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Original Article

Characteristics and outcomes of patients requiring airway rescue by the difficult airway response team in the emergency department and wards: A retrospective study

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Abstract

Objective: In this retrospective cohort study, we aimed to determine the characteristics and outcomes of patients in the emergency department (ED) and wards who required emergency tracheal intubation by the difficult airway response team (DART). **Materials and Methods:** All patients between 18 and 80 years old receiving emergency tracheal intubation by the DART at a single tertiary referral hospital from January 2014 to December 2016 were reviewed and divided into ward and ED groups. Patient characteristics, comorbidities, indications for intubation, airway maintenance technique, and survival-to-discharge rates were analyzed and compared. **Results:** Totally, 192 patients (ward, n = 135; ED, n = 57) were eligible for the current study. Compared with the ward group, patients in the ED group were younger (58.9 ± 13 vs. 51.5 ± 15.6 years, P = 0.001), male-predominant (71.1% vs. 87.7%, P = 0.014), and had a higher incidence of trauma (6.7% vs. 22.8%, P = 0.001). The most common indications for tracheal intubation were respiratory distress (52.6%) and cardiac arrest (17.8%) in the ward group, and respiratory distress (31.6%) and airway protection (28.1%) in the ED group. Patients in the ED group received more fiberoptic intubations (42.1% vs. 17.8%, P = 0.039) and had a higher survival-to-discharge rate (87.7% vs. 44.4%, P < 0.001) than those in the ward group. **Conclusions:** Better recognition of differences in patient characteristics and indications for intubation in different units of the hospital may enable the DART to customize specialized equipment to improve efficiency and implement appropriate strategies for airway rescue to improve patient outcomes.

Keywords: *Airway response team, Emergency tracheal intubation, Survival rate*

Introduction

Emergency tracheal intubation (ETI) is a common procedure for patients with cardiopulmonary distress, airway obstruction, or cardiac arrest. Inability to intubate and ventilate critically ill patients is associated with significant morbidity and mortality. Not only is the incidence of difficult tracheal intubation higher in nonoperating room (OR) settings (10.3%) than in the OR (5.8%) [1,2], but the rates of various complications as well as cardiac arrest are also higher for ETI outside the OR [3,4].

Previous studies have reported high initial and overall success rates for tracheal intubation performed by emergency department (ED) residents and attending physicians [5-7] comparable with those for anesthesia physicians in the intubation of trauma patients [8]. This finding is compatible with that of another large-scale study of 3423 emergency non-OR intubations, in which only 1.1% occurred in the ED, whereas 60.3% and 38.6% were in the intensive care unit and wards, respectively [1]. In one study, the incidence of airway rescue in the ED was relatively low at 3%, and emergency physicians could not satisfactorily handle this procedure without assistance from other specialists (e.g., anesthesiologists) [9]. Therefore, it is anticipated that this subgroup of patients may have clinical features distinct from those in other hospital units.

The activation of a difficult airway response team (DART), which is responsible for airway rescue, has been reported to reduce the incidence of surgical airway [10,11] and in-hospital cardiac arrest [12]. However, the characteristics and clinical features of patients requiring airway rescue by the DART in

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the ED remain poorly addressed. In this study, we aimed to determine the characteristics and outcomes of patients in need of airway rescue in an ED setting to customize specialized equipment and tailor appropriate strategies to cater for the special needs of this patient population. A control group of patients receiving ETI by the DART in a non-critical care setting (ward) was used for comparison.

Materials and methods

Patient population

With the approval of the Institutional Review Board (EMRP-106-028), all call events for the DART in the hospital committee records were retrospectively reviewed from January 1, 2014, to December 31, 2016. The study group comprised patients receiving ETI by the DART in the ED of a tertiary care hospital. Exclusion criteria included: (1) incomplete or inconsistent data; (2) airway established by other physicians before DART arrival; (3) pregnancy; (4) inappropriate activation; (5) activation of the DART because of accidental self-extubation; (6) patient age >80 years; (7) documented "not for resuscitation" order; and (8) tracheostomy *in situ*. All patients' data were anonymized and de-identified before analysis. The patients were divided into two groups, the ED group and the ward group, based on the hospital location where ETI was performed by the DART.

Characteristics of the difficult airway response team

The DART at our institution was formed for airway rescue outside the OR. It is led by an anesthesia resident with a minimum of 2 years of anesthesia training, a certified registered anesthesia nurse, and an attending anesthesiologist. The DART provides airway services 24 h/day 7 days/week and is called to hospital locations through a "stat" alert. The consensus criteria for activation of the DART include two futile attempts to establish an airway with a Macintosh laryngoscope or the presence of a complex airway (limited oral opening). Following DART activation, advanced airway equipment (fiberoptic bronchoscopes) is brought to the scene. In our institution, Macintosh laryngoscopes and fiberscopes are the most commonly used rescue devices outside the OR.

Tracheal intubations are performed by an anesthesia resident at the discretion and under the supervision of an attending anesthesiologist. Cricoid pressure is applied during intubation to limit gastric distention and passive regurgitation. According to policies in our institution, tracheal intubation without the use of neuromuscular block agents (succinylcholine) is attempted initially in patients in cardiopulmonary distress. If patients are unable to cooperate with the intubation procedure, sedatives (midazolam), or neuromuscular blocks are administered at the discretion of the DART. If repeated tracheal intubation is required, the DART provides noninvasive bag valve mask oxygen ventilation before another intubation attempt. To confirm successful tracheal intubation, a capnometer is used in most instances to assess the end-tidal carbon dioxide concentration, along with inspection and auscultation of the chest and epigastrium. If an airway cannot be successfully established after three intubation attempts, an otolaryngologist is called to the bedside to create a surgical airway. Chest radiography is routinely performed after intubation to determine the distance between the carina and the tip of the tracheal tube.

Study parameters

Data on patient characteristics (age, gender), anthropometric parameters (body weight, height, body-mass index [BMI]), comorbidities (diabetes mellitus, hypertension), indications for airway management (altered mental status, respiratory distress), airway devices (fiberscope), time of intervention (day shift: 8:00 a.m. – 4:00 p.m.; evening shift: 4:00 p.m. – midnight; night shift: midnight – 8:00 a.m.), and survival-to-discharge rate (the patient was alive at discharge) were retrospectively collected.

Statistical analysis

Quantitative variables were expressed as mean value ± standard deviation, while qualitative variables were expressed as percentages (%). Parametric values between the two groups were compared using the two-tailed Student's *t*-test, whereas categorical variables were compared using the Chi-square or Fisher's exact test. Data were analyzed using SPSS (version 20, SPSS Inc., Chicago, IL, USA) and $P < 0.05$ was considered statistically significant.

Results

From January 1, 2014, to December 31, 2016, there were 212 call events for the DART in the general wards and ED, an average of 5.9 calls per month. After exclusion of 20 patients (incomplete information, $n = 2$; unexpected extubation, $n = 6$; age >80 or age <18, $n = 12$), the final study population comprised 192 patients [Figure 1]. The baseline characteristics and comorbidities of the two groups are summarized in Table 1. The DART was less frequently activated in the ED ($n = 57$) than in the ward ($n = 135$). There was no significant difference in BMI between groups. Compared with patients in the ward group, those in the ED group were younger (51.5 ± 15.6 vs. 58.9 ± 13 years, respectively, $P = 0.001$), and male predominant (87.7% vs. 71.1%, respectively, $P = 0.014$), and had a higher incidence of trauma ($P = 0.001$) [Table 1]. By contrast, the prevalence of

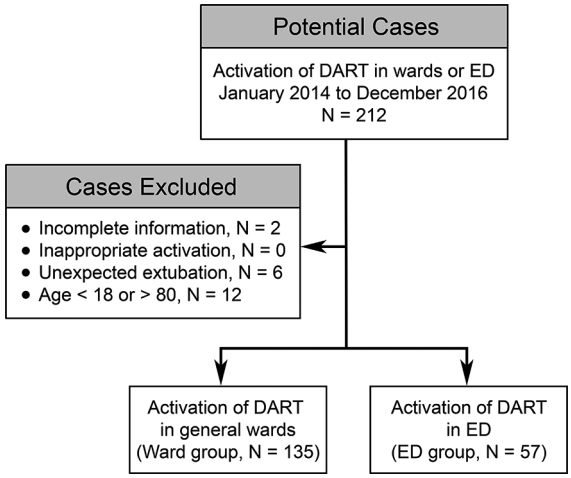

Figure 1: Identification of eligible cases and division into groups after exclusion of inappropriate cases during a retrospective chart review. DART: Difficult airway response team, ED: Emergency department

comorbidities such as a history of diabetes mellitus ($P = 0.021$), renal disease ($P = 0.001$), and liver disease ($P = 0.005$) was lower in the ED group than the ward group.

All tracheal intubations were successfully performed by the DART without resort to surgical airway. Indications for tracheal intubation, advanced airway techniques used (fiberoptic intubation), time of intervention, and survival-to-discharge rates are shown in Table 2. The most frequent indication for ETI in the ward group was respiratory distress (52.6%, $n = 71$) followed by cardiac arrest (17.8%, $n = 24$), while the most frequent indication in the ED group was respiratory distress (31.6%, $n = 18$) followed by airway protection (28.1%, $n = 16$). Respiratory distress was the most common indication for tracheal intubation in both groups. There were significant differences in the prevalence of indications between the two groups [Table 2]. Patients in the ED group received more fiberoptic intubation (42.1% vs. 17.8%, respectively, $P = 0.001$) and had a higher survival-to-discharge rate (87.7% vs. 44.4%, respectively, $P < 0.001$) than those in the ward group [Table 3].

Table 1: Characteristics of patients requiring tracheal intubation at ward versus emergency department

Variables	Ward group (*n*=135)	ED group (*n*=57)	*P*
Gender (male)	96 (71.1)	50 (87.7)	0.014
Age (years)	58.9±13	51.5±15.6	0.001
Height (cm)	163.7±8.7	166.3±8.1	0.057
Weight (kg)	66.4±19.6	68±20.4	0.606
BMI (kg/m^2)	24.7±6.9	24.3±6.2	0.688

Values are mean (SD) or number (proportion). BMI: body mass index.

Table 2: Comorbidities of patients requiring tracheal intubation at ward versus emergency department

Variables	Ward group (*n*=135)	ED group (*n*=57)	*P*
CAD	9 (6.7)	5 (8.8)	0.561
Heart failure	15 (11.1)	5 (8.8)	0.628
AMI	7 (5.2)	1 (1.8)	0.44
Arrhythmias	15 (11.1)	3 (5.3)	0.204
Sepsis	32 (23.7)	10 (17.5)	0.346
Diabetes mellitus	46 (34.1)	10 (17.5)	0.021
Hypertension	46 (34.1)	16 (28.1)	0.416
Renal disease	53 (39.3)	9 (15.8)	0.001
Lung disease	74 (54.8)	28 (49.1)	0.47
COPD	15 (11.1)	5 (8.8)	0.628
Asthma	8 (5.9)	2 (8.8)	0.533
Pneumonia	32 (23.7)	15 (26.3)	0.701
Pulmonary edema	20 (14.8)	6 (10.5)	0.428
Lung cancer	8 (5.9)	7 (12.3)	0.148
Others	10 (7.4)	4 (7.0)	0.924
Liver disease	22 (16.3)	1 (1.8)	0.005
Electrolyte imbalance	31 (23)	8 (14)	0.16
Neurologic disease	22 (16.3)	11 (19.3)	0.614
ENT cancer	31 (23)	17 (29.8)	0.316
Trauma	9 (6.7)	13 (22.8)	0.001
GI bleeding	15 (11.1)	4 (7)	0.385

Values are numbers (proportions). ED group: patients requiring airway rescue at the emergency department, CAD: Coronary artery disease, AMI: Acute myocardiac infarction, COPD: Chronic obstructive pulmonary disease. ENT cancer: Ear, Nose and Throat cancer, GI: Gastrointestinal.

Discussion

The need for airway rescue in the experienced hands of emergency physicians[9] has raised concerns regarding difficulty in airway management in these patients. Although Bair *et al*. analyzed airway rescue techniques after initial failure of tracheal intubation in the ED, patient characteristics and indications for tracheal intubation as well as the outcomes in this patient subgroup were not reported [9]. This study is the first to identify the distinct clinical features of this patient population in an attempt to better address their special needs in terms of equipment and treatment strategy to optimize emergency care.

In our study, the DART was activated less often in the ED ($n = 57$) than the ward ($n = 135$), implying ED physicians are more familiar with tracheal intubation than attending physicians in the ward. In the present study, the prevalence of indications for ETI varied between the two groups. The most frequent indications for ETI in the ward group were respiratory distress (52.6%, $n = 71$), followed by cardiac arrest (17.8%, $n = 24$), highlighting the importance of underlying medical causes for airway rescue. These findings are consistent with those in a previous study of the prevalence of indications (respiratory distress 51.7% and cardiac arrest 44.6%) and incidence of airway rescue in different hospital units (ward vs. ED: 38.6% vs. 1.1%) [1]. In contrast, the indications for DART activation in the ED were respiratory distress (31.6%, $n = 18$) and airway protection (28.1%, $n = 16$), underscoring the acute nature of the reasons for intubation. However, our results contradict those in a previous study which showed a high frequency of DART activation in the ED (71%) which may be attributable to a high incidence of angioedema-associated airway obstruction in that study [13].

Although a study by Mark *et al*. demonstrated that a fiberscope was the most commonly used airway adjuvant by the DART outside the OR [14], the need for special adjuvants in different hospital units was not addressed. Fiberoptic intubation is a common technique adopted by anesthesiologists when anticipating or encountering difficult intubation. In our study, fiberoptic intubation was performed in up to 42.1% of ED patients compared with an incidence of 17.8% in the ward group ($P = 0.001$). The higher prevalence of trauma in the ED than the ward group in the present study may imply higher incidences of head and neck injuries predisposing to suboptimal oropharyngeal visualization and a need for cervical spine immobilization, for which fiberoptic intubation is indicated. This proposal was supported by a previous study of 366 intubation events in the ED, which demonstrated that difficult intubation was more likely in patients with trauma [15]. Moreover, the fact that airway obstruction, which was more common in the ED group (22.8% vs. 10.4% in the ward group), is a commonly accepted indication for fiberoptic intubation may partially account for the relatively high prevalence of this procedure in the ED group than the ward group in the current study. These findings highlight the necessity for including a fiberscope as

Table 3 Indications for tracheal intubation, advanced airway techniques, and survival-to-discharge rate in patients requiring airway rescue in wards or emergency department

Variables	Ward group (*n*=135)	ED group (*n*=57)	*P*
Indications			
Altered mental status	14 (10.4)	8 (14)	0.466
Respiratory distress	71 (52.6)	18 (31.6)	0.008
Airway protection	9 (6.7)	16 (28.1)	<0.001
Airway obstruction	14 (10.4)	13 (22.8)	0.024
Cardiac arrest	24 (17.8)	2 (3.5)	0.008
Fiberoptic intubation	24 (17.8)	24 (42.1)	0.001
Shift during which DART activated			
8:00 a.m. - 16:00 p.m	48 (35.6)	18 (31.6)	0.774
16:00 p.m. - 12:00 p.m	53 (39.3)	22 (38.6)	
12:00 p.m. - 8:00 a.m	34 (25.2)	17 (29.8)	
Survival-to-discharge rate	60 (44.4%)	50 (87.7%)	<0.001

Values are numbers (proportions). ED group: patients requiring airway rescue at the emergency department, DART: difficult airway response team.

standard equipment for airway rescue in ED patients requiring DART intervention as well as the need for adequate training of DART members in this procedure.

Although indications for tracheal intubation appeared to be more acute in the ED group than the seemingly more underlying disease-related causes in the ward group, the survival-to-discharge rate was higher in the ED than the ward group (87.7% vs. 44.4%, respectively, $P < 0.001$). There are several possible explanations. First, patients in the ward were older (58.9 ± 13 vs. 51.5 ± 15.6 years, respectively, $P = 0.001$) and had more comorbidities than those in the ED group. Both factors may partially contribute to the observed difference in the survival rate, taking into consideration a 100% success rate of intubation in both groups. Second, the DART was activated for a higher proportion of patients because of respiratory distress (52.6% vs. 31.6%, respectively, $P = 0.008$) and cardiac arrest (17.8% vs. 3.5%, respectively, $P = 0.008$) in the ward than the ED group. ETI for acute respiratory failure has been reported to be an independent risk factor for severe cardiovascular collapse after it was associated with a significantly higher 28-day mortality rate [16]. The higher rate of respiratory distress in the ward compared with the ED group in the present study ($P < 0.008$), may partly explain the lower survival-to-discharge rate in the former ($P < 0.001$). In addition, peri-intubation cardiac arrest, which has been reported to be a risk factor for difficult intubation [17], has been shown to increase the odds of hospital mortality 14-fold [18]. Hence, the relatively high rate of cardiac arrest in airway rescue patients in the present study may have contributed to a lower survival-to-discharge rate in the ward group. Third, in the ED environment, critically ill patients are monitored, and advanced life support skills are immediately available to allow timely intervention. This has been reported to decrease the incidence of cardiac arrest and improve the outcomes in patients with acute physiological deterioration [19].

In the present study, the mortality rate was 12.3% in ED patients requiring airway rescue by the DART (a survival rate of 87.7%), which is lower than that in a previous study in which ED physicians performed all tracheal intubations in the ED (mortality rate 26%) [18]. Heffner *et al*. reported that patient weight was independently associated with peri-intubation cardiac arrest with the odds of cardiac arrest increasing 1.37-fold for every 10 kg increase in weight [18]. Cardiac arrest, in turn, was associated with a 14-fold increase in the odds of hospital death as mentioned above. Therefore, the relatively low incidence of mortality in the ED group in the present study may be partly attributed to the lower body weight of our ED patients (68 ± 20.4 kg) compared with that in the study by Heffner *et al*. (82.2 ± 22.5 kg).

Although ETI-associated acute complications (esophageal intubation, aspiration, and hemodynamic changes) are commonly used as outcome parameters for patients receiving emergency ETI outside the OR [1,20,21], the wide range of differences in the reported incidence, definition, and duration of each complication, as well as discrepancies in data collection, hamper objective comparison. Therefore, the survival-to-discharge rate was used as the final long-term outcome parameter in the present study.

There were several limitations in this study. First, the retrospective setting precluded data collection on immediate complications (hemodynamic changes or hypoxemia). In addition, the differences between ED patients with and without DART assistance were not addressed. Recognizing these differences may allow ED staff to activate the DART more efficiently. Second, although the incidence of complications has been associated with the number of failed laryngoscopic intubation attempts [1,4], this information was not available in this study. Nevertheless, Heffner *et al*. reported that the number of intubation attempts had no negative impact on the occurrence of cardiac arrest, a significant predictor of hospital mortality after ETI in the ED [18]. Third, data in the present study were from a single institution with a DART, which may not be extrapolated to other hospitals without similar functional teams. Fourth, the impact of ED crowding on patient mortality [22] was not evaluated. Finally, although other advanced airway equipment, including the McCoy laryngoscope (Truphatek International Ltd, Netanya, Israel) and Trachway intubating stylet (Trachway; Biotronic Instrument Enterprise, Tai Chung, Taiwan, China), are available in the OR, their use outside the OR is rare. Therefore, the impact of this airway equipment on patient outcomes was not evaluated.

Conclusions

Patient characteristics, airway techniques used, indications for tracheal intubation, and outcomes after airway rescue by the DART varied according to the hospital unit. When airway rescue is required in the ED, anesthesiologists should be alert to the equipment and skills required as well as the appropriate treatment strategy to allow timely intervention and optimize outcomes in this patient population.

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Conflicts of interest

There are no conflicts of interest.

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