

# Improving pediatric resident laryngoscopy training through the use of a video laryngoscope

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## ABSTRACT

**Importance:** Opportunities for pediatric residents to perform direct laryngoscopy and tracheal intubation (DLTI) are few and the success rate is low.

**Objective:** We hypothesize that incorporation of video laryngoscope (McGrath MAC) into pediatric residents DLTI simulation course will improve the simulated DLTI success rate.

**Methods:** Residents were given 3 attempts at DLTI: (1) baseline using a conventional laryngoscope (CL); (2) using a video laryngoscope (VL); and (3) again using the CL. Residents were given up to 120 seconds to complete each DLTI attempt. Time to successful DLTI was collected. Residents recorded their best view (larynx, epiglottis, vocal cords) with each DLTI attempt.

**Results:** Prior to the intervention, 15/17 (88.2%) and 16/17 (94.1%) of the participants reported prior exposure to DLTI as “less than 10 total attempts” in simulated and live patients respectively. Seventeen pediatric residents performed 51 DLTI attempts (34 with a CL and 17 with the VL). Success rates for DLTI are as follows: Baseline with CL 11/17 (64.7%), VL 12/17 (70.6%), and last attempt with CL 13/17 (76.5%) ( $P = 0.15$ ). Compared to the baseline, the use of VL resulted in a shorter but non-significant decrease in time to successful DLTI (Mean 34.2 sec [SD, 22.0] vs. 56.5 sec [SD, 40.2];  $P = 0.08$ ). Repeat attempts at DLTI with the CL, however, were significantly shorter than baseline (Mean 20.3 sec [SD, 12.8] vs. 56.5 sec [SD, 40.2];  $P = 0.003$ ). Using the VL, more residents could visualize the vocal cords compared to the baseline (14/17 [82.3%] vs. 9/17 [52.9%];  $P = 0.03$ ).

**Interpretation:** Repeated training is certainly a way to improve successful DLTI. Use of VL as a new teaching method led to greater visualization of the vocal cords, shortening operating time and raising self-confidence.

## KEYWORDS

Critical Care, Medical Education, Pulmonology, Video laryngoscope

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## INTRODUCTION

Tracheal intubation (TI) is one of the most important life-saving procedures to maintain an effective airway, oxygenation and ventilation. However; if performed incorrectly, there is a potential risk of complications such as unrecognized esophageal intubation, trauma to teeth, lips and vocal cords, and exacerbation of cervical spine injuries,<sup>1</sup> particularly in novice residents.

Although, intubation training for pediatric residents has been done during the current Pediatric Advanced Life Support (PALS) course, only 22% of pediatric residents in a tertiary PICU center<sup>2</sup> were the primary operators of orotracheal intubation, with only 40% for a first- attempt success rate. This opportunity in community hospitals is also much less frequent. In addition, recently the Accreditation Council for Graduate Medical Education (ACGME) standards<sup>3</sup> implemented restricted working hours which may decrease intubation experience. Therefore, simulation training should be considered another effective reliable tool,<sup>4</sup> not only for improving learning skills but also repeating practice in a safe learning environment.<sup>5</sup>

Considering the results found by Overly et al<sup>6</sup> regarding simulation, the success rate of intubation was only 56% for pediatric residents with direct laryngoscopy and tracheal intubation (DLTI) techniques. Another approach to increasing the success rate, in adults, incorporating videolaryngoscope as a primary intubation device has shown improved acquisition of these skills for novices.<sup>7-9</sup> Based on that knowledge, we hypothesized that by using the McGrath videolaryngoscope (Aircraft Medical, Edinburgh, United Kingdom) into our simulation would improve both self-confidence and competency for intubation in a community setting.

## METHODS

This prospective observational cross-sectional study was conducted at the Unterberg Children’s Hospital at Monmouth medical center and approved by the institutional review board. During the study period, all pediatric residents (PGY1 to 3) were recruited. We excluded any participant with previous exposure to the McGrath videolaryngoscope. All airway training occurred in a simulation room.

Residents received 20 minutes of instruction in DLTI, consisted of the orientation, a 10-minute video on orotracheal intubation from the *New England Journal of Medicine*<sup>1</sup> and demonstration of McGrath videolaryngoscope. Then, residents were allowed 3 attempts at DLTI: (1) baseline using a conventional laryngoscope (CL); (2) using a video laryngoscope (VL); and (3) again using the CL.

The equipment for the training consisted of a manikin with an adult-sized airway, orotracheal tube No. 6.5 with stylet, standard Macintosh blade No. 2 for DLTI and McGrath

videolaryngoscope.

Demographic data were collected on each participant, including their year of residency training, previous attempts at DLTI in both live patients and manikins. Self-confidence levels were scored by using a Likert scale from one to ten before and after each attempt. Performance data were also recorded such as time to orotracheal tube placement, best view during baseline/repeated DLTI and McGrath videolaryngoscopy.

Successful orotracheal tube placement was defined by directly observed passing the orotracheal tube into the trachea of manikin within 120 seconds.<sup>10</sup> Time to intubation began with the insertion of the either direct laryngoscopy or video laryngoscopy and ended with successful ET-tube placement.

Debriefing after the completing session was provided for all participants.

Quantitative data were presented as mean (SD) or median (IQR) and number (percentage or interquartile range). A parametric test (t-test) or nonparametric test (Wilcoxon signed-rank test) for repeated measures was therefore to help analyze the data. Categorical dichotomous variables were compared using McNemar. Statistical significance was denoted by *P*-value less than 0.05. Statistical analyses were performed using SPSS version 17.0 (SPSS, Chicago, IL).

## RESULTS

During this study period, 17 subjects were enrolled in the study (7 PGY-1, 6 PGY-2 and 4 PGY-3) and no data were excluded from analysis. Prior to the intervention, 15/17 (88.2%) and 16/17 (94.1%) participants reported prior exposure to DLTI as “less than 10 total attempts” in simulated and live patients respectively regardless of training level. Pediatric resident demographics are shown in Table 1.

**TABLE 1** Pediatric resident demographics

Factors	Baseline CL, N(%)
Sex	
Male	4 (23.5)
Female	13 (76.5)
Training level	
PL-1	7 (41.2)
PL-2	6 (35.3)
PL-3	4 (23.5)
Previous intubation	
Real patients	
<10	16 (94.1)
11–50	1 (5.9)
>50	0
Manikins	
<10	15 (88.2)
11–50	2 (11.8)
>50	0

CL, conventional laryngoscope

A total of 51 DLTI attempts were performed (34 with a CL and 17 with the VL). Success rates for DLTI are as follows: baseline with CL 11/17 (64.7%), VL 12/17 (70.6%), and a last attempt with CL 13/17 (76.5%) ( $P = 0.15$ ). Compared to baseline, the use of VL resulted in a shorter but non-significant decrease in time to successful DLTI (Mean 34.2 sec [SD, 22.0] vs. 56.5 sec [SD, 40.2];  $P = 0.08$ ). Using the VL, more residents could visualize the vocal cords compared to baseline (14/17 [82.3%] vs. 9/17 [52.9%];  $P = 0.03$ ). Performance and self-confidence between baseline CL and VL are shown in Table 2.

**TABLE 2** Performance between baseline conventional laryngoscopy (CL) and video laryngoscopy (VL)

Variables	Baseline CL	Videolaryngoscopy	<i>P</i>
Success rate (%)	11/17 (64.7)	12/17 (70.6)	0.15
Time to intubation (secs) mean±SD	56.5±40.2	34.2±22.0	0.08
Vocal cord view (%)	9/17 (52.9)	14/17 (82.3)	0.03

After VL as an intervention, repeat attempts at DLTI with the CL were significantly shorter than the baseline (Mean 20.3 sec [SD, 12.8] vs. 56.5 sec [SD, 40.2];  $P = 0.003$ ). The success rate, however, non-significantly increased (64.7% vs 70.6%;  $P = 0.15$ ). The median confidence scores increased significantly (6 [4,6] vs 7 [4.5,8];  $P = 0.007$ ). Performance and self-confidence between baseline CL and VL are shown in Table 3.

**TABLE 3** Performance and self-confidence between baseline and last attempt conventional laryngoscopy (CL)

Variables	Baseline CL	Last attempt CL	<i>P</i>
Success rate (%)	11/17 (64.7)	13/17 (76.5)	0.15
Time to intubation (secs) mean±SD	56.5±40.2	20.3±12.8	0.003
Confidence level Median (IQR 25, 75)	6 (4, 6)	7 (4.5, 8)	0.007

## DISCUSSION

The use of McGrath videolaryngoscope in our simulation given to pediatric residents resulted in shortening the time to place intubation and increasing the self-confidence significantly. However, the success rate did not change significantly.

Not surprisingly, the first attempt success rate in our participants was only 64.7%. Because most of them have limited experience in intubation. Our findings support those of previous studies that show novices would have low success rates if they performed direct laryngoscope intubation less than approximately 50 times.<sup>11</sup> Furthermore, a survey study of PGY-1 and PGY-2

pediatric residents has demonstrated a very low frequency of self-reported experience with orotracheal intubation.<sup>12</sup> This number can be more challenging in the community setting of three-year pediatric training.

By incorporating the McGrath videolaryngoscope, we found no difference in the success rate for novices, in contrast to the study of Ray et al.<sup>13</sup> It is possible that the residents were not familiar with McGrath which needs at least 3 attempts in training to achieve a success rate of more than 90% consistently.<sup>13</sup> In addition, our study has shown a better visualization of vocal cords as opposed to a better success rate. It might be due to the loss of three-dimensional visual depth on the screen and the fulcrum effect of the stylet that may have influenced psychomotor skills acquisition.<sup>14</sup>

Time to place orotracheal tube was progressively shortened followed by McGrath and repeated DLTI group respectively. It may imply that McGrath can help shorten the learning period of orotracheal intubation. However, the clinical relevance is currently unknown.

In terms of self-confidence, we found that residents had low self-confidence to perform intubation but significantly improved following our training session, similar to previous reports.<sup>15,16</sup> One explanation for this finding might be that during the training, residents dramatically improved better their basic cognitive understanding of the procedure. However, several studies have shown that self-confidence correlates poorly with actual skills abilities.<sup>15,17</sup> This finding further supports that self-confidence alone, should not be used for a trainee's readiness to perform a procedure. However, increasing self-confidence facilitates improvement of clinical performance.

There are possible advantages of using VL during simulation. Firstly, visualization of airway structures is more enlarged by using VL, compared to DL. The views of the airway structures can be obscured during attempts of DLTI. Therefore, sometimes endotracheal tube might slip into esophagus instead. Secondly, instructor can guide novices during procedure as we observe simultaneously the image on the video monitor. With the video image projected from the distal end of the laryngoscope blade, both instructor and learner can see the tip of endotracheal tube pass through the vocal cords without blocking the view by endotracheal tube.

This study has the advantage of providing a feasible didactic session with hands-on experience that can be practically conducted in the community hospitals. We have only one rater which minimizes inter-rater variability.

The limitation of this study is that we did not evaluate tracheal intubation-associated events that can occur such as esophageal intubation, bronchial intubation, hypotension or cardiac arrest. We had no difficult airway

situations.

For our resident population, who may be called upon to perform DLTI in a clinical setting, the simulated success rate is only ~70%. Repeated training is certainly a way to improve time to successful DLTI. Use of VL as a new teaching method led to greater visualization of the vocal cords, shortening operating time and raising self-confidence but in our study did not result in a greater DLTI success rate (less than 120 seconds as a success rate). In future studies using VL, we plan to examine why successful vocal cord visualization did not result in successful DLTI.

## CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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