared with sedation-only or no-medication approaches. Future work is needed to evaluate the association between rapid sequence intubation approach and peri-intubation adverse events and clinical outcomes.

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Data sharing statement: Data set is available on request from ESO by contacting Remle Crowe, PhD, at remle.crowe@eso.com. Analysis code is available on request by emailing Jeffrey Jarvis, MD, at jjarvis@medstar911.org.

All authors attest to meeting the four ICMJE.org authorship criteria: (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND (2) Drafting the work or revising it critically for important intellectual content; AND (3) Final approval of the version to be published; AND (4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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REFERENCES

1. Jarvis JL, Lyng JW, Miller BL, et al. Prehospital drug assisted airway management: an NAEMSP position statement and resource document. *Prehosp Emerg Care*. 2022;26(Suppl 1):42-53.
2. Mandt M, Harris M, Lyng J, et al. Quality management of prehospital pediatric respiratory distress and airway programs: an NAEMSP position statement and resource document. *Prehosp Emerg Care*. 2022;26(Suppl 1):111-117.
3. Vithalani V, Sondheim S, Cornelius A, et al. Quality management of prehospital airway programs: an NAEMSP position statement and resource document. *Prehosp Emerg Care*. 2022;26(Suppl 1):14-22.
4. Jarvis JL, Panchal AR, Lyng JW, et al. Evidence-based guideline for prehospital airway management. *Prehosp Emerg Care*. 2024;28:545-557.
5. Acquisto NM, Mosier JM, Bittner EA, et al. Society of critical care medicine clinical practice guidelines for rapid sequence intubation in the critically ill adult patient. *Crit Care Med*. 2023;51:1411-1430.
6. Mosier JM, Sakles JC, Stolz U, et al. Neuromuscular blockade improves first-attempt success for intubation in the intensive care unit. A propensity matched analysis. *Ann Am Thorac Soc*. 2015;12:734-741.
7. Wilcox SR, Bittner EA, Elmer J, et al. Neuromuscular blocking agent administration for emergent tracheal intubation is associated with decreased prevalence of procedure-related complications. *Crit Care Med*. 2012;40:1808-1813.
8. Bozeman WP, Kleiner DM, Huggett V. A comparison of rapid-sequence intubation and etomidate-only intubation in the prehospital air medical setting. *Prehosp Emerg Care*. 2006;10:8-13.
9. Rose WD, Anderson LD, Edmond SA. Analysis of intubations. Before and after establishment of a rapid sequence intubation protocol for air medical use. *Air Med J*. 1994;13:475-478.
10. Nwanne T, Jarvis J, Barton D, et al. Advanced airway management success rates in a national cohort of emergency medical services agencies. *Resuscitation*. 2020;146:43-49.
11. Jarvis JL, Wampler D, Wang HE. Association of patient age with first pass success in out-of-hospital advanced airway management. *Resuscitation*. 2019;141:136-143.
12. Collins J, O'Sullivan EP. Rapid sequence induction and intubation. *BJA Educ*. 2022;22:484-490.
13. Trakulsrichai S, Sundarathiti P, Chalermdamrichai P, et al. An observation study of rapid sequence, awake and sedation-only intubations in an emergency department in Thai patients. *J Med Assoc Thai*. 2009;92:1022-1027.
14. NEMSIS. NEMSIS. NEMSIS. Accessed December 28, 2024. https://nemsis.org/
15. Von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. *Int J Surg*. 2014;12:1495-1499.
16. Thomas J, Crowe R, Schulz K, et al. Association between emergency medical service agency intubation rate and intubation success. *Ann Emerg Med*. 2024;84:1-8.
17. Trent SA, Kaji AH, Carlson JN, et al. Video laryngoscopy is associated with first-pass success in emergency department intubations for trauma patients: a propensity score matched analysis of the National Emergency Airway Registry. *Ann Emerg Med*. 2021;78:708-719.
18. Nikolla DA, Carlson JN, Jimenez Stuart PM, et al. Impact of video laryngoscope shape on first-attempt success during non-supine emergency department intubations. *Am J Emerg Med*. 2022;57:47-53.
19. Driver BE, Prekker ME, Reardon RF, et al. Comparing emergency department first-attempt intubation success with standard-geometry and hyperangulated video laryngoscopes. *Ann Emerg Med*. 2020;76:332-338.
20. Brown CA, Kaji AH, Fantegrossi A, et al. Video laryngoscopy compared to augmented direct laryngoscopy in adult emergency department tracheal intubations: a National Emergency Airway Registry (NEAR) study. *Acad Emerg Med*. 2020;27:100-108.
21. Jarvis JL, McClure SF, Johns D. EMS intubation improves with king vision video laryngoscopy. *Prehosp Emerg Care*. 2015;19:482-489.
22. van Buuren S, Groothuis-Oudshoorn K. mice: multivariate imputation by chained equations in R. *J Stat Softw*. 2011;45:1-67.
23. Bates D, Martin M. Fitting linear mixed-effects models using {lme4}. *J Stat Softw*. 2015;67:1-48.
24. Fox J, Weisberg S. *An R Companion to Applied Regression*. 3rd ed. Sage; 2019.
25. R Core Team. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing. 2024. Accessed May 23, 2025. https://www.R-project.org/
26. Jarvis JL, Barton D, Wang H. Defining the plateau point: when are further attempts futile in out-of-hospital advanced airway management. *Resuscitation*. 2018;130:57-60.
27. Smida T, Menegazzi J, Scheidler J, et al. A retrospective comparison of the King Laryngeal Tube and iGel supraglottic airway devices: a study for the CARES surveillance group. *Resuscitation*. 2023;188:109812.
28. Lesnick JA, Moore JX, Zhang Y, et al. Airway insertion first pass success and patient outcomes in adult out-of-hospital cardiac arrest: the pragmatic airway resuscitation trial. *Resuscitation*. 2021;158:151-156.
29. Wang HE, Schmicker RH, Daya MR, et al. Effect of a strategy of initial laryngeal tube insertion vs endotracheal intubation on 72-hour survival in adults with out-of-hospital cardiac arrest: a randomized clinical trial. *JAMA*. 2018;320:769-778.
30. Benger JR, Kirby K, Black S, et al. Effect of a strategy of a supraglottic airway device vs tracheal intubation during out-of-hospital cardiac

arrest on functional outcome: the airways-2 randomized clinical trial. *JAMA*. 2018;320:779-791.
31. Okubo M, Gibo K, Hagiwara Y, et al. The effectiveness of rapid sequence intubation (RSI) versus non-RSI in emergency department: an analysis of multicenter prospective observational study. *Int J Emerg Med*. 2017;10:1.
32. Pound J, Verbeek PR, Cheskes S. CPR induced consciousness during out-of-hospital cardiac arrest: a case report on an emerging phenomenon. *Prehosp Emerg Care*. 2017;21:252-256.
33. Pourmand A, Hill B, Yamane D, et al. Approach to cardiopulmonary resuscitation induced consciousness, an emergency medicine perspective. *Am J Emerg Med*. 2019;37:751-756.
34. Parnia S, Keshavarz Shirazi T, Patel J, et al. AWAreness during REsuscitation-II: a multi-center study of consciousness and awareness in cardiac arrest. *Resuscitation*. 2023;191:109903.
35. Pappal RD, Roberts BW, Mohr NM, et al. The ED-AWARENESS study: a prospective, observational cohort study of awareness with paralysis in mechanically ventilated patients admitted from the emergency department. *Ann Emerg Med*. 2021;77:532-544.
36. Leslie K, Chan MT, Myles PS, et al. Posttraumatic stress disorder in aware patients from the B-aware trial. *Anesth Analg*. 2010;110:823-828.