Emergency. 2018; 6 (1): e58

OPEN ACCESS

ORIGINAL RESEARCH

Evaluation of Airway Management Proficiency in Pre-Hospital Emergency Setting; a Simulation Study

Shahrzad Ghiyasvandian[1], Afshin Khazaei[2*], Masoumeh Zakerimoghadam[3], Rasoul Salimi[4], Ali Afshari[5], Abbas Mogimbeigi[6]

1. Department of Medical Surgical Nursing, School of Nursing and Midwifery, Tehran University of Medical Sciences, Tehran, Iran.

2. Intensive Care and Management Nursing Department, School of Nursing and Midwifery, Tehran University of Medical Sciences, Tehran, Iran.

3. Intensive Care and Management Nursing Department, School of Nursing and Midwifery, Tehran University of Medical Sciences, Tehran, Iran.

4. Emergency Department, Besat Hospital, Hamadan University of Medical Sciences, Hamadan, Iran.

5. Intensive Care and Management Nursing Department. School of Nursing and Midwifery, Hamadan University of Medical Sciences, Hamadan, Iran.

6. Department of Biostatistics and Epidemiology, School of Public Health, Hamadan University of Medical Sciences, Hamadan, Iran.

Received: July 2018; Accepted: September 2018; Published online: 2 October 2018

Abstract: **Introduction:** Infrequency and low exposure to critically ill patients requiring airway management will lead to reduction in the skills and performance of the Emergency Medical Technicians (EMTs) over time. The present study was conducted primarily aiming to evaluate airway management in stationary ambulance simulations and identify the factors affecting Endotracheal Intubation (ETI) success rate. **Methods:** This is a simulation study. The study population comprised of active EMTs in prehospital emergency bases in Hamadan province. The participants were placed at the back of an ambulance to perform the airway management scenario, which had already been prepared. To investigate the factors affecting the success (≤3 attempts) or failure rate of intubation, both unadjusted and adjusted odds ratios (95% confidence intervals) for univariate and multivariate regressions were reported. **Results:** 184 subjects with the mean age of 33.91+6.25 years and the median work experience of 8 years were studied (54.3% with a history of training in the past year). The median number of previous intubations performed by technicians in the last year was 7 times (IQR 4-9). The total success rate at ventilation, intubation and back-up airway were 50.67%, 53.29%, and 50.0%, respectively. Out of the total 552 attempts for ETI placement, 58.2% of the technicians were able to perform ETI within 3 attempts. Univariate analysis showed that age (OR=1.06, P=0.022), previous number of ETIs (OR=2.49, P<0.001), work experience (OR=1.13, P<0.001), and previous ETI training (OR=1.85, P=0.041) were significantly associated with ETI success rate. After adjustment, previous number of ETIs (OR=2.66, P<0.001) was the most effective factor on ETI success rate. **Conclusion:** Success rate in airway management, especially ETI, is low. Therefore, improvement in modifiable factors such as increasing the number of ETIs performed and gaining experience in the same conditions as pre-hospital emergency is necessary.

Keywords: Airway Management; Endotracheal Intubation; Emergency Medicine Technicians

© Copyright (2018) Shahid Beheshti University of Medical Sciences

Cite this article as: Ghiyasvandian Sh, Khazaei A, Zakerimoghadam M, Salimi R, Afshari A, Mogimbeigi A. Evaluation of Airway Management Proficiency in Pre-Hospital Emergency Setting; a Simulation Study. Emergency. 2018; 6(1): e58.

1. Introduction

Airway management in the out of hospital setting is associated with major challenges [1]. Conditions such as limited access to advanced airway equipment, immobilized patients, confined spaces with dim light, shortage of person-

*Corresponding Author: Khazaei Afshin; Intensive Care and Management Nursing Department, School of Nursing and Midwifery, Nosrat St, Tehran, Iran. Email: khazaei-a@razi.tums.ac.ir, Tel: 00989183143075

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0). Downloaded from: www.jemerg.com

nel, lack of back-up force and limited choice of alternative methods are substantial challenges of airway management in pre-hospital emergencies [2]. In the pre-hospital conditions, airway management involves a series of sequential steps and action to ensure airway openness to provide ventilation in the patient's lungs [3]. Inadequate performance at any step during airway management leads to irreparable injuries and complications in the patient [4, 5]. The most important stages of airway management include assessment, positioning, cleaning up the upper airway, adjunct oral airway insertion, supplemental oxygen administration, Bag-valve Mask Ventilation (BMV), placement of an Endotracheal Tube (ETT), ETT placement verification, stabilizing ETT and applying alternative methods after unsuccessful Endotracheal Intubation (ETI) [3]. The current training of EMTs is not enough to improve the patient's airway management outcome [6]. Furthermore, infrequency and low exposure to critically ill patients requiring airway management (especially ETI) has added to the complexity of the situation and leads to poor skills and performance of the personnel over time [7]. The gold standard for advanced airway management is ETI [8]. Studies assessing ETI success rate in an ambulance or a simulator are scarce. With the current overall out of hospital ETI success rates ranging from 77 to 85% [9, 10] and a complication rate of 48 per 1000 intubations [10], the need to assure high levels of skill for performance and maintenance in a simulated environment is felt [10, 11]. Consequently, accurate and continuous assessment and evaluation procedures for retention of airway management performance are critical to the improvement of patient outcomes [10, 11]. Therefore, the primary objective of this study was evaluation of airway management in a simulated environment and the secondary purpose was identifying the factors affecting the success rate of ETI in the EMTs.

2. Methods

2.1. Study design and setting

This is a simulation study. The study was conducted in 115 Emergency medical services in Hamadan province, with 20 urban bases, 30 roadside bases and an air base (12). The present study was conducted from March 2018 to May 2018. EMTs participated in the study voluntarily and individual performance results were not reported to EMS authorities. EMTs willing to participate in the study were requested to complete a brief demographic questionnaire and consent to video recording of their performance on the simulation practice. This study was approved by the Ethics Committee of Hamadan University of Medical Sciences as research project No. 9611247613 and with the unique ID No. IR.UMSHA.REC.1396.808.

2.2. Participants

The population of this study comprised EMTs in 115 emergency bases in Hamadan province, which were recruited. In a study carried out by Wang HE et al. ETI success rates were reported as 0.77% [9]. Using this data and taking into account the relative error of 5% and 95% confidence interval, as well as applying the coefficient of the limited population (a total of 307 active EMTs, by formula); we calculated that a sample size of 184 is required. The active EMTs who were present on a full-time basis in urban, road-side and air emergency and announced their oral and written consent were included in the study. Non-active EMS personnel were excluded from the study. The participants were placed in the back of an ambulance to perform the airway management scenario, which has already been prepared by experts. All stages of airway management by the EMTs were performed on a mannequin located in an ambulance resembling the pre-hospital emergency situation.

2.3. Scenario 1

You have departed, along with your colleague, to a mission where a client's consciousness is declined in a car accident. While examining, you notice that there is an incomprehensible voice in him. With painful stimuli, he opens his eyes and withdraws. On the left side of the temple, there is boggy contusion. It will take at least 20 minutes from the place of accident to the hospital. Perform the required ventilation procedures based on the airway management protocol in the pre-hospital emergency in order a) through bag-valve mask, and b) then ETI for the patient.

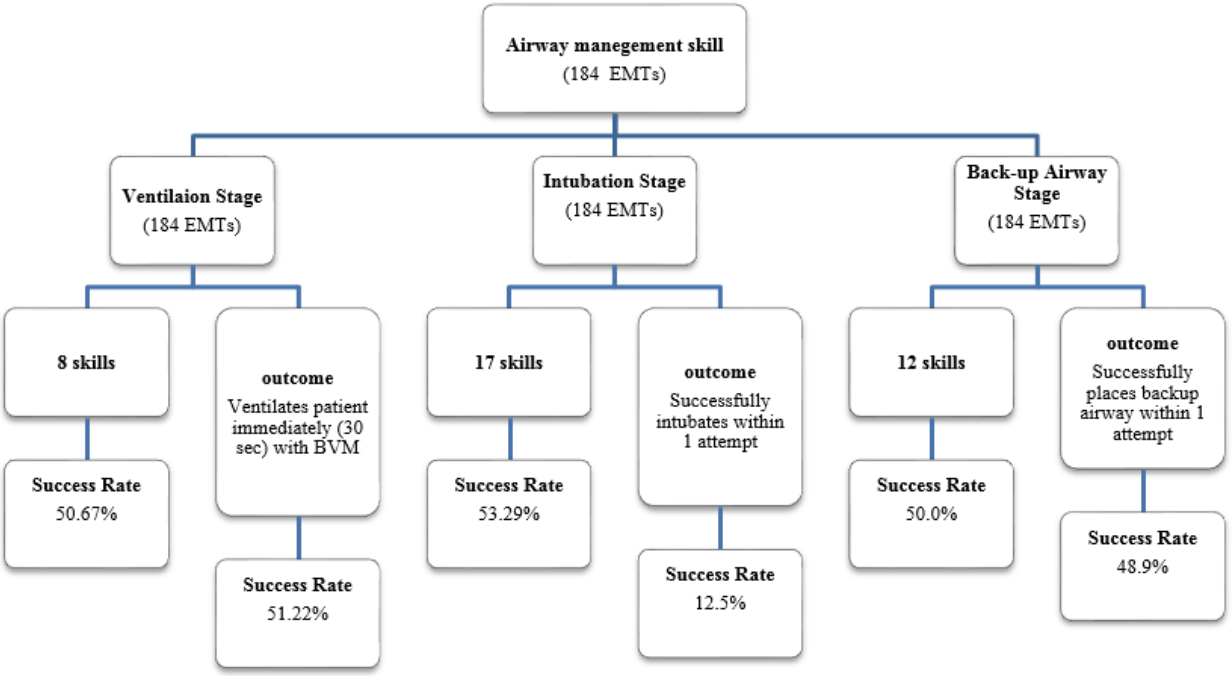
2.4. Scenario 2

During the course, you notice that the patient's ET Tube has been accidentally dislodged. You have attempted to intubate this patient twice since your first successful ETI. You have noted that the airway was significantly edematous, full of secretions and you were unable to visualize the ET tube pass through the vocal cords. Pulse oximetry is also 80%. Take the necessary measures in accordance with the Airway Management Standard in the pre-hospital emergency.

2.5. Data gathering

The research instrument included a) demographic questionnaire of EMT (including age, work experience, degree, employment status, intubation experience, previous training in airway management field); and b) Airway Management Proficiency Checklist (AMPC) designed by David P. Way et al. in 2017 [12]. This checklist consists of 3 standard performance scales for airway management, including ventilation, intubation and back-up airway, and a total of 37 psychomotor skills (8 skills for the ventilation scale, 17 skills for the

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0).
Downloaded from: www.jemerg.com



Flowchart 1: Course of the airway management proficiency and the success rate of technicians in each of the stages of ventilation, intubation and back-up airway as well as outcome. BVM: Bag Vale Mask.

ETI scale and 12 skills for the back-up airway scale) required for a comprehensive airway management. All 37 items were considered easily observable and rated by a qualified evaluator, and it's had internal consistency in the three stages of ventilation (KR-20=0.95), intubation (KR-20=0.88) and back-up airway (KR-20=0.82) (13). This checklist was filled out through direct observation made by two pre-hospital emergency training experts and under the supervision of an emergency medicine specialist. During the performance assessment, a trained supervisor read a standardized orientation (Included an overview of the scenario, the available equipment, and a reminder to follow standard EMS protocols for airway management) to the EMTs. All EMTs (184 cases) were evaluated individually with the two scenarios. Also, all technicians, both those who were successful and those who failed in the first scenario were allowed to continue to the second scenario. Based on the Standard Airway Management Guidelines [3], the maximum attempts (successful intubation) for ETI was determined 3 times. If the technicians failed to perform ETI in three attempts the result was recorded as failed intubation. Also, if the technician had successful intubation during three attempts, it was recorded as successful intubation. The evaluators watched the recording and scored their performance using the 37 item checklist. The 37 items on the checklist were scored dichotomously either a "1" representing successful execution of the task, or a "0" representing a failed attempt or no attempt at all. After data collection, the status of technicians' proficiency was determined at each stage of ventilation, intubation, back-up airway and sectors related to such stages.

The evaluators used Karl Storz 8403ZXK C-MAC Video Laryngoscope, which allows observation and video recording of ET tube placement, but EMTs were not shown the screen views during the simulation. The forward-only translation technique was used due to the lack of a Persian version of the tool [13]. Thus, after obtaining permission from the developer, the English version of the instrument was first translated individually into Persian by two emergency medicine specialists. Then the points of difference were investigated at a meeting with the presence of experts and pre-hospital emergency experts and specialists. Finally, a single Persian version of instrument was provided. For content and face validity, the checklist was given to 10 faculty members, emergency medicine specialist and emergency technicians, and their comments and suggestions were taken into consideration. Tool reliability (in the mentioned three steps) was also confirmed via completion of 15 checklists by two emergency experts and determining the intra-rater reliability and calculating Kappa coefficient (0.84%, 0.79%, and 0.91%).

2.6. Statistical Analysis

Continuous variables that were normally distributed were expressed as mean ± standard deviation (SD) while non-normally distributed variables were expressed as median

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0).
Downloaded from: www.jemerg.com

(IQR). We dichotomized ETI intervention into ≤3 attempts (successful) and >3 attempts (failure). ETT correct positioning was determined by the placement of the tube within the trachea approximately 2-3 cm above the carina [17]. Univariate logistic regression (Unadjusted) was used to identify factors (Continuous variables such as age, work experience, and previous number of ETIs and categorical variables such as previous training history [yes-no], degree [emergency medical technicians, nurse, operation room technician, anesthetist technician], and employment status [formal and informal]) associated with success or failure rate of ETI. Also, we used a multivariate logistic regression model for adjusting ORs of continuous and categorical variables with ETI success rate. To select covariates for the adjusted models used, the forward selection (wald) method was applied. ORs and 95% CIs were calculated. The selection of variables for the model was done according to factors known from the literature, which had previously assessed ETI success rate [14-16]. All statistical analyses were performed using IBM SPSS Statistics (V.17). P<0.05 was considered significant (two-tailed).

3. Results

3.1. Demographic information

184 EMTs took part in the study after being qualified for the inclusion criteria. The mean age of participants was 33.91+6.25 years and their median work experience was 8 years (IQR 5-13). The median number of intubations performed by technicians in the past year was 7 (IQR 7-9) times. 54.3% of the technicians reported a history of airway management training in the past year. 51.1% of the technicians had formal employment and some had academic degrees as emergency medical technicians (36.4%), nurses (27.2%), operation room technicians (20.1%) and anesthesiologists (16.3%). Hosmer-Lemeshow test showed good fit for the model (p = 0.48).

3.2. Ventilation stage

At the ventilation stage, the highest (65.2%) and the lowest (31.5%) success rates belonged to choosing correct adjunct airway size and checking pulse using thenar eminence technique, respectively. In the first section, 60.9% participants placed simple adjuncts prior to intubation to facilitate bag valve mask (BVM) performance. Choosing the correct adjunct airway size was only observed in 60.9% of the technicians. 54.3% of the technicians succeeded in inserting adjunct airway with proper depth. The rate of BVM ventilation was also one of the evaluated sections. Out of all the participants, less than 50% of the technicians ventilated the patient at the correct rate of 10–12 breaths per minute. In the next section, 42.9% (79 of 198) of the participants were observed for BVM technique for 30 seconds. Using thenar eminence technique (E-C grip), in which downward pressure is applied with the thenar eminences while the four fingers of each hand pull the jaw upwards toward the mask, was only performed by 31.5% of the technicians. Another significant section that was evaluated at the ventilation stage was taking precautions for cervical spine injuries (jaw-thrust maneuver, head-tilt/chin-lift maneuver), which only 48.9% of the technicians focused on this issue in our study while inserting airway and ventilating the patient with the BVM. Eventually, the main outcome evaluated at this stage was ventilating the patient immediately (w/in 30 sec) with BVM and 53.8% of the technicians were able to do it. Table 1 presents other results of the ventilation stage.

3.3. Enodotercheal Inutubation (ETI) stage

The complete item list for this process is listed in table 2. In the ETI stage, the highest (89.7%) and the lowest (20.7%) success rates belonged to grasping laryngoscope with the left hand and checking end-tidal CO_2 after ETT placement, respectively. In the first section of this stage, nearly three-quarters (71.2%) of the technician used straight-to-cuff stylette curvature technique. 34.8% of the technicians passed ETT through cords with limited or no impingement. Also, 61.4% maintained their view correctly until ETT stopped advancing. less than 50% of the technicians provided the correct position for the patient's head before insertion of the laryngoscope into the mouth. Passing tube through cords (laryngoscope in mouth to tracheal placement) in ≥20 seconds was only perfomed by 34.8% of the technicians. Investigation of end-tidal CO_2 is another significant section of this stage which is considered one of the non-invasive methods for determining the correct position of the ETI. Only 20.7% of the EMTs checked end-tidal CO_2 after ETT placement. In our study, nearly half of the EMTs (49.2%) succeeded in placing the tube at the appropriate depth in the trachea. Passing the tube through cords (laryngoscope in mouth to tracheal placement) in less than 20 seconds was also another important section of the intubation stage that only 22.8% of the technicians were able to perform this skill. One of the maneuvers that facilitate passing of the tube into the trachea is the use of pressure on the epiglottis to better see the trachea when inserting the tube [18]. In this section, only 39.1% of the technicians requested the assistant to apply pressure on the patient's epiglottis. Finally, the technicians lacked enough skill to evaluate the main consequence of this stage, which was placement ETI with one attempt, and only 12.5% of the technicians were able to show this skill. Table 2 presents the other parts of the intubation stage.

3.4. Back-up airway stage

At the backup airway placement stage, the highest (93.5%) and the lowest (16.8%) success rates belonged to immedi-

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0).
Downloaded from: www.jemerg.com

Table 1: Frequency of paramedics who correctly performed tasks related to airway (n = 184)

Description	Frequency (%)
Inserts oropharyngeal (adjunct) airway	112 (60.9)
Chooses correct adjunct airway size	112 (65.2)
Inserts adjunct airway to proper depth	100 (54.3)
Ventilates patient at rate of 10–12/min	87 (47.3)
Observes BVM technique for 30 seconds*	79 (42.9)
Orients mask correctly	106 (57.6)
Uses thenar eminence technique (E-C grip)	58 (31.5)
Maintains C-spine precautions during BVM	90 (48.9)
Ventilates patient immediately (w/in 30 sec) with BVM	99 (53.8)

* Evaluates volumes (visible chest rise); Endotracheal Tube (ETT); C-spine: Cervical spine; BVM: Bage Valve Mask.

ately disconnecting syringe after inflating cuff and checking end-tidal CO_2 after backup airway placement, respectively. The need for backup airway in the patients was only recognized by 36.4% of technicians in the designed scenario (scenario 2). However, in this scenario, technicians who did not recognize the need for a back-up airway in the patient were asked to complete the back-up airway process based on the protocol. Identifying an appropriate backup airway device was only done by 58.7% of the technicians. Only 36.4% of the technician confirmed proper placement by auscultation bilaterally over each lung-Backup airway. Also, approximately 50% of technicians succeeded in inserting laryngeal mask airway in one step as the main outcome of this stage. Table 3 indicates other results in this section. Logistic regression results also showed that implementation of previous intubation in the last 12 months (OR=2.66) and work experience (OR=1.52) in the presence of other variables (such as dgree, previous ETI training, employment status), are the most impactful factors that can increase the chance of successful intubation. In the unadjusted univariate analysis, number of previous ETIs (OR=2.49: CI 95% [1.98-3.59], P<0.001), age (OR=1.06: CI 95% [1.00-1.11], P=0.022), work experience (OR=1.13: CI 95% [1.06-.1.2], P<0.001) and previous ETI training (OR=1.85: CI 95% [1.02-3.36], P=0.041) were significantly associated with ETI success rate. Also, factors such as degree (EMT: OR=0.92 CL 95% [0.38-2.23], P = 0.868, Nurse: OR=0.92 CI 95% [0.36-2.31], P=0.860, Operating room technician: OR=0.87 CI 95% [0.32-2.32], P=0.869), employment status (OR=0.74: CI 95% [0.41-1.33], P=0.319) were not significantly associated with ETI success rate. When adjusted for previous number of ETI, age, degree, and previous ETI training and employment status, only number of previous ETIs (OR=2.70: CI 95% [1.98-1.38], P<0.001) and work experience (OR=1.52: CI 95% [1.15-2.01], P=0.003) correlated with ETI success rate (sensitivity [85.7], specificity [89.7]). Age (OR=0.78: CI 95% [0.62-0.98], P=0.037) was a negative predictive factors with ETI success rate. Hosmer–Lemeshow test also showed goodness of fit for the model (p=0.496).

4. Discussion

The total success rate in the three stages of ventilation, intubation and airway back-up were 50.67%, 53.29%, and 50.0%, respectively. Out of the total 552 attempts for ETI placement, 58.2% of the technicians were able to perform ETI in ≤3 attempts and 43.9% of technicians took more than 3 attempts to perform this skill. Also, 12.5% (23 of 184) of the EMTs were successful at ETI in their first attempt, which increased to 17.9% and 27.7% in the 2nd and 3rd attempts, respectively. These results are quite disappointing compared to other studies performed in this area. In the Panchal study, the first pass ETI success rate was 55.6% [19]. The study by Griesdale et al. also indicated that 94% of the experienced EMTs succeed in ETI within 2 attempts and only 6.6% of intubation cases by technicians required three attempts [20]. The poor results of our study at the ETI stage are highlighted by the fact that re-intubation on the real patients will lead to complications, such as hypoxemia, aspiration, bradycardia and cardiac arrest [21]. Passing the tube through cords (laryngoscope in mouth to tracheal placement) in less than 20 seconds was also another important section of the intubation stage, in which only 22.8% of the technicians succeeded. There is no doubt regarding the significance of the mentioned step (rapid intubation) because based on the results of previous studies, rapid intubation in cardiopulmonary resuscitation can lead to favorable outcomes, including improved neurological status and increased survival of patients [22, 23]. Also, inserting the tube with the appropriate depth is another important skill for ETI, which is crucial because ignoring this issue leads to serious complications that may even lead to death in some cases [24, 25]. Unfortunately, 42.9% of the EMTs paid attention to this issue. The initial approach to airway management in the pre-hospital emergency is Bag-valve Mask Ventilation (BMV) [26, 27], which is more vital than intubation procedures in some special circumstances (e.g. severe airway trauma, lack of experience in personnel, children, etc.) [28, 29]. Hansen et al. also indicated in their study that for airway management in chil-

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0).
Downloaded from: www.jemerg.com

Table 2: Frequency of paramedics who correctly performed tasks related to endotracheal intubation (n = 184)

Description	Frequency (%)
Uses straight-to-cuff stylette curvature technique	131 (71.2)
Checks equipment for cuff leaks	55 (29.9)
Positions head properly	85 (46.2)
Grasps laryngoscope with left hand	165 (89.7)
Elevates mandible from 45–90 degrees w/laryngoscope	122 (66.3)
Flips up epiglottis to expose larynx	72 (39.1)
Inserts laryngoscope to appropriate depth	79 (42.9)
Moves blade tip smoothly without shaking or jerking	83 (45.1)
Maintains view until ETT has stopped advancing	113 (61.4)
Passes ETT through cords with limited or no impingement	64 (34.8)
Passes tube through cords in ≥ 20 seconds *	42 (22.8)
Disconnects syringe immediately after inflating cuff of ETT	149 (81.0)
Listens over each lung	124 (67.4)
Checks end-tidal CO2- After ETT placement	38 (20.7)
Checks pulse oximeter-After ETT placement	63 (34.2)
Maintains control over ETT placement	124 (67.4)
Secures ET tube (with device)	158 (85.9)
Successfully intubates within 1 attempt	21 (12.5)

* laryngoscope in mouth to tracheal placement; ET: Endotracheal; ETT: Endotracheal Tube.

Table 3: Frequency of paramedics who correctly performed tasks related to backup airway (n = 184)

Description	Frequency (%)
Recognizes need for backup airway	67 (36.4)
Identifies an appropriate backup airway device	108 (58.7)
Checks equipment for cuff leaks	78 (42.4)
Immediately inflates cuff, prior to ventilation	163 (88.6)
Immediately disconnects syringe after inflating cuff	172 (93.5)
Confirms proper placement by auscultation*	67 (36.4)
Checks end-tidal CO_2-after Backup airway placement	31 (16.8)
Checks Pulse Oximeter-after Backup airway placement	82 (44.6)
Appropriately positions equipment needed for backup airway	53 (28.8)
Maintains control over backup airway after placement	68 (37.0)
Secures backup airway device	118 (64.1)
Introduces backup airway and advances to proper depth	97 (52.7)
Successfully places backup airway within 1 attempt	90 (48.9)

* bilaterally over each lung-backup airway.

dren, BVM would lead to a higher survival rate for the patient in hospital compared to ETI [30]. Ventilation with BVM seems a simple technique, though its proper implementation is difficult in practice, especially when the technicians lack enough experience in this area. In our study, the success rate of ventilating the patient with the rate of 10–12/min was low and this problem is more pronounced when knowing the increase (hyperventilate) or reduction (hypoventilation) in ventilation is determining the patient's final condition [31]. Unfortunately, in the backup airway stage also only 36.4% of the technicians recognized need for backup airway. When EMTs confronted with failed ETI, using an alternative airway such as combitube and laryngeal mask airway (LMA) would be an effective and efficient way to keep the airway open and ventilate [32]. In the backup airway (16.8%) and intubation stage (20.7%), the lowest success rate belonged to checking end-tidal CO_2 after backup airway placement. This method along with auscultation of bilateral breath sounds is the gold standard for determining the correct position of the ET tube in the pre-hospital setting [33], which has 100% sensitivity and specificity in pre-hospital conditions [34]. Therefore, the American Heart Association (AHA) recommends it for all intubations [35]. Also, in the present study, the success rate of backup-airway insertion in difficult conditions (scenario 2) was higher than the ETI (48.6% VS 18.6%). This result confirms the ease of using laryngeal mask airway compared to ETI, which is consistent with the results of other studies in this area [36, 37].

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0).
Downloaded from: www.jemerg.com

Regression test also showed that one of the factors that can affect the success rate of airway management is to perform this skill in situations similar to the pre-hospital environment. After adjustment for confounding variables, gaining experience through implementation of intubation was found to be effective in enhancing the skills of ETI, so that with performing one previous intubation, success rate increased by 2.66%. This result is confirmed by other studies, because achieving a 90% success rate in ETI requires a history of performing 50–150 intervention [38, 39]. Also, unadjusted regression shows that previous training in intubation was also significantly associated with ETI success rate but when it's adjusted for other factors such as previous number of intubations, this relationship was no longer significant. These results confirm that training methods such as theory-based teaching, lecture-based teaching as well as writing exam, cannot guarantee the success of technicians in managing practical skills. Finally, the results of this study should be cautiously interpreted in the field. A major limitation of this study was the possibility of selection bias because technicians who have improved airway management proficiency may have been included in the study. Also, since this study was conducted at a stationary ambulance and did not have the limitations of conducting airway management in a moving ambulance, its results may not reflect the current performance of the technicians in this study. In addition, the use of simulation in addition to the bias created by the ambulance personnel's awareness result in the personnel not having environmental stresses such as encountering the scene of an accident, the risk of a patient's life, the pressure of personnel to control and stabilize the patient's condition and the existence of complications such as secretion, hemorrhage, vomiting in airway interventions and these factors may lead to false results of ETI. In conclusion, the results of this study may be different from real situations.

5. Limitation

This type of study is not possible in the field due to acuity of illness, inability to accurately observe the details, and infrequency of airway management. The obtained results in this study should be carefully interpreted and used due to the lack of devices for determining the proper placement of ETI such as end-tidal CO_2 detection device, as well as alternative back-up airway equipment such as combitube and laryngeal mask airway in the pre-hospital emergency service of Hamadan province.

6. Conclusion

Success rate in airway management, especially ETI, is low. Therefore, improvement in modifiable factors such as increasing the number of ETIs performed and gaining experience in the same conditions as pre-hospital emergency is necessary.

7. Appendix

7.1. Acknowledgements

The authors are grateful to Vice-Chancellor of Research and Technology in Hamadan University of Medical Sciences for supporting this study with a grant under the project number 9611247613.

7.2. Author contribution

Khazaei Afshin, Ghiyasvandian Sharzad and Zakerimoghadam designed the simulation study. Khazaei Afshin, Salimi Rasoul and Afshari Ali carried out the implementation and supervised the work. Mogimbeigi Abbas analyzed the data and aided in interpreting the results. Finally, Khazaei Afshin and Ghiyasvandian Sharzad discussed the results and contributed to the final manuscript.

Authors' ORCIDs
Ghiyasvandian Shahrzad: 0000-0003-0137-5499
Khazaei Afshin: 0000-0002-8063-3419
Zakerimoghadam Masoumeh: 0000-0002-9762-1887
Salimi Rasoul: 0000-0002-6463-6046
Afshari Ali: 0000-0002-4579-5869
Mogimbeigi Abbas: 0000-0002-3803-3663

7.3. Funding/Support

This work was supported by the Vice-chancellor of Research and Technology, Hamadan University of Medical Sciences under Grant number 9611247613.

7.4. Conflict of interest

The authors report no conflict of interest. The authors alone are responsible for the content and writing of the paper.

References

1. Prekker, M.E., H. Kwok, J. Shin, D. Carlbom, A. Grabinsky, and T.D. Rea, The Process of Prehospital Airway Management: Challenges and Solutions During Paramedic Endotracheal Intubation. Critical care medicine, 2014. 42(6): p. 1372-1378.
2. Byars, D., B. Lo, and J. Yates, Evaluation of paramedic utilization of the intubating laryngeal mask airway in high-fidelity simulated critical care scenarios. Prehosp Disaster Med, 2013. 28(6): p. 630-1.
3. Frerk, C., V.S. Mitchell, A.F. McNarry, C. Mendonca, R. Bhagrath, A. Patel, E.P. O'Sullivan, N.M. Woodall, and I. Ahmad, Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults().

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0).
Downloaded from: www.jemerg.com

BJA: British Journal of Anaesthesia, 2015. 115(6): p. 827-848.
4. Cook, T.M., N. Woodall, and C. Frerk, Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: anaesthesia. Br J Anaesth, 2011. 106(5): p. 617-31.
5. Ahmed, A., F.A. Khan, and S. Ismail, Reliability and validity of a tool to assess airway management skills in anesthesia trainees. Journal of Anaesthesiology, Clinical Pharmacology, 2016. 32(3): p. 333-338.
6. Thomas, J.B., B.N. Abo, and H.E. Wang, Paramedic perceptions of challenges in out-of-hospital endotracheal intubation. Prehosp Emerg Care, 2007. 11(2): p. 219-23.
7. Lammers, R.L., M.J. Byrwa, W.D. Fales, and R.A. Hale, Simulation-based assessment of paramedic pediatric resuscitation skills. Prehosp Emerg Care, 2009. 13(3): p. 345-56.
8. Soar, J., J.P. Nolan, B.W. Bottiger, G.D. Perkins, C. Lott, P. Carli, T. Pellis, C. Sandroni, M.B. Skrifvars, G.B. Smith, K. Sunde, and C.D. Deakin, European Resuscitation Council Guidelines for Resuscitation 2015: Section 3. Adult advanced life support. Resuscitation, 2015. 95: p. 100-47.
9. Wang, H.E., N.C. Mann, G. Mears, K. Jacobson, and D.M. Yealy, Out-of-hospital airway management in the United States. Resuscitation, 2011. 82(4): p. 378-85.
10. Diggs, L.A., J.E. Yusuf, and G. De Leo, An update on out-of-hospital airway management practices in the United States. Resuscitation, 2014. 85(7): p. 885-92.
11. Komasawa, N. and B.W. Berg, Simulation-based Airway Management Training for Anesthesiologists - A Brief Review of its Essential Role in Skills Training for Clinical Competency. J Educ Perioper Med, 2017. 19(4): p. 1-4.
12. Way, D.P., A.R. Panchal, G.I. Finnegan, and T.E. Terndrup, Airway Management Proficiency Checklist for Assessing Paramedic Performance. Prehosp Emerg Care, 2017. 21(3): p. 354-361.
13. Maneesriwongul, W. and J.K. Dixon, Instrument translation process: a methods review. J Adv Nurs, 2004. 48(2): p. 175-86.
14. Park, L., I. Zeng, and A. Brainard, Systematic review and meta-analysis of first-pass success rates in emergency department intubation: Creating a benchmark for emergency airway care. Emerg Med Australas, 2017. 29(1): p. 40-47.
15. Choi, H.J., S.M. Je, J.H. Kim, and E. Kim, The factors associated with successful paediatric endotracheal intubation on the first attempt in emergency departments: a 13-emergency-department registry study. Resuscitation, 2012. 83(11): p. 1363-8.
16. Kim, C., H.G. Kang, T.H. Lim, B.Y. Choi, Y.J. Shin, and H.J. Choi, What factors affect the success rate of the first attempt at endotracheal intubation in emergency departments? Emerg Med J, 2013. 30(11): p. 888-92.
17. Hardcastle, T.C., M. Faurie, and D.J.J. Muckart, Endotracheal tube cuff pressures and tube position in critically injured patients on arrival at a referral centre: Avoidable harm? African Journal of Emergency Medicine, 2016. 6(1): p. 24-29.
18. Ali, M.S., M.H. Bakri, H.A. Mohamed, H. Shehab, and W. Al Taher, External laryngeal manipulation done by the laryngoscopist makes the best laryngeal view for intubation. Saudi Journal of Anaesthesia, 2014. 8(3): p. 351-354.
19. Panchal, A.R., G. Finnegan, D.P. Way, and T. Terndrup, Assessment of Paramedic Performance on Difficult Airway Simulation. Prehosp Emerg Care, 2016: p. 1-10.
20. Griesdale, D.E., T.L. Bosma, T. Kurth, G. Isac, and D.R. Chittock, Complications of endotracheal intubation in the critically ill. Intensive Care Med, 2008. 34(10): p. 1835-42.
21. Mort, T.C., Emergency tracheal intubation: complications associated with repeated laryngoscopic attempts. Anesth Analg, 2004. 99(2): p. 607-13, table of contents.
22. Wang, C.H., W.J. Chen, W.T. Chang, M.S. Tsai, P.H. Yu, Y.W. Wu, and C.H. Huang, The association between timing of tracheal intubation and outcomes of adult in-hospital cardiac arrest: A retrospective cohort study. Resuscitation, 2016. 105: p. 59-65.
23. Kangelaris, K.N., L.B. Ware, C.Y. Wang, D.R. Janz, Z. Hanjing, M.A. Matthay, and C.S. Calfee, Timing of Intubation and Clinical outcomes in Adults with ARDS. Critical care medicine, 2016. 44(1): p. 120-129.
24. Varshney, M., K. Sharma, R. Kumar, and P.G. Varshney, Appropriate depth of placement of oral endotracheal tube and its possible determinants in Indian adult patients. Indian Journal of Anaesthesia, 2011. 55(5): p. 488-493.
25. Miller, K.A., A. Kimia, M.C. Monuteaux, and J. Nagler, Factors Associated with Misplaced Endotracheal Tubes During Intubation in Pediatric Patients. J Emerg Med, 2016. 51(1): p. 9-18.
26. Bucher, J.T. and J.S. Cooper, Bag Mask Ventilation (Bag Valve Mask, BVM), in StatPearls. 2018, StatPearls Publishing StatPearls Publishing LLC.: Treasure Island (FL).
27. Soleimanpour, M., F. Rahmani, A. Ala, H.R. Morteza Bagi, A. Mahmoodpoor, S.E.J. Golzari, F. Zahmatyar, R. Mehdizadeh Esfanjani, and H. Soleimanpour, Comparison of four techniques on facility of two-hand Bag-valve-mask (BVM) ventilation: E-C, Thenar Eminence, Thenar Eminence (Dominant hand)-E-C (non-dominant hand) and Thenar Eminence (non-dominant hand) – E-C (dominant hand). Journal of Cardiovascular and Thoracic Research, 2016. 8(4): p. 147-151.
28. Siegler, J., M. Kroll, S. Wojcik, and H.P. Moy, Can EMS

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0).
Downloaded from: www.jemerg.com

Providers Provide Appropriate Tidal Volumes in a Simulated Adult-sized Patient with a Pediatric-sized Bag-Valve-Mask? Prehosp Emerg Care, 2017. 21(1): p. 74-78.
29. Mahmoodpoor, A., H. Soleimanpour, K.S. Nia, J.R. Panahi, M. Afhami, S.E.J. Golzari, and K. Majani, Sensitivity of Palm Print, Modified Mallampati Score and 3-3-2 Rule in Prediction of Difficult Intubation. International Journal of Preventive Medicine, 2013. 4(9): p. 1063-1069.
30. Hansen, M.L., A. Lin, C. Eriksson, M. Daya, B. McNally, R. Fu, D. Yanez, D. Zive, and C. Newgard, A comparison of pediatric airway management techniques during out-of-hospital cardiac arrest using the CARES database. Resuscitation, 2017. 120: p. 51-56.
31. Costello, J.T., P.B. Allen, and R. Levesque, A Comparison of Ventilation Rates Between a Standard Bag-Valve-Mask and a New Design in a Prehospital Setting During Training Simulations. J Spec Oper Med. 17(3): p. 59-63.
32. Bosch, J., J. de Nooij, M. de Visser, S.C. Cannegieter, N.J. Terpstra, C. Heringhaus, and J. Burggraaf, Prehospital use in emergency patients of a laryngeal mask airway by ambulance paramedics is a safe and effective alternative for endotracheal intubation. Emergency Medicine Journal : EMJ, 2014. 31(9): p. 750-753.
33. Grmec, S. and S. Mally, Prehospital determination of tracheal tube placement in severe head injury. Emergency Medicine Journal : EMJ, 2004. 21(4): p. 518-520.
34. Silvestri, S., G.A. Ralls, B. Krauss, J. Thundiyil, S.G. Rothrock, A. Senn, E. Carter, and J. Falk, The effectiveness of out-of-hospital use of continuous end-tidal carbon dioxide monitoring on the rate of unrecognized misplaced intubation within a regional emergency medical services system. Ann Emerg Med, 2005. 45(5): p. 497-503.
35. Neumar, R.W., M. Shuster, C.W. Callaway, L.M. Gent, D.L. Atkins, F. Bhanji, S.C. Brooks, A.R. de Caen, M.W. Donnino, J.M. Ferrer, M.E. Kleinman, S.L. Kronick, E.J. Lavonas, M.S. Link, M.E. Mancini, L.J. Morrison, R.E. O'Connor, R.A. Samson, S.M. Schexnayder, E.M. Singletary, E.H. Sinz, A.H. Travers, M.H. Wyckoff, and M.F. Hazinski, Part 1: Executive Summary: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation, 2015. 132(18 Suppl 2): p. S315-67.
36. Saeedi, M., H. Hajiseyedjavadi, J. Seyedhosseini, V. Eslami, and H. Sheikhmotaharvahedi, Comparison of endotracheal intubation, combitube, and laryngeal mask airway between inexperienced and experienced emergency medical staff: A manikin study. International Journal of Critical Illness and Injury Science, 2014. 4(4): p. 303-308.
37. Kapoor, S., D.D. Jethava, P. Gupta, D. Jethava, and A. Kumar, Comparison of supraglottic devices i-gel(®) and LMA Fastrach(®) as conduit for endotracheal intubation. Indian Journal of Anaesthesia, 2014. 58(4): p. 397-402.
38. Konrad, C., G. Schupfer, M. Wietlisbach, and H. Gerber, Learning manual skills in anesthesiology: Is there a recommended number of cases for anesthetic procedures? Anesth Analg, 1998. 86(3): p. 635-9.
39. Schupfer, G.K., C. Konrad, and J.I. Poelaert, [Manual skills in anaesthesiology]. Anaesthesist, 2003. 52(6): p. 527-34.
40. Burton, J.H., M.R. Baumann, T. Maoz, J.R. Bradshaw, and J.E. Lebrun, Endotracheal intubation in a rural EMS state: procedure utilization and impact of skills maintenance guidelines. Prehosp Emerg Care, 2003. 7(3): p. 352-6.

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0).
Downloaded from: www.jemerg.com