PRACE POGLĄDOWE

Advanced airway management in out-of-hospital cardiac arrest – to intubate or not to intubate: a narrative review of the existing literature

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Abstract

Restoring partial flow of oxygenated blood is a fundamental goal of cardiopulmonary resuscitation. The ideal devices used for this purpose should have features such as low incidence of complications, high survival rate, rapid control of the airway, and adequate ventilation. Besides limiting the frequency and duration of interruptions in chest compressions, they can improve the survival and clinical outcomes of return of spontaneous circulation during cardiopulmonary resuscitation. The overall rates of survival from out-of-hospital cardiac arrest have improved dramatically in recent years. However, optimal airway management during out-of-hospital cardiac arrest is a controversial issue. The proposed standard of care, i.e. endotracheal intubation, may have paradoxical adverse effects on intended outcomes by interrupting cardiopulmonary resuscitation and by reduction of coronary and cerebral perfusion pressure during resuscitation. The aim of this narrative review is to provide health care providers with an overview of relevant studies in the area, with a focus on alternative advanced airway techniques.

Key words: cardiopulmonary resuscitation, airway management, out-of-hospital cardiac arrest.

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Out of hospital cardiac arrest (OHCA) is still the leading cause of death, affecting about 600,000 people each year in Europe. Unfortunately, the OHCA survival rate of hospital is around 7–10% worldwide [1]. Adequate oxygenation is essential for advanced life support. The points that determine this issue to be controversial are the absence of evidence that a routine tool or basic method should be at the forefront of airway management during cardiac arrest. There is no consensus yet on the best airway management strategy to improve patient outcome. In this regard, reliable scientific evidence cannot be obtained. Therefore, it becomes difficult for a definitive recommendation.

There are a few known methods to increase survival after OHCA. Most prominent among them is minimalising interruptions during chest compressions with early defibrillation [2]. It has been revealed in studies that limiting the frequency and duration of interruptions in chest compressions can improve the survival and clinical outcomes of return of spontaneous circulation (ROSC) during cardiopulmonary resuscitation (CPR) [3]. Several registries have been established in North America and Europe, including the Resuscitation Outcomes Consortium (ROC), Cardiac Arrest Registry to Enhance Survival (CARES), Ontario Prehospital Advanced Life Support, and European Registry of Cardiac Arrest, in order to improve OHCA survival rates.

Cardiac arrest is the sudden cessation of blood flow due to the inability of effective heart contraction during systole [4]. Normal tissue metabolism is dependent on providing adequate oxygen. The delivery of oxygen is related with oxygen content and cardiac output. In cases of cardiac arrest, tissue hypoxia, acidosis, and metabolic disorders appear. Consequently, hypoperfusion brings anaerobic metabolism and lactic acidosis. Therefore, there is a critical relationship between continued chest compression and coronary perfusion. Also, it is closely related to the recovery of cerebral function following cardiac arrest. Ventilation is necessary to achieve adequate gas exchange [5].

The European Resuscitation Council (ERC) and American Heart Association (AHA) recommend tracheal intubation (TI) to secure the airway, by qualified and properly trained staff [6, 7]. Although con-

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troversial, in the absence of personal skills in TI, the supraglottic airway device (SGA) or a bag mask ventilation (BMV) are two other acceptable alternatives.

The International Liaison Committee on Resuscitation task forces suggests the use of BMV or an advanced airway strategy during CPR for adult patients. SGA was recommended in OHCA as an advanced airway in settings with a low tracheal intubation success rate. On the other hand, in settings with a high tracheal intubation success rate, SGA or tracheal intubation was recommended. In cases with in-hospital cardiac arrest, an SGA insertion or tracheal intubation was recommended as an advanced airway.

Several authors have even emphasised that providing a safer airway regardless of technique may sometimes be more harmful due to the time-consuming effect. Advanced airway management is considered as a separate concern that the increased intrathoracic pressure may cause decreased coronary and cerebral perfusion pressure in patients during resuscitation. Another concern is increased mortality of hyperoxaemia during ventilation with tracheal tubes. The outcome is reported to be better in patients with bag-valve-mask ventilation and basic airway intervention. The conclusion regarding which airway device should be considered the priority remains unclear [8].

Although we do not have any evidence to emphasise that advanced airway management has a negative effect on the prognosis of patients, the optimum airway management method is still a controversial issue. The summary of the studies is available in Table 1.

TRACHEAL INTUBATION DURING CARDIOPULMONARY RESUSCITATION

The incidence of unrecognised oesophageal intubation has been reported as 2.4–17.0% in studies involving paramedics [9]. Besides 3% tracheal tube displacement, 3% multiple intubation, hyperoxaemia and long-term interruption in CPR were observed. All were associated with increased risk for intubation related adverse events including negative effect on coronary and cerebral perfusion. According to the ERC recommendation, tracheal intubation should not last longer than five seconds. In cardiac arrest studies, unrecognised misplacement of the tracheal tube has been reported to be associated with morbidity and mortality ranging from 2.9 to 16.7% [10].

It was also demonstrated that TI is not an aspiration-risk-free method [11]. Therefore, TI gradually loses its unique importance in this field. In AIRWAYS-2 randomised clinical trial the regurgitation and aspiration rates were not significantly different between tracheal intubation and SGA groups [12].

The harms and advantages of tracheal intubation during CPR are summarised in Table 2.

CONCERNS ABOUT SUPRAGLOTTIC AIRWAY

The role of the laryngeal mask in resuscitation was first introduced in the 1990s by Leach *et al*. [13], and the discussions on the subject have continued until today. SGA placement has gained popularity due to its simple technique and less CPR interruption than tracheal intubation. It was first proposed by the 1997 Liaison Committee on Resuscitation (ILCOR) as an alternative airway management tool to TI in adults during resuscitation [14].

Compared to TI, less than 10% of SGA interventions require multiple attempts. Decreased lung compliance or high airway resistance may require the use of high inspiratory airway pressures, which can increase the risk of aspiration by causing gastric insufflation. Finally, ventilation cannot be achieved with the use of a laryngeal mask in case of obstruction of the airway, which may develop in the presence of a lesion under the glottis. The balloon and fitting part of the device, which settles in the supraglottic area, can compress vital vascular structures such as the carotid artery and lead to carotid blood flow reduction that may adversely affect the patient's outcome [15].

In a six-year period using Laryngeal tubes (LT) and involving 189 patients, the mean initial cuff pressure was 100 cmH_2O, tongue swelling incidence was 38.6%, the cannot ventilate – cannot intubate scenario incidence was 1.0%, and the rate of massive stomach distention was found as 10.6% [16]. However, in several studies comparing supraglottic airway devices, different results were reported. The incidence of "traumatic placement" can increase up to 49% in LTS-D and 21% in laryngeal mask supreme [17].

MANIKIN STUDIES

In manikin studies, the researchers aimed to measure which device or method is superior to minimise interruptions during CPR. Gatward *et al*. [18] revealed a statistically significant delay (mean delay 3.3 s, CI: 1.80–5.45, $P = 0.0001$) in chest compressions during tracheal intubation.

In the study of Wiese *et al*. [19] comparing LTS-D with i-gel, no statistically significant difference was found between two groups in terms of no flow time (104.7 s vs. 105.1 s; $P > 0.05$, respectively) and insertion time (10.4 s vs. 9.3 s; $P > 0.05$, respectively).

In 2011, Ruetzler *et al*. [20] compared five different airway devices (endotracheal tube [Mallinckrodt, Athlone, Ireland], Combitube [Covidien, Mansfield, MA, USA], EasyTube [Teleflexmedical Ruesch, Research Triangle Park, NC, USA], laryngeal tube

TABLE 1. The summary of the included studies

Authors	Year	Airway device	Study type	Main outcome	Results	Statistical significance
Benger *et al.*	2016	i-gel ($n = 232$) vs. LMA Supreme ($n = 174$)	Cluster-randomised trial	Study feasibility, including paramedic and patient recruitment and protocol adherence	No significant difference between groups in terms of ROSC on hospital arrival, survival to hospital discharge until 90 days	$P > 0.05$
Benger *et al.*	2018	I-gel ($n = 4886$) vs. ETT ($n = 4410$) OHCA	Multicentre, cluster randomised clinical trial	Modified Rankin Scale score at hospital discharge or 30 days after out-of-hospital cardiac arrest	Favourable functional outcome at hospital discharge (I-gel: 6.4% vs. ETT: 6.8%)	$P > 0.05$
Cady *et al.*	2009	ETT ($n = 4335$) vs. Combitube ($n = 1437$)	Retrospective cohort study	ROSC, survival to hospital admission and survival to hospital discharge	No significant difference between groups in term of ROSC, survival to hospital admission or survival to hospital discharge	$P > 0.05$
Evans *et al.*	2016	ETT ($n = 1282$) vs. BMV ($n = 715$) vs. SGA (n = 273) OHCA	Multi-centre, prospective study involving Epistry and PROPHET trauma registries	The association between ALS procedures and survival	ETT and SGA groups experienced decreased odds of survival compared BMV	$P > 0.05$
Fiala *et al.*	2017	LT ($n = 54$) vs. BVM ($n = 58$)	Open prospective randomised multicentre study	Comparison of ease of handling and efficacy of ventilation	No significant difference between LT and BVM in terms of efficacy of on-site ventilation (71.4% vs. 58.5%) and the frequency of complications (11.4% vs. 19.5%)	$P = 0.686$ and $P = 0.961$
Hanif *et al.*	2010	ETT (n =1027) vs. BVM ($n = 131$) vs. Combitube/EOA ($n = 131$)	Retrospective cohort study	Comparison of survival to hospital discharge among adult OHCA patients	Lower survival rate to hospital discharge for ETT than BVM (OR: 4.5)	$P < 0.0001$
Hasegawa *et al.*	2013	ETT ($n = 41{,}972$) vs. SGA ($n = 239{,}550$) vs. BVM ($n = 281{,}522$)	Prospective, nationwide, population-based study	Favourable neurological outcome 1 month after an OHCA	Both ETT and SGA were similarly associated with decreased odds of neurologically favourable survival	$P > 0.05$
Honold *et al.*	2015	ETT ($n = 69$) vs. LT ($n = 21$)	Monocentric retrospective analysis	The indices for aspiration and early onset pneumonia	Higher mortality in the LT group compared ETT (60% vs. 28.9%, respectively)	$P = 0.018$
Jabre *et al.*	2018	ETT ($n = 1022$) vs. BMV ($n = 1018$) OHCA	Multicentre randomised clinical trial	Survival with favourable neurological function at day 28	Favourable neurological function at 28 days (BMV: 4.3% vs. ETT: 4.2%)	$P > 0.05$
Jarman *et al.*	2017	ETT with DL ($n = 148$) vs. ETT with VL ($n = 125$) vs. LT ($n = 43$) OHCA	Cohort analysis of prospectively collected clinical and defibrillator data	Comparison of interruptions in CPR, longest pause, and the number of pauses greater than 10 seconds	First pass success with LT: 77%, DL: 68% and VL: 67%	$P > 0.05$
Kajino *et al.*	2011	ETT ($n = 1679$) vs. LMA ($n = 3698$)	Observational, population-based cohort study that used a prospective, Utstein-Style population cohort database	One-month survival with neurologically favourable outcome	Longer intervention time (ETT: 17.2 min vs. LMA: 15.8 min) No significant difference in one-month survival with favourable neurological outcome (ETT: 3.6% vs. LMA: 3.6%)	$P < 0.001$ and $P = 0.945$

TABLE 1. Cont.

Authors	Year	Airway device	Study type	Main outcome	Results	Statistical significance
Kang *et al*.	2016	ETT ($n = 1195$) vs. BMV ($n = 29684$) vs. SGA ($n = 1634$) OHCA	Population-based, retrospective cohort study	Neurologically favourable survival to discharge	The odds of neurologically favourable survival to discharge was significantly higher in ETT compared to the BVM	Adjusted OR, 1.405; 95% CI: 1.1001–1.971
Lin *et al*.	2014	ETT ($n = 44$) vs. LMA ($n = 1384$) vs. non-rebreather facemask ($n = 108$) vs. BVM ($n = 376$)	Retrospective review of a database	The effectiveness of LMA	No significant difference in survival to discharge prevalence	$P > 0.05$
Maignan *et al*.	2015	LT ($n = 41$) vs. BVM ($n = 41$)	Open prospective multicentre study	Assessment of chest compression fraction using an accelerometer connected to the defibrillator	Higher chest compression fraction in LT (75%) than BVM (59%)	$P < 0.01$
McMullan *et al*.	2014	ETT ($n = 5591$) vs SGA ($n = 3110$) vs. no advanced airway ($n = 1929$)	Secondary analysis of OHCA data from the Cardiac Arrest Registry to Enhance Survival (CARES) registry	Sustained ROSC, survival to hospital admission, and discharge, and neurologically-intact survival to hospital discharge	Higher sustained ROSC (OR = 1.35), survival to hospital admission (1.36), hospital survival (1.41) and hospital discharge with good neurologic outcome (1.44) with ETT than SGA	OR = 1.35; 95% CI: 1.19–1.54 and 1.36; 1.19–1.55 and 1.41; 1.14–1.76 and 1.44; 1.10–1.88
Nagao *et al*.	2012	ETT ($n = 10$) vs. LMA ($n = 147$) vs. BVM ($n = 156$) vs. Combitube ($n = 42$)	Retrospective cohort study	A favourable neurological outcome	Lower rate of overall ROSC and ICU admission in BVM No significant difference in the rate of pre-hospital ROSC	$P = 0.0352$ and $P = 0.0089$ and $P = 0.2465$
Ono *et al*.	2015	LT ($n = 148$) vs. LMA ($n = 165$)	Prospective, cluster-randomised, and open-label study	A favourable neurological outcome 1 month after cardiac arrest	No significant difference between groups in terms of successful pre-hospital ventilation, ROSC, survival, and neurological outcomes	$P > 0.05$
Park *et al*.	2017	ETT ($n = 15$) vs. LMA ($n = 51$)	Retrospective study based on a multicentre prospective cohort registry	The association of prehospital SGA on neurologic outcome	28-day good neurologic outcome (OR = 7.88; 95% CI: 1.33–46.53; $P = 0.023$) when postresuscitation variables were adjusted, although there were no significant association with the acquisition of sustained return of spontaneous circulation (OR = 0.992; 95% CI = 0.591–1.666; $p = 0.976$). 28-day good neurologic outcome (odds ratio [OR] = 7.88; 95% CI = 1.33–46.53; $P = 0.023$] when postresuscitation variables were adjusted, although there were no significant association with the acquisition of sustained return of spontaneous circulation (OR = 0.992; 95% CI = 0.591–1.666; $P = 0.976$). Better 28-day neurological outcome with LMA	$P = 0.0023$

TABLE 1. Cont.

Authors	Year	Airway device	Study type	Main outcome	Results	Statistical significance
Roth *et al*.	2015	LT ($n = 395$) vs. BMV ($n = 74$)	Prospective multicentre observational cohort study	Comparison of safety and feasibility	More frequently successful ventilation with LT (93%; adjusted risk ratio)	$P = 0.01$
Shin *et al*.	2012	ETT ($n = 250$) vs. LMA ($n = 391$) vs. BVM ($n = 4637$)	Retrospective cohort study	Comparison of airway management technique during ambulance transport	Similar adjusted survival to admission and discharge for BVM and ETT Significantly lower adjusted survival to admission and discharge in LMA than BVM	OR = 1.0 and 0.91, respectively and OR = 0.72 and 0.52, respectively
SOS-KANTO study group	2009	LMA ($n = 173$) vs. BVM ($n = 203$)	Prospective multicentre study, non-randomised control trial	Arterial blood gases on hospital admission of resuscitated patients	Higher median arterial pH in LMA than BVM (7.117 vs. 7.075). No difference in $PaCO_2$ (52.9 vs. 55.3) and PaO_2 (64.6 vs. 71.9)	$P = 0.02$ and $P = 0.06$ and $P = 0.56$
Sulzgruber *et al*.	2018	ETT ($n = 793$) vs. LT ($n = 404$) OHCA	Prospective population-based cohort study	A favourable neurological outcome	LT: The lowest 30-day survival rate LT: The lowest rate of good neurological performance (6.7%)	$P < 0.001$ and $P < 0.001$
Tanabe *et al*.	2013	ETT ($n = 16,054$) vs. LMA ($n = 34,125$) vs. EOA ($n = 88,069$)	Nationwide population-based observational study	A favourable neurological outcome	Significantly higher rates of neurologically favourable 1-month survival in ETT (1.14%) than LMA (0.98%) and EOA (1.04%)	OR = 0.77, 95% CI: 0.64–0.94 and OR = 0.81, 95% CI: 0.68–0.96
Wang *et al*.	2012	ETT ($n = 8487$) vs. SGA ($n = 1968$)	Secondary analysis of data from the multicentre Resuscitation Outcomes Consortium (ROC) PRIMED trial	Survival to hospital discharge with satisfactory functional status with MRS ≤ 3	Higher survival to hospital discharge with satisfactory functional status with ETT (4.7% vs. 3.9%) Increased rate of ROSC and 24-h survival with ETT	OR = 1.78 and OR = 1.74
Wang *et al*.	2018	ETT ($n = 1499$) vs. LT ($n = 1505$) OHCA	Multicentre pragmatic cluster-crossover clinical trial	Comparison of the effectiveness of a strategy	72-hour survival (LT: 18.3% vs. ETT: 15.4%) ROSC (LT: 27.9% vs. ETT: 24.3%) Hospital survival (LT: 10.8% vs. ETT: 8.1%)	$P = 0.04$ and $P = 0.03$ and $P = 0.01$

ETT – endotracheal tube, LT – laryngeal tube, BMV – bag mask ventilation, DL – direct laryngoscopy, VL – video laryngoscopy, ROSC – return of spontaneous circulation, EOA – oesophageal obturator airway, ALS – advanced life support, SGA – supraglottic airway, MRS – Modified Rankin Scale

TABLE 2. Potential advantages and harms of tracheal intubation during cardiopulmonary resuscitation

Harmful effects	Advantages
Technically challenging	Maintenance of a patent airway
Risk for the first attempt failure	Facilitate oxygenation and ventilation
Prolonged interruption of chest compression due to the failure	Uninterrupted and high-quality chest compressions
Raised intrathoracic pressure and depressed coronary perfusion pressure	Reduced no-flow time
Risk of hyperventilation and hyperoxia	
Unrecognized oesophageal intubation	

[King-LT-D, VBM, Sulz, Germany], Laryngeal Mask Airway [LMA Company North America, San Diego, CA, USA], and i-gel [Intersurgical Ltd., Wokingham, England]) in terms of hands-off time during airway management. The results were as follows: laryngeal tube [King-LT-D, VBM, Sulz, Germany] 8.4 s, Combitube [Covidien, Mansfield, MA, USA] 10.0 s, EasyTube [Teleflexmedical Ruesch, Research Triangle Park, NC, USA] 11.4 s, LMA[LMA Company North America, San Diego, CA, USA] 13.3 s, and for i-gel [Intersurgical Ltd., Wokingham, England] 15.9 s.

However, Miller *et al.* [21] did not determine an increase in no-flow time with either TI or LMA insertion. However, ventilation was provided significantly faster by laryngeal mask compared to tracheal intubation (31.6 s vs. 49.2 s, respectively, $P < 0.001$).

Saracoglu *et al*. [22] compared Mac, Miller, MacCoy, and Mcgrath intubation blades, and it was found that TI could be completed within an average of 8 s during uninterrupted chest compressions.

Szarpak *et al*. [23] compared insertion times of supraglottic airway devices and found 40.46 s ± 4.64 s, 33.96 s ± 6.23 s, 17.2 s ± 4.63 s, and 49.23 s ± 13.19 s for laryngopharyngeal tube SALT (ECOLAB, St. Paul, MN), ILMA (Intavent Direct Ltd, Buckinghamshire, United Kingdom), Cobra PLA (Engineered Medical Systems Inc, Indianapolis, IN), and Air-Q (Mercury-Medical, Clearwater, FL), respectively. The success rates were determined as 86.7%, 85.7%, 100%, and 71.4%, respectively ($P < 0.05$). Computed tomography (CT) scans of 20 adult trauma patients were compared with CT scans of two airway trainers and four simulators [24]. In this study it was clearly stated that the airway anatomy airway trainers and simulators do not reflect the human anatomy.

Murray *et al*. [25] revealed that although the success rate in manikins was 100%, the transfer rate of knowledge into the clinical practice for adult patients with nontraumatic out-of-hospital cardiac arrest was just 64%.

As a result of manikin studies, they can reflect the ventilation performance, and impact the peak pressure and tidal volume. The success rate of novice users can be measured, and the learning curves can be determined. However, it is difficult to simulate the factors complicating airway management, including the presence of secretion, mucosal oedema, blood, or fogging, in manikin studies [26]. Therefore, the measurements may be open to bias because they are subjective. Also, high heterogeneity was reported in the analysis [27].

CLINICAL STUDIES

Success of device insertion

In a randomised crossover study using 12 female pigs, cerebral blood flow reduced following the insertion of Combitube (Kendall-Sheridan, Argyll, NY) and i-gel (Intersurgical, Wokingham, UK) compared to TI [28]. The authors concluded that SGA insertion was associated with decreased carotid blood flow during CPR.

The Resuscitation Outcomes Consortium PRIMED study included a total of 2767 patients using 2051 TI and 671 using SGA. They identified differences in chest compression fraction (CCF) measured by thoracic impedance sensors and demonstrated a measurable improvement in CCF of up to 4.5% with SGA use [29].

Another study with i-gel, including paramedics and emergency physicians, achieved uninterrupted compression in 74% of patients, adequate ventilation in 96%, and a first attempt success rate of 90% [30].

The North East Ambulance Service National Health Service Foundation Trust (NEAS) confirmed that both basic and advanced airway management methods are used successfully in cardiac arrest scenarios. The success rates for i-gel insertion were higher than TI (94% vs. 90%, respectively) [31]. The authors stated that i-gel may become the preferred first-line airway device during CPR in the near future.

A single-centre, prospective parallel-group, open-label randomised controlled trial was conducted in subjects with OHCA. i-gel was compared with the Portex Soft Seal Laryngeal Mask (PSS-LM) (Smiths Medical, Kent, UK) within a large Australian ambulance service population. i-gel (Intersurgical, Wokingham, UK) had a significantly higher success rate than the PSS-LM (Smiths Medical, Kent, UK) (90% vs. 57%, $P = 0.023$). Also, the median "ease of insertion" scores were significantly lower in in this group [32].

According to the literature review, in most of the studies conducted before 2016, better outcomes were reported with TI than SGA in both prospective and retrospective studies. However, in 2018, the Airways 2 [12] and PART [33] trials raised concerns. The Airways 2 trial included 9296 patients with out-of-hospital cardiac arrest. There was no significant difference between TI and i-gel regarding favourable functional outcome at hospital discharge or after 30 days (6.8% vs. 6.4%, respectively). As a seconder outcome, the aspiration and regurgitation rates were similar. In the PART trial, the SGA was a laryngeal tube, which was associated with significantly greater likelihood of 72-hour survival in comparison with TI (18.3% vs. 15.4%, respectively, $P = 0.04$). Both studies concluded that advanced airway management does not make a significant difference. In some of the studies, tracheal intubation was performed by doctors, and in others, by paramedics; this reveals that these results are not generalisable.

In a recent systematic review, 78 observational and 11 controlled studies were included [34]. Tracheal intubation success rates were emphasised as 98% in Jabre's study, 69% in Benger's study, and 52% in Wang's study. There was bias for the duration of resuscitation, lack of blinding, clinical and methodological heterogeneity, the lack of any threshold value for success, and the use of different types of SGA. Therefore, the authors stated that trials of advanced airway management during in-hospital cardiac arrest are lacking.

Also, the difference in education affects the results. For example, the national curriculum of paramedics in the United States requires students to perform five successful tracheal intubations in order to graduate. This increases to 25 successful intubations in the UK and 30 in Japan [35].

Newell *et al*. [11] introduced a stepwise approach and concluded that there was no evidence to favour an optimal airway management technique during CPR. Therefore, it was stated that rescuers should use the airway devices with which they are most proficient.

The available guidelines are predominantly based on evidence from observational studies and agreed consensus; new and ongoing randomised controlled trials should provide more information. The 2015 CoSTR stated that the choice of using the BVM, SGA, or TI is completely dependent on the ability of the rescuer [36].

According to the update published by the AHA, recommendation IIb stated that BVM or advanced airway methods can be used for oxygenation and ventilation in cardiac arrest both for in- and out-of-hospital cardiac arrest [7]. The authors declared that trained staff can perform either SGA or TI as the initial approach.

Aspiration protection

In a cadaver study, aspiration was detected in 40% receiving i-gel or LMA and in 60% with bag valve mask (BVM) ventilation [37]. On the other hand, there was no detected aspiration in cadavers with TI and EasyTube. The authors concluded that tracheal intubation provides better protection against pulmonary aspiration and regurgitation of gastric contents.

It is another fact that in routine medico-legal autopsies, aspiration of stomach contents is observed in up to 25% of all cases [38]. However, it was reported that 2/3 of the patients had aspirated at the scene before the CPR initiated by the EMS team. Regurgitation occurs in 1/3 of OHCA; however, this occurs before arrival of emergency medical service staff in at least 2/3 of these cases [39]. Ruetzler *et al*. [40] stated that the incidence of pulmonary aspiration is generally high in patients undergoing CPR when a laryngeal tube is used for ventilation. Pulmonary aspiration was observed in seven (39%) cadavers with interrupted chest compressions and in nine (50%) with continuous chest compressions.

Honold *et al*. [41] compared 90 patients with invasive ventilation by either Laryngeal Tube S or tracheal intubation. The authors concluded that higher rates of pneumonia and aspiration were recorded following tracheal intubation, in particular in OHCA patients.

Return of spontaneous circulation

In the multicentre ROC PRIMED trial, a total of 10,455 adult OHCA patients were included [42]. Successful TI was associated with increased rate of ROSC, survival to hospital discharge, and 24-h survival in comparison with successful SGA. Also, pulmonary or airway complications were not associated with TI.

In the CARES study, the records of 10,691 OHCA patients were evaluated, comparing the results between TI, SGA (Combitube [Kendall-Sheridan Corporation, Mansfield, MA], LMA [LMA North America, San Diego, CA], King LT [King Systems, Inc., Noblesville, IN]) and basic airway management [43]. Neurological survival was 5.4% in TI, 5.2% in SGA, and 18.6% in basic airway management. Compared with SGA, TI had a higher ROSC, reduced hospitalisation time, increased hospital survival, and better neurological results.

In the ROSC meta-analysis, survival to hospital admission, survival to hospital discharge, and neurologically intact survival to hospital discharge were investigated for outcome analysis [44]. Traumatic cardiac arrest, paediatric patients, rapid sequence induction, and videolaringoscopic intubations were excluded. In this study, 34,533 patients were included in the TI group and 41,116 patients in the SGA group. Compared to SGA, statistically significantly higher ROSC rates (OR = 1.28, 95% CI: 1.05–1.55) and longer duration of hospital stay (OR = 1.34, CI: 1.03–1.5) were observed in intubated patients. However, when this study is interpreted, there was a lack of control for confounders such as shockable rhythm, witnessed arrest, or bystander CPR. This leads to bias and causes confusion.

72-hour survival

In the Bayesian analysis of the pragmatic airway resuscitation trial, 72-hour survival and hospital survival were compared to estimate the benefit of laryngeal tube over tracheal intubation on OHCA outcomes [45]. Both under a neutral and sceptical prior distribution, better outcomes were observed with laryngeal tube than with tracheal intubation.

In a multicentre cluster-crossover pragmatic clinical trial, the resuscitation outcomes of 3004 patients with OHCA were evaluated [33]. In comparison with tracheal intubation, the 72-h survival was improved with initial laryngeal tube insertion (15.3% vs. 18.2%).

Neurological outcomes

Many studies in the literature focused on outcome analysis. However, significant differences could not be found in patients with TI or SGA in retrospective or prospective studies. In a study that retrospectively analysed ambulance records between 2013 and 2014, the data of 209 patients revealed no difference in terms of neurological outcome [46].

The REVIVE-Airways Trial is a cluster-type analysis planned in a single ambulance service in the UK [47]. During a 12-month period, 184 paramedics performed i-gel insertion or TI for adult patients with OHCA. A total of 615 patients were included in the study, with 80% adherence, and no difference was detected in OHCA in terms of neurological outcomes. However, the early use of advanced airway tools was associated with positive outcome.

In the All-Japan Utstein Registry study, 649,654 consecutive patients who had OHCA were resuscitated by emergency responders [48]. Neurological outcomes of these patients at one month were compared. Of these patients, 367,837 (57%) were ventilated with bag-valve-mask, and advanced airway management was used in 281,522 (43%). Neurological results were significantly lower in patients with advanced airway management (1.1% vs. 2.9%; odds ratio [OR], 0.38; 95% CI: 0.36–0.39). In the analysis of a propensity score-matched cohort (357,228 patients), neurological survival was low for both tracheal intubation (corrected OR = 0.45; 95% CI: 0.37–0.55) and supraglottic airway device (corrected OR = 0.36; 95% CI: 0.33–0.39).

A population-based observational study was planned in Japan using a national database of OHCA cases over a three-year period [49]. Advanced airway devices were used in 138,284 of 318,141 patients. Endotracheal tube (ETT) was used in 16,054 patients (12%), LMA in 34,125 patients (25%), and oesophageal obturator airway (EOA) device in 88,069 patients (63%). Neurologically, one-month survival rates were 1.14% in the ETT group, 0.98% in the LMA group, and 1.04% in the EOA group. Prehospital use of supraglottic airway devices was associated with mild but significantly poor neurological outcomes compared to tracheal intubation.

A nationwide study including the records between 2010 and 2013 in Korea evaluated the neurological outcome of TI, SGA, or BVM provided in 98,896 prehospital non-traumatic adult OHCA patients [50]. The probability of survival to hospital discharge was significantly higher in the TI group than in the BVM group.

CONCLUSIONS

Trying to come to a definitive conclusion from the existing literature is challenging. The data cannot support the routine use of a particular approach to airway management. Tracheal intubation in prehospital settings requires a comprehensive, competency-based, and regular training of skills. Although the best method is not known, answers should be beyond the tools: stepwise-skill tailored airway management. Further studies are required to demonstrate the specific outcomes of tracheal intubation. Furthermore, well-designed, large, randomised clinical trials are further needed to focus on OHCA patients to support or refute this finding.

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