Emergency Medicine Postgraduate Year, Laryngoscopic View, and Endotracheal Tube Placement Success

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Study objective: Prior work has found first-attempt success improves with emergency medicine (EM) postgraduate year (PGY). However, the association between PGY and laryngoscopic view – a key step in successful intubation – is unknown. We examined the relationship among PGY, laryngoscopic view (ie, Cormack–Lehane view), and first-attempt success.

Methods: We performed a retrospective analysis of the National Emergency Airway Registry, including adult intubations by EM PGY 1 to 4 resident physicians. We used inverse probability weighting with propensity scores to balance confounders. We used weighted regression and model comparison to estimate adjusted odds ratios (aOR) with 95% confidence intervals (CIs) between PGY and Cormack–Lehane view, tested the interaction between PGY and Cormack–Lehane view on first-attempt success, and examined the effect modification of Cormack–Lehane view on the association between PGY and first-attempt success.

Results: After exclusions, we included 15,453 first attempts. Compared to PGY 1, the aORs for a higher Cormack–Lehane grade did not differ from PGY 2 (1.01; 95% CI 0.49 to 2.07), PGY 3 (0.92; 0.31 to 2.73), or PGY 4 (0.80; 0.31 to 2.04) groups. The interaction between PGY and Cormack–Lehane view was significant (P-interaction$<$0.001). In patients with Cormack–Lehane grade 3 or 4, the aORs for first-attempt success were higher for PGY 2 (1.80; 95% CI 1.17 to 2.77), PGY 3 (2.96; 1.66 to 5.27) and PGY 4 (3.10; 1.60 to 6.00) groups relative to PGY 1.

Conclusion: Compared with PGY 1, PGY 2, 3, and 4 resident physicians obtained similar Cormack–Lehane views but had higher first-attempt success when obtaining a grade 3 or 4 view. [Ann Emerg Med. 2024;84:11-19.]

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INTRODUCTION

Background

Tracheal intubation is an essential emergency airway management skill learned by emergency medicine (EM) postgraduate trainees.[1] Performing this procedure with the goal of first-attempt success is essential to avoid complications and adverse events.[2] Excepting blind techniques, the procedure has 2 distinct sequential components, laryngoscopy (visualization) followed by endotracheal tube delivery (tracheal placement), which trainees must master during residency. EM resident physicians have improved first-attempt success by year as they progress through residency.[3,4] However, it is unknown whether this improvement occurs due to improved laryngoscopy, endotracheal tube placement, or both.

Importance

Educational interventions for EM residents learning endotracheal intubation and emergency airway management are of increasing importance. Emergency endotracheal intubations occur infrequently compared with elective cases and may be decreasing in frequency overall.[5-7] Including simulation, EM residents only intubate approximately 30 times per year.[8] Given the fewer opportunities to learn emergency intubation by clinical practice alone, EM residents will need additional deliberate practice in a simulation setting. Understanding which steps of endotracheal intubation require additional focus to improve will create opportunities for targeted training interventions.

Goals of This Investigation

We aimed to examine the relationship among postgraduate training year (PGY), laryngoscopic view (ie, Cormack–Lehane view), and endotracheal tube placement by Cormack–Lehane view. We hypothesized that PGY 2, 3, and 4 trainees would obtain lower (ie, better) Cormack–Lehane grades and higher first-attempt success at

Editor's Capsule Summary

What is already known on this topic

Endotracheal intubation success improves over the course of emergency medicine residency training.

What question this study addressed

Is such progressive success due to improved laryngoscopic views?

What this study adds to our knowledge

In this retrospective, secondary database analysis with 15,453 intubations, the quality of the laryngoscopic view was similar regardless of progressive postgraduate year (PGY) of training. For patients with poor laryngoscopic views, first-attempt success improved with progressive PGY level.

How this is relevant to clinical practice

Endotracheal intubation training needs change over time, notably after reaching a functional limit for laryngoscopic view early in emergency medicine residency training.

each Cormack–Lehane grade compared with PGY 1 trainees.

MATERIALS AND METHODS

Study Design and Setting

We performed a retrospective, secondary analysis of observational data in the National Emergency Airway Registry (NEAR). The most current iteration of the registry contains data on emergency department (ED) intubations from 25 university and community sites from January 1, 2016, to December 31, 2018. All sites have EM residents who intubate. We obtained ethical approval from each site's institutional review board and the coordinating site was Brigham and Women's Hospital, Boston, MA.

Data Collection

The methodology of data collection has been described in detail previously.[9] Briefly, after each intubation, the intubating clinician completed a structured case report form on a web-based data capture platform (StudyTRAX; version 3.47.0011, 2016; ScienceTRAX, Macon, GA). The form included figures, such as an image of each Cormack–Lehane grade beside the data entry field, to mitigate the risk of misclassification. In addition, the reported Cormack–Lehane grade for each intubation was the "best" view obtained during that attempt. Sites must submit data for ≥90% of intubations to include their data in the registry. We defined an intubation attempt as an insertion of the laryngoscope into the oropharynx.

Participants

We included the first attempt for all ED intubations on subjects aged 14 years or older using the oral route. We excluded subjects intubated without direct or video laryngoscopes (Table E1, available at http://www.annemergmed.com) and those intubated by non-EM residents or EM residents beyond PGY 4. We excluded alternative devices and techniques, such as bronchoscopy-assisted intubation and digital intubation, because these modalities are uncommonly used.[10-13] Therefore, experience with these alternative devices and techniques may not be associated with training length.

Variables

We examined predefined NEAR variables related to patient characteristics and intubation management across postgraduate years. Patient characteristics included age (years), sex (ie, male, female), body habitus (ie, very thin, thin, normal, obese, and morbidly obese per the assessment of the intubating clinician), number of difficult airway findings (ie, 1, 2, and 3+), emergency intubation (no time for preoxygenation), supine versus nonsupine position, trauma indication, and cardiopulmonary resuscitation performed during the intubation. We summed the following difficult airway findings per subject: reduced neck mobility, Mallampati score of more than 2, mouth opening of more than 3 fingers, thyromental distance of more than 3 fingers, facial trauma, and blood in the airway. Trauma indications in the study data set included facial trauma, polytrauma, combative/agitated, head injury with hemorrhage, abdomen trauma, head injury without hemorrhage, burn/inhalation injury, shock (hemorrhagic), neck trauma, chest trauma, shock (spinal trauma), and traumatic arrest. Intubation management variables included use of induction medications (sedation and paralysis, sedation only, paralysis only, topical anesthesia, topical with sedation, and no induction medications), paralytic medication choice (rocuronium, succinylcholine, vecuronium, and no paralytic), laryngoscope (ie, direct, hyperangulated video, standard geometry video, or other video device), bougie use, and use of the external laryngeal manipulation technique. For paralytic choice, a missing paralytic medication was coded as "No Paralytic" if the induction medication variable indicated that no paralytic was used (eg, sedation only) but coded as "Missing" if the induction medication variable indicated a paralytic was used (eg, sedation and paralysis). The main outcome for our initial analysis was the proportions of Cormack–Lehane grades (1 to 4) by PGY, whereas the main outcome for our subsequent analysis was the first-attempt success for each PGY by Cormack–Lehane grade.

Statistical Analysis

Sample size calculations are presented in the appendix (Figure E1; Table E2, available at http://www.annemergmed.com). We provide descriptive statistics for each variable and outcome across PGYs. For adjusted analyses, we performed inverse probability weighting using propensity scores to balance covariates between PGY groups. Using PGY 1 versus 2, 3, or 4 as the outcome, we calculated the propensity scores with an ordinal regression model for the average treatment effects, including covariates that might confound the association between PGY and difficult intubation (either by difficult laryngoscopic view or endotracheal tube placement). We included patient age, sex, body habitus, number of anatomical difficult airway characteristics, emergency intubation (no time for preoxygenation), supine versus nonsupine position, paralytic choice, laryngoscope, trauma indication, and cardiopulmonary resuscitation during intubation (Figures E2 and E3, available at http://www.annemergmed.com). Justification for each covariate used to generate propensity scores is provided in the appendix (Table E3, available at http://www.annemergmed.com). All these variables would be known by the clinical team at the time of or before the exposure (PGY of the intubating resident on the first attempt). We did not adjust for either external laryngeal manipulation or bougie use in the main analyses nor did we adjust for physiological variables, such as pre-intubation hypoxemia or hypotension (see captions below Table E3 for justification). We used the propensity scores to weigh each first attempt by the inverse probability of receiving their actual exposure to an intubating resident of either PGY 1 versus 2, 3, or 4. All variable levels were well balanced with standardized differences of less than 0.1 after weighting (Figures E4 to E6, available at http://www.annemergmed.com).

For our initial adjusted analysis, we used an ordinal logistic regression model with inverse probability weighting to examine the adjusted association between PGY and Cormack–Lehane view. For the subsequent adjusted analysis, we examined the interaction and effect modification between PGY and Cormack–Lehane view on first-attempt success. To examine the interaction, we used logistic regression models with inverse probability weighting including (full model) and excluding (reduced model) interaction terms between the levels of PGY and Cormack–Lehane view. A significant likelihood ratio test (P value for interaction <0.05) between the full and reduced models indicated a multiplicative interaction. We also calculated the relative reduction in the root mean square error between the reduced and full models to quantify the variation in first-attempt success explained by the interaction. To examine effect modification, we performed a stratified analysis. Within each Cormack–Lehane grade subgroup, we used logistic regression models with inverse probability weighting to estimate the association between PGY and first-attempt success. However, due to the small number of intubations with grade 3 (n=946) and 4 (n=513) views, we combined these grades into a single subgroup.

For both outcomes (ie, Cormack–Lehane view and first-attempt success), adjusted odds ratios (aORs) are presented with 95% confidence intervals (CIs) derived from cluster robust standard errors clustered by site. Model terms were considered significant if the 95% CI of the aOR excluded 1. We did not adjust for multiplicity because we investigated 2 separate research questions with separate methods and conclusions (the association between PGY and Cormack–Lehane view as well as the interaction/effect modification of Cormack–Lehane view on the association between PGY and first-attempt success).[14] The number of observations and Akaike information criterion are presented for each model. We performed sensitivity analyses for both outcomes after multiple imputation, after inclusion of external laryngeal manipulation for the Cormack–Lehane view outcome and bougie use for the first-attempt success outcome in the output regression models, and among the subset of cases intubated with direct laryngoscopy. For the nonparametric multiple imputation sensitivity analysis, we used a random forest model to impute missing values for all model variables (Table E4 for additional details, available at http://www.annemergmed.com). Normality was checked with the Shapiro–Wilk test, and multicollinearity was excluded with generalized variance inflation factors <2. We report our results in accordance with the Strengthening the Reporting of Observational studies in Epidemiology Initiative.[15] The analysis was performed with R (Version 4.2.3 2023-03-15, R Foundation for Statistical Computing, Vienna, Austria) with packages reported in the appendix (Figure E7, available at http://www.annemergmed.com).

RESULTS

Descriptive

Of 19,071 patients in the registry, we included 15,453 first attempts from 25 sites. There were 1,903 first attempts by PGY 1 intubators, 5,391 by PGY 2, 6,773 PGY 3, and

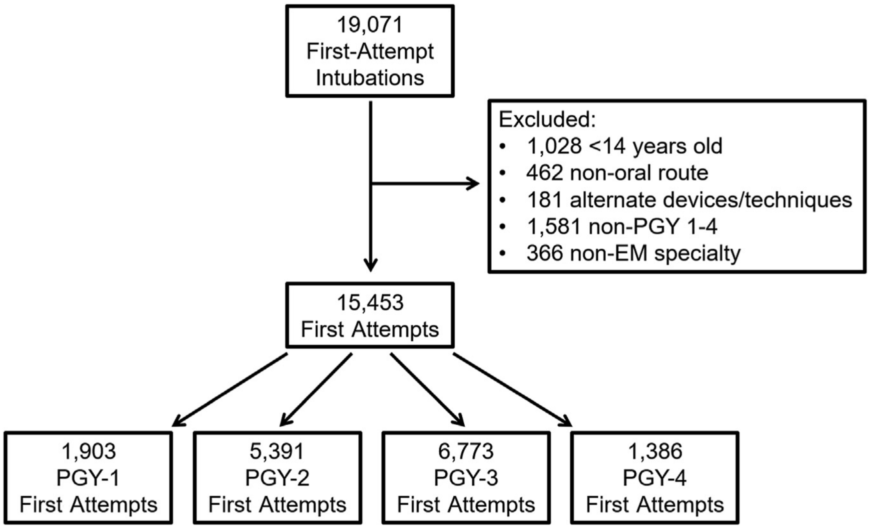

Figure 1. Exclusion and inclusion counts for the study population.

1,386 by PGY 4 (Figure 1). The proportions of body habitus levels and number of difficult airway characteristics were similar across PGY groups (Table 1). However, the proportion of first attempts with trauma indications increased each year (Table 1).

Cormack–Lehane View Outcome

The unadjusted proportions of Cormack–Lehane views (grades 1 to 4) were similar across PGYs (Table 2, Figure 2). Compared with PGY 1, the PGY 2, 3, and 4 intubators were not associated with Cormack–Lehane view in the adjusted analysis (Table 3). The results were similar in all sensitivity analyses (Tables E5 to E7, available at http://www.annemergmed.com), including after adjusting for external laryngeal manipulation (Table E6) and subsetting the direct laryngoscopy cases (Table E7).

First-Attempt Success Outcome

The unadjusted proportions of first-attempt success decreased by Cormack–Lehane view for all PGY groups (Table 2, Figure 3). However, the decrease in first-attempt success by Cormack–Lehane view appeared to be less substantial for PGYs 3 and 4 than for PGYs 1 and 2 (Table 2, Figure 3). In the adjusted interaction analysis, the interaction between PGY and Cormack–Lehane view was significant (P-interaction<0.001). However, the interaction only accounted for a 4.50% relative reduction in root mean square error on the outcome of first-attempt success (Table E8, available at http://www.annemergmed.com). Similar results were observed in all sensitivity analyses examining the interaction (Tables E8 to E11, available at http://www.annemergmed.com), including after adjusting for bougie (Table E10).

In the adjusted effect modification analysis, compared to PGY 1, the aORs for first-attempt success were 1.25 (95% CI 0.83 to 1.87) for PGY 2, 1.33 (0.74 to 2.39) for PGY 3, and 1.49 (0.77 to 2.87) for PGY 4 in the Cormack–Lehane grade 1 subgroup (Table E12, available at http://www.annemergmed.com). However, the aORs for first-attempt success were 1.80 (1.17 to 2.77) for PGY 2, 2.96 (1.66 to 5.27) for PGY 3, and 3.10 (1.60 to 6.00) for PGY 4 in the Cormack–Lehane grade 3 or 4 subgroup (Table E12). Similar results were observed in all sensitivity analyses (Tables E13 to E15, available at http://www.annemergmed.com).

LIMITATIONS

We used observational data reported by intubating clinicians, which exposes the results to unmeasured confounding, information, and hindsight bias. However, we used directed acyclic graphs to graphically map the assumed variable relationships in our modeling approach, measured and adjusted for the major confounding variables, avoided adjusting for mediators or colliders, and performed sensitivity analyses accounting for missingness.[16] Additionally, we used inverse probability weighting to balance covariates, which ameliorates bias compared with regression-based statistical adjustment by not making assumptions, such as linearity of the logit for continuous variables.[16,17] These analytical steps ameliorate bias from observational data.[16] However, some systematic biases may still exist.

Table 1. Subject, intubator, and intubation characteristics.

	PGY1	PGY2	PGY3	PGY4
n	**1,903**	**5,391**	**6,773**	**1,386**
Patient age (y), median [IQR]	57 [40, 69]	55 [38, 69]	51 [33, 64]	52 [35, 67]
Patient sex, n (%)				
Female	744 (39.1)	1,908 (35.4)	2,127 (31.4)	435 (31.4)
Missing	0 (0.0)	0 (0.0)	2 (0.0)	0 (0.0)
Patient body habitus, n (%)				
Very thin	77 (4.0)	221 (4.1)	209 (3.1)	57 (4.1)
Thin	304 (16.0)	857 (15.9)	907 (13.4)	179 (12.9)
Normal	839 (44.1)	2,393 (44.4)	3,470 (51.2)	710 (51.2)
Obese	558 (29.3)	1,590 (29.5)	1,806 (26.7)	347 (25.0)
Morbidly obese	120 (6.3)	316 (5.9)	341 (5.0)	76 (5.5)
Missing	5 (0.3)	14 (0.3)	40 (0.6)	17 (1.2)
Number of difficult airway findings, n (%)*				
0	765 (40.2)	1,998 (37.1)	2,943 (43.5)	556 (40.1)
1	603 (31.7)	1,699 (31.5)	2,046 (30.2)	430 (31.0)
2	315 (16.6)	887 (16.5)	989 (14.6)	227 (16.4)
3+	220 (11.6)	807 (15.0)	795 (11.7)	173 (12.5)
Emergency intubation (no preoxygenation), n (%)	632 (33.2)	2,165 (40.2)	2,137 (31.6)	550 (39.7)
Trauma indication, n (%)†	261 (13.7)	1,189 (22.1)	1,840 (27.2)	378 (27.3)
CPR during intubation, n (%)	213 (11.2)	781 (14.5)	826 (12.2)	189 (13.6)
Induction medications, n (%)‡				
Sedation and paralysis	1,649 (86.7)	4,387 (81.4)	5,631 (83.1)	1,127 (81.3)
Missing	0 (0.0)	0 (0.0)	1 (0.0)	0 (0.0)
Paralytic choice, n (%)				
Rocuronium	960 (50.4)	2,704 (50.2)	3,080 (45.5)	567 (40.9)
Succinylcholine	708 (37.2)	1,832 (34.0)	2,807 (41.4)	615 (44.4)
Vecuronium	8 (0.4)	5 (0.1)	10 (0.1)	6 (0.4)
No paralytic	227 (11.9)	850 (15.8)	870 (12.8)	198 (14.3)
Missing	0 (0.0)	0 (0.0)	6 (0.1)	0 (0.0)
Laryngoscope, n (%)				
Direct	532 (28.0)	1,879 (34.9)	1,937 (28.6)	539 (38.9)
Hyperangulated video	635 (33.4)	1,540 (28.6)	1,521 (22.5)	313 (22.6)
Standard geometry video	729 (38.3)	1,964 (36.4)	3,302 (48.8)	531 (38.3)
Other video	7 (0.4)	8 (0.1)	13 (0.2)	3 (0.2)
Bougie use, n (%)				
Yes	104 (5.5)	637 (11.8)	1,932 (28.5)	181 (13.1)
Missing	3 (0.2)	14 (0.3)	243 (3.6)	19 (1.4)
ELM, n (%)				
Yes	485 (25.5)	1,432 (26.6)	1,622 (23.9)	371 (26.8)
Missing	4 (0.2)	27 (0.5)	344 (5.1)	26 (1.9)
Supine vs nonsupine position, n (%)				
Yes	1,690 (88.8)	4,854 (90.0)	6,076 (89.7)	1,272 (91.8)
Missing	3 (0.2)	17 (0.3)	271 (4.0)	23 (1.7)

CPR, Cardiopulmonary resuscitation; *ELM*, external laryngeal manipulation; *IQR*, interquartile range.

*The following variables were summed to total the number of difficult airway findings: reduced neck mobility, Mallampati >2, mouth opening <3 fingers, thyromental distance <3 fingers, facial trauma, and blood in the airway.

†Trauma indications present in the study population included facial trauma, polytrauma, combative/agitated, head injury with hemorrhage, abdomen trauma, head injury without hemorrhage, burn/inhalation injury, shock (hemorrhagic), neck trauma, chest trauma, shock (spinal trauma), and traumatic arrest.

‡The induction medication variable included levels for sedation and paralysis, sedation only, paralysis only, topical anesthesia, topical with sedation, and no induction medications. However, most intubations used sedation and paralysis, and the proportions were similar across PGYs. Thus, we only report sedation and paralysis here.

Table 2. Outcomes.

	PGY1	PGY2	PGY3	PGY4
n	**1,903**	**5,391**	**6,773**	**1,386**
Cormack–Lehane view, n (%)				
Grade 1	1,233 (64.8)	3,383 (62.8)	4,331 (63.9)	943 (68.0)
Grade 2	492 (25.9)	1,417 (26.3)	1,529 (22.6)	274 (19.8)
Grade 3	106 (5.6)	367 (6.8)	379 (5.6)	94 (6.8)
Grade 4	65 (3.4)	194 (3.6)	201 (3.0)	53 (3.8)
Missing	7 (0.4)	30 (0.6)	333 (4.9)	22 (1.6)
First-attempt success at each Cormack–Lehane view, n/total (%)				
Grade 1	1,167/1,233 (94.6)	3,231/3,383 (95.5)	4,162/4,331 (96.1)	904/943 (95.9)
Grade 2	400/492 (81.3)	1,212/1,417 (85.5)	1,351/1,529 (88.4)	238/274 (86.9)
Grade 3	34/106 (32.1)	145/367 (39.5)	220/379 (58)	48/94 (51.1)
Grade 4	7/65 (10.8)	33/194 (17)	43/201 (21.4)	15/53 (28.3)
Missing	6/7 (85.7)	23/30 (76.7)	320/333 (96.1)	21/22 (95.5)

For example, the inter-rater reliability of Cormack–Lehane view has been reported to be poor to fair and may be a source of bias.[18-21] However, Cormack–Lehane view was strongly associated with first-attempt success (Figure 3, Tables E8 to E11), illustrating face and construct validity given the known importance of glottic visualization for successful intubation.[22] In addition, we defined 1 attempt in NEAR as 1 laryngoscope insertion, as opposed to a single laryngoscope insertion associated with a single endotracheal tube insertion definition.[23] Therefore, multiple attempts at endotracheal tube placement may

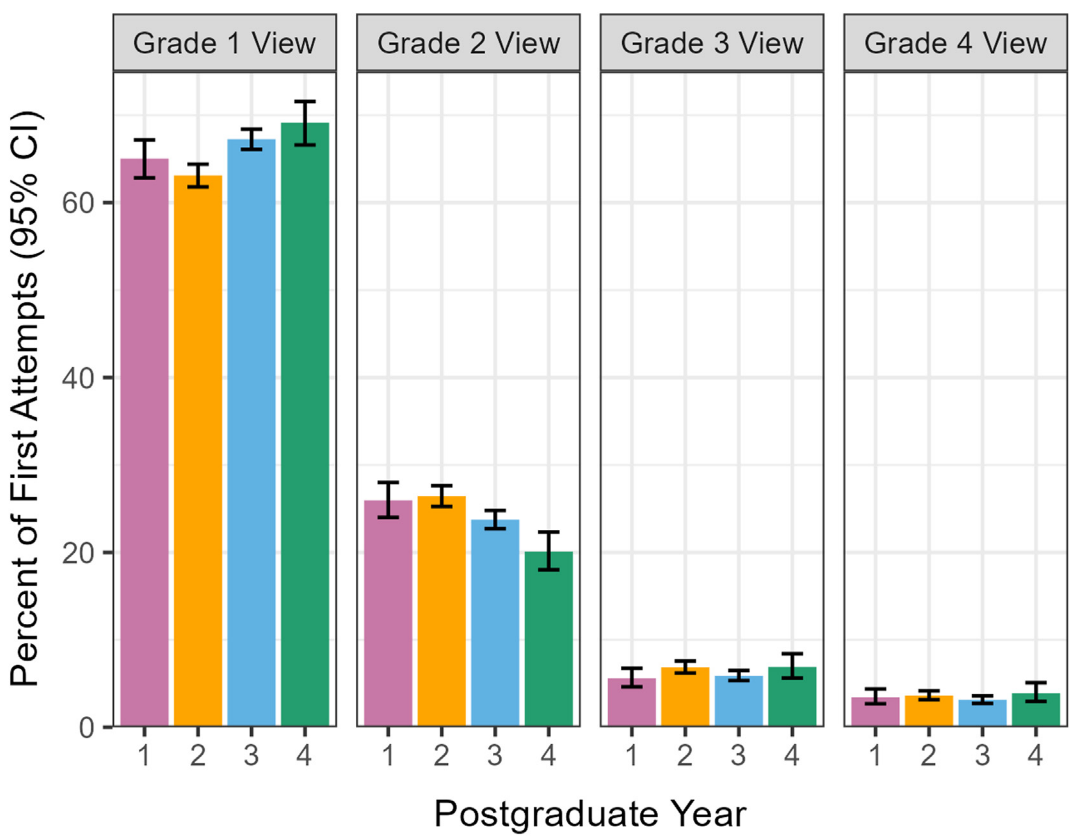

Figure 2. The percentage of first attempts by PGY and Cormack–Lehane view.

Table 3. Adjusted odds ratios for a higher (worse) Cormack–Lehane grade by PGY from complete cases.

Variable	aOR (95% CI)*
Postgraduate Year	
PGY 1	Reference
PGY 2	1.01 (0.49-2.07)
PGY 3	0.92 (0.31-2.73)
PGY 4	0.80 (0.31-2.04)
AIC	108,564
Observations	14,907

AIC, Akaike information criterion; *aOR*, adjusted odds ratio.
*Confounding variables were balanced using inverse probability weighting, and CIs were calculated from standard errors clustered at the site level. Confounding variables included patient age, sex, body habitus, number of anatomical difficult airway characteristics, emergency intubation (no time for preoxygenation), supine vs. nonsupine position, paralytic choice, laryngoscope, trauma indication, and CPR during intubation.

have occurred during the first laryngoscope insertion and could explain differences in first-attempt success between PGYs. Additionally, we grouped PGYs into the same levels; however, the acquisition of airway skills may vary between programs and across rotation schedules. Therefore, progression from PGY 1 to PGY 2 in program A versus B may not equate to the same progression of intubation skills. Nevertheless, we reported CIs from cluster robust standard errors at the site level, accounting for between-site variation.[24,25] Furthermore, intubation skills accrue with experience, not necessarily time, and the registry does not track individual clinicians, which would have allowed us to assess intubation experience at the clinician level.[26] In addition, we did not study potential mediators using mediation analysis methods to explain the association between PGY and Cormack–Lehane view or first-attempt success. Our outcomes, namely, Cormack–Lehane view and first-attempt success, inform the acquisition of intubation skills related to anatomical challenges.[27] However, we did not examine outcomes that inform intubation performance related to physiological challenges, such as peri-intubation cardiac arrest or hemodynamic collapse.[27,28] We combined Cormack–Lehane grades 3 and 4 for our effect modification analyses due to the small number of grade 4 views in our sample (Table 2, Table E2). Finally, we had broad inclusion criteria and did not examine all possible subgroups of patients (eg, trauma patients), and we did not examine cases using

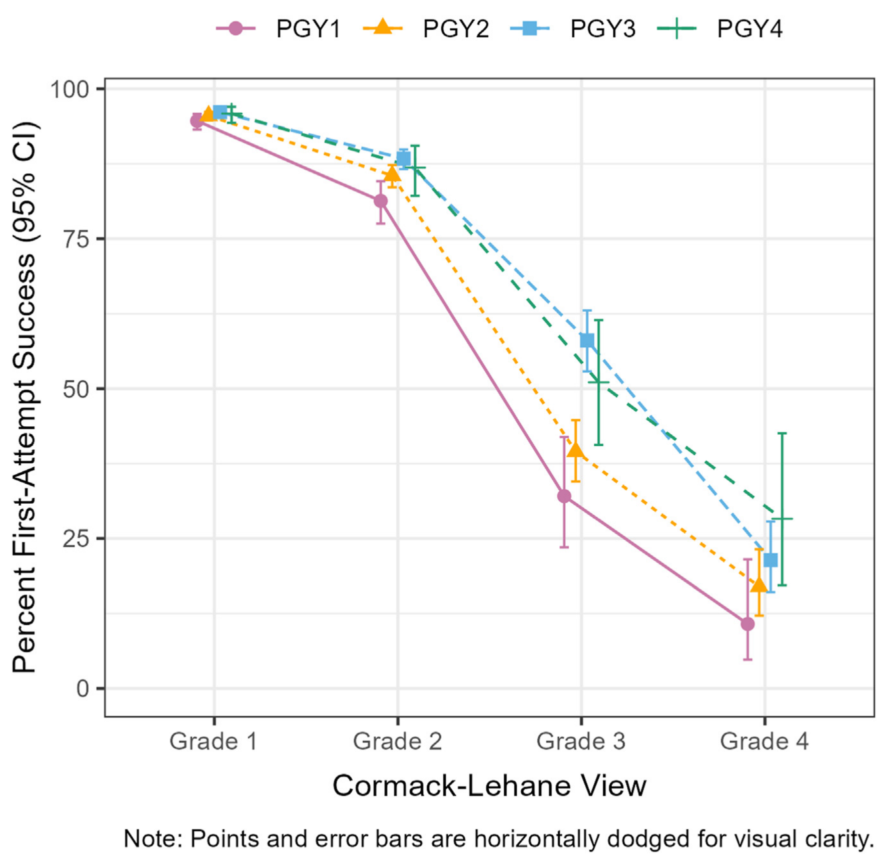

Figure 3. The percent first-attempt success by Cormack–Lehane view and PGY.

alternative routes (eg, front of neck, nasal) or devices (eg, bronchoscopy-assisted intubation, channeled blades). Although we did not observe a difference between PGYs on the outcome of Cormack–Lehane view (Table 3, Tables E5 to E7), a difference may still exist within certain patient subgroups not examined. These results should not discredit the value of clinical experience; rather, they should help inform the direction of training interventions.

DISCUSSION

In this sample of ED intubations performed by EM residents, PGY was not associated with Cormack–Lehane view. However, compared to PGY 1, PGY 2, 3, and 4 residents had greater first-attempt success when a grade 3 or 4 view was obtained and the interaction between PGY and Cormack–Lehane view on first-attempt success was significant. However, given the infrequency of grade 3 to 4 views (Table 2) and the strong association between Cormack–Lehane view and first-attempt success (Table E8), the interaction between PGY and Cormack–Lehane view only explains a small amount of the variation in first-attempt success with a relative reduction in root mean square error of 4.50% (Table E8). Nevertheless, these results provide insight into the acquisition of intubation skills during EM residency, suggesting that endotracheal tube placement skills are acquired later in residency than laryngoscopy skills.

Our results are similar to other works examining resident intubation performance. Cumulative intubation experience and PGY have both been associated with first-attempt success among EM postgraduate trainees.[3,4,29] However, investigations into Cormack–Lehane view by PGY are scarce. A study of 191 ICU intubations by PGY 1 to 3 residents (only 5.8% of intubations from EM residents) observed that PGY was inversely associated with multiple attempts but not with Cormack–Lehane views.[30] Notably, 93.2% of first attempts in this study used direct laryngoscopy.[30] This context suggests that our observation of similar Cormack–Lehane views across PGYs may not be explained by the high utilization of video laryngoscopy in the study population, 68.4% of first attempts (Table 1), which is corroborated by our sensitivity analysis among first attempts with direct laryngoscopy (Table E7). In contrast, first-attempt success was the same (85%) for both anesthesia PGY 2 and 3 residents (no PGY 1 residents were included in the sample), suggesting that anesthesia residency training may saturate the learning curve as measured by first-attempt success earlier during their residency training compared to other specialties.[30] Nevertheless, our results suggest that EM residents acquire their laryngoscopy skills early in training (ie, PGY 1) and their endotracheal tube placement skills later in training (ie, PGY 2 to 4). Our study cannot explain why this difference in timing exists, but we conjecture that it may be due to the infrequency of Cormack–Lehane grade 3 or 4 views (9.4% of included first attempts), limiting opportunities to intubate with a poor glottic view (Table 2). Therefore, each intubation performed by an EM resident may not contribute equally to the acquisition of each component of intubation skills, and troubleshooting difficult airways should be a training priority.

However, skill acquisition for emergency endotracheal intubation is complex and multifaceted. Breaking down intubation steps into laryngoscopy and endotracheal tube placement is crude and not representative of the complex decisions made by intubating clinicians before, during, and after emergency intubations as well as the physical microskills necessary for success.[31] Future research should explore additional sources of skill acquisition data, including automated collection of time varying physiologic data from both the patient and clinician, motion-based analysis of the clinician, and measures of cognitive load and critical decisionmaking.[31] Acquisition of intubation skills among EM residents may be facilitated by more targeted training guided by knowledge of deficiencies across the steps of the intubation procedure.

In conclusion, in this study population, compared to EM PGY 1, PGY 2, 3, and 4 trainees obtained similar Cormack–Lehane views but had higher first-attempt success when a grade 3 or 4 view was obtained. Understanding the relationship between improved first-attempt success with higher (worse) Cormack–Lehane grades over time represents an opportunity to better focus intubation educational efforts as residents advance through training.

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