Does Video Laryngoscopy or Direct Laryngoscopy affect first pass success rates for intubation among Attending and Non-Attending Emergency Physician in the Emergency Department?

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Abstract

Background: To our knowledge, there has been no study comparing intubation characteristics between attending and non-attending Emergency Physicians in South-East Asia. We aim to identify whether the use of Direct Laryngoscopy (DL) compared to Video Laryngoscopy (VL) affects first pass success rates between Attending Emergency Physicians (AEP) and Non-Attending Emergency Physicians (NAEP).

Materials and Methods: Retrospective analysis of data from 2009 to 2016 in an existing airway registry managed by and academic Emergency Department in Singapore. Primary outcome is first pass success intubation rate. The secondary outcome was first pass success rate for difficult intubations. Difficult intubations were defined as LEMON score of more than 1 or more than 1 attempt at intubation.

Results: There were 2909 intubation carried out by emergency physicians in the Emergency Department from 2009 to 2016. AEP conducted 1748 intubations while NAEP conducted 1161 intubations. The first pass success rates for AEP was 84.2% while that for NAEP was 67.4%. 86.2% of intubations by AEP were done with a direct laryngoscope. 89.0% of the intubations by NAEP were done with a direct laryngoscope. 18.9% of intubations by the AEP were difficult compared to 35.2% by the NAEP (p<0.01 95% C.I 13.0%-19.6%). First pass success rate with VL was lower than DL for all intubations (OR 0.66, 95% C.I 0.51-0.84). In the subgroup of difficult intubations, VL did not improve first pass success rate among AEP (OR 0.77, 95% C.I 0.38-1.58) but it did for NAEP (OR 2.46, 95% C.I 0.94-6.45).

Conclusion: Our study showed that VL has a poorer first pass success rate for all intubations in general. However, specifically for difficult intubations, VL is associated with improved first pass success rates among NAEP.
Introduction

First pass success in emergency intubations has been associated with fewer adverse events\(^1\) than if more than a single attempt is needed at intubation. Level of experience and choice of Video Laryngoscopy (VL) or Direct Laryngoscopy (DL) have been reported to be features associated with first pass success in intubations\(^2,3,4\). In South-East Asia, there have been no studies examining the relationship between these two factors and how they relate to first pass success in intubation. We aim to identify whether the use of VL compared to DL affects first pass success rates for regular or difficult endotracheal intubations when performed by Attending Emergency Physicians (AEP) and Non-Attending Emergency Physicians (NAEP).

Materials And Methods

This was a single-center retrospective observational study. Data was obtained from the Airway Registry of an academic Emergency Department (ED) at the Singapore General Hospital (SGH), Singapore, between 2009 and 2016. All intubations conducted in the ED during this period were documented on a standardized hardcopy form. The entries were then transcribed into an electronic Airway Registry. Approval from the Institution Review Board was obtained for data collection into the Airway Registry. For this study, only intubations done by Emergency Physicians were analysed. Intubations performed in the ED by other operators, e.g. Anaesthetists, were excluded.

Attending Emergency Physicians (AEP) are senior physicians who have completed Residency training and are board certified in Emergency Medicine by the Specialist Accreditation Board of the Ministry of Health, Singapore. Non-attending Emergency Physicians (NAEP) are physicians who are not – these include Emergency Medicine Residents, and Medical Officers who are not in a Residency Programme. All intubations by NAEP were supervised by AEP.

The VLs used during this period were the GlideScope® (Verathon Medical Inc., Bothell, USA), C-MAC (Karl Storz GmbH & Co. KG, Tuttingen, Germany) and McGrath (Aircraft Medical, UK). DL was carried out with the Macintosh Curved or Miller Straight Blade (Welch Allyn, NY).

The primary outcome was rate of successful first pass intubation. A single pass was defined as an attempt to pass the endotracheal tube (ETT) through the vocal cords. A pass will usually be followed by airway maneuvers e.g. bagging or suctioning.
The LEMON (Look externally, Evaluate 3-3-2, Mallampati, Obstruction, Neck Mobility) criteria is a commonly used tool to assess a difficult airway. The presence of any of these features in the criteria will be given a score of 1. A difficult intubation is defined as a LEMON score of more than 1 or the number of attempts required for a successful intubation being more than 1.

Secondary outcomes were the first pass intubation success rate for difficult intubations. Statistical calculations were performed using SPSS 26.0 for Windows (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). Continuous and ordinal variables were presented as means and categorical variables as frequencies. Categorical variables were analysed using Chi-Squared Test for differences between groups. The t-test was used to identify differences between groups for continuous variables. Statistical significance was considered if *p*<0.05. Odds Ratios (OR) and 95% confidence intervals (95% CI) were presented where applicable.

Results

Patient Characteristics

There were 2950 intubations carried out at the ED, SGH from 2009 to 2016. Of these, 2909 (98.6%) were conducted by Emergency Physicians with 1748 (59.3%) intubations by AEPs and 1161 (39.3%) by NAEPs (Table 1). Those patients intubated by NAEPs were slightly older than those intubated by AEPs (63.5 versus 60.7 years, *p*<0.01). Gender distribution between the groups was similar. AEPs performed more trauma intubations than NAEPs (13.6% versus 8.5%). NAEPs encountered more difficult intubations than did AEPs (35.2% versus 18.9%).

All Intubations

AEPs had a higher overall first pass success rate than NAEPs (84.2% versus 67.4%, *p*<0.01). The mean number of attempts was 1.24 and 1.46 for AEPs and NAEPs, respectively.

The first pass success rate for all intubations was lower for VL (70.6%) than for DL (78.5%) (*p* = 0.0008, OR 0.66, 95% CI 0.51-0.84). However, for the subgroup of difficult intubations, there was a slightly higher, though not statistically significant, success rate for VL (13.8%) versus DL (10.6%) for all practitioners (*p* = 0.3081, OR 1.34, 95% CI 0.76-2.39).

AEPs were also more likely to use video laryngoscopy than NAEPs (*p* = 0.0139). Among AEPs, VL had a lower first pass success rate when compared to use of DL (70.6% versus
86.3%, p = 0.0001, OR 0.38, 95% CI 0.28 - 0.52). Among NAEP (Table 2), there was no difference in first pass success rates whether VL (70.5%) or DL (67.1%) was used (p = 0.4481, OR 1.17, 95% CI 0.78 - 1.77).

**Difficult Intubations**

Altogether, there were 739 difficult intubations. Of these 330 were encountered by AEPs and 409 by NAEPs.

For all patients with a LEMON score of \( \leq 1 \), first pass success rate was 85.6% by AEPs and 69.0% by NAEPs (p < 0.0001, OR 2.68, 95% CI 2.22 - 3.23).

Patients with a LEMON score of >1 were encountered by 5.3% of AEPs and 6.1% of NAEPs (p = 0.32). For all patients with a LEMON score > 1, the first pass success rate was 58.7% when intubated by AEPs and 42.2% when intubated by NAEPs (p = 0.04, OR 1.94, 95% CI 1.04 - 3.64).

However, with difficult intubations, though VL appeared to have a higher first pass success rate (13.8%) compared to DL (10.6%), this difference did not reach statistical significance (p = 0.3081, OR 1.34, 95% CI 0.76-2.39). First pass success rates did not differ for VL-assisted difficult intubations by AEPs and NAEPs (13.6% vs 14.2%, p = 0.9144, OR 0.94, 95% CI 0.32 - 2.76). For difficult intubations done with DL, AEPs had a higher first pass success rate (16.9%) than NAEPs (6.3%) (p = 0.0001, OR 3.01, 95% CI 1.76 - 5.16).

**Video Laryngoscopy**

The GlideScope had the highest first pass success rate among all VL (OR 2.85, 95% CI 0.39-20.7), followed by C-MAC (OR 1.79 95% CI 0.24-13.14) and lastly McGrath. For each variant of VL used, there was no statistically significant difference in the first pass success rates between AEP and NAEP (Table 3). This finding was also consistent regardless of whether it was a difficult intubation.

**Discussion**

The observed finding of VL having lower overall first pass success rate compared to DL (p = 0.0008, OR 0.66 95% CI 0.51-0.84) is dissimilar to existing literature. Existing publications \(^6,7,8,9,10\) report no statistically significant difference in first pass success rates between VL and DL. The greater familiarity with DL likely accounted for the higher rates of DL use in our study and the lower rates of first pass success with VL.

For difficult intubations, VL was associated with marginally better overall first pass success rates (p = 0.3081, OR 1.34, 95% CI 0.76-2.39). With VL, the GlideScope had the highest first pass success rate compared to the other two VL. The presence of a video
camera at the distal end of the VL allows for visualization of the vocal cords without alignment of the various intubation axes. Specifically, the rigid stylet for the GlideScope Video Laryngoscope allows for smooth insertion\textsuperscript{11,12} of the ETT along the hyperacute angle of the laryngoscope blade. These features likely helped improve first pass success rates in difficult intubations \textsuperscript{7,11,12,13}, especially where small mouth opening, and limited neck mobility posed a challenge. The C-Mac allows the user to perform intubation as per DL or via its attached video camera with an external monitor. The McGrath has a monitor attached to the laryngoscopy blade, allowing the user to maintain line of sight of the patient and hand positions while intubating. Despite the various traits of each device, our study did not show statistically significant improved first pass intubation rates when these devices were used by AEPS than by supervised NAEPs (Table 3). Moreover, these results are further augmented in the subgroup of difficult intubations among the NAEP\textsuperscript{7,11,12,13}. An improved glottic view and ease in anatomy identification are reported mechanisms resulting in success with VL among NAEP for difficult intubations. In addition, the ability to visualize the NAEP’s field of view with VL also allows the supervising AEP to provide timely and appropriate advice during the intubation. Therefore, video laryngoscope-assisted intubations are useful for training relative novices in endotracheal intubations skills, especially during difficult intubations by these groups of healthcare workers\textsuperscript{14,15}.

Our study clearly demonstrated that persons performing endotracheal intubations performed better with devices they were familiar with, such as with direct laryngoscopy. Therefore, trained AEPS did better, as would be expected, than NAEPs with DL and also used DL more effectively than VL. However, when encountering difficult airways the large differences in first-pass successful intubation rates between DL and VL were greatly reduced. These attest to the need for training with use of VL and to the use of VL as a secondary adjunct for gaining airway access during difficult intubations. First pass success during Emergency Intubations are associated with fewer adverse effects and better patient outcomes\textsuperscript{14,15}. Therein lies the importance to balance operator level of training and device choice so that an optimal first pass success rate is achieved. If novice operators are not provided with the opportunity to conduct Emergency Intubations, this may eventually affect their first pass success rates as future airway managers.

Limitations
This was a single-center study with data derived from an Airway Registry. Cases were entered into the Airway Registry by manually transcribing into the electronic database from a hard copy form. This allows for errors in transcription. In addition, since the forms were completed by the operators after completion of the resuscitation which included the intubation, recall bias may contribute to inaccurately recorded data. This may thus affect the generalizability of the results. Of note, our results specifically for the difficult intubation subgroup are consistent with that of existing literature.

Our definition of a difficult intubation did not use a single standardized definition such as the Intubation Difficulty Score (IDS)\textsuperscript{16}. In addition to the LEMON score, we included all first pass intubation failures. The greater unfamiliarity of NAEPs with endotracheal intubation likely contributed to the higher proportion of difficult intubations in this group and the larger overall number of such intubations. The LEMON score, by itself, has been shown to correlate well with difficulty of intubation\textsuperscript{17,18}.

Conclusions

Our study shows that VL has a poorer first pass success rate for all intubations in general. However, specifically for difficult intubations, VL is associated with improved first pass success rates especially when used by supervised NAEPs. Between AEPs and NAEPs, while DL use was easier with trained AEPs, whether for standard or difficult airways, there was no statistically significant difference in first pass intubation rates with VL use.

Declarations

\textit{Ethics Approval and Consent to Participate}

Approval from the Singhealth Institution Review Board was obtained for data collection into the Airway Registry used for this study.

\textit{Consent for Publication}

Not Applicable

\textit{Availability of Data and Materials}

The dataset analysed in this current study may be made available on reasonable request. Please contact WPW.

\textit{Competing Interests}

There are no competing interests to declare.

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Not applicable

\textit{Authors’ Contributions}
WPW, NDZ, EW developed the study and supervised its data collection. SGC assisted with data collection and entry. WPW analysed the data. WPW drafted the manuscript. NDZ and EW provided advice the manuscript and contributed as corresponding authors. WPW take responsibility for the paper.

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Tables

Table 1: Baseline Characteristics
|                               | Attending (1748) | Non-attending (1161) | p Value |
|-------------------------------|------------------|----------------------|---------|
| **Gender**                    |                  |                      |         |
| Female                        | 560 (32.0%)      | 384 (33.1%)          | 0.56    |
| Male                          | 1188 (68.0%)     | 777 (66.9%)          |         |
| Mean age (years)              | 60.7 (0.1-100.0) | 63.5 (7.0-110.0)     | <0.01   |
| **Medical/trauma**            |                  |                      |         |
| Medical                       | 1509 (86.4%)     | 1062 (91.5%)         | <0.01   |
| Trauma                        | 237 (13.6%)      | 99 (8.5%)            |         |
| **Device used**               |                  |                      |         |
| Direct laryngoscope           |                  |                      |         |
| Macintosh                     | 1506             | 1033                 | 0.01    |
| Miller                        | 1486 (98.7%)     | 1028 (99.5%)         |         |
| Miller                        | 20 (1.3%)        | 5 (0.5%)             |         |
| Video laryngoscope            |                  |                      |         |
| GlideScope                    | 238              | 122                  |         |
| McGrath                       | 162 (68.1%)      | 77 (63.1%)           |         |
| C-mac                         | 4 (1.7%)         | 0 (0.0%)             |         |
| Others**                      | 72 (30.2%)       | 45 (36.9%)           |         |
| Others**                      | 4 (0.2%)         | 6 (0.5%)             |         |
| **Crash intubation**          |                  |                      | 0.06    |
|                               | 804 (46.0%)      | 493 (42.5%)          |         |
| **RSI with medications**      |                  |                      | 0.06    |
|                               | 944 (54.0%)      | 668 (57.5%)          |         |
| **Difficult intubation**      |                  |                      |         |
| Yes                           |                  |                      | <0.01   |
| LEMON> 1                      | 330 (18.9%)      | 409 (35.2%)          |         |
| >1 attempt at intubation      | 54 (16.4%)       | 30 (7.3%)            |         |
| LEMON > 1 AND >1 attempt at intubation | 238 (72.1%) | 338 (82.6%)          |         |
| No                            | 1418 (81.1%)     | 752 (64.8%)          |         |
| **First pass success rate (%)** | 84.2% (1472/1748) | 67.4% (782/1161) | <0.01   |
| **Mean number of attempts**   | 1.24(1.21-1.27)  | 1.46(1.41-1.50)      | <0.01   |

*2 cases were not included as the data was unavailable ** Data was not available on the specific device used, not included in analysis in VL, DL groups.
|                                    | First Pass Success | >1 Attempt Success | P value | First Pass Success Odds Ratio | 95% C. I       |
|------------------------------------|--------------------|--------------------|---------|------------------------------|----------------|
| **All Intubations**                |                    |                    |         |                              |                |
| VL                                | 254                | 106                | 0.0008  | 0.66                         | 0.51-0.84      |
| DL                                | 1993               | 546                |         |                              |                |
| **All Difficult Intubations**      |                    |                    |         |                              |                |
| VL                                | 17                 | 106                | 0.3081  | 1.34                         | 0.76-2.39      |
| DL                                | 65                 | 546                |         |                              |                |
| **All Intubations by AEPs**        |                    |                    |         |                              |                |
| VL                                | 168                | 70                 | < 0.0001| 0.38                         | 0.28-0.52      |
| DL                                | 1300               | 206                |         |                              |                |
| **Difficult Intubations by AEPs**  |                    |                    |         |                              |                |
| VL                                | 11                 | 70                 | 0.4766  | 0.77                         | 0.38-1.58      |
| DL                                | 42                 | 206                |         |                              |                |
| **All Intubations by NAEP**        |                    |                    |         |                              |                |
| VL                                | 86                 | 36                 | 0.4481  | 1.17                         | 0.78-1.77      |
| DL                                | 693                | 340                |         |                              |                |
| **Difficult Intubations by NAEP**  |                    |                    |         |                              |                |
| VL                                | 6                  | 36                 | 0.0662  | 2.46                         | 0.94-6.45      |
| DL                                | 23                 | 340                |         |                              |                |
Table 3: First Pass Success Rate for various VL

| All VL                     | First Pass Success | >1 Attempt Success | First Pass Success Odds Ratio | 95% C. I       |
|----------------------------|--------------------|--------------------|-------------------------------|---------------|
| McGrath                   | 2                  | 2                  | Reference                      |               |
| C-MAC                     | 75                 | 42                 | 1.79                          | 0.24-13.14    |
| GlideScope                | 177                | 62                 | 2.85                          | 0.39-20.7     |
| GlideScope and Difficult Intubation |            |                    |                               |               |
| AEP                       | 119                | 43                 | 0.91                          | 0.49-1.69     |
| NAEP                      | 58                 | 19                 |                               |               |
| C-MAC                     | 47                 | 25                 | 1.14                          | 0.53-2.47     |
| NAEP                      | 28                 | 17                 |                               |               |
| C-MAC and Difficult Intubation |          |                    |                               |               |
| AEP                       | 2                  | 25                 | 0.45                          | 0.07-3.01     |
| NAEP                      | 3                  | 17                 |                               |               |