

## Pre-hospital airway management preferences of paramedics

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### Abstract

**Aim:** The success of paramedics in the pre-hospital airway management in traumatic and non-traumatic critically ill patients, especially in cardiac arrest, is very important in terms of mortality and morbidity.

**Materials and Methods:** Patients who were admitted to the Emergency Department by pre-hospital emergency ambulance service were included in the study. The standard data registration form was created for the study. Demographic data, pre-hospital and in-hospital vital signs, GCS scores, cardiac rhythms, applied airway method, transport time and 48-hour mortality rates were recorded in the study form.

**Results:** While the initial approach to airway management was a bag-valve mask in 80 patients (82%), advanced airway management was performed in 18 (18%) patients. The mean time period for the ambulance arriving at the patient was  $6.52 \pm 3.06$  min and the mean time period of transport to the hospital was  $11.42 \pm 9.53$  min in all patients. Although there was no difference between patients managed with BVM and patients managed with advanced airway interventions in terms of a time period needed to access patient ( $p=0.957$ ), there were significant differences in terms of a time period needed to access emergency service ( $p=0.001$ ) and total time period ( $p=0.001$ ) Among patients with CPA, there was a significant difference between patients managed with and without advanced airway interventions in terms of 48-hour mortality ( $p=0.035$ ).

**Discussion:** Although the pre-hospital airway management still remains its mystery, we think that providing ventilation with BVM without losing time and transportation to the hospital would be more appropriate for patients in short distances and for patients with less risk of aspiration in terms of mortality and transportation time.

### Keywords

Supraglottic airways; Heart arrest; Airway management

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## Introduction

The success of paramedics in the pre-hospital airway management in traumatic and non-traumatic critically ill patients, especially in cardiac arrest, is very important in terms of mortality and morbidity [1]. Endotracheal intubation (ETI) is regarded as the gold standard for advanced airway management. Misplaced intubation, iatrogenic hypoxia, and disruption of cardiac resuscitation are the disadvantages in patients with cardiac arrest. Also, the success of ETI depends on the experience and skill of the practitioner. The pre-hospital ETI success rates of paramedics were found to be between 33-100% [2]. Therefore, alternative airway management methods such as esophageal-tracheal combitube (ETC), laryngeal mask airway (LMA), LMA Fastrach™ and laryngeal tube (LT) were developed.

While pre-hospital emergency ambulance services in the United States are provided by paramedics, in Europe these services are provided mainly by physicians [2]. Although these services were previously provided only by physicians in our country, the majority of these services are provided by paramedics today [3, 4].

In this study, we investigated the pre-hospital airway management methods preferred by paramedics, the factors that influence these choices and the effect of these methods on mortality.

## Material and Methods

This is a prospective analytical cross-sectional study performed in Antalya Training and Research Hospital. According to our power analyses we aimed to include 98 patients consecutively in the study and an approximately 2 year period (January 3, 2013- January 1, 2015) was estimated by us to consider the aimed number of the patients. Informed consent was obtained from the paramedics and patient relatives for the study. Our study was approved by the ethics committee (approval number 15/5). The patients who were admitted to the Emergency Department of Antalya Education and Research Hospital by 112 emergency ambulance services were included in the study. Patient who were  $\geq 16$  years with the following criteria: a) emergency ambulance service provided by paramedics, b) patients with a Glasgow Coma Scale (GCS)  $\leq 8$ , c) traumatic and non-traumatic patients with an advanced airway management necessity d) patients undergoing proper cardiopulmonary resuscitation were included in the study. The exclusion criteria were as follows: a) transports from hospitals to hospitals, b) emergency ambulance service provided by physicians and patients with malignancies. The number of patients excluded was not recorded. The standard data registration form was created for the study. Demographic data, pre-hospital and in-hospital vital signs, GCS scores, cardiac rhythms, applied airway method, ambulance arrival time period to the patient and the transport period time to the hospital were recorded.

These data were obtained from patient transport form or provided by an on-duty paramedic. In-hospital SPO2 values were measured and recorded. Forty-eight-hour mortality rates of the hospitalized patients were recorded in the study form. In addition, period of professional work experience, training history, ETI and supraglottic airway experiences in the last 1

year, preferred advanced airway management method and the reason for this preference of a total of 28 paramedics were also recorded.

## Statistical analysis

Data were evaluated using SPSS 22 (Statistical Package for the Social Sciences), IBM, USA, licensed by Sivas Cumhuriyet University. Frequency, average value, and percentages were calculated in statistical analysis. Power analyses were made with NCSS PASS-2008 home power analysis and sample size. The sample size and power were calculated according to the previous similar studies by taking mean values, standard deviation,  $\alpha=0.05$ , and  $\beta=0.20$  ( $1-\beta=0.80$ ). As a result, the power was determined as 0,802. According to these results we included 98 patients in this study and then they were classified according to the airway management. The Chi-square is used for the non-parametric values, the Mann-Whitney U test is used to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed. A p- value  $<0.05$  was considered statistically significant.

## Results

The study included 98 patients, 35 (36%) women, and 63 (64%) men. While the admission cause was traumatic in 22 (22.5%) patients, 76 (77.5%) admitted due to non-traumatic diseases. While the first cardiac rhythm detected in CPA (+) patients was following: asystole 22 (69%), Pulseless electrical activity (PEA) 6 (19%), Ventricular fibrillation (VF)/pulseless ventricular tachycardia (VT) 4 (12%), the first rhythm among patients without CPA was as follows: normal sinus rhythm (NSR) 63 (95%), Sinus bradycardia 3 (5%). Twelve (54.5%) traumatic patients and 47(61.8%) non-traumatic patients admitted with a 3 point GCS.

Generally, the initial approach to airway management was bag-valve-mask (BVM) in 80 patients (81.6%); advanced airway management was performed only in 18(18.4%) patients. The correct placement of the tube in all patients with advanced airway interventions was confirmed with a capnograph in the emergency room.

None of the patients had vomiting and aspiration. ETI was preferred as the first option in all patients with performed advanced airway management. LMA was applied only in two patients due to a failed ETI attempt. Due to the failure of ETI in 4 patients with cardiopulmonary arrest, BVM was used as the second choice. There was a significant difference in the preferred airway methods between the patient groups according to cardiac arrest ( $p=0.003$ ) (Table 1). CPA was present in 12 (67%) patients with performed advanced airway management. The mean arrival time for the ambulance to the patient was  $6.52 \pm 3.06$  min and the mean transport time period to the hospital was  $11.42 \pm 9.53$  min in all patients. The patients' arrival time to the emergency services was longer for the cardiac arrest patients ( $p=0.025$ ) (Table 2). Although there was no difference between patients managed with BVM and advanced airway in terms of time period needed to access patient ( $p=0.957$ ), there were significant differences in terms of emergency service arrival time period ( $p=0.001$ ) and total time period ( $p=0.001$ ) (Table 3).

Table 1. Performed airway methods

| Airway management | CPA (+)<br>n (%) | CPA (-)<br>n (%) | Total<br>n (%) |
|-------------------|------------------|------------------|----------------|
| BM                | 20 (25%)         | 60 (75%)         | 80 (100%)      |
| OETI              | 11 (68.7%)       | 5 (31.3%)        | 16 (100%)      |
| LMA               | 1 (50%)          | 1 (50%)          | 2 (100%)       |
| Total             | 32 (32.6%)       | 66 (67.4%)       | 98 (100%)      |

$\chi^2=11.38$ ;  $p=0.003$ ;  $p<0.05$

Table 2. The comparison of the total time period of transportation of patients with and without CPA

|                                         | CPA (+)<br>Mean $\pm$ SD<br>(minute) | CPA (-)<br>Mean $\pm$ SD<br>(minute) | p     |
|-----------------------------------------|--------------------------------------|--------------------------------------|-------|
| Patient access time                     | 6.72 $\pm$ 3.01                      | 6.42 $\pm$ 3.10                      | 0.658 |
| Time period to access emergency service | 14.50 $\pm$ 11.76                    | 9.92 $\pm$ 7.92                      | 0.025 |
| Total time period                       | 19.74 $\pm$ 9.77                     | 16.20 $\pm$ 9.22                     | 0.087 |

Table 3. Comparison of the total time period for transporting patients managed with BVM or advanced airway interventions

|                                         | BVM (n=80)<br>mean $\pm$ SD<br>(minute) | Advanced airway<br>interventions<br>(n=18) mean $\pm$ SD<br>(minute) | P     |
|-----------------------------------------|-----------------------------------------|----------------------------------------------------------------------|-------|
| Time period to access patient           | 6,51 $\pm$ 3,21                         | 6,56 $\pm$ 2,38                                                      | 0,957 |
| Time period to access emergency service | 9,48 $\pm$ 6,87                         | 20,06 $\pm$ 14,23                                                    | 0,001 |
| Total time period                       | 15,86 $\pm$ 8,51                        | 24,24 $\pm$ 11,04                                                    | 0,001 |

Among patients with CPA, the time period needed to access emergency service for patients who were managed with BVM (8.85 $\pm$ 5.78min) was significantly shorter than the patients with advanced airway interventions (20.58 $\pm$ 15.93min) ( $p<0.005$ ). While the admission sPO2 value was 75.72 $\pm$ 22.79 among patients managed with advanced airway, mean sPO2 result was 77.88 $\pm$ 20.69 in the patients managed with BVM among the patients without cardiac arrest, and there was no significant difference between two groups ( $p=0.696$ ). Likewise, the admission SPO2 value was 63.30 $\pm$ 22.21 in patients managed with advanced airway interventions and 67.67 $\pm$ 22.55 in patients managed with BVM among patients with CPA, and there was no significant difference between two groups ( $p=0.644$ ). At the end of the 48-hour follow-up, 49 patients survived and 49 patients died. There was no difference between these patients in terms of transport time periods.

Among patients with CPA, there was a significant difference between patients managed with and without advanced airway management in terms of 48-hour mortality ( $p=0.035$ ). All patients who underwent advanced airway management (n=12) died within 48 hours. While 6 of 20 patients without advanced airway management survived, the remaining 14 patients died. The mean period of professional work experience of paramedics was 5 $\pm$ 3 years. They were found to be trained for ETI, supraglottic airway and BVM on patients, cadavers, and models. Twenty-five (89%) paramedics had not received

advanced airway training except ETI on cadavers and patients. It was found that they practiced an average of 10-12 ETIs and 2 supraglottic interventions in the last year and that 22 (79%) of them preferred ETI, 3 (10.7%) preferred supraglottic airway and 3 (10.7%) preferred BVM as the first choice. The stated reasons for preference were ease of applicability and high rate of success.

Discussion

Appropriate airway management in order to provide effective pre-hospital ventilation in patients is important in terms of mortality and neurological outcome [5]. Although the optimal airway management strategy for patients with CPA is still unclear, it is recommended that best airway management should be determined by the environmental conditions and practitioner’s knowledge and skills and that supraglottic airway methods should be used as an alternative to gold standard ETI in the airway management in the pre-hospital setting [6,7].

Supraglottic airway methods provided rapid and effective ventilation during cardiopulmonary resuscitation (CPR) and were suggested as an alternative to ETI as they minimized the duration of chest compression interruption [8]. In a study by Bahathiq et al. paramedics in difficult and easy airway scenarios, they achieved 68% success by direct laryngoscopy, 97% by LMA and 97% by video laryngoscopy on the first attempt in easy airway scenario. The success rates were 60%, 90%, and 94% respectively in difficult airway scenario. In the same study, the time period for the provision of airway in case of easy and difficult airway scenarios were 31.5 vs. 40 seconds by direct laryngoscopy, 20 vs. 19 seconds by LMA and 22 vs. 21 seconds by video laryngoscopy, respectively [9].

In a study, paramedics achieved successful crash ETI in 29 (64%) patients out of 45 patients, including 27 patients with CPA. They also had a success rate of 92% for crash supraglottic airway attempt [10]. Timmerman et al. found that the success rate of inexperienced practitioners was 90% on the first attempt and 100% on the second attempt for LMA, and the application period was found to be as short as 10-30 seconds [11]. Likewise, Reutzler et al. found that paramedics had a success rate of 78% and duration of 24.43 sec. for ETI on models, and a success rate of 100% and duration of 10.8 sec. for LMA [12]. Besides having higher success rates, short application period of supraglottic airway methods is another advantage. In our study, ETI was attempted in patients with CPA, but only 69% of them were successful, so 1 patient had undergone LMA and 4 patients had undergone BVM. As in other studies, ETI success rate was found to be lower in our study. Although supraglottic airway devices were present in the ambulance and supraglottic airway interventions are a part of the training of paramedics, supraglottic airway interventions had been used only in 2 patients. Although ETI was the preferred method in terms of applicability and success rate, we believe that one of the main reasons of disfavor of supraglottic airway interventions by paramedics is basically the lack of experience, possibly due to inadequate supraglottic airway applications in the last year, application of supraglottic airway training only on models, and inadequacy of training on cadavers or patients. Ventilation with BVM is the most basic positive pressure ventilation technique.

But it may be inadequate to provide effective ventilation. Some portion of the air that was aimed to be sent to the lungs during ventilation with BVM continuously flows to the stomach and distends the stomach. Regurgitation and aspiration due to stomach distension are the most serious complications. These complications hinder the effectiveness of CPR. The success rate of effective ventilation with BVM is 43-51%. While the incidence of aspiration was 12% with BVM, it was 3% with LM [13]. In another study performed in non-hospital cardiac arrest patients, the success rate of effective ventilation with LM was found to be 85% [14]. In our study, 80 patients (82%) had been transported with BVM and aspiration was not detected in any of our patients. We linked the absence of aspiration to a short time period ( $9.48 \pm 6.87$  minutes) needed to access emergency service and the inability of BM to cause gastric distension and regurgitation in such a short time. No significant difference was detected between patients managed with BVM and patients managed with advanced airway interventions among patients with cardiac arrest in terms of admission sPO<sub>2</sub> values. This situation was interpreted as the similarity of ventilation efficiency of BVM to advanced airway interventions in short ranges. This finding supports the idea that BVM may be used for transportation of patients for short distances.

There is no evidence that advanced airway placement increases survival rates in CPA in the pre-hospital setting. During a CPR with rescuers with good knowledge of supraglottic airway, supraglottic airway interventions are good alternatives to BVM (Class IIa, Level of Evidence B) and ETI (Class IIa, Level of Evidence A) [15]. In a study in patients with pre-hospital CPA in Japan, patients managed with advanced airway methods were found to have worse neurological outcomes compared to patients managed with BVM [16]. In their systematic review, Jensen et al. compared ETI with alternative airway methods and found no difference in any study in terms of mortality rates [17]. Likewise, compared with BVM, advanced airway interventions were found to increase mortality especially in CPA cases in a number of other studies [18, 19].

Consistent with the literature, 48-hour mortality was also found to be increased in CPA patients with advanced airway management compared to patients with BVM in our study. Regarding transportation durations, while there was no difference between patients with and without CPA in terms of a time period needed to access patient, a time period of access to emergency service significantly increased in patients with CPA. Likewise, a time period of access to emergency service was significantly higher in patients with advanced airway management compared to patients managed with BVM among CPA patients. Among all patients, a time period of access to emergency service was significantly increased in patients with advanced airway management compared to patients managed with BVM. Especially in CPA and ETI patients, arrival time period to emergency service has been increased due to lack of paramedics' experience, unsuitable ETI conditions of the ambulance and unsuccessful trials of ETI during transport. Lack of significant difference in effective ventilation in patients managed with BVM and the presence of significantly reduced mortality support the use of BVM in patients with particularly short transport duration and less risk of aspiration.

The most common cardiac rhythms in patients with pre-hospital CPA were VF and pulseless VT, followed by pulseless electrical activity (PEA) and asystole. The return of spontaneous circulation possibility of VF decreases by time, and rhythm turns into asystole or pulseless electrical activity [20-22]. In our study, emergency service admission rhythm was asystole in 69% of the patients. The increased rate of asystole was thought to be associated with delayed activation of the ambulance system.

### Limitations

Conditions associated with increased mortality, such as multisystem injuries in trauma patients and concomitant diseases in non-traumatic patients, were not evaluated. The absence of alternative airway methods, except for 2 patients, highlighted the comparison of ETI method and BVM. As there are no clear studies in terms of the transportation durations of patients in the literature, we introduced the short distance as a predicted period of time. Also, we did not know the consistency of capabilities of participant paramedics. We believe that our results on transportation duration and airway method preference will become stronger and clearer with future studies in multicenter studies with larger patient populations.

### Conclusion

Although pre-hospital airway management still keeps its mystery, effective ventilation should be ensured as soon as possible and the patient should be transported. As is the case in our study, we think that providing ventilation with BVM without losing time and transport to the hospital for patients in short distances and for patients with less risk of aspiration would be more appropriate in terms of mortality and transport time.

### Scientific Responsibility Statement

*The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.*

### Animal and human rights statement

*All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.*

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### Conflict of interest

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