PEDAGOGY

Simulation learning in the emergency department: Impact on VideoLaryngoscope Intubation Skills

Apprentissage par simulation aux urgences: Impact sur les compétences en intubation par vidéolaryngoscopie

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Abstract

Introduction-Aim: In the emergency department (ED), learning by simulation provides a safe acquisition of procedural skills. This study's objective was to evaluate the impact of the simulation-based learning on videolaryngoscope (VL) orotracheal intubation (OTI) skills among residents practicing in ED.

Methods: evaluative, prospective study, including residents practicing in teaching hospitals ED in Tunis. They were novices in direct laryngoscopy. We scheduled a procedural simulation session. Residents were evaluated before and after the session. The primary endpoint was the rate of successful OTI after learning session.

Results: 32 residents were enrolled. The mean age was 28 ± 2.5 years. Gender ratio was 0.18. The mean exercise seniority was 1.53 ± 0.7 years. The rate of successful OTI before and after the training was observed in 4 residents (12.5%) vs 23 (71.8), p=0.689. The average time of OTI was respectively 149.81±108 seconds (sec) vs. 51±96 sec (p<0.001). The rate of esophageal intubation was n (%): 16 (50%) vs 9 (28%) (p=0.49) and the mean number of attempts was 3.81 vs. 1.84 (p<0.001). Intubation time after the session more than 12 sec was an independent factor of intubation failure (Adjusted OR= 3.5, p=0.001 and 95%CI [1.018-10.69]).

Conclusion: Learning by simulation in the ED provides residents with a skill that allows complete OTI in less time and a smaller number of attempts. Intubation time is an independent factor predicting intubation failure among doctors learning intubation by VL.

Key words : Simulation, pedagogy, intubation, emergency

Résumé

Introduction-Objectif: L'apprentissage par simulation a une place importante dans l'enseignement des gestes aux urgences. L'intubation orotrachéale (IOT) par vidéolaryngoscopie (VL) est une compétence importante à acquérir. L'objectif de notre étude était d'évaluer l'impact de l'apprentissage par simulation sur les compétences en IOT par VL chez résidents exerçant aux urgences.

Méthode : Étude prospective, incluant des résidents exerçant aux urgences des hôpitaux du Grand Tunis et novices en laryngoscopie directe. On a programmé une séance de simulation. Les résidents ont été évalués avant et après la séance. Le critère de jugement principal était le taux de succès de l'IOT après la séance.

Résultats : Inclusion de 32 résidents. L'âge moyen était de 28 ± 2,5 ans. Sex ratio à 0,18. Le taux de succès de l'IOT avant et après la formation était de n (%) : 4 (12.5) vs 23 (71.8) ;p=0,689. Le temps moyen d'IOT (secondes) respectivement de 149,81± 108 vs. 51±96 (p<0,001). Le nombre d'intubations œsophagiennes était de n (%) : 16 (50) vs 9 (28) ; p=0,49 et le nombre moyen de tentatives était de 3,81 vs. 1,84 (p<0,001). Un temps d'intubation après la formation supérieur à 12 secondes était un facteur prédictif d'échec de l'IOT (OR= 3,5, p=0,001, IC 95% [1,018-10,69]).

Conclusion : L'apprentissage par simulation procédurale a permis une amélioration significative du niveau de connaissances théoriques, une réduction du temps nécessaire à l'IOT et du nombre de tentatives. Un temps d'intubation après la formation supérieur à 12 secondes était un facteur prédictif d'échec de l'IOT

Mots clés: Simulation, pédagogie, intubation, urgence

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Introduction

Orotracheal intubation (OTI) is one of the most practiced techniques in the emergency department (ED). It is an essential skill for the management of airways. This skill is difficult to teach and supervise at the bedside because the instructor cannot share the direct view with the trainees during the intubation. In recent decades, new devices emerged, and videoassisted technology was added to improve the angle and visual field of laryngoscopists. These devices were rapidly incorporated into medical practice, helping with the teaching and training process [1, 2]. The videolaryngoscope (VL) is an interesting tool for facilitating the OTI. It allows a shared experience between the instructor and the student since both simultaneously visualize the images through the video screen, they enable immediate corrections by the instructor and greater understanding of the maneuver by the student [3]. A Recent metanalysis collecting 222 studies and including 26,149 participant undergoing tracheal intubation comparing VL versus Direct laryngoscopy (DL) showed that VL was associated with improved glottic view, fewer failed attempts and less complications when compared with DL [4]. The effectiveness of video training has been highlighted in the literature. Groups of inexperienced laryngoscopists (medical students, paramedics and physicians with a history of no or a small number of laryngoscopies) achieved high success rates in tracheal intubation when trained with the use of VL [5]. VL has been recommended as the first-line device wherever feasible in guidelines for the prevention of unrecognised oesophageal intubation [6], of the American Society of Anaesthesiologists Difficult Airway Algorithm, and by the Canadian Airway Focus Group [7].
Procedural simulation learning currently occupies an important place in the teaching techniques in medicine and particularly in ED.
The purpose of this study was to evaluate the impact of the simulation-based learning on the performances of OTI by a VL among residents practicing in the ED and novices in direct laryngoscopy.

Methods

We conducted a multicentric, evaluative and prospective study in the emergencies departments of Tunis between October and November 2022. We included the residents practicing in the ED and novices in direct laryngoscopy, the Residents who never intubated using a VL. All participants had agreed to have their performance evaluated and their results used anonymously for scientific and educational purposes. We did not include the residents that had already intubated using a VL and those who refused to have their performance evaluated. We excluded the participants who withdrew their consent secondarily and those who left the training session before the post-test.
The primary endpoint was the success rate of OTI defined by the simultaneous presence of the following criteria: 1-Time elapsed between the insertion of the blade and the verification of the correct positioning of the intubation tube of less than 120 seconds (sec) [8-9]; 2-Absence of esophageal intubation. Selective intubation was considered successful intubation in this study.

Intubation failure was defined by:
Intubation not completed within 120 sec or esophageal intubation.
The secondary endpoints were: 1- Number of intubation attempts; 2- The compliance with the different steps of intubation
Protocol study design: We recruited residents practicing in the ED of Tunis (Habib Thameur hospital, Ben Arous hospital, Charles Nicolle hospital, Poison control center (CAMU), Emergency Medical Service (SAMU), Rabta hospital and Mongi Slim hospital). We scheduled a procedural simulation session (learning intubation by VL). The protocol included a pre-test which was made by a questionnaire of ten questions evaluating theoretical knowledge of intubation and video laryngoscopy. We assigned a mark out of 20 for each learner. A mark of 2 was assigned for each question. We used a French Version for the pre and the post-test (Appendix1). Before the simulation session, an initial evaluation of the leaners' intubation skills was performed on a standardized simulator according to a pre-established simulation scenario (Appendix 2) based on the following evaluation grid (Appendix 3). The instructor evaluated each attempt and provided no debriefing.
A theoretical training was made, learners received a 20 minutes presentation on the anatomy of the airways, the Cormack and Lehane classification (degree of exposure of the glottis) and a presentation of the different types of the videolaryngoscope and the mode of the use followed by a tutorial video showing the intubation technique using VL. The practical training included a procedural simulation learning based on four steps:

1. The instructor performed the intubation by VL without commenting the different steps
2. The instructor performed the intubation by VL with a describing of the different steps
3. The learners described the different steps of the procedure, and the instructor performed the intubation
4. The learners performed the intubation individually, describing the different steps.

After that, we let the learners train on VL until they feel ready for the final evaluation the debriefing was carried out immediately for each learner.
At the end of the session, each learner was evaluated according to the same evaluation grid (Appendix 3). By a questionnaire of ten questions, we evaluated the knowledge of intubation and videolaryngoscopy (The post-test was the same than the pretest).
For Statistical analyzes quantitative variables were expressed as means ± standard deviation (SD) when normally distributed and as medians and interquartile range when non-normally distributed. Qualitative variables were expressed as numbers and percentages. To compare intubation times before and after training, we used the paired t-test, Mann–Whitney U test, or McNemar's test, Wilcoxon test as appropriate. For

all statistical tests, a p-value <0.05 was considered as statistically significant.
All residents signed a written informed consent and agreed to the results of the study being used anonymously for scientific purposes. Data confidentiality was respected. Local ethics committee approved this study.

Results

Thirty-seven learners participated to the study, three learners were not included because they had already intubated using a VL and two learners were excluded because they left the learning session before finishing the post-test, finally we included 32 learners in our study (Figure 1). The mean age was 28± 2.5 years. There were 5 males and 27 females (Gender-ratio=0.18). Their specialties were n (%): family medicine 18 (56.3), emergency medicine 9 (28), intensive care medicine 5 (15.6%). Twenty learners (62.5%) were in the first year, 7 (22%) in the second year and 5 (15.6%) in the third year of their course.

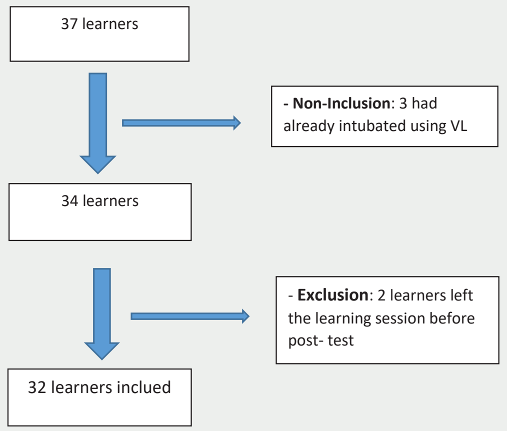

Figure 1. Inclusion diagram

The rate of intubation failure before training was 87 %.
The mean note (/20) of the pretest was 12.9±1.6 before training versus a mean post-test equal to 14,6/20±1,5 after the training with a statistically significant difference (p<0.001).
There was a statistically significant difference between pre and posttest for theorical questions concerning steps of intubation, Cormack-Lehane classification, definition of intubation failure, materials to prepare before intubation, right position for intubation, checking the correct positioning of the probe and balloon pressure level (Table 1).
Regarding practical training, we found no significant difference before and after training in rate of successful intubation, esophageal intubation and compliance with the different steps of intubation. There was a significant difference regarding time of intubation and number of tempt for a successful intubation (Table 2).
We compared intubation time for each learner before and after the training (Figure 2). The majority of learners had an intubation time lower after learning session (Figure3). The number of attempts for successful intubation was lower after the session (figure 4).

Table 1. Comparison of results of theorical questions before and after the training

	Pretest Beforetrainig	Post test Aftertrainig	p
Question 1 : Steps of intubation (/2) median	1	1.5	**0.007**
Question 2 : Cormack-Lehane classification (/2) median	0.75	1	**0.002**
Question 3 : Use of videolaryngoscope : (/2) median	1.5	1.5	0.14
Question 4 : Definition of intubation failure (/2) median	1	1	**0.03**
Question 5 : Intubation complication (/2) median	1.5	1.5	0.08
Question 6 : Behaviour in case of selective intubation (/2) median	1.5	1.5	**0.012**
Question 7 : Verification of the correct positioning of the probe (/2) median	1	1.5	**<0.001**
Question 8 : Probe balloon pressure (/2) median	0	2	**<0.001**
Question 9 : Material preparation before intubation (/2) median	2	2	**0.039**
Question 10 : The best position for intubation (/2) median	0.5	1	**0.002**

Table 2. Univariate analysis and comparison of results before and after practical training

	Before training	After training	p
Successful Intubation n (%)	4 (12.5)	23 (71.8)	0.69
Mean Time for intubation (seconds), median, IQR	129 [65-230]	15 [11-27]	**$<10^{-3}$**
Esophageal intubation n (%)	15 (50)	9(28)	0.5
Mean Number of attempts median, IQR	4 [3-4]	1 [1-2]	**$<10^{-3}$**
Compliance with steps n(%)	17 (54.8)	29 (93.8)	0.19

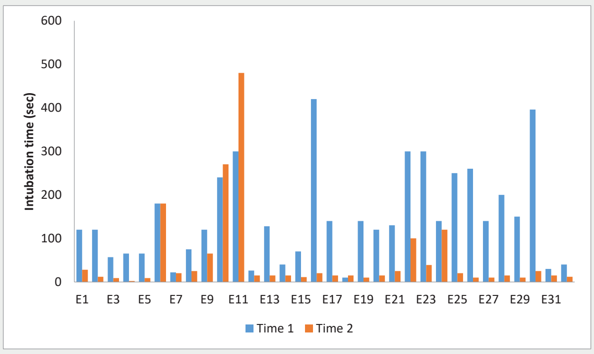

Figure 2. Intubation time before and after training for Each learner

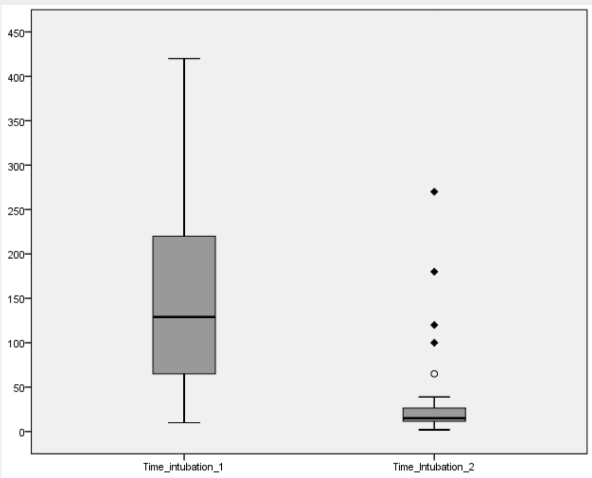

Figure 3. Intubation time before and after training session

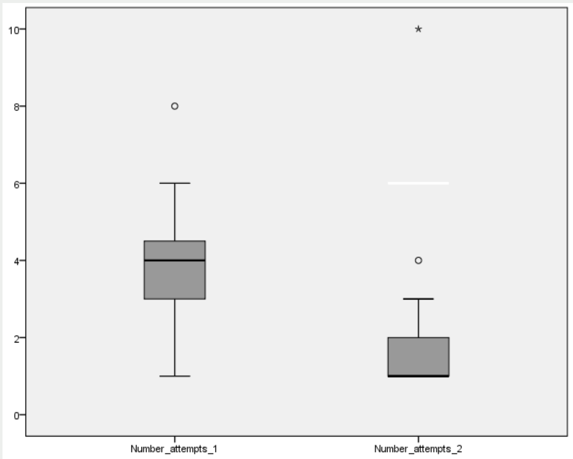

Figure 4. Learning curve for number of attempts

In the multivariate analysis, we found that intubation time after the session superior to 12 seconds was an independent factor of intubation failure (Adjusted OR= 3.5, p=0.001 and 95%CI [1.018-10.69]). There were no statistically significant differences for resident specialty (p=0.86), OTI failure before training (p=0.882), compliance with different steps (p= 0.96) and the years of exercise (p=0.7).

Discussion & conclusion

The assess of the impact of procedural simulation learning on videolaryngoscope intubation skill in residents practicing in the ED and novices in direct laryngoscopy showed a statistically significant differences in 70% of theorical questions before and after training. For practical training, there was no significant difference in terms of successful intubation rate and esophageal intubation rate, but we found a statistically significant difference in time of intubation and number of attempts for a successful intubation.

An intubation time superior to 12 seconds after the session was an independent factor of intubation failure.

Simulation is now an established educational modality in healthcare education. Its value is increasingly being realized, especially for emergency care physicians. Sree Kumar E J et al. [3] analyzed the impact of simulation-based education to manage life-threatening situations of anesthesiology residents and found that the skills of preoperative assessment, preoperative care and communication quickly improved but the specific skill of managing a difficult airway as measured by adherence to an airway algorithm required more than 6 months.

Repeated simulations over a longer period help in better reinforcement, retention of knowledge, recapitulation and implementation of technical and non-technical skills. In our study, we found a statistically significant and quickly improvement after the training of theoretical knowledge especially regarding steps of intubation, Cormack-Lehane classification, definition of intubation failure, materials to prepare before intubation, right position for intubation, checking the correct positioning of the probe and the balloon pressure level.

During airway management, tracheal intubation is considered a fundamental maneuver to ensure ventilation and oxygenation to the patient. Mort TC [5] showed that the greater the number of attempts and the longer the time for successful intubation, the higher the relative risk of serious clinical complications such as severe hypoxia, regurgitation of gastric contents with bronchial aspiration, and even cardiorespiratory arrest. Our study showed that procedural simulation learning helped learners for shorter time of intubation (149.81±108 seconds vs. 51± 96 seconds; p=<0.001) and fewer attempts (3.81 ± 1.44 vs 1.84± 1.86; p=<0.001).

Herbstreit et al. [10] observed medical students undergoing training with VL, they found an average intubation performance 11 seconds faster than that of the control group.

Vanderbilt et al. [11] showed in their meta-analysis that the simulation-based practicing is a very effective way for training with VL skills and that VL allows for a higher success rate, faster response time and a decrease in the number of attempts by health care students and health care professionals under the conditions based on the eleven studies reviewed. Thus, some authors advocate the standardization of VL as the technique of choice for the initial approach in all cases of tracheal intubation, considering it to be efficient and safer for patients, and recommending that all anesthesiologists receive adequate training and have access to these devices [12]. Another highlight for learning with VL is that the instructor can accompany the maneuver simultaneously viewing the screen and can make observations or instant corrections to guide the inexperienced laryngoscopist. Studies using VL as a teaching tool for novices performing tracheal intubation in neonates and infants, showed a greater success rate of tracheal intubation [13]. In a simulation-randomized trial evaluating the impact of introducing a VL in the initial training of laryngoscopy for under graduated medical students, Malito et al. [8] showed that the VL group were faster than the direct laryngoscopy (DL) group in all intubation attempts. In parallel, most students in the VL group reported excellent viewing conditions (75% of the attempts received a Cormack-Lehane grade 1 classification). The VL technique favored the glottic structures visualization, which resulted in faster intubations. In our study, simulation learning permitted significant lower time for intubation and fewer attempts, which is safer for patients arriving to the ED in critical condition. This kind of training should be introduced in the training course of emergency medicine and intensive care residents to generalize the use of VL in the ED and to improve conditions of intubation in the ED. It also should be scheduled regularly to maintain knowledge and skills.

This study had some limitations. Training mannequins do not accurately reproduce the airway anatomy, the muscle tone of the structures or the presence of secretions. Therefore, the results do not directly represent what occurs in clinical practice. Further studies with larger samples of participants evaluating the VL application in the training of different groups, such as academics, resident doctors and experienced physicians, may present more relevant information about the value of these devices in the development and safety of laryngoscopy in the ED. For logistical reasons and a lack of availability of the participants, it has not been possible to follow the students in the post-study period and assess the degree of their retention of the trained technical skill. This type of follow-up could suggest the appropriate time interval to repeat the training to preserve knowledge and skills.

Learning by procedural simulation in the ED provides young residents with a skill that allows them to complete OTI in less time and fewer attempts, which is safer for patients arriving to the ED in vital distress. VL is a valuable tool for teaching medical students the skill of OTI. This type of training should be introduced in training course of all residents practicing in the ED for standardization of use of VL as a technique of choice for the initial approach of tracheal intubation in the ED. Further studies for validation of the long-term benefits of this educational tool should be performed.

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