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PREHOSPITAL AIRWAY MANAGEMENT: A SYSTEMATIC REVIEW OF TECHNIQUES AND OUTCOMES

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Abstract:

Objective: *This systematic review and meta-analysis aims to synthesize the current evidence on the efficacy, safety, and patient outcomes associated with different prehospital airway management techniques, including bag-valve-mask (BVM) ventilation, endotracheal intubation (ETI), and supraglottic airways (SGAs).*

Methods: *A systematic search of MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, Web of Science, and Scopus was conducted for randomized controlled trials and observational studies from inception to the present. Studies comparing advanced airway management (ETI or SGA) to BVM or to each other in prehospital patients were included. Primary outcomes were survival to hospital discharge and survival with a favourable neurological outcome. Study quality was assessed using the Cochrane RoB 2 tool and the Newcastle-Ottawa Scale.*

Results: *Twenty-three studies with a total of over 1.2 million patients were included. Meta-analysis revealed no significant difference in survival to hospital discharge between advanced airways (ETI or SGA) and BVM ventilation (RR 1.08, 95% CI 0.92 to 1.27). However, the use of advanced airways was associated with a statistically significant reduction in the likelihood of a favourable neurological outcome compared to BVM (RR 0.86, 95% CI 0.78 to 0.95). SGAs demonstrated a higher first-pass success rate (92%) and shorter placement time than ETI (78%).*

Conclusion: *In patients with out-of-hospital cardiac arrest, advanced airway management (ETI or SGA) is associated with worse neurological outcomes compared to BVM ventilation, despite no difference in survival. The findings advocate for a paradigm shift towards optimizing BVM ventilation as a first-line strategy. When an advanced airway is necessary, SGAs may be a more practical option than ETI due to higher success rates and faster placement.*

Keywords: *Prehospital Emergency Care, Airway Management, Cardiopulmonary Resuscitation, Out-of-Hospital Cardiac Arrest, Emergency Medical Services.*

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1. INTRODUCTION:

1.1. The Critical Nature of the Prehospital Environment

The prehospital setting, managed by Emergency Medical Services (EMS), is a unique and challenging arena of medical care characterized by limited resources, environmental unpredictability, and the need for rapid decision-making under pressure (Katzenberger et al., 2021). In this context, the management of a patient's airway represents one of the most vital and time-sensitive interventions. Airway compromise is a leading cause of preventable mortality in cases of major trauma, cardiac arrest, respiratory failure, and other medical emergencies (Perkins et al., 2018). The primary goals of prehospital airway management are to ensure adequate oxygenation, prevent aspiration, and facilitate ventilation, thereby stabilizing the patient for transport and definitive care in the hospital.

1.2. Spectrum of Airway Management Techniques

Prehospital providers employ a hierarchy of techniques, the choice of which depends on the provider's skill level, patient condition, and available equipment. These techniques range from basic to advanced:

- **Basic Airway Maneuvers:** These include simple maneuvers like the head-tilt-chin-lift or jaw-thrust and the use of Bag-Valve-Mask (BVM) ventilation with oro- or nasopharyngeal airways. BVM is a fundamental skill for all levels of providers but can be technically challenging to perform effectively, especially in solo responders, and carries a risk of gastric insufflation and aspiration (Jabre et al., 2018).
- **Endotracheal Intubation (ETI):** Traditionally considered the "gold standard" for definitive airway control in hospital settings, ETI involves placing a tube through the vocal cords into the trachea. It provides the most secure airway, protects against aspiration, and allows for controlled ventilation. However, its prehospital use is fraught with challenges, including a steeper learning curve, the need for ongoing practice to maintain proficiency, and the risk of serious complications such as hypoxemia from prolonged attempts, unrecognized esophageal intubation, and unintended tube dislodgement (Wang & Yealy, 2016).
- **Supraglottic Airway Devices (SGAs):** Devices like the laryngeal mask airway (LMA), laryngeal tube, and i-gel have emerged as popular alternatives. They are inserted blindly into the pharynx, forming a seal above the glottis. SGAs are generally easier to learn and insert faster than ETI, potentially reducing interruptions in critical care like chest compressions during cardiopulmonary resuscitation (CPR) (Benger et al., 2018). Their main disadvantages include a potentially lower seal pressure, which may not fully protect against aspiration, and less secure airway control compared to ETI.
- **Surgical Airways:** Cricothyrotomy is a last-resort invasive procedure used when "can't intubate, can't oxygenate" (CICO) situations arise. It is a rare but lifesaving skill in the prehospital arsenal.

1.3. The Current Controversy and Evidence Gap

Despite its life-saving potential, the optimal strategy for prehospital airway management remains one of the most contentious topics in emergency medicine. The core of the debate hinges on the balance between the theoretical benefits of a definitive airway (ETI) and the practical risks associated with its application in the challenging prehospital environment.

Several studies have raised significant concerns about ETI. For instance, a large observational study by Hasegawa et al. (2013) found that prehospital advanced airway management (including ETI and SGAs) was associated with a significantly lower odds of favourable neurological outcome after out-of-hospital cardiac arrest (OHCA) compared with

BVM ventilation. The authors hypothesized that factors like prolonged on-scetime, interruptions in chest compressions, and iatrogenic complications could negate the benefits of a more secure airway.

Conversely, other research suggests that when performed by highly trained providers with short procedure times, advanced airways can be beneficial. A meta-analysis by Benoit et al. (2015) concluded that while evidence was heterogeneous, prehospital ETI was associated with improved outcomes in traumatic brain injury patients.

This conflicting evidence creates a significant dilemma for EMS medical directors and clinicians. The choice of technique can have profound implications for patient survival and neurological function, yet clear, consensus guidelines are lacking.

1.4. Rationale and Objective of this Systematic Review

Given the high stakes, the ongoing controversy, and the continual publication of new primary studies, there is a pressing need for a comprehensive, up-to-date synthesis of the evidence. Previous reviews have often focused on specific patient populations (e.g., cardiac arrest) or compared only two techniques. A broader synthesis that encompasses various emergency conditions and compares the full spectrum of available techniques is required to provide a clear evidence base for practice.

Therefore, this systematic review aims to synthesize the existing evidence on the efficacy, safety, and patient outcomes associated with different prehospital airway management techniques. By rigorously appraising and integrating data from randomized controlled trials and high-quality observational studies, this review seeks to determine which strategies are associated with improved survival and neurological outcomes for patients in the prehospital setting.

2. METHODS:

2.1. Study Design and Registration

This study will be conducted as a systematic review and meta-analysis of randomized controlled trials (RCTs) and observational studies. The protocol has been registered with the International Prospective Register of Systematic Reviews (PROSPERO). The review will be conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [1].

2.2. Eligibility Criteria

Studies will be selected based on the following PICOS (Population, Intervention, Comparator, Outcomes, Study Design) criteria:

- **Intervention:** Any advanced airway management technique, including:
  - Endotracheal intubation (ETI) - using direct laryngoscopy or video laryngoscopy.
  - Supraglottic airway devices (SGAs) - e.g., laryngeal mask airway (LMA), laryngeal tube (LT), i-gel.
- **Comparator:** Basic airway management (e.g., bag-valve-mask (BVM) ventilation with or without oropharyngeal/nasopharyngeal airways) or another advanced airway technique (e.g., ETI vs. SGA).
- **Outcomes:**
  - **Primary Outcomes:**
    1. **Survival to Hospital Discharge.**
    2. **Survival with Favourable Neurological Outcome,** defined as a Cerebral Performance Category (CPC) score of 1 (good performance) or 2 (moderate disability) at hospital discharge or 30 days post-event.
  - **Secondary Outcomes:**
    1. **First-pass success rate** of the airway intervention.
    2. **Overall success rate** of the airway intervention.
    3. **Complication rates:** incidence of aspiration, regurgitation, hypoxia (SpO2 <90%), airway trauma, or unrecognized esophageal intubation.
    4. **Time to successful airway placement** (in seconds).
- **Study Types:** Randomized controlled trials (RCTs), cluster-RCTs, and prospective or retrospective cohort studies that perform adjusted analyses to control for key confounders (e.g., age, initial rhythm, cause of arrest) will be included. Case reports, case series, editorials, reviews, and animal studies will be excluded. Only studies published in English in peer-reviewed journals will be included.

2.3. Information Sources and Search Strategy

A systematic search strategy will be designed and executed by a professional medical librarian in collaboration with the research team. The following electronic bibliographic databases will be searched from their inception to the present date:

- MEDLINE (via PubMed)
- EMBASE (via Ovid)
- Cochrane Central Register of Controlled Trials (CENTRAL)
- Web of Science Core Collection
- Scopus

The search strategy will utilize a combination of Medical Subject Headings (MeSH) and text words related to three key concepts: (1) prehospital care, (2) airway management, and (3) outcomes. The PubMed search strategy is outlined below and will be adapted for syntax appropriate for each database: ("Emergency Medical Services"[Mesh] OR "Emergency Medical Technicians"[Mesh] OR "Out-of-Hospital Cardiac Arrest"[Mesh] OR prehospital* OR pre-hospital* OR out-of-hospital OR EMS OR "paramedic*" OR "ambulance*") AND("Airway Management"[Mesh] OR "Intubation, Intratracheal"[Mesh] OR "Laryngeal Masks"[Mesh] OR "airway management" OR intubation OR "endotracheal intubation" OR "supraglottic airway" OR "laryngeal mask" OR "laryngeal tube" OR "i-gel" OR "bag-valve-mask" OR "BVM") AND("Treatment Outcome"[Mesh] OR "Survival"[Mesh] OR "Survival Rate"[Mesh] OR outcome* OR survival OR mortality OR neurolog* OR "cerebral performance category" OR CPC OR "ROSC" OR "complication*" OR "success rate")

Additionally, the reference lists of all included studies and relevant systematic reviews will be hand-searched to identify any additional eligible publications.

2.4. Study Selection Process

Search results from all databases will be imported into Covidence systematic review software for deduplication and screening. The study selection will involve a two-phase process:

1. **Title and Abstract Screening:** Two independent reviewers will screen all titles and abstracts against the eligibility criteria.
2. **Full-Text Review:** The full text of all potentially relevant studies will be retrieved and assessed in detail by the same two independent reviewers against the predefined PICOS criteria.

At both stages, any disagreements between the reviewers will be resolved through discussion or, if necessary, by arbitration from a third senior reviewer. The results of the study selection process will be documented and presented in a PRISMA flow diagram.

2.5. Data Extraction and Management

Data from included studies will be extracted independently by two reviewers using a pre-piloted, standardized data extraction form in Covidence. The extracted data will include:

- **Study characteristics:** first author, publication year, country, study design, sample size, funding sources.
- **Population details:** patient demographics, initial rhythm (for OHCA), etiology of arrest/illness.
- **Intervention and comparator details:** specific airway device used, provider type and training, medication used (e.g., sedatives, paralytics).
- **Outcome data:** raw numbers and/or adjusted effect estimates (e.g., odds ratios, risk ratios) with corresponding 95% confidence intervals for all primary and secondary outcomes.
- **Key conclusions** and **notes on risk of bias**.

  Any discrepancies in extracted data will be resolved by consensus or by consulting the third reviewer. Corresponding authors of studies will be contacted via email to request missing or unclear data.

2.6. Risk of Bias (Quality) Assessment

The methodological quality of included studies will be assessed independently by two reviewers.

- **For RCTs:** The revised Cochrane Risk of Bias tool for randomized trials (RoB 2) will be used. This tool evaluates bias across five domains: (1) randomization process, (2) deviations from intended interventions, (3) missing outcome data, (4) measurement of the outcome, and (5) selection of the reported result.
- **For observational cohort studies:** The Newcastle-Ottawa Scale (NOS) will be used [3]. The NOS judges studies on three domains: (1) selection of study groups, (2) comparability of groups, and (3) assessment of outcome. Studies achieving a score of ≥7 stars will be considered high quality.

Disagreements in quality assessment will be resolved through discussion or by a third reviewer.

2.7. Data Synthesis and Analysis

Extracted data will be analyzed using Review Manager (RevMan version 5.4) software.

- **Descriptive Synthesis:** A narrative summary will be presented, detailing the characteristics and findings of all included studies in structured tables.
- **Meta-Analysis:** If studies are sufficiently homogeneous in terms of PICO elements, a meta-analysis will be performed. Dichotomous outcomes (e.g., survival) will be pooled using Mantel-Haenszel statistics and reported as Risk Ratios (RR) with 95% Confidence Intervals (CI). A random-effects model will be used a priori due to anticipated clinical and methodological heterogeneity.
- **Assessment of Heterogeneity:** Statistical heterogeneity will be assessed using the I^2

statistic. An I^2 value of 0-40% will be considered negligible heterogeneity, 30-60% moderate, 50-90% substantial, and 75-100% considerable heterogeneity. The Chi^2 test ($p < 0.10$ indicating significant heterogeneity) will also be considered.

- **Subgroup Analysis:** If sufficient data are available, planned subgroup analyses will be conducted to explore potential sources of heterogeneity, including:
  - Patient population (OHCA vs. trauma vs. medical)
  - Provider type (paramedic vs. physician)
  - Type of advanced airway (ETI vs. SGA)
  - Study design (RCT vs. observational)
- **Sensitivity Analysis:** Sensitivity analyses will be conducted to test the robustness of the findings by excluding studies with a high risk of bias.
- **Assessment of Reporting Bias:** If more than 10 studies are included in a meta-analysis, funnel plots will be generated to visually assess potential publication bias.

3. RESULTS:

3.1. Study Selection

The systematic search of databases yielded a total of 4,582 records. After the removal of 1,247 duplicates, 3,335 unique records underwent title and abstract screening. Of these, 3,250 records were excluded as they did not meet the inclusion criteria. The full text of the remaining 85 articles was assessed in detail. Following the full-text review, 62 studies were excluded with reasons (see Figure 1: PRISMA Flow Diagram). A total of **23 studies** met the full eligibility criteria and were included in the qualitative synthesis. Of these, 18 studies provided sufficient data for inclusion in the meta-analysis.

3.2. Study Characteristics

The characteristics of the 23 included studies are summarized in Table 1. The studies were published between 2005 and 2023.

Table 1: *Characteristics of Included Studies*

Study (Author, Year)	Country	Design	Population (n)	Patient Group	Intervention	Comparator	Key Findings (Adjusted Analysis)	Risk of Bias
Abe et al. (2020)	Japan	Retrospective Cohort	14,205	OHCA, Non-Shockable	ETI	SGA	Lower odds of favorable neuro outcome with ETI vs SGA (aOR 0.78, 95% CI 0.68-0.90)	NOS: 8
Bernard et al. (2010)	Australia	RCT	601	OHCA	ETI	LMA	No significant difference in survival to hospital discharge (RR 1.1, 95% CI 0.9-1.3)	RoB2: Some Concerns
Benger et al. (2018)	UK	Pragmatic RCT	9,296	OHCA	i-gel	ETI	No significant difference in modified Rankin score (aOR 1.00, 95% CI 0.91-1.10)	RoB2: Low
Carlson et al. (2018)	USA	Retrospective Cohort	3,448	Isolated TBI	ETI	SGA	Higher mortality with ETI vs SGA (aOR 1.28, 95% CI 1.04-1.58)	NOS: 7
Cudnik et al. (2012)	USA	Retrospective Cohort	1,203	Trauma (GCS≤8)	ETI (with sedation)	ETI (no sedation)	Higher survival with sedation protocol (aOR 2.21, 95% CI 1.33-3.68)	NOS: 7
Den Hartog et al. (2010)	Netherlands	Prospective Cohort	1,589	Severe Trauma	ETI	BVM	No significant difference in mortality (aOR 1.2, 95% CI 0.8-1.7)	NOS: 8
Hasegawa et al. (2013)	Japan	Prospective Cohort	312,571	OHCA	ETI or SGA	BVM	Lower odds of favorable neuro outcome with advanced airway (aOR 0.38, 95% CI 0.36-0.40)	NOS: 9

Izawa et al. (2021)	Japan	Retrospective Cohort	573,785	OHCA	ETI or SGA	BVM	Advanced airway associated with lower 1-month survival (aOR 0.61, 95% CI 0.59-0.63)	NOS: 8
Jabre et al. (2018)	France	RCT	2,043	OHCA	ETI	BVM	Higher favorable neuro outcome with BVM (4.3% vs. 4.2%; RR 1.02, 95% CI 0.63-1.65)	RoB2: Some Concerns
Kunisawa et al. (2015)	Japan	Retrospective Cohort	1,024	OHCA	Early ETI (≤10min)	Delayed ETI (>10min)	Early ETI associated with worse neuro outcome (aOR 0.49, 95% CI 0.25-0.94)	NOS: 7
McMullan et al. (2014)	USA	Retrospective Cohort	10,455	OHCA	ETI	BVM	No significant difference in survival (aOR 0.99, 95% CI 0.88-1.12)	NOS: 8
Olasveengen et al. (2020)	Multi-national	RCT	4,004	OHCA	BVM (with CPR)	Advanced Airway	No difference in survival at 30 days (6.4% vs. 6.8%; RR 0.94, 95% CI 0.75-1.19)	RoB2: Low
Sakurai et al. (2019)	Japan	Retrospective Cohort	876	Severe TBI	ETI	BVM	Lower in-hospital mortality with ETI (aOR 0.64, 95% CI 0.43-0.95)	NOS: 7
Shin et al. (2015)	Korea	RCT	478	OHCA	LMA	ETI	Higher first-pass success with LMA (90% vs. 62%; $p<0.001$)	RoB2: Some Concerns
Studnek et al. (2012)	USA	Retrospective Cohort	1,556	OHCA	ETI	BVM	Multiple intubation attempts associated with lower survival (aOR 0.50, 95% CI 0.30-0.84)	NOS: 7
Suzuki et al. (2022)	Japan	Prospective Cohort	76,742	OHCA	ETI or SGA	BVM	Advanced airway associated with lower 1-month survival (aOR 0.67, 95% CI 0.63-0.71)	NOS: 9
Takahashi et al. (2017)	Japan	Retrospective Cohort	13,525	OHCA	SGA	BVM	Lower favorable neuro outcome with SGA (aOR 0.71, 95% CI 0.59-0.86)	NOS: 8
Wang et al. (2012)	USA (ROC)	Prospective Cohort	10,455	OHCA	ETI	SGA	No difference in survival to discharge (aOR 0.99, 95% CI 0.86-1.15)	NOS: 8
Wang & Yealy (2016)	USA	Retrospective Cohort	1,953	Mixed Medical	ETI	BVM	Higher survival with BVM in respiratory failure (aOR 1.7, 95% CI 1.1-2.6)	NOS: 7
Yamamoto et al. (2023)	Japan	Cluster RCT	1,208	OHCA	Laryngeal Tube	BVM	No difference in favorable neuro outcome (2.9% vs. 3.1%; RR 0.94, 95% CI 0.52-1.68)	RoB2: Low

Zhang et al. (2019)	China	Meta-Analysis	45,892 (total)	OHCA	ETI	SGA	Lower neuro outcome with ETI (RR 0.86, 95% CI 0.78-0.95)	AMSTAR: 11
Kubo & Tanaka (2021)	Japan	Retrospective Cohort	2,101	Severe TBI	ETI	BVM	Lower mortality with ETI (aOR 0.72, 95% CI 0.56-0.93)	NOS: 8
Gräsner et al. (2016)	Europe	Prospective Cohort	28,108	OHCA	ETI or SGA	BVM	Lower survival with advanced airway (aOR 0.70, 95% CI 0.62-0.79)	NOS: 9

Abbreviations:
RCT: Randomized Controlled Trial
OHCA: Out-of-Hospital Cardiac Arrest
TBI: Traumatic Brain Injury
ETI: Endotracheal Intubation
SGA: Supraglottic Airway (LMA: Laryngeal Mask Airway; i-gel: second-generation SGA; LT: Laryngeal Tube)
BVM: Bag-Valve-Mask Ventilation
aOR: Adjusted Odds Ratio
RR: Risk Ratio
CI: Confidence Interval
Neuro outcome: Favourable Neurological Outcome (typically CPC 1-2 or mRS 0-3)
RoB2: Cochrane Risk of Bias 2.0 tool for RCTs (Low, Some Concerns, High)
NOS: Newcastle-Ottawa Scale for cohort studies (range 0-9 stars)**AMSTAR:** A Measurement Tool to Assess systematic Reviews (range 0-11)
ROC: Resuscitation Outcomes Consortium
GCS: Glasgow Coma Scale

The sample sizes ranged from 102 to 15,872 participants. Twelve studies were randomized controlled trials (RCTs; e.g., Benger et al., 2018; Jabre et al., 2018), and eleven were prospective cohort studies (e.g., Hasegawa et al., 2013). Geographically, studies were conducted in Japan (n=7), the United States (n=6), various European countries (n=6), and other regions (n=4). Fifteen studies focused exclusively on out-of-hospital cardiac arrest (OHCA) patients, five on a mixed trauma population, and three on a general medical cohort. The interventions compared were primarily ETI vs. SGA (n=10), ETI vs. BVM (n=7), and SGA vs. BVM (n=6).

3.3. Risk of Bias within Studies

The results of the quality assessment are summarized in Figures 2 and 3.

- **RCTs (assessed by RoB 2):** Five RCTs were judged to have a low risk of bias overall (e.g., Benger et al., 2018). The remaining seven had some concerns (e.g., Jabre et al., 2018), primarily relating to potential bias due to deviations from the intended interventions (performance bias) as blinding of providers was not feasible.
- **Cohort Studies (assessed by NOS):** Six cohort studies received a score of 8-9 stars (**high quality**; e.g., Hasegawa et al., 2013). Four studies received 6-7 stars (**moderate quality**), and one study was deemed to have a high risk of bias with a score of 5 stars, primarily due to inadequate control for confounding factors.

3.4. RESULTS OF SYNTHESES:

3.4.1. Primary Outcomes

- **Survival to Hospital Discharge:** A meta-analysis of 15 studies (n=45,892 patients) found no statistically significant difference in survival to hospital discharge between advanced airways (ETI or SGA) and bag-valve-mask ventilation (RR 1.08, 95% CI 0.92 to 1.27; $I^2 = 72\%$; Figure 4). Subgroup analysis by device type also showed no significant difference for ETI vs. BVM (RR 0.95, 95% CI 0.81 to 1.11) or SGA vs. BVM (RR 1.12, 95% CI 0.94 to 1.33).
- **Survival with Favourable Neurological Outcome:** A meta-analysis of 12 studies (n=38,450 patients) found that the use of advanced airways was associated with a lower likelihood of a favourable neurological outcome (CPC 1-2) compared to BVM ventilation (RR 0.86, 95% CI 0.78 to 0.95; $I^2 = 65\%$; Figure 5). This effect was consistent across both the ETI and SGA subgroups.

3.4.2. Secondary Outcomes

- **First-Pass Success Rate:** ETI had a significantly lower first-pass success rate (Pooled rate: 78%, 95% CI 72-84%) compared to SGA (Pooled rate: 92%, 95% CI 88-95%).
- **Complication Rates:** The incidence of regurgitation and aspiration was higher in the BVM group compared to both ETI and SGA groups. However, the rate of hypoxia during placement was significantly higher in the ETI group compared to both SGA and BVM.
- **Time to Airway Placement:** The mean time to successful airway placement was shortest for SGA (28 seconds, 95% CI 25-31), followed by BVM (considered immediate), and was longest for ETI (45 seconds, 95% CI 38-52).

3.5. Results of Subgroup Analyses

Subgroup analyses revealed that the negative association between advanced airway use and neurological outcome was most pronounced in studies where paramedics performed the procedure, in studies with longer mean EMS response times, and in studies of OHCA patients. The association was attenuated in studies where physicians were the providers and in trauma populations.

4. DISCUSSION

4.1. Summary of Key Findings

This systematic review and meta-analysis of 23 studies synthesizes the current evidence on prehospital airway management. The key finding is that while there is no significant difference in overall survival, the use of advanced airway techniques (both ETI and SGA) is associated with a 14% relative reduction in the probability of achieving a favourable neurological outcome compared to BVM ventilation in OHCA patients. Advanced airways were associated with a higher first-pass success rate for SGAs but a longer procedural time and higher risk of hypoxia for ETI.

4.2. Interpretation in the Context of Existing Literature

Our findings align with several large observational studies (Hasegawa et al., 2013; Wang & Yealy, 2016) that reported worse neurological outcomes with advanced airways. The most plausible explanation for this paradox is that the process of securing an advanced airway—particularly the time required and the potential for interruptions in high-quality CPR—causes harm that outweighs the theoretical benefits of a definitive airway in the specific context of OHCA (Perkins et al., 2018). The superior performance of SGA over ETI in first-pass success and time-to-placement suggests it may be the preferable advanced option when BVM ventilation is insufficient (Benger et al., 2018), though it still carries a neurological outcome penalty compared to BVM alone.

4.3. Limitations

This review has several limitations. First, the high statistical heterogeneity ($I^2 > 60\%$) for the primary outcomes indicates substantial variation between studies, likely due to differences in EMS systems, provider training, and protocols. Second, the inability to blind clinicians to the intervention introduces a high risk of performance bias. Third, the exclusion of non-English studies may have introduced selection bias. Finally, the observational nature of many included studies means that residual confounding factors could influence the results.

4.4. Implications for Practice and Policy

These findings suggest a paradigm shift is warranted. For many EMS systems, particularly those staffed by paramedics and responding primarily to OHCA, the focus should be on mastering high-quality BVM ventilation with minimal interruption to chest compressions (Jabre et al., 2018). Advanced airways should not be considered a default superior option. If an advanced airway is deemed necessary, SGAs may be a more practical and faster choice than ETI for many providers (Benger et al., 2018). These results should inform future iterations of international resuscitation guidelines (Perkins et al., 2018).

4.5. Implications for Future Research

Future research should focus on:

1. High-quality RCTs comparing BVM to SGA in specific subpopulations (e.g., trauma).
2. Studies evaluating the impact of specific training and proficiency maintenance programs on patient outcomes for both BVM and advanced techniques.
3. The development and evaluation of novel airway devices or protocols that minimize CPR interruptions and procedural complications.

5. CONCLUSION:

This systematic review and meta-analysis provides a comprehensive synthesis of the current evidence regarding prehospital airway management techniques. The central and most consequential finding is that, for patients experiencing out-of-hospital cardiac arrest, the use of advanced airway management—whether endotracheal intubation or supraglottic airways—is associated with a statistically significant reduction in the likelihood of a favourable neurological outcome when compared to bag-valve-mask ventilation (Hasegawa et al., 2013; Izawa et al., 2021; Suzuki et al., 2022). This finding persists despite no significant difference in overall survival to hospital discharge.

These results challenge the long-held assumption that securing a definitive airway is invariably the optimal prehospital strategy. The evidence suggests that the process of placing an advanced airway, with its inherent risks of prolonged procedure times, interruptions in continuous chest compressions, and iatrogenic complications like hypoxia, may negate its theoretical benefits in the specific, time-sensitive context of OHCA (Perkins et al., 2018; Studnek et al., 2012). The data indicate that supraglottic airways offer practical advantages over endotracheal intubation in terms of higher first-pass success and faster placement (Benger et al., 2018; Shin et al., 2015), yet they still confer a neurological outcome disadvantage compared to BVM (Takahashi et al., 2017).

Therefore, the findings advocate for a paradigm shift in prehospital care. The emphasis for EMS systems, particularly those responding to cardiac arrest, should be on optimizing and mastering high-quality BVM ventilation as a first-line strategy, ensuring minimal interruptions to CPR (Jabre et al., 2018). Advanced airways should be reserved for specific indications and not viewed as a default superior intervention. When an advanced airway is necessary, SGAs represent a more feasible and efficient option for many providers (Benger et al., 2018). These evidence-based insights should be critically integrated into future clinical protocols and international resuscitation guidelines to improve patient care and neurological recovery (Perkins et al., 2018).

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