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Complications of Endotracheal Intubation in the Intensive Care Unit: A Single-center Experience after Training

ORIGINAL INVESTIGATION

İlhan Bahar, Gülseren Elay, Ramazan Coşkun, Kürşat Gündoğan, Muhammet Güven, Murat Sungur

ABSTRACT

Objective: Endotracheal intubation is a frequently performed procedure in the intensive care unit (ICU). Extremely serious complications occur during this procedure. In this study, theoretical and practical training were given to residents who started to work in the medical intensive care unit, and it was aimed to evaluate the complications following training.

Materials and Methods: This study was conducted prospectively.

Results: A total of 36 patients were included in the study; 16 (45%) were male, and the average age of the patients was 64±16.0 years. The most common indications for admittance to the ICU were shock (50%) and acute respiratory failure (36%). The most common indication for intubation was determined as acute respiratory failure (44%). The intubation was performed as an emergency procedure in 27% of these patients, whereas it was performed semi-urgently in 8% and electively in 65%. Among intubated patients, at least one complication developed in 13 (36%) cases. The drugs most commonly used for sedation were midazolam (76%) and propofol (16.7%).

Conclusion: Complications of endotracheal intubation are significant problems in ICUs. A successful procedure of intubation avoids complications. Regular training for endotracheal intubation in the ICU decreases the complications.

Keywords: Endotracheal intubation, learning, clinical skill

INTRODUCTION

In the intensive care unit (ICU), maintaining the patency of the airway is important (1, 2). The physiological reserves of intensive care patients are limited and unstable. In addition to these, the intubation time is also limited (3). The ICU is a chaotic environment. Advanced intubation techniques are not present, and the intubation procedure is performed by basic equipment. Furthermore, this procedure is performed by physicians having various degrees of experience (4). Drugs used during endotracheal intubation lead to hypotension. Life-threatening complications develop during this procedure (1, 5). Generally, the rate of these complications is approximately 39%-41% (6, 7). In a previous study conducted at the same clinic, the complication rate was determined as 41% (6). Studies have shown that the complication rate decreased following training (8).

Our aim was to determine the rate of complications during endotracheal intubation, following theoretical and practical training of residents of the internal medicine department who were working in the medical intensive care unit (MICU).

MATERIALS and METHODS

This study was conducted prospectively in the MICU of the Erciyes University Medical Faculty between May 1st, 2014 and October 1st, 2014. Approval of Erciyes University Ethics Committee was obtained for the study (Number: 2014/222, Date: 04.04.2014). Written informed consent for all procedures was obtained from patients or their relatives. All patients intubated with various indications were enrolled in the study. The demographic data of the patients, indications of the patients for admittance to the ICU and their intubations, emergency conditions regarding the intubation, the lowest and highest systolic-diastolic blood pressures before and after the intubation, heart rate, oxygen saturation, Glasgow Coma Score, fluid volume administered before intubation, and whether they received vasopressor drugs were recorded. Additionally, airway support used in patients prior to the intubation was also recorded. The duration of internal medicine training for the resident performing the intubation procedure, the number of the resident in the row of physicians performing that intubation, the number of attempts for laryngoscopy, and intubation time were also recorded. Drugs used for anesthesia induction for the intubation procedure were recorded. Complications that developed during the procedure were recorded.

Department of Medicine, Division of Intensive Care, Erciyes University Faculty of Medicine, Kayseri, Turkey

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Correspondance
Dr. İlhan Bahar, Erciyes Üniversitesi Tıp Fakültesi, Yoğun Bakım Bilim Dalı, Kayseri, Türkiye
Phone: +90 507 349 93 47
e.mail: inb2001@gmail.com

The MICU was a tertiary care unit consisting of 18 beds. In this unit, 1st, 2nd, and 3rd year residents (Internal Medicine, Emergency Medicine, Infectious Diseases, and Pulmonary Medicine) who work in rotation for 3–4 months duration were present. Additionally, there were residents of Intensive Care Subspecialty working in this unit.

Training of the residents for endotracheal intubation was performed by an experienced physician who specialized in this subject. Each group was trained by the same person. Training consisted of two sections. The first section was theoretical, and the second section involved practical training on models. Training was performed according to the Guideline of American Society of Anesthesiologists (9).

Statistical analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) 15.0 for Windows (SPSS Inc.; Chicago, USA). For the assessment of categorical data and continuous variables, chi-square test and independent t-test were performed, respectively. $P<0.05$ was considered significant.

RESULTS

A total of 36 patients were enrolled in the study. General data of the patients enrolled in our study are shown in Table 1. In total, 16 (45%) of the patients were female and 20 (55%) were male. The mean age of the patients was 64±16.0 years. The most common indications for admittance to the ICU were shock (50%) and acute respiratory failure (36.1%). The most common indication for intubation was determined as acute respiratory failure (44.4%).

The number of patients who did not develop complications was significantly higher in the group of patients intubated for shock (p=0.047). As shown in Table 2, the intubation was performed as an emergency procedure in 27% of the patients, whereas it was performed semi-urgently in 8% and electively in 65%. Among these patients, at least one complication developed in 13 (36%) cases. The common complication was difficult intubation (21%) (Figure 1). When the duration of residency training was taken into consideration for physicians who performed the intubation, it was observed that the highest number of intubations belonged to physicians who were residents for 2 years (75%) (Table 2). In addition, 61% of the intubations were performed during the first laryngoscopy attempt. When patients who developed complications were compared in terms of laryngoscopy attempts with patients in whom no complications were observed, the complication rate was determined to be increased with an increasing number of attempts for laryngoscopy ($p<0.001$). A total of 77 laryngoscopy attempts were performed on patients (Table 2). As shown in Table 3, the most frequently used drugs were midazolam (76%) and propofol (16.7%) for sedation.

When the group with complications was compared with the complication-free group, there were no significant differences between the lowest systolic blood pressures measured before and after the endotracheal intubation (p=0.097) (Figure 2).

When the group with complications and the complication-free group were compared in terms of the highest pulse rates measured before and after the endotracheal intubation, there were no significant differences (p=0.99) (Figure 3).

Table 1. General characteristics of the patients

Variable	Total n=36	Complication n=13	No complication n=23	p
Age, (±SD) years	64±16.0	62.5±21.0	64.2±16.0	0.242
Weight, (±SD) kg	74.5±19.0	70.3±20.0	76.8±18.0	0.503
Length, (±SD) cm	163.8±8.9	163.8±8.5	163.8±9.1	0.965
Sex, n (%)				
Male	16 (45)	5 (31)	11 (69)	0.001
Female	20 (55)	7 (35)	13 (65)	0.001
Reasons for admission to the intensive care unit, n (%)				
Acute respiratory failure	13 (36)	5 (38)	8 (42)	0.178
Shock	18 (50)	6 (33)	12 (67)	0.075
Trauma				
Cardiac arrest	3 (8.3)	1 (33)	2 (66)	0.294
Neurological	2 (5.6)	1 (50)	1 (50)	0.396
Other				
Intubation reasons, n				
Acute respiratory failure	16 (44.4)	7 (43.7)	9 (56.2)	0.074
Shock	13 (36.1)	4 (30.7)	9 (69.2)	0.047
Coma	1 (2.7)	0	1 (100)	0.460
Tube exchange	2 (5.5)	0	2 (100)	0.360
Unplanned extubation	4 (11.1)	2 (50)	2 (50)	0.141

SD: standart deviation

Table 2. General information regarding the intubation process

Variable	Total n=36	Complication n=13	No complication n=23	p
Intubation time, n (%)				
Night	18 (50)	4 (28.5)	14 (77.7)	0.210
Day	18 (50)	9 (50)	9 (50)	0.70
Amount of fluid, mL (%)				
500	18 (50)	4 (28.5)	14 (77.5)	0.982
Did not receive additional liquid	18 (50)	9 (50)	9 (50)	0.030
Intubation urgency, n (%)				
Urgent	10 (27)	4 (40)	6 (60)	0.310
Semi-urgent	3 (8)	2 (66.6)	1 (33.3)	0.236
Elective	23 (65)	7 (30)	16 (70)	0.184
Vasopressor use, n (%)	10 (100)	3 (30)	7 (70)	0.908
Ventilation prior to intubation				
Non-invasive MV	15 (41.6)	5 (33.3)	10 (66.6)	0.226
Invasive MV	5 (13.8)	2 (40)	3 (60)	0.162
O_2 mask	16 (44.4)	6 (37.5)	10 (62.5)	0.132
Resident working time, years (%)				
1 year	1 (2.7)	0	1 (100)	0.460
2 year	27 (75)	9 (33.3)	18 (66.6)	0.049
3 year	8 (22.2)	3 (37.5)	5 (62.5)	0.176
Number of attempts to perform laryngoscopy, n (%)				
1	22 (61)	6 (27.2)	16 (72.7)	0.466
2	5 (13.8)	4 (80)	1 (20)	0.175
3	2 (5.5)	1 (50)	1 (50)	0.396
5	1 (2.7)	0	1 (100)	0.460
6	4 (11.1)	0	4 (100)	0.701
8	2 (5.5)	1 (50)	1 (50)	0.236

MV: mechanical ventilation

Table 3. Drugs used for induction of anesthesia

Variable	Total n=36	Complication n=13	No complication n=23	p
Hypnotic, n (%)				
Propofol	6 (16.7)	1 (20)	5 (80)	0.03
Etomidate	1 (2.7)	0	1 (100)	0.69
Midazolam	23 (76)	4 (13.9)	19 (86.1)	0.002
Neuromuscular drugs, n (%)				
Vecuronium bromide	1 (100)	0	1(100)	0.57

DISCUSSION

In this study, we aimed to determine the complications of endotracheal intubation, following theoretical and practical training of residents of the internal medicine department who were working in the MICU. Because the complication rate was found to be high (41%) in a previously conducted study at our clinic (6), we performed this study.

As a result of this study, we determined that the complication rate of endotracheal intubation was 36%. The rate of life-threatening complications was 11%, mainly consisting of severe hypoxemia (8%) and cardiac arrest (2%). In the previous study conducted at our clinic (6), the life-threatening complication rate was found to be 19% (severe hypoxemia 12% and cardiac arrest 7%). The reduction in the rate of life-threatening complications can be explained by the contribution of theoretical and practical training. When fluid administration prior to intubation was evaluated, 4 out of 18 patients who were administered fluids (500 mL or less) developed complications and 14 were complication-free. Complications developed in 9 out

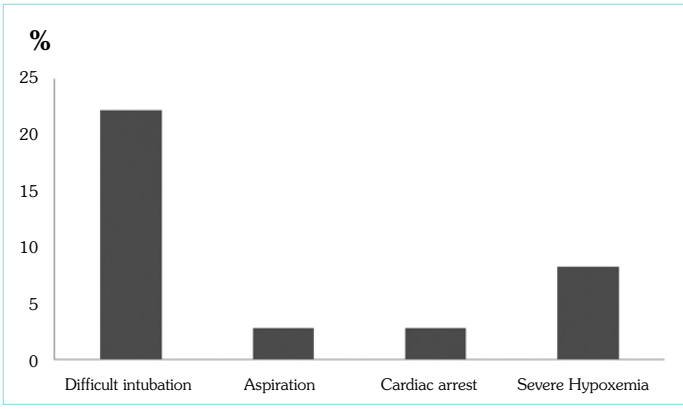

Figure 1. Severe complication of endotracheal intubation

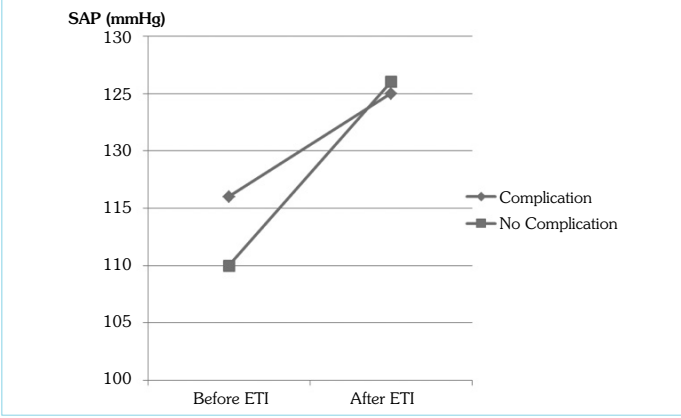

Figure 2. Systolic blood pressure before and after intubation
SAP: systolic arterial pressure; ETI: endotracheal intubation

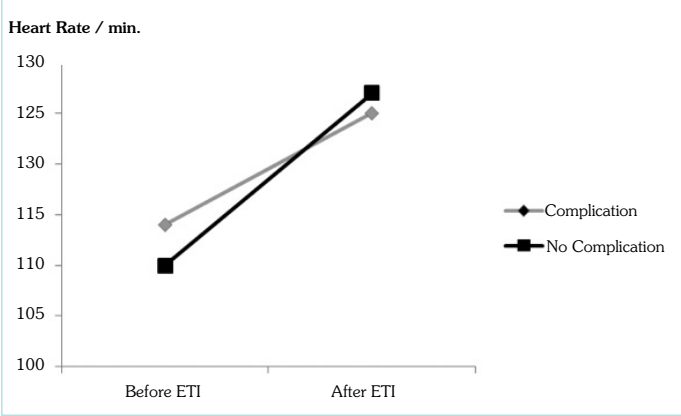

Figure 3. Heart rate before and after intubation
ETI: endotracheal intubation

of 18 patients who did not receive any fluids, whereas 9 were complication-free. Fluid administration prior to the intubation might have reduced the rate of cardiac arrest by avoiding hypotension. In studies with etomidate which has less adverse effects on hemodynamics than other agents, a single dose of etomidate was shown not to have any effect on mortality in patients with septic shock (10, 11). Ketamine is another preferred agent in patients with septic shock. In studies conducted with this drug, no adverse effect was present regarding mortality (12). In our study, midazolam was the most commonly used drug (76%) for the induction of anesthesia. In a study in which midazolam and propofol were used in combination, midazolam caused more hypotension (13). We suggest that they preferred using midazolam because midazolam usage was more habitual in our clinic. Patients using propofol had less complications compared with those using midazolam and ethomidate during intubation (p=0.002). When both studies were compared, the other complication with a decreasing rate was severe hypoxemia. The reason for the decrease of this severe complication might have been that the SpO_2 (pulse oximetry) value of the patient had been maintained at or above 94% using ambu mask ventilation prior to intubation. We emphasized this subject in our training sessions.

In their study, Gündoğan et al. (6) have found that the rate of tooth injury as 10% and dangerous agitation as 1%. In our study, we did not observe the complications mentioned above. The highest complication rate belonged to difficult intubation (21%) in our study. This ratio was found to be 23% in the study previously conducted at our clinic (6). The rates found in both studies were similar. The reason for this might have been the inadequate intubation experience of residents in internal medicine. In another study, the difficult intubation rate was 12% (14). In that study, the people who performed the intubation procedure were experienced anesthesiologists. That value was significantly lower than our rate. In another study, Sanders et al. (10) reported the rate of difficult intubation as 6%. In that study, the operators performing the intubation were more experienced.

In our study, the success rate of intubation was 61% in the first attempt. The complication rate was determined to increase with an increasing number of laryngoscopy attempts. In our previous study, the successful intubation rate was found to be similar. In their study, Sanders et al. (10) demonstrated a success rate lower than ours at the first laryngoscopy attempt (37%). The similarity of their study to ours is that, in both studies, residents were responsible for intubations. In another study, experienced anesthesiologists performed the intubations, and the first attempt success rate was 95% (16). Our finding of a low success rate at the first attempt and this rate left unchanged following training might have been related to experience. Residents work in periods of 4 months in our clinic. They do not perform many intubations outside the ICU.

The limitations of our study are inabilities to implement Sellick's maneuver, rapid sequence intubation, and difficult airway strategy in our ICU. When emergency intubation becomes necessary, Sellick's maneuver can avoid aspiration pneumonia in patients fed by enteral nutrition in ICUs.

CONCLUSION

In Turkey, excluding anesthesiology, a significant number of residents in the departments of internal medicine continue working in ICUs. Endotracheal intubations are frequently performed in ICUs in which these residents are working. Because of the intubation procedure, a high rate of complications is observed. Some of these complications can be avoided by regular training.

Ethics Committee Approval: Ethics committee approval was received for this study.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Authors' Contributions: Conceived and designed the experiments or case: İB, GE. Performed the experiments or case: RC, KG. Analyzed the data: MG, MS. Wrote the paper: İB, GE. All authors have read and approved the final manuscript.

Conflict of Interest: The authors declare that there is no conflict of interest.

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