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# Comprehensive Review Of Prehospital Airway Management Techniques

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## Abstract

Prehospital airway management is a critical aspect of emergency medical care that directly impacts patient survival and long-term outcomes. This comprehensive review examines the techniques, challenges, and evidence-based recommendations for airway management in the prehospital setting. Basic airway interventions, including manual maneuvers, oropharyngeal and nasopharyngeal airways, and bag-valve-mask ventilation, are foundational skills for all emergency medical services (EMS) providers. Advanced airway devices, such as supraglottic airways and endotracheal intubation, offer definitive airway control but require higher levels of training and expertise. The choice of airway technique depends on various factors, including provider skill level, patient characteristics, and situational constraints. Recent guidelines emphasize a stepwise approach, prioritizing oxygenation and ventilation over procedural complexity. Bag-valve-mask ventilation is recommended as the initial management strategy, followed by supraglottic airway devices when advanced interventions are necessary. Endotracheal intubation is reserved for systems with established high-quality performance and continuous provider training. Complications, such as hypoxia, aspiration, and airway trauma, can be mitigated through rigorous adherence to protocols, prompt use of rescue devices, and ongoing simulation-based training. Special considerations for pediatric, geriatric, and trauma patients are discussed, highlighting the importance of patient-centered decision-making. The integration of advanced technologies, such as video laryngoscopy, and the emphasis on competency-based education and quality improvement initiatives are shaping the future of prehospital airway management. This review provides a comprehensive understanding of the current state of prehospital airway management, guiding EMS providers and systems in delivering safe and effective care in challenging out-of-hospital environments.

**Keywords**: Prehospital Airway Management, EMS, Paramedicals.

## Introduction

Prehospital airway management refers to a set of procedures and strategies employed by emergency medical services (EMS) personnel to establish and maintain a patent airway in patients before arrival at the hospital,

a foundational aspect of prehospital emergency care essential for patient survival and optimal outcomes (Carney, Cheney, et al., 2021c).

Prehospital airway management encompasses interventions from basic measures (such as positioning and suction) to advanced techniques (including supraglottic airway devices and endotracheal intubation), all aimed at ensuring adequate oxygenation and ventilation outside the hospital environment. The scope includes trauma, cardiac arrest, medical, and mixed emergencies in adult and pediatric populations (Carney, Cheney, et al., 2021d).

The evolution of prehospital airway management began with basic maneuvers and progressed to bag-valve-mask ventilation, supraglottic airway devices, and field endotracheal intubation—pioneered in the 1970s by paramedics like John Moon of Freedom House Ambulance. Over subsequent decades, innovations such as rapid sequence intubation and video laryngoscopy further advanced prehospital care options (Gage et al., 2024).

Effective airway management is the highest priority in EMS—an airway must be patent for oxygenation to occur, directly influencing survival and neurological outcome, especially in cardiac arrest, trauma, and respiratory failure. The establishment of airway competence is thus core in all provider training and EMS protocols.

Prehospital airway techniques range from manual positioning and bag-valve-mask ventilation to advanced airway adjuncts (supraglottic airways and intubation). Recent systematic reviews focus on the comparative effectiveness and risks of each method, often emphasizing patient-centered outcomes like survival, neurological status, and procedure-related complications.

**EMS Systems and Provider Levels**

EMS airway management capabilities depend on provider level:

- Emergency Medical Responders (EMR) may perform basic manual maneuvers.
- EMTs (Basic) can use adjuncts like oropharyngeal/nasopharyngeal airways and bag-valve-mask ventilation.
- Advanced EMTs (AEMT) can provide certain advanced interventions including supraglottic devices and, in some systems, intubation.
- Paramedics have the highest level of airway skills, including rapid sequence intubation and use of video laryngoscopy (Berkenbush et al., 2023).

**Indications for Airway Intervention**

- Inadequate oxygenation or ventilation (respiratory insufficiency)
- Airway obstruction risk or presence (trauma, foreign bodies, reduced consciousness)
- Cardiac arrest requiring airway protection and ventilation
- Trauma to the head, neck, or maxillofacial region.

**Challenges Unique to the Prehospital Environment**

- Limited space and variable lighting
- Environmental hazards (e.g., bodily fluids, weather)
- Difficult patient positioning (confined spaces, entrapment)

- Limited personnel and resources
- Time-critical decision-making under stress
- High frequency of airway compromise and potential for complications, such as failed attempts, aspiration, and hypoxia.

**Classification of Airway Management Techniques**

Airway management in prehospital settings is generally categorized as basic or advanced. Basic airway management includes non-invasive techniques and adjuncts, whereas advanced management involves devices and procedures to secure and maintain a definitive airway, such as supraglottic and endotracheal devices or surgical methods.

**Basic Airway Management**

**Manual Airway Maneuvers: Head Tilt-Chin Lift & Jaw Thrust**

The head tilt–chin lift and jaw-thrust maneuvers are foundational manual techniques to relieve airway obstruction, especially when the tongue occludes the upper airway. The head tilt–chin lift is preferred in the absence of suspected cervical spine injury, whereas the jaw-thrust is vital for trauma patients to avoid neck movement. Both maneuvers can significantly restore airway patency. The jaw-thrust and the two-handed E-C mask technique with full head extension yield comparable tidal volumes for effective ventilation (Caro, 2013).

**Oropharyngeal and Nasopharyngeal Airways**

- Oropharyngeal airways (OPA): Inserted into the mouth, OPAs prevent the tongue from occluding the airway in unconscious patients. They are contraindicated if the patient has an intact gag reflex (Castro & Freeman, 2023).
- Nasopharyngeal airways (NPA): NPAs are passed through the nostril into the pharynx, suitable for patients with a gag reflex or oral/facial trauma. NPAs provide effective airway support, particularly in scenarios such as sedation or upper airway obstruction, and can reduce the risk of aspiration and increase patient comfort (Atanelov et al., 2024).

**Bag-Valve-Mask (BVM) Ventilation**

BVM ventilation is a cornerstone of prehospital airway management. It provides positive pressure ventilation and is often the initial approach in both cardiac arrest and respiratory failure. Efficacy depends on proper mask seal, airway maneuvers, and sometimes adjunct use. Recent systematic reviews emphasize BVM as a first-line intervention, especially when advanced devices are unavailable or delayed (Carney, Cheney, et al., 2021a).

BVM ventilation is a frontline technique for patients with inadequate or absent spontaneous breathing in prehospital settings, appropriate in both cardiac and respiratory arrest (Bucher et al., 2025).

Manual positive pressure ventilation is delivered via a self-inflating bag attached to a facemask, requiring a proper mask seal and airway positioning. Effectiveness is highly operator-dependent (Lyng, Guyette, et al., 2022).

BVM is non-invasive, widely available, and effective when performed correctly. However, studies reveal significant inconsistency, with variable efficacy based on provider skill, mask seal, and hand fatigue. Risk of inadequate ventilation or aspiration remains, especially when performed by inexperienced personnel.

Evidence from randomized studies and guidelines suggests no clear superiority of BVM over SGA or ETI for adult out-of-hospital cardiac arrest (OHCA) regarding survival or neurologic outcomes. Some pediatric trials favor BVM over ETI for OHCA, while adult data are mixed, influenced by system resources and skill.

**Advanced Airway Devices**

**Supraglottic Airway Devices (SGAs)**

SGAs, such as the laryngeal mask airway (LMA) and i-gel, are designed to provide ventilation without tracheal intubation. They are easier and faster to insert than endotracheal tubes and are used when BVM ventilation is inadequate or intubation fails. Their effectiveness and ease of use make them valuable in both adult and pediatric emergency airway scenarios. Studies demonstrate comparable outcomes in terms of survival and neurological recovery relative to endotracheal intubation in many prehospital situations (Carney, Cheney, et al., 2021b).

SGAs include laryngeal mask airway (LMA), i-gel, and laryngeal tubes. These devices are inserted blindly into the oropharynx to establish a perilaryngeal seal, requiring minimal training and facilitating oxygen delivery without laryngoscopy (Lyng, Baldino, et al., 2022).

SGAs provide rapid, effective airway management, especially in challenging prehospital environments or when expertise with ETI is lacking. They offer better hemodynamic stability and lower airway trauma risks than intubation. However, complications may include inadequate seal, aspiration, and rare airway trauma. In comparative studies, SGA efficacy is similar to ETI or BVM with respect to survival and airway protection; but SGA is superior in scenarios of repeated failed attempts or when rapid airway placement is necessary.

**Endotracheal Intubation (ETI)**

ETI is considered the gold standard for airway protection, allowing for definitive airway control and prevention of aspiration. However, success rates in the field depend on provider experience and patient factors. Some systematic reviews reveal limited differences in patient-centered outcomes compared to SGAs or BVM, highlighting the potential risks of unsuccessful or delayed intubation (Carney, Totten, et al., 2021).

Direct laryngoscopy (DL) is traditional, while video laryngoscopy (VL) provides improved visualization. Randomized controlled trials and meta-analyses show VL increases first-pass success, overall success rate, and decreases the number of attempts, especially in difficult airways. Nevertheless, DL remains standard where VL is unavailable or training is limited (Pourmand et al., 2023a).

VL enables higher first-pass success and is less affected by provider inexperience or skill decay. Skill retention with DL tends to decline rapidly without regular practice, while VL has a shorter learning curve and greater success among EMS providers (Gadek et al., 2021).

Complication rates for ETI, such as esophageal intubation, hypoxia, and airway trauma, are significant, especially when first-pass success is not achieved. VL reduces some complications by improving glottic visualization and reducing procedure time, but evidence remains mixed regarding mortality or severe morbidity benefit (Pourmand et al., 2023b).

**Surgical Airways: Cricothyrotomy and Tracheostomy**

Surgical airways are rare but lifesaving when other methods fail. Cricothyrotomy is the preferred prehospital surgical airway, offering rapid access in cases of upper airway obstruction or severe facial trauma. Tracheostomy is typically reserved for controlled settings and rarely performed prehospital due to

complexity and time constraints. Guidelines recommend surgical techniques only when all other airway management strategies are impossible or unsuccessful (McMahon et al., 2025).

Surgical cricothyrotomy is reserved for "cannot intubate, cannot ventilate" scenarios, such as massive facial trauma or failed less invasive airway attempts in prehospital care (Lacy et al., 2025).

The technique involves a horizontal incision through the cricothyroid membrane to access the trachea. Success rates in prehospital settings range from 80–90%, but immediate complication rates can reach 31%, including hemorrhage, tube misplacement, airway trauma, and failure to obtain the airway. Long-term complications (e.g., stenosis) are less frequent. Provider experience and stressful field conditions substantially affect outcomes, with higher morbidity if performed by less experienced staff (Macêdo et al., 2016).

## Special Populations

### Pediatric Airway Management

Prehospital pediatric airway management is uniquely challenging due to anatomical differences, limited experience among providers, and difficulties with equipment selection and sizing. Endotracheal intubation carries a high risk of safety events and is rarely required, with bag-mask ventilation often providing equivalent or better outcomes. Evidence does not support routine prehospital intubation in children over basic airway maneuvers, and lack of training remains a major contributor to adverse events (Hansen et al., 2016).

### Geriatric Considerations

Geriatric patients have age-related anatomical changes—such as tissue redundancy and decreased pharyngeal support—that make airway management more difficult. Anticipated complications include cervical spine immobility, fragility of tissues, and increased aspiration risk. Special care, adjuncts like supraglottic devices, and gentle technique are needed to reduce complications.

### Trauma Patients vs. Medical Emergencies

Trauma patients often present with multi-injuries, cervical spine precautions, and risk for rapid decompensation, requiring balancing rapid transport with airway interventions. Medical emergencies (e.g., cardiac arrest, respiratory failure) may allow a more controlled airway approach. Individualized assessment and iterative decision-making are emphasized; managing hypoxia and ventilation effectively is prioritized over specific techniques (Carney et al., 2022a).

## Situational Factors Affecting Airway Choice

### Out-of-Hospital Cardiac Arrest

For adult cardiac arrest, evidence suggests that bag-valve-mask (BVM) and supraglottic airway (SGA) are equivalent in survival and neurological outcomes compared to endotracheal intubation, supporting the use of the simplest effective technique (Carney et al., 2022b).

### Trauma and Multi-Injury Scenarios

Airway management in trauma prioritizes oxygenation and ventilation. Invasive airways can increase mortality if not urgently indicated, and timely transport to trauma centers is crucial. Injury type, scene safety, and available resources must inform approach.

### Limited Resource Settings

In resource-limited or austere environments, BVM and SGA may be preferable due to minimal equipment and training requirements. Providers must adapt to constraints with simple, reliable techniques.

### Environmental and Scene Logistics

Challenging environments (e.g., confined spaces, hazardous conditions) can affect both method and success of airway management, requiring adaptation and proficiency with multiple approaches.

### Complications and Pitfalls

### Failed Airway/Rescue Techniques

Failed airway situations may arise due to patient factors, challenging anatomy, or provider inexperience. Rescue devices such as SGAs and continuous reassessment are essential.

### Adverse Events

Common complications include hypoxia, gastric insufflation, and aspiration. These may be mitigated through proper technique, patient positioning, and careful airway adjunct use.

### Mitigation Strategies

Ongoing education, high-fidelity simulation, and adherence to evidence-based protocols help reduce adverse events, with a strong focus on competency and frequent skill rehearsal.

### Training Requirements

Initial and recurrent hands-on training, simulation, and case reviews are recommended to maintain provider competence, especially given rarity of advanced airway interventions in the field.

### Simulation and Competency

Simulation-based assessment improves procedural skills and helps identify performance gaps, with competency checklists supporting objective evaluations.

### Evidence-Based Guidelines and Recommendations

National guidelines by AHRQ, NHTSA, and consensus panels recommend prioritizing BVM or SGA for most prehospital scenarios except when endotracheal intubation is clearly indicated and feasible by highly skilled providers. Guidelines stress technique proficiency, rapid oxygenation/ventilation, airway protection, and patient-centered choices.

## Discussion

Recent evidence-based guidelines have emerged to direct prehospital airway management strategies, emphasizing a patient-centered, skill-level adjusted approach. A 2023 guideline developed by experts using the GRADE methodology recommends starting with bag-valve-mask (BVM) ventilation in adult patients with out-of-hospital cardiac arrest, trauma, or medical emergencies, followed by the selective use of supraglottic airway (SGA) devices if BVM is insufficient. Endotracheal intubation (ETI) is recommended only in systems with established high-quality performance and continuous provider training and quality improvement programs. Pediatric airway management guidelines caution against routine ETI due to low procedure frequency, lower first-pass success, and associated adverse events; SGAs are favored when advanced airway intervention is needed in children.

Physiological complications remain significant challenges in prehospital airway management. Peri-intubation hypotension and hypoxia are key predictors of morbidity and mortality, particularly in shock patients who represent some of the highest risk scenarios for paramedics. These critical events can cause anoxic brain injury if not anticipated and managed meticulously. Pre-oxygenation is stressed as a top priority before intubation, alongside careful hemodynamic monitoring to avoid cardiovascular collapse post-procedure. The out-of-hospital environment complicates these measures due to lack of resources and

situational challenges such as limited personnel, confined spaces, and environmental distractions, necessitating adaptable protocols and high operator proficiency.

Complication mitigation strategies focus heavily on education, standardized protocols, and simulated practice to enhance provider competence and patient safety. Failed airway situations, aspiration risks, and airway trauma incidence can be reduced by rigorous adherence to stepwise airway algorithms, prompt use of rescue devices like SGAs, and continuous skill training. Simulation is invaluable for objective skill assessment, competency maintenance, and identification of performance gaps given the rarity but high stakes of advanced airway interventions in prehospital settings. Agencies are encouraged to tailor airway management approach choices based on provider skills, system capabilities, and patient factors, ensuring proficiency with devices in current use, including video laryngoscopy, which has demonstrated higher first-pass success and fewer complications compared to direct laryngoscopy (Cook & MacDougall-Davis, 2012).

## Conclusion

Prehospital airway management remains one of the most critical and challenging components of emergency medical care, directly influencing patient survival and long-term outcomes. Evidence consistently supports a stepwise, patient-centered approach tailored to the provider's skill level, environmental constraints, and available resources. Bag-valve-mask ventilation continues to serve as the cornerstone of initial management, with supraglottic airway devices offering reliable and rapid alternatives when advanced interventions are required. Endotracheal intubation retains its role as the gold standard for definitive airway protection but should be reserved for systems with robust training, high first-pass success, and continuous quality improvement.

Across diverse clinical scenarios—from cardiac arrest and trauma to pediatric and geriatric emergencies—airway decisions must prioritize oxygenation and ventilation over procedural complexity. Simulation-based training, frequent skill reinforcement, and adherence to evidence-based guidelines are essential to reducing complications and maintaining provider proficiency. Ultimately, the integration of evolving technologies such as video laryngoscopy, combined with ongoing education and system-level support, will continue to shape best practices. A pragmatic, adaptable approach to airway management ensures that patients receive the safest, most effective care in the unpredictable prehospital environment.

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