EURASIAN JOURNAL OF EMERGENCY MEDICINE
DOI: 10.4274/eajem.galenos.2024.56688
Systematic Review and Meta-analysis
Eurasian J Emerg Med. 2024;23(2): 84-94

Endotracheal Intubation Versus Supraglottic Airway for Airway Management in Adults with Out-of-hospital Cardiac Arrest: A Systematic Review and Meta-analysis

Miroslaw Dabkowski[1], Pawel Wieczorek[1], Başar Cander[2], Dawid Kacprzyk[1], Michal Pruc[3], Lukasz Szarpak[4]

[1]LUXMED Group, Department of Clinical Research and Development, Warsaw, Poland
[2]Bezmialem Vakıf University Faculty of Medicine, Department of Emergency Medicine, İstanbul, Turkey
[3]International European University, Department of Public Health, Kiev, Ukraine
[4]Baylor College of Medicine, Henry J.N. Taub Department of Emergency Medicine, Texas, United States

Abstract

Aim: The goal of this meta-analysis is to evaluate and compare the effectiveness of endotracheal intubation (ETI) and supraglottic airway (SGA) devices in airway management during out-of-hospital cardiac arrest events.

Materials and Methods: Study was designed as a systematic review and meta-analysis and was conducted according to the 2020 PRISMA guidelines. Relevant studies published up to January 2024 were searched systematically using the following databases: PubMed, EMBASE, Scopus, Web of Science, and Cochrane Library. Pooled effect sizes were calculated using a random-effects model and reported as the odds ratios and 95% confidence intervals.

Results: Out of 4218 records initially identified, 25 eligible studies were selected for inclusion in a meta-analysis. Survival to hospital admission was 26.8% for ETI and 14.5% for SGA ($p<0.001$). Survival rates among patients treated with ETI vs. SGA varied and amounted to: 25.5% vs. 17.6% for 24-h survival rate ($p<0.001$); 13.4% vs. 15.1% ($p=0.002$); and 8.6% vs. 6.0% for survival to hospital discharge/30-d survival ($p=0.09$). Survival with favorable neurological outcomes occurs in 5.3% in ETI group, compared to 3.8% in SGA group ($p=0.35$).

Conclusion: Our analysis reveals the nuanced and context-dependent nature of airway management in prehospital emergency care. The high heterogeneity across studies suggests that factors such as provider experience, patient characteristics, and the specific emergency context significantly influence outcomes.

Keywords: Endotracheal intubation, supraglottic airway device, airway management, out-of-hospital cardiac arrest, survival rate

Introduction

Airway management is a cornerstone of resuscitation in out-of-hospital cardiac arrest (OHCA), a critical medical emergency with low survival rates globally (1,2). The primary goal during resuscitation is to ensure adequate oxygenation and ventilation to support the heart and brain until spontaneous circulation can be restored (3,4). Over the years, the strategies for airway management in OHCA have evolved from basic methods like mouth-to-mouth respiration to advanced techniques involving endotracheal intubation (ETI) and supraglottic airway (SGA) devices. These advancements reflect the ongoing efforts to improve patient outcomes by optimizing the airway management approach during the critical minutes following cardiac arrest.

ETI has long been considered the gold standard for securing the airway in emergency medicine, given its ability to provide a secure airway, protect against aspiration, and enable controlled ventilation (5,6). ETI, however, requires significant skill and experience to perform successfully, especially in the challenging

Corresponding Author: Lukasz Szarpak MD, Baylor College of Medicine, Henry J.N. Taub Department of Emergency Medicine, Texas, United States
Phone: +48500186225 **E-mail:** lukasz.szarpak@gmail.com **ORCID ID:** orcid.org/0000-0002-0973-5455

Received: 13.02.2024
Accepted: 01.04.2024

Cite this article as: Dabkowski M, Wieczorek P, Cander B, Kacprzyk D, Pruc M, Szarpak L. Endotracheal Intubation Versus Supraglottic Airway for Airway Management in Adults with Out-of-hospital Cardiac Arrest: A Systematic Review and Meta-analysis. Eurasian J Emerg Med. 2024;23(2): 84-94.

conditions encountered during OHCA. Studies, including those by Bartos et al. (7) have explored the impact of ETI in OHCA, with a focus on the procedure's success rates, its influence on survival outcomes, and potential complications arising from its use in the ETI setting.

On the other hand, SGA devices have emerged as a viable alternative to ETI for airway management in OHCA. SGAs are designed to be easier to insert and require less skill and training than ETI. They have gained popularity due to their simplicity and the potential for rapid deployment, which is crucial in time-sensitive scenarios like OHCA. The literature, including studies by Becker et al. (8), Benger et al. (9), and others, has examined the efficacy of SGAs compared to ETI, assessing metrics such as insertion success rates, ventilation quality, and the impact on patient outcomes including survival to hospital discharge (SHD) and neurological status.

The debate between the use of ETI and SGA devices in OHCA management centers around several key issues. These include the skill level required for effective implementation, the impact on patient outcomes, and the operational challenges faced by emergency medical services in different regions. Factors such as the availability of skilled personnel, training programs, and the specific circumstances of each cardiac arrest case (e.g., etiology of arrest, patient anatomy, presence of bystanders) play critical roles in determining the most appropriate airway management strategy.

The evolution of airway management strategies reflects a broader trend in emergency medicine towards evidence-based practice. Randomized controlled trials and observational studies have provided valuable insights into the relative benefits and drawbacks of ETI and SGA devices. For instance, research has shown that while ETI may offer superior airway protection, the technical challenges and potential for procedural complications can adversely affect outcomes. Conversely, the ease of use associated with SGA devices might lead to faster airway control but could be associated with increased rates of improper placement and inadequate ventilation in some cases.

The goal of this meta-analysis is to evaluate and compare the effectiveness of ETI and SGA devices in airway management during OHCA events. This work aims to integrate available data from studies comparing these two methods with respect to key outcome indicators, such as survival to hospital admission (SHA), SHD, and the neurological status of patients who survived the cardiac arrest.

Materials and Methods

This study was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines (10) and the Cochrane Handbook for Systematic Review of Interventions (11). The review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO-CRD42024500150). This study did not require ethical approval and informed consent as it was a systematic review and meta-analysis of previously published studies.

Search Strategy

We did a systematic review and network meta-analysis. We searched the PubMed, EMBASE, Scopus, Web of Science, and Cochrane Library databases from the date of their inception to January 31, 2024, with restriction to English language.

We used the search terms compilation "endotracheal intubation" OR "intubation" OR "direct laryngoscope" OR "direct intubation" OR "Macintosh laryngoscope" OR "laryngoscope" OR "MAC" AND "supraglottic airway device" OR "SGA" OR "i-gel" OR "IGEL" OR "laryngeal mask airway" OR "laryngeal tube" OR "LMA-Classic" OR "LMA-Proseal" OR "LMA" OR "SoftSeal" OR "air-Q" OR "cobra perilaryngeal airway" OR "self-pressurised air-Q" OR "Ambu Aura-I" OR "Ambu AuraGain" OR "Ambu AuraOnce" AND "heart arrest" OR "cardiac arrest" OR "out-of-hospital cardiac arrest" OR "OHCA" OR "OOHCA" OR "OH-CA" OR "prehospital cardiac arrest" OR "sudden cardiac death". We also checked the reference lists of included studies.

Study Selection

Two researchers (M.D. and M.P.) independently screened titles and abstracts of the identified papers in order to select relevant and not-relevant papers. Each citation was reviewed with full-text retrieval of any citation considered potentially relevant. All studies meeting the following PICOS criteria were included in our analysis: adult (aged 18 years or older) patients with OHCA (P); airway management with ETI (I); airway management with SGA devices (C); return of spontaneous circulation (ROSC), SHA with sustained ROSC; SHD, with good neurological outcome defined as a score 1 or 2 according to Cerebral Performance Categories (CPC) Scale (O); randomized controlled trial as well as non-randomized trials (S). We excluded trials focusing on pediatric population or conducted among simulation or animal model, systematic reviews, reviews, commentaries/editorials, letter to editors, and literature reviews, as well as studies not addressing our review question.

Data Extraction and Data Retrieval

After identifying those studies meeting inclusion criteria, two members (M.D. and D.K.) of our team should have independently reviewed and assessed each of the included studies. Any disagreement on both study selection and data extraction was planned to be solved by discussion with a further author (L.S.) or by contacting the corresponding author.

The following information was collected: first author, year of the study, country, study design, type of SGA device, total number of patients per group, sex and age. Furthermore, we collected: witnessed arrest and bystander cardiopulmonary resuscitation, ROSC, SHA with sustained ROSC; SHD with good neurological outcome defined as a CPC 1-2. If data were missing, a request was sent by e-mail to the corresponding author of the study. If no response was received after our initial request, a second request was sent seven days later.

Quality Assessment and Certainty of Evidence Assessment

Two researchers (M.D. and M.P.) independently evaluated the quality of included RCTs by using the risk of bias (RoB) 2 Tool (12) and for non-RCT by using ROBINS-I Tool (13). Disagreements were resolved by discussion with a third researcher (B.C.).

RoB 2 Tool assesses study quality and RoB by exploring five domains (bias arising from the randomization process, bias due to deviations from intended interventions, bias due to missing outcome data, bias in the measurement of the outcome, bias in the selection of the reported result) and each domain is judged on a three-grade scale (low RoB, high RoB or some concerns).

In contrast, in the case of the ROBINS-I tool, the following domains were assessed: bias due to confounding; bias due to the selection of participants; bias in the classification of intervention; bias due to deviations from the intended interventions; bias due to missing data; bias in the measurement of outcomes; bias in the selection of the reported result.

An overall RoB among both tools was expressed based on the above domains on a three-grade scale (low RoB, high RoB or some concerns).

Both the single domains and the overall judgement are based on the criteria reported in the RoB 2 Tool (14).

Statistical Analysis

Statistical analyses utilized Review Manager software (v5.4, by the Nordic Cochrane Centre of the Cochrane Collaboration) and Stata software (v18, from StataCorp in College Station, TX, USA) for computations. We conducted all statistical comparisons as two-tailed, setting the threshold for significance at $p<0.05$. The analysis employed (OR) with 95% confidence intervals (CIs) for binary outcomes, and mean differences with 95% CIs for continuous outcomes. When studies reported continuous outcomes using medians and ranges, we derived means and standard deviations using Hozo et al.'s (15) method. A random-effects model underpinned all analyses, with heterogeneity quantified by I^2 statistics, categorizing it as low (<25%), moderate (25-50%), or high (>50%). To detect publication bias, we applied Egger's test and constructed funnel plots, specifically examining asymmetry in analyses involving more than ten studies. Finally, in sensitivity analyses, leave-one-out analysis was performed.

Results

Study Selection

Our literature search identified a total of 4218 studies; the process of study selection is summarized in Figure 1. We excluded 1171 duplicates and 3022 citations after title and abstract screening. We identified 25 trials (with 160,071 participants) to include in this meta-analysis (7-9,16-37). Baseline characteristics of the included studies were provided

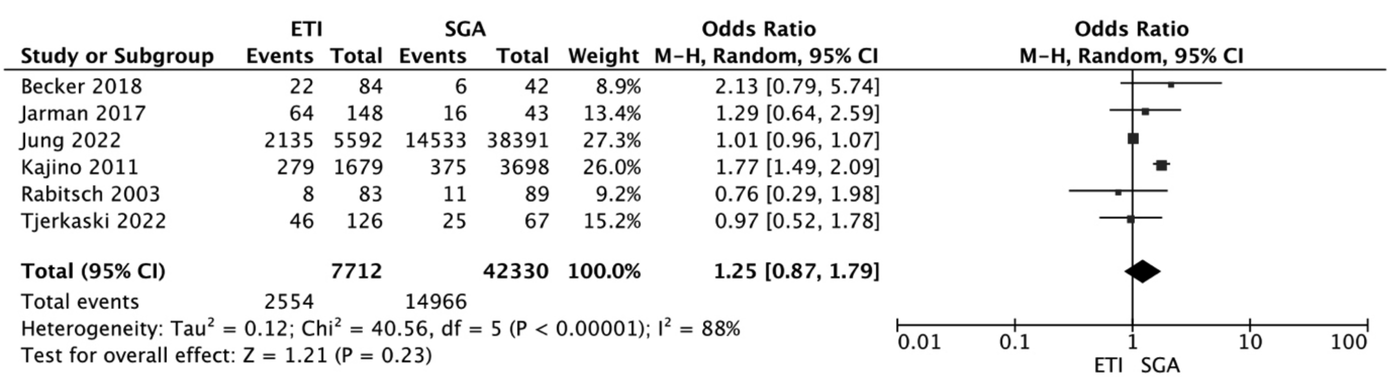


Figure 1. PRISMA flow chart

ETI: Endotracheal intubation, SGA: Supraglottic airway device, CI: Confidence interval, PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-analyses

Table 1. Baseline characteristics of included trials

Study	Country	Study design	Study groups	No.	Age	Sex, male, n (%)	Witnessed arrest, n (%)	Bystander CPR, n (%)	Shockable rhythm, n (%)
Bartos et al. (7), 2023	USA	RS	ETI	179	57.3±12.4	144 (80.5)	138 (77.1)	132 (73.7)	NS
			SGA	204	57.2±11.4	167 (81.9)	157 (77.0)	135 (66.2)	NS
Becker et al. (8), 2018	USA	RS	ETI	84	68.5±3.4	56 (66.7)	NS	4 (4.8%)	NS
			SGA	42	62.4±4.4	25 (59.5%)	NS	8 (19.0%)	NS
Behrens et al. (16), 2020	Germany	RS	ETI	2776	70.4±14.6	1862 (67.1)	1236 (44.5)	940 (33.9)	624 (22.5)
			SGA	2776	70.9±14.2	1862 (67.1)	1236 (44.5)	940 (33.9)	624 (22.5)
Benger et al. (9), 2018	England	RCT	ETI	4410	73.3±3.5	2791 (63.3)	2788 (63.2)	2774 (63.9)	1023 (23.3)
			SGA	4886	72.3±3.5	3132 (64.1)	3100 (63.4)	3149 (64.4)	1133 (23.2)
Bernhard et al. (17), 2018	Germany	RS	ETI	17.884	68.2±16.9	11.397 (63.7)	8303 (46.4)	5581 (31.2)	4421 (24.7)
			SGA	4463	67.9±15.5	2914 (65.3)	1914 (42.9)	1530 (34.3)	952 (21.3)
Chiang et al. (18), 2018	Taiwan	RS	ETI	1541	77.0±3.3	961 (62.4)	504 (32.7)	463 (30.1)	144 (9.3)
			SGA	3099	76.3±3.8	1968 (63.5)	1051 (33.9)	936 (30.2)	355 (11.5)
Christ et al. (19), 2016	Germany	RS	ETI	164	70.5±13	106 (64.6)	119 (72.6)	75 (45.7)	60 (36.6)
			SGA	62	67.6±13.7	32 (51.6)	42 (67.7)	29 (46.8)	19 (30.6)
Deakin et al. (20), 2021	England	RCT	ETI	78	60.9±26.5	50 (64.1)	56 (71.8)	16 (20.5)	17 (21.8)
			SGA	67	61.6±23.0	43 (64.2)	44 (65.7)	15 (22.4)	15 (22.4)
Jarman et al. (21), 2017	USA	PS	ETI	148	60.8±3.5	95 (64.2)	77 (52.0)	75 (50.7)	37 (25.0)
			SGA	43	58.8±6.3	27 (63.8)	22 (51.2)	22 (51.2)	16 (37.2)
Jung et al. (22), 2022	Korea	RS	ETI	5592	NS	3606 (64.5)	2910 (52.0)	1372 (24.5)	1064 (19.0)
			SGA	38.391	NS	24.784 (64.6)	19.903 (51.8)	9124 (23.8)	7351 (19.1)
Kajino et al. (23), 2011	Japan	PS	ETI	1679	73.8±14.6	1021 (60.8)	NS	686 (40.9)	278 (16.6)
			SGA	3698	71.9±15.2	2291 (62.0)	NS	1472 (39.8)	622 (16.9)
Kim et al. (24), 2019	Korea	RS	ETI	121	73.0±3	71 (58.7)	70 (57.9)	62 (51.2)	21 (17.4)
			SGA	965	68.5±3.7	673 (69.7)	536 (55.5)	524 (54.3)	207 (21.5)
Lee et al. (25), 2022	Taiwan	RCT	ETI	517	72.1±16.4	330 (63.8)	219 (42.4)	374 (72.3)	95 (18.4)
			SGA	419	74.7±38.1	239 (57.0)	200 (47.7)	290 (69.2)	52 (12.4)
Lesnick et al. (26), 2021	USA	RCT	ETI	1224	62.3±6.9	738 (60.3)	578 (47.2)	579 (47.3)	214 (17.5)
			SGA	1418	64.2±4.1	881 (62.1)	621 (43.8)	659 (46.5)	248 (17.5)
Lin et al. (27), 2014	Taiwan	RS	ETI	44	72.3±6.9	32 (72.7)	19 (43.2)	16 (36.4)	NS
			SGA	1384	73.5±4.0	909 (65.7)	607 (43.9)	322 (23.3)	NS
Lupton et al. (28), 2019	USA	RS	ETI	1299	64.0±23.0	780 (60.0)	604 (46.5)	613 (48.6)	214 (16.5)
			SGA	1353	64.0±23.0	846 (62.5)	604 (44.6)	629 (48.8)	253 (18.7)
Nakayama et al. (29), 2023	Japan	PS	ETI	413	77.3±3.2	245 (59.2)	291 (70.5)	188 (45.5)	38 (9.2)
			SGA	1114	75.5±3.0	667 (59.9)	704 (63.2)	523 (46.9)	207 (18.6)
Okubo et al. (30), 2022	USA	RCT	ETI	776	64.5±3.8	467 (60.2)	290 (37.4)	439 (56.6)	132 (17.0)
			SGA	923	64.3±3.8	584 (63.3)	332 (36.0)	486 (52.7)	180 (19.5)
Rabitsch et al. (31), 2003	Austria	RCT	ETI	83	54.7±20.4	64 (77.1)	NS	8 (9.6)	74 (89.2)
			SGA	89	60.7±16.2	67 (75.3)	NS	11 (12.4)	78 (87.6)
Ryan et al. (32), 2021	US	RS	ETI	767	27±47.5	526 (68.6)	184 (24.0)	348 (45.4)	67 (8.7)
			SGA	458	41±36.5	331 (72.3)	127 (27.7)	158 (34.5%)	45 (9.8)
Shin et al. (33), 2012	Korea	RS	ETI	250	61.7±17.0	160 (64.0)	83 (33.2)	10 (4.0)	32 (12.8)
			SGA	391	61.0±16.9	270 (69.1)	136 (34.8)	16 (4.1)	32 (8.2%)

Table 1. Continued

Study	Country	Study design	Study groups	No.	Age	Sex, male, n (%)	Witnessed arrest, n (%)	Bystander CPR, n (%)	Shockable rhythm, n (%)
Sulzgruber et al. (34), 2018	Austria	PS	ETI	793	67.5±3.7	515 (64.9)	493 (62.2)	315 (39.7)	243 (30.6)
			SGA	404	68.3±3.2	267 (66.1)	230 (56.9)	197 (48.8)	94 (23.3)
Tanabe et al. (35), 2013	Japan	RS	ETI	16.054	73.8±15.3	9397 (58.5)	7126 (44.4)	6722 (41.9)	1201 (7.5)
			SGA	34.125	72.1±15.9	20.657 (60.5)	13.413 (39.3)	12.930 (37.9)	2943 (9.8)
Tjerkaski et al. (36), 2022	Multicountry	Post hoc sub-analysis of RCT	ETI	126	64.8±10.7	98 (77.8)	NS	78 (61.9)	42 (33.3)
			SGA	67	65.5±12.2	49 (73.1)	NS	40 (59.7)	22 (32.8)
Wang et al. (37), 2018	USA	RCT	ETI	1499	64.3±3.8	901 (60.1)	708 (47.2)	709 (55.4)	270 (18.0)
			SGA	1505	64.3±3.8	928 (61.7)	691 (45.9)	698 (55.5)	301 (20.0)

ETI: Endotracheal tube intubation, NS: Not specified, PS: Prospective study, RCT: Randomized controlled trial, RS: Retrospective study, SGA: Supraglottic airway device, CPR: Cardiopulmonary resuscitation

Study or Subgroup	ETI Events	ETI Total	SGA Events	SGA Total	Weight	Odds Ratio M-H, Random, 95% CI
Becker 2018	12	84	1	42	0.7%	6.83 [0.86, 54.46]
Behrens 2020	1082	2776	761	2776	7.8%	1.69 [1.51, 1.89]
Benger 2018	1249	4404	1495	4880	7.9%	0.90 [0.82, 0.98]
Bernhard 2018	7138	17887	1162	4463	8.0%	1.89 [1.75, 2.03]
Chiang 2018	478	1541	758	3099	7.7%	1.39 [1.21, 1.59]
Deakin 2021	31	78	15	67	3.4%	2.29 [1.10, 4.75]
Kajino 2011	688	1679	1412	3698	7.8%	1.12 [1.00, 1.26]
Kim 2019	17	121	134	965	4.6%	1.01 [0.59, 1.75]
Lee 2022	139	517	108	419	6.6%	1.06 [0.79, 1.42]
Lesnick 2021	408	1224	506	1418	7.6%	0.90 [0.77, 1.06]
Lin 2014	3	44	11	1384	1.5%	9.13 [2.45, 33.98]
Rabitsch 2003	34	83	34	89	4.1%	1.12 [0.61, 2.07]
Ryan 2021	296	767	103	458	6.9%	2.17 [1.66, 2.82]
Shin 2012	55	250	80	391	5.8%	1.10 [0.74, 1.61]
Sulzgruber 2018	36	210	18	210	4.2%	2.21 [1.21, 4.03]
Tanabe 2013	1162	16054	1671	34125	7.9%	1.52 [1.40, 1.64]
Wang 2018	365	1499	420	1505	7.6%	0.83 [0.71, 0.98]
Total (95% CI)		**49218**		**59989**	**100.0%**	**1.35 [1.13, 1.62]**
Total events	13193		8689			

Heterogeneity: Tau² = 0.10; Chi² = 284.54, df = 16 (P < 0.00001); I² = 94%
Test for overall effect: Z = 3.34 (P = 0.0008)

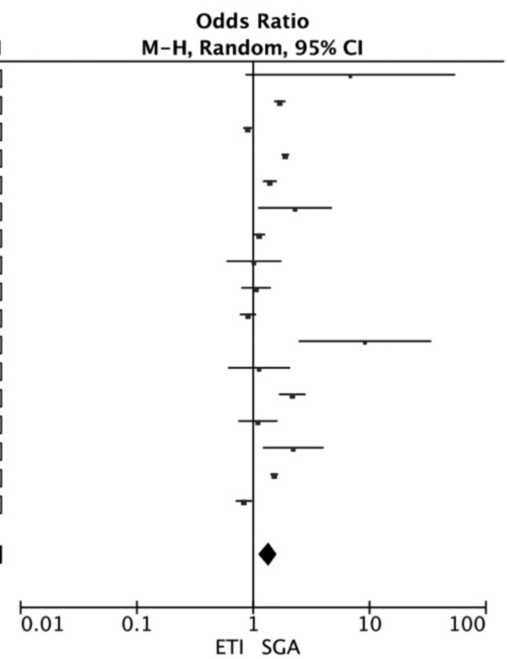


Figure 2. Forest plot of prehospital return of spontaneous circulation among ETI and SGA groups. The center of each square represents the odds ratios for individual trials, and the corresponding horizontal line stands for a 95% confidence interval. The diamonds represent pooled results

ETI: Endotracheal intubation, SGA: Supraglottic airway device, CI: Confidence interval

in Table 1. Of the included articles, eight were conducted in the US, three each in Germany, Taiwan, Korea and Japan, two in England, and two in Austria. In addition, one study was an international survey covering Belgium, the Czech Republic and Sweden. Both prospective and retrospective studies had low RoB (Supplementary Figures 1-4).

Summary of Studies

Our analysis included data from 160,071 out-of-hospital cardiac arrest cases. Among them, 57,921 airways were protected with ETI, while in 102,150 cases with SGA. Patient characteristics are shown in Table 2. In the analysis of airway management outcomes, the odds of being male were marginally lower in the ETI group (62.2%) compared to the SGA group (63.1%), with an odds ratio of 0.94 (95% CI, 0.92 to 0.97, p<0.001) and low study heterogeneity (I^2=23%). Age did not significantly differ between ETI and SGA groups, with specifics on mean and standard deviation not provided. Witnessed arrests occurred in 47.5% of ETI cases versus 46.6% for SGA, with an OR of 1.04 (95% CI, 0.97 to 1.11, p=0.23) and moderate heterogeneity (I^2=75%).

Bystander CPR was provided in 39.2% of ETI cases against 33.5% in SGA, with an OR of 1.12 (95% CI, 0.98 to 1.27, p=0.09) and high heterogeneity (I^2=94%). These findings suggest that demographic factors and prehospital interventions like witnessed arrest and bystander CPR show no significant differences between the ETI and SGA groups, despite varying levels of heterogeneity across studies.

Meta-analysis Outcomes

Prehospital ROSC was assessed in 6 studies involving 7,712 participants for ETI and 42,330 for SGA (Figure 2). The event rate was 33.1% for ETI compared to 35.4% for SGA. The odds ratio (OR) was 1.25, with a 95% CI of 0.87 to 1.79, indicating no significant difference between the groups (p=0.23). Heterogeneity across trials was high (I^2=88%).

SHA was evaluated in 17 studies with 49,218 participants for ETI and 59,989 for SGA, revealing an event rate of 26.8% for ETI and 14.5% for SGA (Figure 3). The OR was 1.37 (95% CI, 1.32 to 1.42), with a p value of less than 0.001, suggesting a significant difference favoring ETI. However, heterogeneity remained high (I^2=94%).

Study or Subgroup	ETI Events	ETI Total	SGA Events	SGA Total	Weight	Odds Ratio M-H, Random, 95% CI
2.3.1 24-h survival						
Becker 2018	4	84	1	42	0.3%	2.05 [0.22, 18.94]
Behrens 2020	718	2776	505	2776	96.8%	1.57 [1.38, 1.78]
Lin 2014	9	44	235	1384	2.9%	1.26 [0.60, 2.65]
Subtotal (95% CI)		**2904**		**4202**	**100.0%**	**1.56 [1.38, 1.77]**
Total events	731		741			
Heterogeneity: Tau² = 0.00; Chi² = 0.39, df = 2 (P = 0.82); I² = 0%						
Test for overall effect: Z = 6.90 (P < 0.00001)						
2.3.2 72-h survival						
Benger 2018	575	4395	664	4872	35.9%	0.95 [0.85, 1.08]
Lesnick 2021	165	1224	222	1418	16.6%	0.84 [0.68, 1.04]
Lupton 2019	174	1299	218	1353	16.9%	0.81 [0.65, 1.00]
Okubo 2022	85	776	138	923	10.5%	0.70 [0.52, 0.93]
Wang 2018	230	1495	275	1505	20.1%	0.81 [0.67, 0.99]
Subtotal (95% CI)		**9189**		**10071**	**100.0%**	**0.85 [0.77, 0.94]**
Total events	1229		1517			
Heterogeneity: Tau² = 0.00; Chi² = 5.52, df = 4 (P = 0.24); I² = 27%						
Test for overall effect: Z = 3.13 (P = 0.002)						
2.3.3 SHD / 30-d survival						
Behrens 2020	333	2776	253	2776	6.8%	1.36 [1.14, 1.62]
Benger 2018	373	4407	395	4882	7.0%	1.05 [0.91, 1.22]
Bernhard 2018	2065	17887	350	4463	7.2%	1.53 [1.36, 1.73]
Chiang 2018	141	1541	193	3099	6.3%	1.52 [1.21, 1.90]
Christ 2016	41	164	18	62	2.9%	0.81 [0.42, 1.56]
Jung 2022	508	5592	2262	38391	7.3%	1.60 [1.44, 1.76]
Kajino 2011	180	1679	361	3698	6.7%	1.11 [0.92, 1.34]
Kim 2019	13	121	87	965	3.1%	1.21 [0.66, 2.25]
Lee 2022	44	517	35	419	4.2%	1.02 [0.64, 1.62]
Lesnick 2021	75	1224	105	1418	5.6%	0.82 [0.60, 1.11]
Lin 2014	2	44	29	1384	0.8%	2.22 [0.51, 9.63]
Lupton 2019	75	1299	109	1353	5.6%	0.70 [0.52, 0.95]
Nakayama 2023	121	413	388	1114	6.2%	0.78 [0.61, 0.99]
Okubo 2022	37	776	67	923	4.6%	0.64 [0.42, 0.97]
Rabitsch 2003	2	83	5	89	0.6%	0.41 [0.08, 2.20]
Ryan 2021	73	767	16	458	3.5%	2.91 [1.67, 5.06]
Shin 2012	20	250	22	391	3.0%	1.46 [0.78, 2.73]
Sulzgruber 2018	36	210	18	210	3.2%	2.21 [1.21, 4.03]
Tanabe 2013	673	16054	1242	34125	7.3%	1.16 [1.05, 1.27]
Tjerkaski 2022	16	126	9	67	1.9%	0.94 [0.39, 2.25]
Wang 2018	121	1495	163	1504	6.2%	0.72 [0.57, 0.93]
Subtotal (95% CI)		**57425**		**101791**	**100.0%**	**1.13 [0.98, 1.30]**
Total events	4949		6127			
Heterogeneity: Tau² = 0.07; Chi² = 129.47, df = 20 (P < 0.00001); I² = 85%						
Test for overall effect: Z = 1.68 (P = 0.09)						

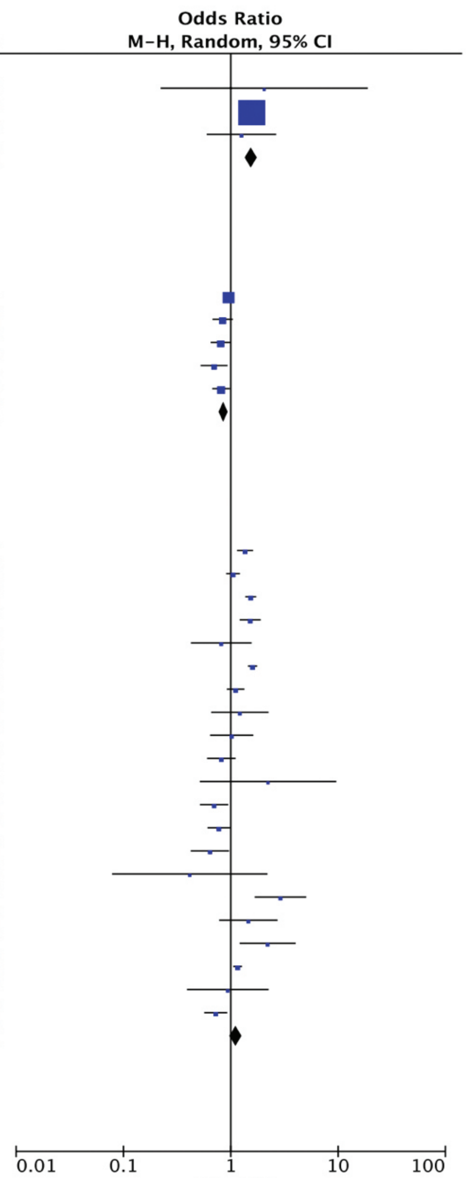


Figure 3. Forest plot of survival to hospital admission among ETI and SGA groups. The center of each square represents the odds ratios for individual trials, and the corresponding horizontal line stands for a 95% confidence interval. The diamonds represent pooled results

ETI: Endotracheal intubation, SGA: Supraglottic airway device, CI: Confidence interval, SHD: Survival to hospital discharge

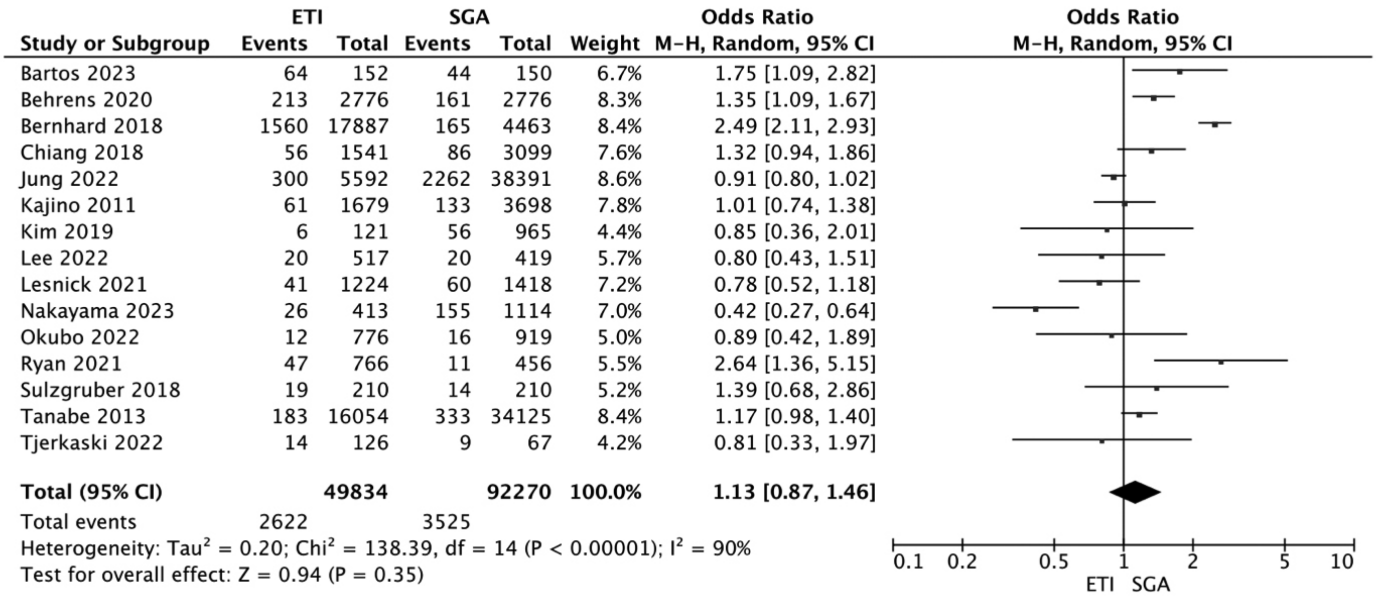


Figure 4. Forest plot of survival periods (a) 24-h survival rate; (b) 72-h survival rate; survival to hospital discharge/30-d survival rate among ETI and SGA groups. The center of each square represents the odds ratios for individual trials, and the corresponding horizontal line stands for a 95% confidence interval. The diamonds represent pooled results

ETI: Endotracheal intubation, SGA: Supraglottic airway device, CI: Confidence interval

Table 2. Baseline of patient characteristics among included trials

Outcome	No. of studies	Event/participants or mean ± SD		Events		Heterogeneity between trials		p value for differences across groups
		ETI	SGA	OR or MD	95% CI	p value	I^2 statistics	
Sex, male	25	36.019/57.921 (62.2%)	64.492/102.150 (63.1%)	0.94	0.92 to 0.97	0.15	23%	<0.001
Age, years	23	70.03±16.91	71.05±15.24	0.58	-0.02 to 1.18	<0.001	97%	0.06
Witnessed arrest	21	26.426/55.678 (47.5%)	45.559/97.849 (46.6%)	1.04	0.97 to 1.11	<0.001	75%	0.23
Bystander CPR	24	22.397/57.132 (39.2%)	33.945/101.284 (33.5%)	1.12	0.98 to 1.27	<0.001	94%	0.09

CI: Confidence interval, CPR: Cardiopulmonary resuscitation, ETI: Endotracheal intubation, MD: Mean difference, OR: Odds ratio, SGA: Supraglottic airway device, SD: Standard deviation

24-hour survival rate among patients treated with ETI and SGA varied and amounted to 25.2% and 17.6% respectively (OR=1.56; 95% CI: 1.38 to 1.77; p<0.001; Figure 4).

For the 72-hour survival rate, 5 studies with 9,189 participants for ETI and 10,071 for SGA showed an event rate of 13.4% for ETI and 15.1% for SGA. The OR was 0.85 (95% CI, 0.77 to 0.94), with moderate heterogeneity (I^2=27%) and a p value of 0.002, favoring SGA.

SHD/30-day survival rate was reported in 21 studies including 57,425 participants for ETI and 101,791 for SGA. The event rate was 8.6% for ETI and 6.0% for SGA, with an OR of 1.13 (95% CI, 0.98 to 1.30). Despite high heterogeneity (I^2=85%), the difference was not statistically significant (p=0.09).

SHD with CPC 1-2 was assessed in 15 studies with 49,834 participants for ETI and 92,270 for SGA. The event rate was 5.3% for ETI compared to 3.8% for SGA. The OR was 1.13 (95% CI, 0.87 to 1.46), and the p value was 0.35, indicating no significant difference, with very high heterogeneity (I^2=90%).

Discussion

This meta-analysis compares the efficacy of ETI versus SGA devices in the prehospital setting, focusing on various survival outcomes. Our findings present mixed results, highlighting the complexity of choosing the optimal airway management technique in emergency situations.

In our analysis for prehospital ROSC, the difference between ETI and SGA was not statistically significant. While a slightly higher event rate was observed for SGA, the OR did not indicate significant differences between the groups. The high degree of heterogeneity (I^2=88%) may reflect variations in study protocols, patient populations, or techniques used for both procedures. Regarding SHA the significant difference favoring ETI suggests that under certain clinical conditions, intubation may provide better outcomes. Nevertheless, the extremely high heterogeneity (I^2=94%) underscores the need for cautious interpretation of these results. The SHD/30-day survival rate did not show a statistically significant difference between ETI and SGA, despite high heterogeneity (I^2=85%). This finding suggests that the immediate benefits of airway management techniques may not translate into long-term survival advantages, highlighting the importance of comprehensive post-resuscitation care. Furthermore, when assessing SHD with CPC of 1-2, no significant difference was observed, indicating that the choice of airway management technique may not significantly impact neurological outcomes, although very high heterogeneity (I^2=90%) was noted. The importance of securing airway patency in prehospital emergency care cannot be overstated, as it is a critical determinant of successful resuscitation outcomes. Both ETI and SGA devices play pivotal roles in ensuring airway management, yet they offer distinct advantages that cater to different emergency scenarios. Isolating the airway through either ETI or SGA is crucial for preventing aspiration, a common and potentially fatal complication during cardiac arrest and other emergencies. Furthermore, these airway management techniques facilitate the delivery of high-quality, uninterrupted chest compressions by allowing for asynchronous resuscitation. This approach, wherein ventilation and chest compressions are not temporally linked, can maximize cerebral and coronary perfusion by eliminating pauses in chest compressions, which are known to negatively impact survival and neurological outcomes.

The ability to provide asynchronous resuscitation underscores the strategic importance of choosing the appropriate airway management device in the prehospital setting. ETI, with its direct access to the trachea, offers a definitive airway that is most beneficial in scenarios requiring long-term ventilation, protection against aspiration, and in situations where advanced airway management skills are readily available.

ETI is recognized as a technically demanding procedure that requires a high level of skill and practice to achieve proficiency. The learning curve for ETI is steep, indicating that a significant number of attempts are needed to reach a level of competency where the success rate stabilizes. Studies suggest that to achieve a high success rate in ETI, practitioners often need to perform a substantial number of intubations under supervision. The complexity of the procedure, variability in patient anatomy, and the emergent nature of situations requiring ETI contribute to this challenging learning curve. As such, continuous training and regular practice are imperative for maintaining proficiency, particularly for providers in the prehospital setting where conditions can be unpredictable and resources limited. In contrast, the learning curve for SGA devices is generally less steep compared to ETI. SGAs are designed for ease of use, allowing for rapid and reliable airway management with minimal interruption to resuscitation efforts. The simpler insertion technique and lower skill threshold needed for effective use make SGAs an attractive option in emergency settings, especially for providers who may not perform airway management procedures frequently. However, while SGAs can be easier to learn and implement, understanding the nuances of proper placement, seal, and potential complications is essential for optimizing patient outcomes.

Study Limitations

This meta-analysis also has several limitations. The included studies showed substantial heterogeneity, which might be attributed to differences in research protocols, patient groups, or procedures. Second, significant imprecision and inconsistency lowered trust in evidence for a range of outcomes. Furthermore, there are questions regarding protocol adherence, since not all patients may get the course of care to which they were allocated. This might be explained by resuscitation time bias, which occurs when patients who fail tracheal intubation get an SGA and are predicted to have a poorer result.

Conclusion

Our analysis reveals the nuanced and context-dependent nature of airway management in prehospital emergency care. The high heterogeneity across studies suggests that factors such as provider experience, patient characteristics, and the specific emergency context significantly influence outcomes. Future research should aim to identify these moderating factors and evaluate the cost-effectiveness of ETI and SGA in various prehospital settings. Additionally, training protocols and guidelines may need to be adapted to reflect the complex decision-making process in choosing the most appropriate airway management technique.

Ethics

Ethics Committee Approval and Informed Consent: This study did not require ethical approval and informed consent as it was a systematic review and meta-analysis of previously published studies.

Authorship Contributions

Surgical and Medical Practices: M.D., Concept: M.D., Design: M.D., Data Collection or Processing: M.D., P.W., M.P., L.S., Analysis or Interpretation: M.D., Literature Search: M.D., P.W., M.P., L.S., Writing: M.D., P.W., B.C., D.K., M.P., L.S.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Dabkowski M, Swieczkowski D, Pruc M, Cander B, Gül M, Bragazzi N, et al. Unraveling the consequences of the COVID-19 pandemic on out-of-hospital cardiac arrest: A systematic review and meta-analysis. Eurasian J Emerg Med. 2023;22:135-45.
2. Meyer-Szary J, Jaguszewski MJ, Smereka J, Gasecka A, Emam MS, John I, et al. Impact of COVID-19 on pediatric out-of-hospital cardiac arrest in the Masovian region. Disaster Emerg Med J. 2021;6:183-5.
3. Zulkhifli MF, Ahmad R Nazri MZAM, Azhar AMN. A Study on the effectiveness of video call dispatcher-assisted cardiopulmonary resuscitation in enhancing the quality of cardiopulmonary resuscitation among laymen bystanders in Malaysia. Eurasian J Emerg Med. 2021;20:172-7.
4. Gadek L, Szarpak L, Konge L, Dabrowski M, Telecka-Gadek D, Maslanka M, et al. Direct vs. video-laryngoscopy for intubation by paramedics of simulated COVID-19 patients under cardiopulmonary resuscitation: A randomized crossover trial. J Clin Med. 2021;10:5740.
5. Korkut S, Szarpak L, Evrin T, Smereka J, Katipoglu B, Gorczyca D. Comparison of the McGrath MAC EMS videolaryngoscope with a conventional laryngoscope for standard and difficult airway intubation: A randomized, cross-over, simulation trial. Eurasian J Emerg Med. 2019;18:211-7.
6. Maslanka M, Smereka J, Czyzewski L, Ladny J, Dabrowski M, Szarpak L. VieScope® laryngoscope versus Macintosh laryngoscope during difficult intubation performed by paramedics: a randomized cross-over manikin trial. Disaster Emerg Med J. 2020;5:134-41.
7. Bartos JA, Clare Agdamag A, Kalra R, Nutting L, Frascone RJ, Burnett A, et al. Supraglottic airway devices are associated with asphyxial physiology after prolonged CPR in patients with refractory out-of-hospital cardiac arrest presenting for extracorporeal cardiopulmonary resuscitation. Resuscitation. 2023;186:109769.
8. Becker TK, Berning AW, Prabhu A, Callaway CW, Guyette FX, Martin-Gill C. An assessment of ventilation and perfusion markers in out-of-hospital cardiac arrest patients receiving mechanical CPR with endotracheal or supraglottic airways. Resuscitation. 2018;122:61-4.
9. Benger JR, Kirby K, Black S, Brett SJ, Clout M, Lazaroo MJ, et al. Effect of a strategy of a supraglottic airway device vs tracheal intubation during out-of-hospital cardiac arrest on functional outcome: The AIRWAYS-2 Randomized Clinical Trial. JAMA. 2018;320:779-91.
10. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71.
11. Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA, (editors). Cochrane handbook for systematic reviews of interventions. 2nd ed. Chichester (UK): John Wiley & Sons; 2019.
12. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ 2019;366:l4898.
13. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: A tool for assessing risk of bias in non-randomised studies of interventions. BMJ 2016;355:i4919.
14. McGuinness LA, Higgins JPT. Risk-of-bias VISualization (robvis): An R package and Shiny web app for visualizing risk-of-bias assessments. Res Synth Methods. 2021;12:55-61.
15. Hozo SP, Djulbegovic B, Hozo I. Estimating the mean and variance from the median, range, and the size of a sample. BMC Med Res Methodol. 2005;5:13.
16. Behrens NH, Fischer M, Krieger T, Monaco K, Wnent J, Seewald S, et al. Effect of airway management strategies during resuscitation from out-of-hospital cardiac arrest on clinical outcome: A registry-based analysis. Resuscitation. 2020;152:157-64.
17. Bernhard M, Behrens NH, Wnent J, Seewald S, Brenner S, Jantzen T, et al. Out-of-hospital airway management during manual compression or automated chest compression devices: A registry-based analysis. Anaesthesist. 2018;67:109-17.
18. Chiang WC, Hsieh MJ, Chu HL, Chen AY, Wen SY, Yang WS, et al. The effect of successful intubation on patient outcomes after out-of-hospital cardiac arrest in Taipei. Ann Emerg Med. 2018;71:387-96.
19. Christ M, von Auenmueller KI, Amirie S, Sasko BM, Brand M, Trappe HJ. Early-onset pneumonia in non-traumatic out-of-hospital cardiac arrest patients with special focus on prehospital airway management. Med Sci Monit. 2016:22:2013-20.
20. Deakin CD, Nolan JP, Ji C, Fothergill RT, Quinn T, Rosser A, et al. The effect of airway management on CPR quality in the PARAMEDIC2 randomised controlled trial. Resuscitation. 2021;158:8-13.
21. Jarman AF, Hopkins CL, Hansen JN, Brown JR, Burk C, Youngquist ST. Advanced airway type and its association with chest compression interruptions during out-of-hospital cardiac arrest resuscitation attempts. Prehosp Emerg Care. 2017;21:628-35.
22. Jung E, Ro YS, Ryu HH, Shin SD. Association of prehospital airway management technique with survival outcomes of out-of-hospital cardiac arrest patients. PLoS One. 2022;17:e0269599.
23. Kajino K, Iwami T, Kitamura T, Daya M, Ong ME, Nishiuchi T, et al. Comparison of supraglottic airway versus endotracheal intubation for the pre-hospital treatment of out-of-hospital cardiac arrest. Crit Care. 2011;15:236.
24. Kim S, Lee DE, Moon S, Ahn JY, Lee WK, Kim JK, et al. Comparing the neurologic outcomes of patients with out-of-hospital cardiac arrest according to prehospital advanced airway management method and transport time interval. Clin Exp Emerg Med. 2020;7:21-9.
25. Lee AF, Chien YC, Lee BC, Yang WS, Wang YC, Lin HY, et al. Effect of placement of a supraglottic airway device vs. endotracheal intubation on return of spontaneous circulation in adults with out-of-hospital cardiac arrest in Taipei, Taiwan: A Cluster Randomized Clinical Trial. JAMA Netw Open. 2022;5:e2148871.
26. Lesnick JA, Moore JX, Zhang Y, Jarvis J, Nichol G, Daya MR, et al. Airway insertion first pass success and patient outcomes in adult out-of-hospital cardiac arrest: The Pragmatic Airway Resuscitation Trial. Resuscitation. 2021;158:151-6.
27. Lin SC, Hsu SC, Weng YM, Kuo CI, Cheng CW, Kuo CW. Dose pre-hospital laryngeal mask airway use has a survival benefit in non-shockable cardiac arrest? SIGNA VITAE. 2014;9:27-32.
28. Lupton JR, Schmicker R, Daya MR, Aufderheide TP, Stephens S, Le N, et al. Effect of initial airway strategy on time to epinephrine administration in patients with out-of-hospital cardiac arrest. Resuscitation. 2019;139:314-20.

29. Nakayama R, Bunya N, Uemura S, Sawamoto K, Narimatsu E. Prehospital advanced airway management and ventilation for out-of-hospital cardiac arrest with prehospital return of spontaneous circulation: A prospective observational cohort study in Japan. Prehosp Emerg Care. 2024;28:470-7.

30. Okubo M, Komukai S, Izawa J, Aufderheide TP, Benoit JL, Carlson JN, et al. Association of advanced airway insertion timing and outcomes after out-of-hospital cardiac arrest. Ann Emerg Med. 2022;79:118-31.

31. Rabitsch W, Schellongowski P, Staudinger T, Hofbauer R, Dufek V, Eder B, et al. Comparison of a conventional tracheal airway with the Combitube in an urban emergency medical services system run by physicians. Resuscitation. 2003;57:27-32.

32. Ryan KM, Bui MD, Dugas JN, Zvonar I, Tobin JM. Impact of prehospital airway interventions on outcome in cardiac arrest following drowning: A study from the CARES Surveillance Group. Resuscitation. 2021;163:130-5.

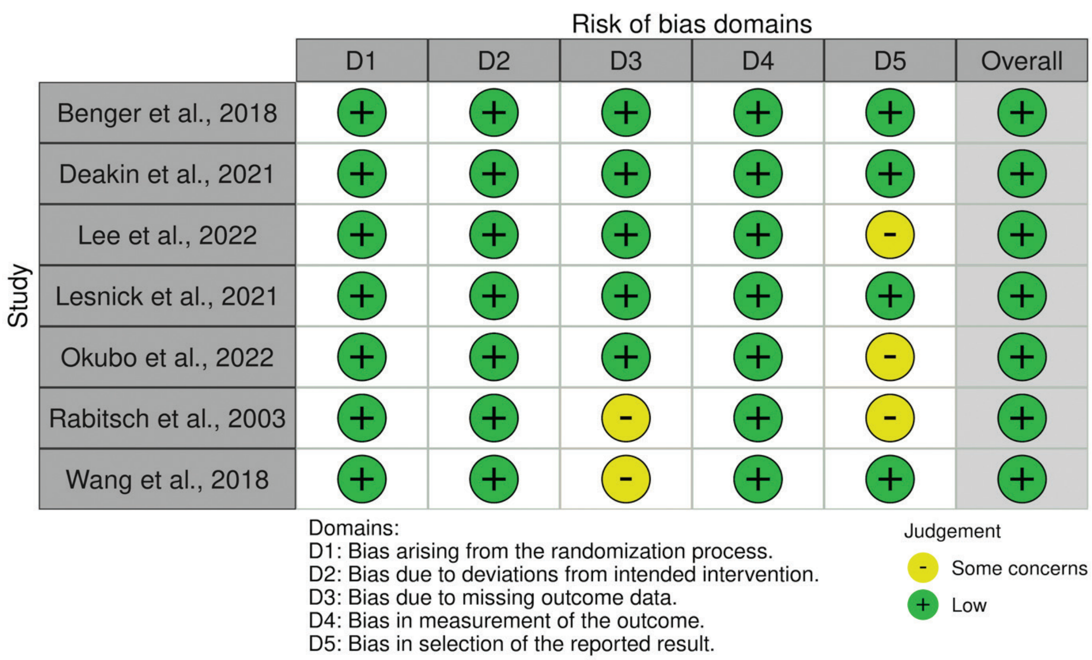
33. Shin SD, Ahn KO, Song KJ, Park CB, Lee EJ. Out-of-hospital airway management and cardiac arrest outcomes: a propensity score matched analysis. Resuscitation. 2012;83:313-9.

34. Sulzgruber P, Datler P, Sterz F, Poppe M, Lobmeyr E, Keferböck M, et al. The impact of airway strategy on the patient outcome after out-of-hospital cardiac arrest: A propensity score matched analysis. Eur Heart J Acute Cardiovasc Care. 2018;7:423-31.

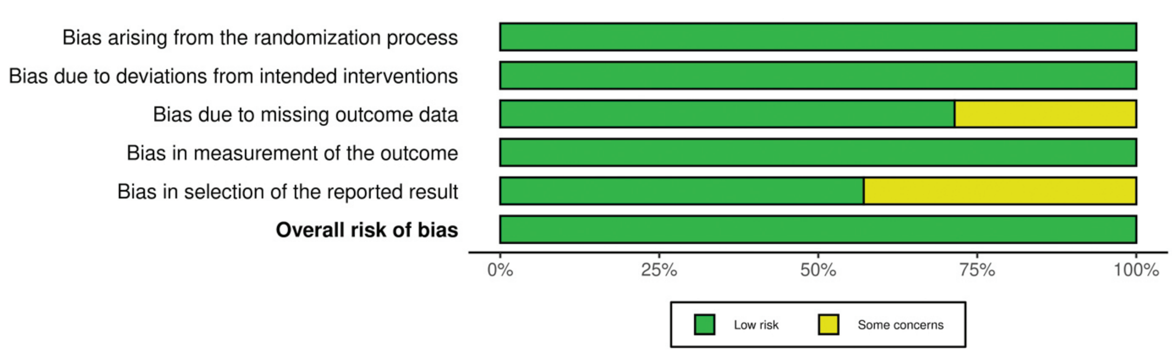
35. Tanabe S, Ogawa T, Akahane M, Koike S, Horiguchi H, Yasunaga H, et al. Comparison of neurological outcome between tracheal intubation and supraglottic airway device insertion of out-of-hospital cardiac arrest patients: a nationwide, population-based, observational study. J Emerg Med. 2013;44:389-97.

36. Tjerkaski J, Hermansson T, Dillenbeck E, Taccone FS, Truhlar A, Forsberg S, et al. Strategies of advanced airway management in out-of-hospital cardiac arrest during intra-arrest hypothermia: Insights from the PRINCESS trial. J Clin Med. 2022;11:6370.

37. Wang HE, Schmicker RH, Daya MR, Stephens SW, Idris AH, Carlson JN, et al. Effect of a strategy of initial laryngeal tube insertion vs endotracheal intubation on 72-hour survival in adults with out-of-hospital cardiac arrest a randomized clinical trial. JAMA. 2018;320:769-78.

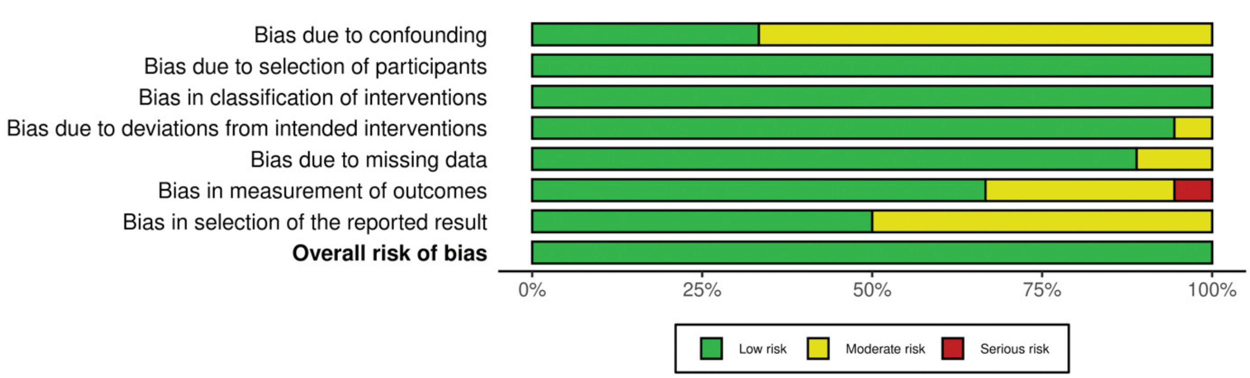


Supplementary Figure 1. A summary table of review authors' judgements for each risk of bias item for randomized study



Supplementary Figure 2. A plot of the distribution of review authors' judgements across randomized studies for each risk of bias item

Supplementary Figure 3. A summary table of review authors' judgements for each risk of bias item for non-randomized trials



Supplementary Figure 4. A plot of the distribution of review authors' judgements across non-randomized studies for each risk of bias item