

Airway Control During Cardiopulmonary Resuscitation: The Experience and Knowledge of Physicians Most Likely to Encounter Patients Requiring Airway Support

Kardiyopulmoner Resüsitasyon Sırasında Havayolu Kontrolü: Havayolu Desteği Gerektiren Hastalarla Karşılaşması En Muhtemel Hekimlerin Deneyim ve Bilgileri

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ABSTRACT

Objective: We aimed to assess the knowledge levels and experience of physicians that often perform in-hospital cardiopulmonary resuscitation (CPR) in terms of their approach to airway management.

Methods: A questionnaire evaluating approach to CPR and airway management was sent to the most current email addresses of physicians (that were working in departments most likely to encounter patients requiring airway support due to in-hospital cardiopulmonary arrest. The participants' age, specialty, experience as a physician, knowledge levels about airway management, and experience with various methods of airway control were questioned.

Results: Among the participants, 83.8% (n=212) were in anesthesiology, while 16.2% (n=41) were in other branches of medicine. The frequency of practicing intubation was less than 10 times per year in 7.3%, between 10-35 times per year in 12%, and more than 35 times per year in 80.7%. Overall, 37% (n=132) reported that they attempted intubation >3 times in case of unsuccessful intubation. The frequency of using muscle relaxants when faced with difficult intubation was reported as 'rarely' by 35% of participants. Anesthesiologists had significantly better knowledge regarding airway management and higher experience with advanced methods.

Conclusion: Our results indicate a significant level of inappropriate knowledge and behavior among physicians. We believe that physicians who frequently apply CPR should further develop and update their knowledge and skills in order to provide better care for patients

Keywords: Cardiopulmonary resuscitation, airway management, supraglottic airway devices

ÖZ

Amaç: Hastane içi kardiyopulmoner resüsitasyonunu (KPR) sıklıkla uygulayan hekimlerin havayolu yönetimine yaklaşımları açısından bilgi düzeylerini ve deneyimlerini değerlendirmeyi amaçladık.

Yöntem: Kardiyopulmoner resüsitasyon ve havayolu yönetimine yaklaşımı değerlendiren bir anket, hastane içi kardiyopulmoner arrest nedeniyle havayolu desteği gerektiren hastalarla karşılaşma olasılığı en yüksek bölümlerde çalışan hekimlerin en güncel e-posta adreslerine gönderildi. Katılımcıların yaşı, uzmanlık alanı, hekimlik deneyimi, havayolu yönetimi hakkındaki bilgi düzeyleri ve çeşitli havayolu kontrol yöntemleriyle ilgili deneyimleri sorgulandı.

Bulgular: Katılımcıların %83,8'i (n=212) anesteziyoloji, %16,2'si (n=41) diğer tıp dallarındandı. Entübasyon uygulama sıklığı %7,3'ünde yılda 10 kereden az, %12'sinde yılda 10-35 kez arasında ve %80,7'sinde yılda 35 kereden fazla idi. Genel olarak, %37'si (n=132) başarısız entübasyon durumunda >3 kez entübasyon girişiminde bulduklarını bildirmiştir. Zor entübasyonla karşılaşıldığında kas gevşetici kullanma sıklığı katılımcıların %35'i tarafından 'nadiren' olarak bildirilmiştir. Anestezi uzmanları havayolu yönetimi konusunda anlamlı derecede daha iyi bilgiye ve ileri yöntemler konusunda daha yüksek deneyime sahipti.

Sonuç: Sonuçlarımız, hekimler arasında önemli düzeyde uygunsuz bilgi ve davranış olduğunu göstermektedir. Sıklıkla KPR uygulayan hekimlerin hastalara daha iyi bakım sağlayabilmek için bilgi ve becerilerini daha da geliştirmeleri ve güncellemeleri gerektiğine inanıyoruz.

Anahtar sözcükler: Kardiyopulmoner resüsitasyon, havayolu yönetimi, supraglottik havayolu araçları

Received/Geliş tarihi : 24.03.2024
Accepted/Kabul tarihi : 11.01.2025
Publication date : 31.01.2025

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Cite as: Dadakci YC, Anka Yilbas A, Uzunçugil F, Akca B, Canbay O, Kanbak M. Airway control during cardiopulmonary resuscitation: The experience and knowledge of physicians most likely to encounter patients requiring airway support. JARSS 2025;33(1):26-31.



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INTRODUCTION

Endotracheal intubation is considered to be the gold-standard method of airway control during cardiopulmonary resuscitation (CPR); however, its successful implementation depends on the knowledge and experience of those who perform the intubation (1-3). The use of supraglottic airway devices (SADs), which require less experience and can be placed without interruption of chest compressions are also recommended as a rather rational option by the current guidelines (4-9).

There is no consensus regarding the level of experience required for a health professional to be considered a 'competent' practitioner of endotracheal intubation (10-12). Intubation attempts by inexperienced hands during CPR may be associated with many complications, especially due to increased duration of interruption of chest compressions (hands-off time). The aim of this study was to evaluate the knowledge, experience and choices of physicians, without an international advanced life-support provider certification, who work in emergency services, intensive care services and the operating rooms of training hospitals located in Turkey, regarding overall airway control and the use of SADs during CPR.

MATERIALS and METHODS

Following ethical committee approval (Non-Interventional Clinical Research Ethics Committee, decision date: 29/03/2017, decision no: GO 17/254-09), physicians actively working in the emergency departments, intensive care units, and operating rooms of university hospitals and 'training and research' hospitals in Turkey were included. Questionnaire forms that were designed to assess experience, knowledge and choices of physicians were delivered to the participants between May 1 and July 1, 2017, via email through anesthesiology associations. Exclusion criteria were not willing to participate, having an active internationally accepted advanced life-support certificate.

Demographic characteristics (age, specialty, working unit, experience as working years), experience in CPR and advanced airway techniques (frequency of performing CPR, frequency of intubation, and use of SAD), preferences on airway approach during CPR (time spent for intubation, availability of airway devices at their work place, and basic methods), approach to difficult airway cases (alternative airway methods, experience with emergency front of neck access (eFONA), use of neuromuscular blockers, number of intubation attempts), approach to verify endotracheal tube location, and reasons for using end-tidal CO₂ (EtCO₂), were assessed in the questionnaire form. The physicians participating in the study were grouped according to their experience (in three groups: general practitioners, residents and specialists) and specialty (an-

esthesiologists and non-anesthesiologists). Appropriate data were grouped according to current guidelines (cut-off point for hands off time was accepted as 5 sec, for endotracheal intubation attempts as 3 attempts).

Statistical Analysis

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) for Windows version 20 (SPSS Inc., Chicago, IL). The normality of distribution of quantitative variables was evaluated by the Kolmogorov-Smirnov test (Lilliefors correction). Quantitative variables with normal distribution were depicted by mean \pm standard deviation, while those that were non-normally distributed were given by median (minimum-maximum) values. Categorical variables were shown as numbers (count, N) and percentage. Pearson's chi-square test and Fisher's Exact test were used to compare the subgroups of categorical data. In comparisons of quantitative data, t-tests or the Mann-Whitney U test was used according to normality of distribution. Comparisons yielding a p value of <0.05 were considered statistically significant.

RESULTS

A total of 357 physicians filled out the questionnaire completely and were included in the study. The mean age was 37.8 ± 8.1 years (median 36 years, range 24-66 years), 7% (n=25) were general practitioners, 22.2% (n=79) were residents, 70.9% (n=253) were specialists. Among specialists, 83.8% were anesthesiologists.

The frequency of practicing intubation was less than 10 times per year in 7.3% (n=26), between 10-35 times per year in 12% (n=43), and more than 35 times per year in 80.7% (n=288). Twenty-four percent (n=86) of the participants stated that during CPR, the duration of interruptions for intubation was longer than 5 sec, while 35.9% (n=128) stated that they did not pause at all. Anesthesiologists were more likely to be in the ≤ 5 sec hands-off time group, compared to non-anesthesiologists (p<0.001). Regardless of specialty, the hands-off time of specialists were more likely to be ≤ 5 sec compared to general practitioners and residents (p=0.001) (Table I, Table II).

The first preferred technique for airway management during CPR was endotracheal intubation in 56.6% (n=202), balloon-valve mask in 42.6% (n=152), and SAD in 0.8% (n=3). Method preferences when faced with difficult intubation were as follows: 59.9% (n=214) preferred balloon-valve mask, 40.1% (n=143) preferred SADs, 29.4% (n=105) utilized video laryngoscopy, 6.4% (n=23) utilized fiberoptic bronchoscopy, 27% (n=97) performed cricothyrotomy or tracheotomy. The frequency of using muscle relaxants when faced with difficult intubation was reported as 'rarely' by 35.0% (n=125), 'frequently' by 18.2% (n=65), 'always' by 11.5% (n=41) of participants.

Table I. Cardiopulmonary Resuscitation Characteristics Regarding Physicians' Experience Level

Characteristic	General practitioner (n=25)	Resident (n=79)	Specialist (n=253)	p
Hands-off time, n (%)				
≤5 sec	14 (56.0) ^a	51 (64.6) ^a	206 (81.4) ^b	0.001
>5 sec	11 (44.0)	28 (35.4)	47 (18.6)	
Probability of preferring SADs over ETT, n (%)				
Yes	8 (32.0) ^a	40 (50.6) ^a	213 (84.2) ^b	<0.001
No	17 (68.0)	39 (49.4)	40 (15.8)	
eFONA experience, n (%)				
Yes	- ^a	2 (2.5) ^a	54 (21.4) ^b	<0.001*
No	25 (100.0)	77 (97.5)	198 (78.6)	
Intubation attempts before switching to an alternative technique, n (%)				
≤3 attempts	7 (28.0) ^a	48 (60.8) ^b	170 (67.2) ^b	<0.001
>3 attempts	18 (72.0)	31 (39.2)	83 (32.8)	

SAD: Supraglottic airway devices, **ETT:** Endotracheal tube, **eFONA:** Emergency front of neck access. *Fisher Exact test was used in comparisons. Pearson's Chi-square test was used for other analyzes. ^{a,b}: Letters denote pairwise comparison results. Same letters denote the lack of statistical difference between respective groups, **a:** Significantly different from "b", **b:** Significantly different from "a".

The first preferred airway technique showed significant difference between anesthesiologists and other physicians; 62.4% of anesthesiologists preferred directly endotracheal intubation and 53.9% of other physicians preferred balloon-valve-mask ventilation in the first line ($p=0.002$). When the participants were asked about the probability of preferring SADs over endotracheal tubes, specialists marked a significantly higher probability of preferring SADs. The ratio of physicians who reported >3 intubation attempts in case of unsuccessful intubation during CPR were 37% ($n=132$) in the total study group. General practitioners (compared to residents and specialists) and non-anesthesiologists (compared to anesthesiologists) had a significantly higher frequency of performing >3 intubation attempts before switching to alternative techniques when faced with difficult intubation ($p<0.001$ and $p=0.003$ respectively) (Table I, Table II).

Physicians that considered themselves sufficiently capable of performing video laryngoscopy were 35.8%, while 30.5% ($n=109$) reported having no experience with video laryngoscopy. Although feeling capable for video laryngoscopy increased significantly in anesthesiologists subgroup ($p<0.001$), the ratio was still 47.1%.

Only 15.6% of participants considered themselves sufficient for eFONA. None of the general practitioners felt experienced in eFONA. The ratio of anesthesiologists considering themselves experienced in eFONA was 20.7%, while the ratio of other physicians considering themselves experienced was 5.2% ($p<0.001$).

The rate of EtCO₂ detector device utilization during CPR was 66.6% in total study population. Experience or specialty did not cause a difference for the primary indication of EtCO₂ detection, which was to verify the correct location of endotracheal tube (ETT). However the frequency of utilizing EtCO₂ levels to determine the number of ventilations, the return of spontaneous circulation, and prognosis were significantly higher among anesthesiologists, than non-anesthesiologists ($p<0.001$, $p=0.005$ and $p<0.001$, respectively) (Table II).

DISCUSSION

In this study, which evaluates the approach of airway control during the CPR applications of the doctors who are actively working in emergency departments, intensive care units and operating rooms in university hospitals and 'training and research' hospitals, it was found that 24% of the physicians interrupt chest compressions more than 5 sec during airway control. The preference of SAD usage was lower in residents and general practitioners compared to specialists, although they have less experience in endotracheal intubation. Anesthesiologists were more compliant with current guidelines than other physicians, and specialists (independent of the specialty) were more compliant with current guidelines than residents and general practitioners (4-6).

According to current guidelines, a hands-off time up to 5 sec is considered to be acceptable as an upper limit of interruption to chest compressions during advanced airway control (4-6). Schuerner et al. reported that university hospital physicians interrupted intubation procedures on mannequins for

Table II. Cardiopulmonary Resuscitation Characteristics Regarding Specialty

Characteristic	Anesthesiologists (n=242)	Non-anesthesiologists (n=115)	p
Hands-off time, n (%)			
≤5 sec	197 (81.4)	74 (64.3)	<0.001
>5 sec	45 (18.6)	41 (35.7)	
Probability of preferring SADs over ETT, n (%)			
Yes	220 (90.9)	41 (35.7)	<0.001
No	22 (9.1)	74 (64.3)	
Video laryngoscopy experience, n (%)			
Yes	114 (47.1)	14 (12.2)	<0.001
No	128 (52.9)	101 (87.8)	
eFONA experience, n (%)			
Yes	50 (20.7)	6 (5.2)	<0.001
No	191 (79.3)	109 (94.8)	
Intubation attempts before switching to an alternative technique, n (%)			
≤3 attempts	165 (68.2)	60 (52.2)	0.003
>3 attempts	77 (31.8)	55 (47.8)	
Primary preference for airway control, n (%)			
Balloon-valve mask	90 (37.2) ^a	62 (53.9) ^b	0.002**
Laryngeal mask	1 (0.4) ^a	2 (1.7) ^a	
Endotracheal tube	151 (62.4) ^a	51 (44.4) ^b	
Intended use of end-tidal CO2 measurements *, n (%)			
Verifying the location of the tube	172 (71.1)	70 (61.4)	0.068
Determining the number of ventilations	90 (37.2)	16 (14.0)	<0.001
Determination of return of spontaneous circulation	110 (45.5)	34 (29.8)	0.005
Determination of prognosis	57 (23.7)	7 (6.1)	<0.001

SADs: Supraglottic airway devices, **ETT:** Endotracheal tube, **eFONA:** Emergency front of neck access. *Multiple options could be selected. **Fisher Exact test was used in comparisons. Pearson’s Chi-square test was used for other analyzes. ^{a,b}: Letters denote pairwise comparison results. Same letters denote the lack of statistical difference between respective groups. **a:** Significantly different from “b”, **b:** Significantly different from “a”.

an average hands-off time of 1.9-3 sec with different laryngoscopes (13). Wang et al. reported that the median hands-off time was 109 sec in out-of-hospital arrests (8). In our study, approximately one-fourth of the participants stated that they interrupted compressions longer than 5 sec (which is normally the limit value) for laryngoscopy. This high rate, which is especially evident in less experienced physicians such as general practitioners and residents, may adversely affect the effectiveness of chest compressions.

If the practitioner is not experienced enough, endotracheal intubation not only carries the risk of long interruptions, but a higher failure rate up to 51% has also been reported during CPR (4). In various studies, the success rate of intubation has been reported to be 91-94% among anesthesiologists and 82-84% among general practitioners (14,15). It has been reported that only 6 months of residency training increases the frequency of successful intubation at the first attempt

(16). Difficult intubation is encountered in approximately 10% of cases in the emergency room (17-20) and around 5% of the cases in the operating room (21). Although there is a long-standing recommendation about avoiding repeated intubation attempts, 37% (n = 132) of the physicians participating in our study, with a higher proportion among non-anesthesiologists, stated that they performed >3 attempts when faced with difficult intubation during CPR. This might cause further interruptions to compressions. That’s why, guidelines prioritize a stepwise-airway approach and the use of SADs during CPR (4-6). Although there is insufficient evidence to compare the safety of SADs and endotracheal tube, when compared with endotracheal intubation, SADs require very little experience and they can be placed without interruption of chest compressions (7-9, 22). The preference of SADs was surprisingly low in physicians less experienced in intubation in our study. This situation suggests the necessity of increasing

the awareness of physicians about SADs and informing them about the advantages of using it in emergency situations.

Our results indicate that anesthesiologists were at a better level of knowledge and experience with regard to almost every variable examined in the study. Of course, this result was highly anticipated due to factors such as more clinical experience with airway management and routine CPR training during residency. Although there are differences between groups, the rate of feeling experienced in video laryngoscopy and e-FONA in anesthesiologists were 47.1% and 20.7%, respectively. Regarding e-FONA, the participants' responses were similar to Vietnamese anaesthetists who responded to a similar survey. This result is also consistent with Australian anesthesiologists, who have shown a 29% success rate when performing on live animals. Considering the limited number of surgeons or anesthesiologists experienced in e-FONA, it raises the question of whether this questionnaire item might have been misunderstood. It seems controversial to suggest that 21% of physicians are proficient in anterior neck interventions. It is quite clear that there is a need for both further research and training to improve skills in this regard (23,24). The limited number of video laryngoscopes in many centers in our country, especially in the pre-covid period, may have affected this. Although it is controversial whether video laryngoscopes shorten hands-off time during CPR, it is known that they provide better laryngeal view, especially in inexperienced hands (13,25). The results of this study reveal that there is an absolute need for video laryngoscopy and eFONA training in all physician groups.

Verifying the location of the endotracheal tube is vital to ensure that effective ventilation is provided. The benefits of EtCO₂ measurement is not limited to this advantage, as it is also instrumental in the assessment of prognosis, evaluation and determination of ventilation characteristics during CPR, and the early recognition of the return of spontaneous circulation (4). Several studies conducted in different countries have shown that, after endotracheal intubation, the rate of routine use of EtCO₂ detection to confirm tube location varies between 32% and 56%, whereas 20% to 25% report that they never use EtCO₂ measurements (26). Also in our study, 33% (n=117) of the physicians reported that they never used EtCO₂ detector devices, which can be considered as an indicator for the necessity of promoting its use. Clinical observations suggest that the use of EtCO₂ detectors is increasing. There is not enough data in the literature on this subject and further studies are needed.

This study has some limitations. The number of physicians reached was higher than that of similar studies, but the questionnaire was mostly focusing on doctors' self-assessment of their competence. We can't know exactly how they will

perform in reality or simulation. The design also may cause a possibility for recall bias or being affected by various environmental factors while completing the questionnaire. Also in this study, due to the deficiencies in the processing of the data in the relevant section, a statistical relationship could not be sought between regional and institutional differences and the responses of doctors working in different types of hospitals in different regions of the country. Therefore, the study may not accurately reflect all physician groups. However, there are very few studies evaluating the airway competencies of healthcare workers, especially in the case of CPR, even around the world, let alone Turkey. For this reason, this study is still a study that sheds light on directing the training of healthcare professionals, which is a very important issue.

Finally, this study assumed that the knowledge and experience of physicians with internationally accepted CPR certificates was already at a standard level and excluded them, but in this case, it was not possible to compare those who were certified with those who did not.

CONCLUSION

Current resuscitation guidelines highlight the importance of continuous and high-quality chest compressions during CPR. As endotracheal intubation is one of the most common causes leading to interruption, the usage of balloon-valve mask ventilation and SADs are recommended in the first line. In this study, 24% of the physicians stated that they interrupt chest compressions more than 5 sec during airway control. The preference of SAD usage was lower in whole population; especially in residents and general practitioners compared to specialists, although they have less experience in endotracheal intubation. Anesthesiologists were more compliant with current guidelines than other physicians, however the experience level with EtCO₂ detection, video laryngoscopy and eFONA can still be interpreted as insufficient. The results of the study reveal the necessity of disseminating practical and theoretical in-service CPR training organized at regular intervals, increasing the quality of training if available, and encouraging physicians to be certified in courses with national and international validity.

AUTHOR CONTRIBUTIONS

Conception or design of the work: YCD, AAY

Data collection: YCD

Data analysis and interpretation: FU, BA

Drafting the article: YCD, AAY

Critical revision of the article: AAY

Other (study supervision, fundings, materials, etc): MK, OC

The author (YCD, AAY, FU, BA, OC, MK) reviewed the results and approved the final version of the manuscript.

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