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The i-gel Device for Airway Management: A Review of Comparative Clinical Effectiveness, Cost-Effectiveness, Safety, and Guidelines

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Abbreviations

AHA	American Heart Association
CPR	cardiopulmonary resuscitation
LOE	level of evidence
RCT	randomized controlled trial

Context and Policy Issues

Airway management includes techniques and procedures to ensure patients' airways remain open and to provide adequate ventilation.[1] Airway management is often the first step of first aid, prior to the management of breathing and circulation.[2] Currently there are several options to secure airways in patients requiring resuscitation, including two levels of airway management: basic airways (such as bag-mask ventilation with or without oropharyngeal airway) and advanced airways (including tracheal intubation and supraglottic airways).[3,4] Advanced airway management requires technical expertise to use devices to keep airways open.[1] Tracheal intubation requires the placement of an endotracheal tube (i.e., inside patients' trachea) and the inflation of a cuff to prevent air leakage. It often necessitates trained staff with proficiency to place the tracheal tubes and manage the airway.[4] An alternative to tracheal intubation is supraglottic airway insertion.[4] Supraglottic airway devices are used to keep the upper airway open without obstructing ventilation.[5-7] Compared to tracheal tubes, supraglottic airway devices can be placed more quickly and do not require as much technical expertise as tracheal intubation.[4]

The use of supraglottic airway devices has increased steadily.[4-7] Recently the design of supraglottic airway devices has been modified, such as with the i-gel device, to improve positive-pressure ventilation and reduce the risk of aspiration.[5-7] In a trial that compared supraglottic airway devices (i.e., the i-gel device) to tracheal tubes placed by paramedics in patients with an out-of-hospital cardiac arrest, there were no significant differences in clinical effectiveness at hospital discharge or 30 days.[4] In other words, i-gel devices and tracheal intubation had similar clinical effectiveness,[4] and since supraglottic airway devices do not require as much technical expertise,[5-7] they have been increasingly used in remote locations where well-trained medical staff may be lacking.[8] Among the supraglottic airway devices, the i-gel devices are the most commonly used.[8]

The objective of this report is to investigate the comparative clinical effectiveness, safety and cost-effectiveness of the i-gel supraglottic airway device performed in a pre-hospital versus in-hospital setting, and the comparative safety of airway management with the i-gel device versus other intubation devices in a pre-hospital setting. Evidence-based guidelines regarding airway management in pre-hospital settings are also reviewed.

Research Questions

1. What is the comparative clinical effectiveness and safety of airway management with the i-gel device performed in a pre-hospital setting versus airway management with the i-gel device performed in-hospital by a physician?
2. What is the comparative safety of airway management with the i-gel device versus other intubation devices when performed in a pre-hospital setting?
3. What is the cost-effectiveness of the i-gel device for airway management?

4. What are the evidence-based guidelines for airway management in pre-hospital settings?

Key Findings

There was one cluster RCT with good-quality evidence for safety outcomes, and seven evidence based guidelines for airway management. No studies comparing the clinical effectiveness of the i-gel device in a pre-hospital setting or in-hospital by physicians were identified. There were no studies regarding the cost-effectiveness of the i-gel device.

In the single RCT, Benger et al. compared the effectiveness and safety profiles of the i-gel with those of tracheal intubation. There was no significant difference between these airway management interventions in terms of clinical effectiveness (measured by modified Rankin Scale scores) or safety (including regurgitation and aspiration).

The evidence-based guidelines included recommendations regarding airway management. In brief, it was recommended in one guideline that it requires training to use supraglottic airway devices. Supraglottic devices are recommended in two guidelines if practitioners consider the potential benefits to outweigh the risks. The remaining five guidelines contained recommendations for different types of airway management, ranging from positional changes to laryngeal masks or tracheal intubation depending on the circumstances.

Methods

Literature Search Methods

A limited literature search was conducted on key resources including Medline via Ovid, the Cochrane Library, University of York Centre for Reviews and Dissemination (CRD) Canadian and major international health technology agencies, as well as a focused Internet search. No filters were applied to limit the retrieval by study type for questions one, two or three. A methodological filter was applied to limit retrieval to guidelines for question four. Where possible, retrieval was limited to the human population. The search was also limited to English language documents published between January 1, 2007 and April 15, 2019.

Selection Criteria and Methods

One reviewer screened citations and selected studies. In the first level of screening, titles and abstracts were reviewed and potentially relevant articles were retrieved and assessed for inclusion. The final selection of full-text articles was based on the inclusion criteria presented in Table 1.

Table 1: Selection Criteria

Population	Patients of all ages, requiring airway management, in a pre-hospital setting (e.g., community health centre, emergency medical services, remote and isolated care facilities)
Intervention	Q1: Airway management with the i-gel device performed in a pre-hospital setting; Q2,3: i-gel device Q4: airway management

Comparator	Q1: Airway management with the i-gel device performed by a physician; Q2: Other endotracheal intubation devices Q3: Other endotracheal intubation devices
Outcomes	Q1: Clinical effectiveness (e.g., airway patency, protection from aspiration, adequate oxygenation and ventilation, patient comfort); Q1,2: Safety (e.g., trauma compression, side effects, adverse events); Q3: Cost-effectiveness outcomes (e.g., QALYs, ICER, ICUR) Q4: Evidence-based guidelines
Study Designs	Health technology assessment, systematic reviews, meta-analyses, randomized controlled trials, non-randomized studies, economic evaluations, and guidelines

ICER = incremental cost-effectiveness ratio; ICUR = incremental cost-utility ratio; QALYs = quality-adjusted life years.

Exclusion Criteria

Articles were excluded if they did not meet the selection criteria outlined in Table 1, they were duplicate publications, or were published prior to 2007. Guidelines with unclear methodology were also excluded.

Critical Appraisal of Individual Studies

Randomized studies were critically appraised by one reviewer using the Downs and Black checklist[9] and guidelines were assessed with the Appraisal of Guidelines for Research and Evaluation (AGREE) II instrument.[10] Summary scores were not calculated for the included studies; rather, a review of the strengths and limitations of each included study were described narratively.

Summary of Evidence

Quantity of Research Available

A total of 649 citations were identified in the literature search. Following screening of titles and abstracts, 605 citations were excluded and 44 potentially relevant reports from the electronic search were retrieved for full-text review. Two potentially relevant publications were retrieved from the grey literature search for full text review. Of these potentially relevant articles, 46 publications were excluded for various reasons, and eight publications met the inclusion criteria and were included in this report. These comprised one RCT and seven evidence-based guidelines. Appendix 1 presents the PRISMA[11] flowchart of the study selection. Additional references of potential interest are provided in Appendix 5.

Summary of Study Characteristics

Additional details regarding the characteristics of included publications are provided in Appendix 2.

Study Design

One relevant cluster randomized controlled trial (RCT), conducted by Benger et al. 2018, was identified.[4]

Seven evidence-based guidelines regarding airway management in pre-hospital settings were identified.[12-18]

One airway management guideline by Rehn et al. was developed by the Scandinavian Society of Anaesthesiology and Intensive Care Medicine.[12] In this guideline, eligible articles were assessed for quality and recommendations were developed based on the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) methodology.[12]

A second guideline by Schmidt et al. was developed by the Wilderness Medical Society.[13] In this guideline, the critical appraisal tools for eligible studies were not reported, but the recommendations were graded based on the American College of Chest Physicians classification.[13]

The remaining five guidelines (by Link et al., Jeejeebhoy et al., Kleinman et al., Singletary et al., and Wyckoff et al.) were published by the American Heart Association (AHA).[14-18] These guidelines included resuscitation and airway management strategies for different populations.[14-18]

The guidelines by Link et al., Kleinman et al., Singletary et al., and Wyckoff et al. were based on the same methodology developed by the American Heart Association and the International Liaison Committee on Resuscitation (ILCOR).[14,16-18] Three major databases (i.e., PubMed, Embase, and the Cochrane Library) were searched for relevant evidence, and the methodology used was based on the approach by the GRADE Working Group.[14,16-18] However, the guideline by Jeejeebhoy et al. were developed using a different methodology. In this guideline, eligible studies were appraised using criteria defined by the authors, and the recommendations were reviewed and published by the AHA Emergency Cardiovascular Care Committee and Scientific Advisory and Coordinating Committee.[15] The classes or strengths of recommendations in the AHA guidelines could be categorized as: I (strong, benefit >>> risk), IIa (moderate, benefit >> risk), IIb (weak, benefit ≥ risk), III: no benefit (benefit = risk), or III: harms (strong, risk > benefit).[19] The level of evidence (LOE) could be grouped as: A (high-quality), B (moderate quality), C (low-quality evidence), C-LD (limited data), or C-EO (expert opinion).[19]

Country of Origin

The first author of the RCT by Benger et al. was based in the UK.[4]

The first authors of the evidence-based guidelines were based in Norway (one guideline)[12] and the US (six guidelines).[13-18]

Patient Population

The cluster RCT included 9,296 patients aged 18 years or older with a non-traumatic out-of-hospital cardiac arrest who were treated by a paramedic.[4]

In the guideline by Rehn et al., the intended users were emergency medical service providers and the target population was critically injured patients of all ages in the pre-hospital setting in Scandinavia (Denmark, Finland, Iceland, Norway and Sweden).[12] In the guideline by Schmidt et al., the intended users were individuals involved in the prevention and acute management of drowning in out-of-hospital and emergency medical care settings and the target population was individuals in need of drowning prevention or management.[13] In the guideline by Link et al., the intended users were practitioners and the target population was adults requiring advanced cardiovascular life support.[14] In the guideline by Kleinman et al., the intended users were not explicitly specified, but the guideline appeared to be intended for those who initiate adult basic life support; the target population was individuals with a sudden cardiac arrest.[16] In the guideline by Singletary et al., the intended

users were anyone who initiated first aid and the target population was individuals requiring first aid.[17] In the guideline by Wyckoff et al., the intended users were health care providers and the target population was neonates requiring neonatal resuscitation.[18] In the guideline by Jeejeebhoy et al., the intended users were health care providers and the target population was patients with cardiac arrest in pregnancy.[15]

Interventions and Comparators

In the RCT by Benger et al., a second-generation supraglottic airway device with a soft non-inflatable cuff (i.e., the i-gel device) was compared to tracheal intubation.[4]

In the guidelines, the following interventions for airway management were considered: airway management interventions (including endotracheal tubes, oropharyngeal and nasopharyngeal airways),[12] techniques related to drowning prevention or management (including airway management by patient positioning and airway devices),[13] resuscitation in adult advanced cardiovascular life support (including advanced airway devices, bag-mask devices and cardiopulmonary resuscitation),[14] resuscitation in adult basic life support (including airway assessment),[16] first aid techniques (including patient positioning for airway management),[17] and neonatal resuscitation techniques (including laryngeal mask and ventilation methods),[18] and resuscitation of patients with cardiac arrest during pregnancy (including bag-mask ventilation and resuscitation team),[15]

Outcomes

The primary outcome in the RCT by Benger et al. was degree of disability or dependence[20]as measured by the modified Rankin Scale score at hospital discharge or 30 days after out-of-hospital cardiac arrest (whichever occurred first).[4] The secondary outcomes were ventilation success, regurgitation, and aspiration.[4]

In the guideline by Rehn et al., the outcomes considered were mortality, morbidity, success rates, and serious adverse events.[12] In the guideline by Schmidt et al., the outcomes considered were morbidity and mortality.[13] In the guideline by Link et al., the outcomes related to airway management were survival with neurological or functional outcomes, survival, return of spontaneous circulation, cardiopulmonary resuscitation (CPR) parameters, and aspiration pneumonia.[14] Kleinman et al. considered clinical, neurological, resuscitation, and physiological outcomes related to adult basic life support.[16] Singletary et al., reported outcomes related to first aid and there were airway management-related outcomes, including mortality, need for airway management, incidence of aspiration, cervical spinal injury, complications, and cardiac arrest.[17] Wyckoff et al. reported outcomes related to neonatal resuscitation and airway management-related outcomes included neonatal brain injury, achieving stable vital signs, increasing Apgar scores, long-term outcomes, a reduction in the need for subsequent intubation, morbidity, and mortality.[18] In the guideline by Jeejeebhoy et al., maternal and fetal outcomes were considered, including cardiac arrest, mortality, and fetus coling.[15]

Summary of Critical Appraisal

Additional details regarding the strengths and limitations of included publications are provided in Appendix 3.

In brief, in the RCT by Benger et al., the study hypothesis, objectives, main outcomes, patient characteristics, interventions, important adverse events, actual probability values, and main findings were described.[4] The distribution of principal confounders in two groups

was compared and was balanced.[4] Different groups were recruited from the same population and the same period of time.[4] Patients were randomized to different groups.[4] The implementation of patient blinding or allocation concealment was not reported. Patients were unlikely to be aware of or anticipate the intervention due to cardiac arrest.[4] The outcome assessors were blinded.[4] The random variability of the outcomes was provided.[4] Patients lost to follow-up were described.[4] The patients in different groups were followed up for similar lengths of time.[4] The main outcomes and the compliance with the interventions were available in medical records and were accurate and reliable.[4] The statistical tests for the main outcomes were appropriate for an RCT.[4]

In all of the guidelines, the overall objectives, health questions, target users, populations, systematic methods for literature searches, and methods to formulate the recommendations were described.[12-18] The health benefits, side effects, and risks were considered in formulating the recommendations.[12-18] There were explicit links between the recommendations and the supporting evidence.[12-18] The recommendations in the guidelines were specific and unambiguous, and different options were presented if available.[12-18] The key recommendations were easily identifiable.[12-18] The facilitators and barriers to the application of the recommendations were described and implementation advice was sometimes provided.[12-18] The competing interests of guideline authors were recorded and addressed.[12-18]

Except for the guideline by Schmidt et al.,[13] relevant professional groups were involved in guideline development and the criteria for evidence selection were described.[12,14-18] Except for the guidelines by Rehn et al. and Schmidt et al.,[12,13] the guidelines were externally reviewed prior to their publication and the role of the funding bodies were described.[14-18] Except for the guidelines by Schmidt et al., Jeejeebhoy et al. and Rehn et al.,[12,13] the views and preferences of the target populations were sought.[14,16-18]

Procedures for updating four of the five AHA guidelines were described.[14,16-18] The AHA guideline by Jeejeebhoy et al. did not report the procedures for updating the recommendations.[15]

The guideline by Rehn et al. was the only one to describe the strengths and limitations of the supporting evidence.[12]

None of the guidelines considered the resource implications of applying the recommendations, or presented monitoring criteria for the recommendations.[12-18]

Summary of Findings

Appendix 4 presents a table of the main study findings and authors' conclusions.

Clinical Effectiveness and Safety of Airway Management with the i-gel Device Performed in a Pre-Hospital Setting versus Performed In-Hospital by a Physician

No relevant evidence regarding the clinical effectiveness and safety of airway management with the i-gel performed in a pre-hospital setting versus performed in-hospital by a physician was identified; therefore, no summary can be provided.

Comparative Safety of Airway Management with the i-gel Device versus Other Intubation Devices in a Pre-Hospital Setting

The safety of the i-gel device was compared to that of other airway management devices in one primary study. There were no significant differences in the occurrence of regurgitation or aspiration between the i-gel device and tracheal intubation.[4]

Cost-Effectiveness of Airway Management with the i-gel Device

No relevant evidence regarding the cost-effectiveness of i-gel device for airway management was identified; therefore, no summary can be provided.

Guidelines for Airway Management in Pre-Hospital Settings

Seven guidelines were identified. Rehn et al. provides recommendations on airway management strategies.[12] The recommendations by Schmidt et al. are related to airway management in drowning patients.[13] Five AHA guidelines have recommendations on airway management for cardiac arrest in pregnenacy,[15] adult requiring advanced[14] or basic life support,[16] first aid,[17] and neonatal resuscitation.[18]

Basic airway management

In the guideline by Rehn et al., in patients with upper airway obstruction it is recommended that emergency medical service providers apply basic airway maneuvers and suggested that oropharyngeal and nasopharyngeal airways be used (good practice recommendation).[12] The recovery position is recommended for unconscious non-trauma patients when advanced airway management not available (strong recommendation, low quality of evidence).[12] A lateral position is recommended for unconscious trauma patients when advanced airway management is not available (strong recommendation, low quality of evidence).[12] In patients with suspected spinal injuries, chin lift or jaw thrust in combination with manual in-line stabilization is recommended (no evidence level).[12]

Supraglottic airway devices

It is recommended that emergency medical service providers with intermediate training use a supraglottic airway device or basic airway maneuvers in out-of-hospital cardiac arrest (weak recommendation, low quality of evidence).[12] The types of supraglottic devices are not specified.[12] Emergency medical service providers are recommended to have advanced training in supraglottic airway devices when they consider themselves likely to use supraglottic devices in patients who may equally benefit from the supraglottic devices and endotracheal intubation (good practice recommendation).[12]

Tracheal intubation

Endotracheal intubation should be conducted by emergency medical service providers with advanced training (strong recommendation, low quality of evidence).[12] Videolaryngoscopy is considered an alternative to endotracheal intubation when direct laryngoscopy fails or is expected to be difficult (weak recommendation, low quality of evidence).[12] When patients cannot be intubated and cannot be ventilated, emergency medical service providers with advanced training are suggested to perform cricothyroidotomy (weak recommendation, low quality of evidence).[12]

Airway management during CPR in drowning patients

Establishing an airway and providing oxygen are priorities in drowning patients (strong recommendation, low-quality or very low-quality evidence).[13] For patients with cardiac

arrest, it is recommended to provide positive-pressure ventilations along with chest compressions using the traditional Airway-Breathing-Circulation model of resuscitation (strong recommendation, low-quality or very low-quality evidence).[13] If advanced airway is available, breaths should be provided every six to eight seconds with continuous compressions (strong recommendation, low-quality or very low-quality evidence).[13] Initial resuscitation is more important than spinal immobilization in patients with severe respiratory distress and in need of aggressive airway management (strong recommendation, low-quality or very low-quality evidence).[13] In the wilderness, patients with abnormal lung sounds, severe coughs, frothy sputum, or foamy material in the airway; depressed mentation; or hypotension should be evacuate to advanced medical care if the benefits of evacuation outweigh the risks (strong recommendation, low-quality or very low-quality evidence).[13]

Airway management in adult basic life support

For patients with suspected spinal injury, rescuers are recommended to use manual spinal motion restriction by placing one hand on either side of the patient's head to hold it still, rather than immobilization devices (strong, risk > benefit; limited data).[16] This is because it may be harmful to use immobilization devices by lay rescuers.[16] In patients without an advanced airway, cycles of 30 compressions and two breaths during CPR should be delivered.[16] The approximately one-second breaths are given during the pauses in compressions (moderate, benefit >> risk; limited data).[16] In patients with an advanced airway, it is recommended to provide one breath every six seconds with continuous chest compressions (weak, benefit ≥ risk; limited data).[16] Routine use of passive ventilation techniques during conventional CPR for adults is not recommended (weak, benefit ≥ risk; limited data).[16] If continuous chest compressions are included in the emergency care bundle, passive ventilation techniques may be considered in the bundle (weak, benefit ≥ risk; limited data).[16]

Airway management in adult advanced cardiovascular life support

A bag-mask device or an advanced airway may be used for oxygenation and ventilation during CPR in hospital or out-of-hospital settings (weak, benefit ≥ risk; limited data).[14] With adequate training, a supraglottic airway device or an endotracheal tube may be used as the initial advanced airway during CPR (weak, benefit ≥ risk; limited data).[14]

When assessing the appropriateness of tracheal tube placement, continuous waveform capnography is recommended in addition to clinical assessment (strong, benefit >>> risk; limited data).[14] When continuous waveform capnometry is unavailable, the alternatives include non-waveform CO_2 detector, esophageal detector device, and ultrasound operated by an experienced operator (moderate, benefit >> risk; limited data).[14] After placing an advanced airway, it is recommended to provide one breath every six seconds with continuous chest compressions (weak, benefit ≥ risk; limited data).[14]

Airway management in first aid

It is recommended to move the person to open the airway and to reach a safe location if that person's position is causing obstructed airway or the area is unsafe (strong, benefit >>> risk; expert opinion).[17]

Airway management in neonatal resuscitation

Laryngeal masks may be used as an alternative to tracheal intubation during resuscitation of the late-preterm and term newborn, more than 34 weeks, if ventilation via a face mask

unsuccessful (weak recommendation, low-quality evidence).[18] After failed positive-pressure ventilation and infeasible intubation, a laryngeal mask is recommended for resuscitation of late-preterm and term newborns (strong recommendation, good clinical practice).[18]

Airway management in cardiac arrest in pregnancy

It is recommended to begin appropriate basic life support airway management using bag-mask ventilation with pure oxygen at a rate of at least 15 L/min (weak, benefit ≥ risk; low-quality evidence).[15] Endotracheal intubation should be conducted by an experienced laryngoscopist (strong, benefit >>> risk); Level of Evidence C (low-quality evidence; low-quality evidence).[15] Prolonged intubation attempts should be avoided to prevent conditions, such as deoxygenation, prolonged interruption in chest compressions, airway trauma and bleeding (strong, benefit >>> risk; low-quality evidence).[15] Circoid pressure is not routinely recommended (moderate, benefit = risk; low-quality evidence).[15] Continuous waveform capnography with clinical assessment is recommended to confirm and monitor endotracheal tube placement (strong, benefit >>> risk; low-quality evidence), and is reasonable for intubated patients to monitor CPR quality, optimize chest compression, and detect return of spontaneous circulation (weak, benefit ≥ risk; low-quality evidence).[15] An increase in the end-tidal pressure of CO_2 (P_{ETCO2}) level or P_{ETCO2} levels greater than 10 mmHg are suggestive of adequate chest compressions or return of spontaneous circulation (moderate, benefit >> risk; low-quality evidence).[15] Interruptions in chest compressions should be minimized during advanced airway placement (strong, benefit >>> risk; low-quality evidence).[15]

Limitations

There were no studies comparing the clinical effectiveness of i-gel devices placed in a pre-hospital setting or in-hospital by a physician. There was only one study comparing safety outcomes of the i-gel devices with other advanced airway devices.[4] There were no cost-effectiveness studies comparing i-gel devices with other devices for airway management. There was only one guideline focusing on airway management.[12] The others were resuscitation guidelines with several recommendations for airway management in patients requiring resuscitation or first aid.[14,15,18] The use of supraglottic airway devices was mentioned only in one guideline.[12] The safety study was published after the guidelines identified in this report were published; therefore, the findings were not used to inform the included guidelines.

Conclusions and Implications for Decision or Policy Making

This report identified one cluster RCT with good-quality evidence regarding the safety of i-gel devices compared with tracheal intubation and seven evidence based guidelines regarding airway management strategies in patients with different characteristics.[4,12-18] There were no studies comparing the clinical effectiveness of the i-gel device in a pre-hospital versus in-hospital setting. There were no studies on the cost-effectiveness of i-gel devices.

In the single relevant primary study that compared the i-gel device with tracheal intubation, there was no significant difference in safety measures, including regurgitation and aspiration.[4]

Of the seven relevant guidelines, one guideline focused on pre-hospital airway management[12] and six guidelines provided recommendations on airway management in

patients requiring resuscitation in different settings.[13-18] In the guideline by Rehn et al., emergency medical service providers are recommended to apply basic airway maneuvers and suggested to use oropharyngeal and nasopharyngeal airways.[12] It is recommended for emergency medical service providers with intermediate training to use a supraglottic airway device or basic airway maneuvers in out-of-hospital cardiac arrest.[12] Emergency medical service providers are recommended to have advanced training in supraglottic airway devices when supraglottic devices are considered equally beneficial as endotracheal intubation. During CPR in drowning patients, establishing an airway and providing oxygen are priorities.[13] Initial resuscitation is more important than spinal immobilization in patients with severe respiratory distress and in need of aggressive airway management.

In the guideline about adult basic life support, in patients without an advanced airway, it is recommended that cycles of 30 compressions and two breaths during CPR be delivered.[16] In the guideline about adult advanced cardiovascular life support, a bag-mask device or an advanced airway may be used for oxygenation and ventilation during CPR inside or outside hospitals.[14] Concerning cardiac arrest in pregnancy, it is recommended to begin appropriate basic life support airway management using bag-mask ventilation with pure oxygen at a rate of at least 15 L/min.[15] Endotracheal intubation should be conducted by an experienced laryngoscopist.

Regarding first aid, it is recommended to move the person to open the airway and to reach a safe location if that person's position is causing obstructed airway or the area is unsafe.[17] In neonatal resuscitation, laryngeal masks may be used as an alternative to tracheal intubation during resuscitation of the late-preterm and term newborn, more than 34 weeks, if ventilation via a face mask unsuccessful.[18]

In conclusion, further research is required to understand the difference in the clinical effectiveness of the i-gel device in a pre-hospital setting or performed in-hospital by physicians and the cost-effectiveness of the i-gel device compared with other advanced airway devices. Findings from a single primary study demonstrated that there was no significant difference in the occurrence of regurgitation or aspiration between airway management performed by paramedics using the i-gel device or tracheal intubation.[4] Evidence-based guidelines provide a variety of recommendations about airway management. Recommendations from one guideline suggest that it requires training to use supraglottic airway devices. Supraglottic devices are recommended in two guidelines if practitioners consider the potential benefits to outweigh the risks. The remaining five guidelines contained recommendations for different types of airway management, ranging from positional changes to laryngeal masks or tracheal intubation depending on the circumstances.

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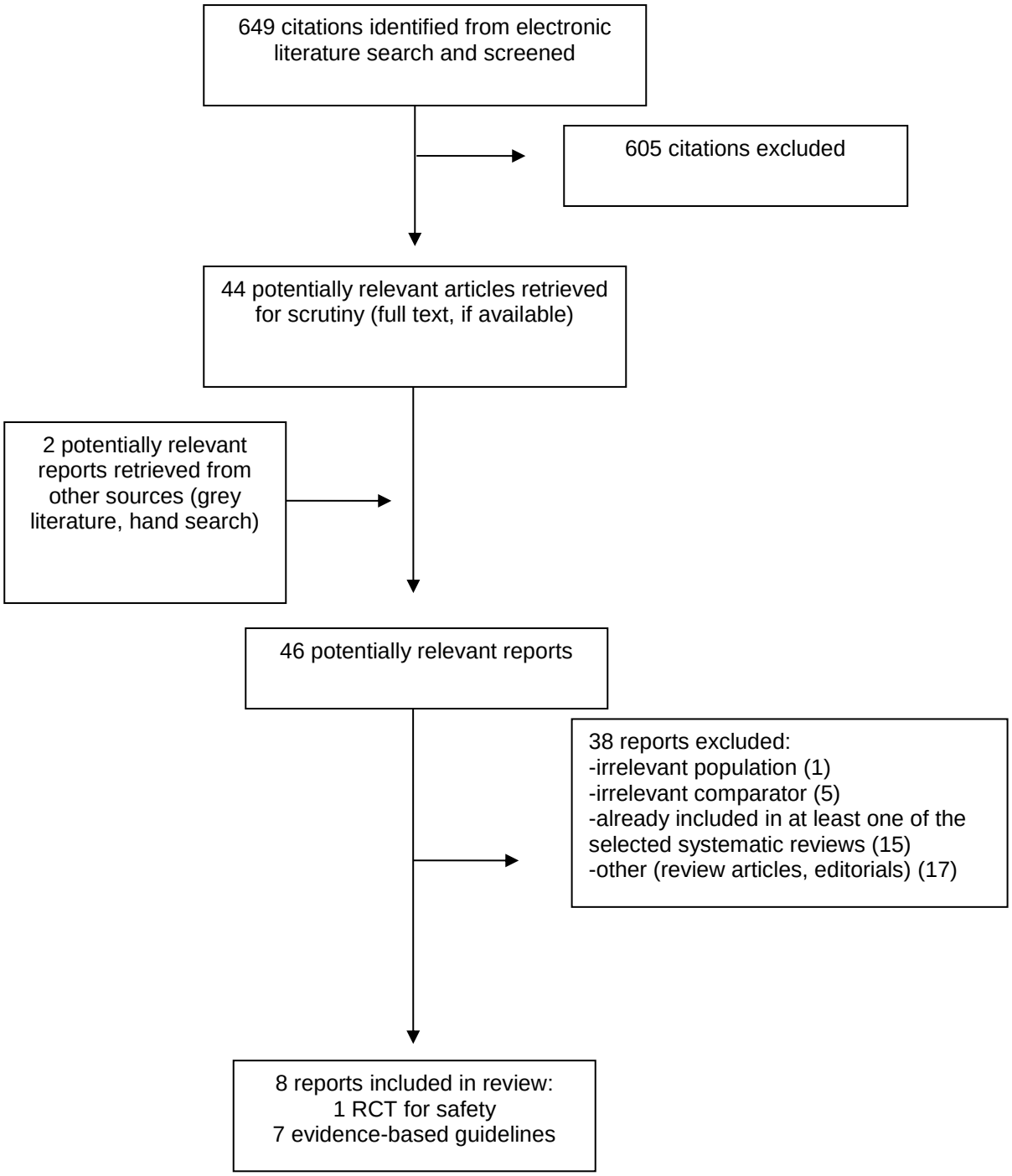
23. Perlman JM, Wyllie J, Kattwinkel J, et al. Part 7: Neonatal resuscitation: 2015 international consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. *Circulation.* 2015;132(16 Suppl 1):S204-241.
24. Wyllie J, Perlman JM, Kattwinkel J, et al. Part 11: Neonatal resuscitation: 2010 international consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. *Resuscitation.* 2010;81 Suppl 1:e260-287.

Appendix 1: Selection of Included Studies



Appendix 2: Characteristics of Included Publications

Table 2: Characteristics of Included Primary Clinical Studies

First Author, Publication Year, Country	Study Design	Population Characteristics	Intervention and Comparator(s)	Clinical Outcomes, Length of Follow-Up
Randomized controlled trials				
Benger et al. 2018,[4] UK	RCT, multicenter, cluster (4 ambulance services in England), 1:1 randomization of paramedic clusters Paramedics not blinded Outcome assessors in the hospitals blinded Registration: ISRCTN 08256118	9,296 patients aged 18 years or older with a non-traumatic out-of-hospital cardiac arrest and treated by a participating paramedic enrolled automatically under a waiver of consent	**Initial advanced airway management strategies compared** Second-generation supraglottic airway device with a soft non-inflatable cuff (i-gel; Intersurgical). versus tracheal intubation (current standard of care using direct laryngoscopy)	**Primary outcomes** Degree of disability or dependence measured by the Modified Rankin Scale score[20] at hospital discharge or 30 days after out-of-hospital cardiac arrest, whichever occurred sooner. Modified Rankin Scale score in 2 ranges: 0-3 (good outcome) or 4-6 (poor outcome; 6 = death) Modified Rankin Scale score: widely used in out-of-hospital cardiac arrest research (no further description by the authors) **Secondary outcomes** ventilation success, regurgitation, and aspiration

ISRCTN = International Standard Randomised Controlled Trial Number; RCT = randomized controlled trial.

Table 3: Characteristics of Included Guidelines

Intended Users, Target Population	Intervention and Practice Considered	Major Outcomes Considered	Evidence Collection, Selection, and Synthesis	Evidence Quality Assessment	Recommendations Development and Evaluation	Guideline Validation
Rehn et al. 2016,[12] Norway Scandinavian Society of Anaesthesiology and Intensive Care Medicine guideline						
Intended users: Emergency medical service (EMS) providers in	Interventions related to "*basic airway manoeuvres, SADs, ETI including*	"*mortality, morbidity, success rates and serious adverse event*" (p. 854)	Databases searched: PubMed, Embase, Centre for Reviews and Dissemination,	Guidelines assessed with the appraisal of guidelines for research and evaluation	GRADE system	Not reported

Intended Users, Target Population	Intervention and Practice Considered	Major Outcomes Considered	Evidence Collection, Selection, and Synthesis	Evidence Quality Assessment	Recommendations Development and Evaluation	Guideline Validation
Scandinavia (Denmark, Finland, Iceland, Norway and Sweden) **Target population:** Critically ill or injured patients of all ages in the pre-hospital setting	*videolaryngo-scopy and emergency cricothy-roidotomy relevant to pre-hospital airway management*" (p. 853) Oropharyngeal and nasopharyngeal airways also described		Cochrane Library and Epistemonikos	(AGREE) instrument "*In line with the principles of the GRADE methodology*" (p. 854)		
Schmidt et al. 2016,[13] US Wilderness Medical Society Drowning						
Intended users: Individuals involved in the prevention and acute management of drowning in out-of-hospital and emergency medical care settings **Target population:** Individuals in need of drowning prevention or management	Techniques related to drowning prevention or management	Morbidity and mortality	Databases searched: PubMed, MEDLINE, and Google Scholar Eligible study design: Randomized controlled trials, observational studies, case series, and review articles	Not reported	Recommendations grading "*American College of Chest Physicians classification scheme, in accordance with prior versions of the Wilderness Medical Society Practice Guidelines*" (p. 236)	Not reported
Jeejeebhoy et al. 2015,[15] US Cardiac Arrest in Pregnancy						
Intended users: Health care providers	All resuscitation methods considered	Maternal and fetal outcomes including cardiac arrest, mortality, fetus cooling	Databases searched: 2010 International Consensus on Cardiopulmonary Resuscitation and	Levels of evidence assessed using a tool developed by the authors	Drafts by volunteers, edited by the chairs of working groups, discussed in webinars, and re-edited	Not reported

Intended Users, Target Population	Intervention and Practice Considered	Major Outcomes Considered	Evidence Collection, Selection, and Synthesis	Evidence Quality Assessment	Recommendations Development and Evaluation	Guideline Validation
Target population: Patients with cardiac arrest in pregnancy	**Airway and Breathing** Including bag-mask ventilation, resuscitation team		Emergency Cardiovascular Care Science With Treatment Recommendations and the 2010 International Liaison Committee on Resuscitation worksheets, PubMed, Embase, and an AHA master resuscitation reference library	Levels A (strongest), B, and C (weakest) for the inclusion of multiple populations, limited populations, and very limited populations; Class I (benefit >>> risk), IIa (benefit >> risk), and IIb (benefit ≥ risk) for the strengths of evidence to implement the intervention	Recommendations peer-reviewed and published by the AHA Emergency Cardiovascular Care Committee and Science Advisory and Coordinating Committee Recommendations classified according to the ACC/AHA Clinical Practice Guideline Recommendation Classification System[19]	
Recommendations in Link et al. 2015,[14] US Part 7: Adult Advanced Cardiovascular Life Support Systematic reviews in Callaway et al. 2015,[21] US Part 4: Advanced Life Support						
Intended users: practitioners **Target population:** Adults requiring life support, characteristics depending on the research questions Question-specific populations listed below	42 PICO questions prioritized, including anti-arrhythmic drugs, airway management strategies, and CPR	Airway-related outcomes below	Literature databases searched: PubMed, Embase, and the Cochrane Library Systematic reviews based on recommendations of the Institute of Medicine of the National Academies	Critical appraisal tools: Cochrane for randomized controlled trials (RCTs), Quality Assessment of Diagnostic Accuracy Studies (QUADAS)-2 for studies of diagnostic accuracy,5 and GRADE for observational studies	Methodological approach proposed by the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) Working Group Recommendations classified according to the ACC/AHA Clinical Practice Guideline Recommendation Classification System[19]	Not reported

Intended Users, Target Population	Intervention and Practice Considered	Major Outcomes Considered	Evidence Collection, Selection, and Synthesis	Evidence Quality Assessment	Recommendations Development and Evaluation	Guideline Validation
Airway management section ALS 714: SGAs Versus Tracheal Intubation **Intended users:** Practitioners **Target population:** Adults who are in cardiac arrest in any setting	SGAs versus Tracheal Intubation as first advanced airway	"*Survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; return of spontaneous circulation ; CPR parameters; development of aspiration pneumonia*" (p. S133)	As above	As above	As above	Not reported
Airway management section, ALS 783 Basic Versus Advanced Airway **Intended users:** Practitioners **Target population:** Adults who are in cardiac arrest in any setting	**Basic Versus Advanced Airway** insertion of an advanced airway (tracheal tube or SGA) versus basic airway (bag-mask device with or without oropharyngeal airway)	Survival with favorable neurologic/functional outcome at discharge, 30 days, 60 days, 180 days, and/or 1 year; survival only at discharge, 30 days, 60 days, 180 days, and/or 1 year; ROSC; CPR parameters; development of aspiration pneumonia	As above	As above	As above	Not reported

Intended Users, Target Population	Intervention and Practice Considered	Major Outcomes Considered	Evidence Collection, Selection, and Synthesis	Evidence Quality Assessment	Recommendations Development and Evaluation	Guideline Validation
Recommendations in Kleinman et al. 2015,[16] US Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality Systematic reviews in Singletary et al. 2015,[17] US Part 15: First Aid, Travers et al. 2015,[22] US Part 3: Adult Basic Life Support and Automated External Defibrillation, and Callaway et al. 2015,[21] US Part 4: Advanced Life Support						
Intended users: Not specified Possibly those initiated adult basic life support **Target population:** Individuals with a sudden cardiac arrest	Interventions related to adult basic life support Depending on the PICO criteria	Clinical, neurological, resuscitation, and physiological outcomes mentioned	Databases searched: PubMed, Embase, and the Cochrane Library Systematic Evidence Evaluation and Review System (SEERS) Evidence reviewed by volunteers based on the systematic review based on the recommendations of the Institute of Medicine of the National Academies	"*Cochrane for randomized controlled trials (RCTs), Quality Assessment of Diagnostic Accuracy Studies (QUADAS)-2 for studies of diagnostic accuracy,5 and GRADE for observational studies that inform both therapy and prognosis questions*" (p. S270 in Singletary 2015, Part 9: First Aid)	Executed by the First Aid Task Force Methodological approach by the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) Working Group Recommendations classified according to the ACC/AHA Clinical Practice Guideline Recommendation Classification System[19]	Not reported
Recommendations in Singletary et al. 2015,[17] US Part 15: First Aid Systematic reviews in Singletary et al. 2015,[17] US Part 9: First Aid						
Intended users: Anyone who initiated first aid **Target population:**	First aid: the helping behaviors and initial care provided for an acute illness or injury	Depending on the research questions	Databases searched: PubMed, Embase, and the Cochrane Library Systematic Evidence	"*Cochrane for randomized controlled trials (RCTs), Quality Assessment of Diagnostic Accuracy*	Executed by the First Aid Task Force Methodological approach by the Grading of Recommendations, Assessment,	Not reported

Intended Users, Target Population	Intervention and Practice Considered	Major Outcomes Considered	Evidence Collection, Selection, and Synthesis	Evidence Quality Assessment	Recommendations Development and Evaluation	Guideline Validation
Individuals requiring first aid			Evaluation and Review System (SEERS) Evidence reviewed by volunteers based on the systematic review based on the recommendations of the Institute of Medicine of the National Academies	*Studies (QUADAS)-2 for studies of diagnostic accuracy,5 and GRADE for observational studies that inform both therapy and prognosis questions*" (p. S270 in Singletary 2015, Part 9: First Aid)	Development, and Evaluation (GRADE) Working Group Recommendations classified according to the ACC/AHA Clinical Practice Guideline Recommendation Classification System[19]	
Airway management section, FA 517 Recovery Position **Intended users:** Anyone who initiated first aid **Target population:** Adults who are breathing and unresponsive outside of a hospital	Positioning in a lateral, side-lying, recovery position versus supine position	"*overall mortality, need for airway management, the incidence of aspiration, the likelihood of cervical spinal injury, complications, incidence of cardiac arrest*" (p. S305)	As above	As above	As above	Not reported
Recommendations in Wyckoff et al. 2015,[18] US Part 13: Neonatal Resuscitation Systematic reviews in Perlman et al. 2015,[23] US Part 7: Neonatal Resuscitation						
Intended users: Health care providers	Interventions and practice related to neonatal resuscitation	Outcomes depending on the research questions	Systematic review based on the recommendations of the Institute of Medicine of the National	Methods proposed by the Grading of Recommendations, Assessment,	Recommendations made based on the consensus by the Neonatal Resuscitation Chapter Collaborators	Not reported

Intended Users, Target Population	Intervention and Practice Considered	Major Outcomes Considered	Evidence Collection, Selection, and Synthesis	Evidence Quality Assessment	Recommendations Development and Evaluation	Guideline Validation
Target population: Neonates requiring neonatal resuscitation			Academies PubMed, Embase, and the Cochrane Library searched	Development and Evaluation (GRADE) Working Group Critical appraisal tools "*Cochrane for randomized controlled trials, Quality Assessment of Diagnostic Accuracy Studies (QUADAS)-2 for studies of diagnostic accuracy, and GRADE for observational studies that inform both therapy and prognosis questions*" (p. S205)	Recommendations classified according to the ACC/AHA Clinical Practice Guideline Recommendation Classification System[19]	
Airway management section, NRP 618 Laryngeal Mask Airway: Intervention In newborn **Intended users:** Health care providers **Target population:** infants at near term (greater than 34 weeks) or term who have	**NRP 618 Laryngeal Mask Airway**: laryngeal masks as a primary or secondary device versus mask ventilation or endotracheal intubation	**NRP 618 Laryngeal Mask Airway**: indicators of neonatal brain injury, achieving stable vital signs, increasing Apgar scores, long-term outcomes, reducing the need for subsequent intubation, or neonatal morbidity and mortality	As above	As above	As above	Not reported

Intended Users, Target Population	Intervention and Practice Considered	Major Outcomes Considered	Evidence Collection, Selection, and Synthesis	Evidence Quality Assessment	Recommendations Development and Evaluation	Guideline Validation
indications for intermittent positive pressure for resuscitation						

ACC = American College of Cardiology; AGREE = appraisal of guidelines for research and evaluation; AHA = American Heart Association; ALS = advanced life support; CPR = cardiopulmonary resuscitation; EMS = emergency medical service; ETI = endotracheal intubation; FA = first aid; GRADE = Grading of Recommendations Assessment, Development and Evaluation; NRP = Neonatal Resuscitation Program; PICO = population, intervention, comparator, and outcome; QUADAS = Quality Assessment of Diagnostic Accuracy Studies; RCT = randomized controlled trial; ROSC = return of spontaneous circulation; SAD = supraglottic airway device; SEERS = Systematic Evidence Evaluation and Review System; SGA = supraglottic airway.

Appendix 3: Critical Appraisal of Included Publications

Table 4: Strengths and Limitations of Clinical Studies using the Downs and Black checklist[9]

Strengths	Limitations
Benger et al., 2018[4]	
- Study hypothesis and objectives described - Main outcomes described in the Methods - Patient characteristics described - Interventions of interest described - Distributions of principal confounders described - Main findings described - Random variability of the outcomes provided - All important adverse events reported - The characteristics of the patients lost to follow-up described - Actual probability values (*P*-values) reported - Similar lengths of follow-up between groups - Statistical tests for the main outcomes appropriate - Compliance with the interventions reliable - Main outcome measures accurate - Different groups recruited from the same population - Different groups recruited from the same period of time - Patients randomized to different groups - Patients lost to follow-up considered - Sample size estimated based on power calculation before study - Patient blinding status not reported, but outcomes unlikely to be influenced by a lack of blinding - Outcome assessors blinded	- Allocation concealment not described - Confounding not adjusted in the analysis

Table 5: Strengths and Limitations of Guidelines using AGREE II[10]

Item	Guideline						
	Rehn et al., 2016[12]	Schmidt et al., 2016[13]	Jeejeebhoy et al., 2015[15]	Kleinman et al., 2015[16] Singletary et al., 2015[17] and Travers et al., 2015[22]	Link et al., 2015[14] and Callaway et al., 2015[21]	Singletary et al., 2015[17] and Singletary et al., 2015[2]	Wyckoff et al., 2015[24] and Perlman et al., 2015[23]
Domain 1: Scope and Purpose							
1. The overall objective(s) of the guideline is (are) specifically described.	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
2. The health question(s) covered by the guideline is (are) specifically described.	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
3. The population (patients, public, etc.) to whom the	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed

Item	Guideline						
guideline is meant to apply is specifically described.							
Domain 2: Stakeholder Involvement							
4. The guideline development group includes individuals from all relevant professional groups.	Strongly agreed	Strongly disagreed	Agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
5. The views and preferences of the target population (patients, public, etc.) have been sought.	Strongly disagreed	Strongly disagreed	Strongly disagreed	Agreed	Agreed	Agreed	Agreed
6. The target users of the guideline are clearly defined.	Strongly agreed	Partly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
Domain 3: Rigour of Development							
7. Systematic methods were used to search for evidence.	Strongly agreed	Agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
8. The criteria for selecting the evidence are clearly described.	Strongly agreed	Strongly disagreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
9. The strengths and limitations of the body of evidence are clearly described.	Partly agreed	Strongly disagreed	Strongly disagreed	Strongly disagreed	Strongly disagreed	Strongly disagreed	Strongly disagreed
10. The methods for formulating the recommendations are clearly described.	Strongly agreed	Agreed	Agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
11. The health benefits, side effects, and risks have been considered in formulating the recommendations.	Agreed	Agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
12. There is an explicit link between the recommendations and the supporting evidence.	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
13. The guideline has been externally reviewed by experts prior to its publication.	Strongly disagreed	Strongly disagreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
14. A procedure for updating the guideline is provided.	Strongly disagreed	Strongly disagreed	Strongly disagreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
Domain 4: Clarity of Presentation							
15. The recommendations are specific and unambiguous.	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
16. The different options for management of the condition	Agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed

Item	Guideline						
or health issue are clearly presented.							
17. Key recommendations are easily identifiable.	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed
Domain 5: Applicability							
18. The guideline describes facilitators and barriers to its application.	Agreed	Strongly agreed	Agreed	Agreed	Agreed	Agreed	Agreed
19. The guideline provides advice and/or tools on how the recommendations can be put into practice.	Agreed	Strongly agreed	Strongly agreed	Agreed	Agreed	Agreed	Agreed
20. The potential resource implications of applying the recommendations have been considered.	Strongly disagreed	Strongly disagreed	Strongly disagreed	Strongly disagreed	Strongly disagreed	Strongly disagreed	Strongly disagreed
21. The guideline presents monitoring and/or auditing criteria.	Strongly disagreed	Strongly disagreed	Strongly disagreed	Strongly disagreed	Strongly disagreed	Strongly disagreed	Strongly disagreed
Domain 6: Editorial Independence							
22. The views of the funding body have not influenced the content of the guideline.	Disagreed	Strongly disagreed	Strongly agreed	Agreed	Agreed	Agreed	Agreed
23. Competing interests of guideline development group members have been recorded and addressed.	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed	Strongly agreed

AGREE = Appraisal of Guidelines for Research & Evaluation.

Appendix 4: Main Study Findings and Authors' Conclusions

Table 6: Summary of Findings of Included Primary Clinical Studies

Main Study Findings	Authors' Conclusion
Randomized controlled trials	
Benger et al., 2018[4]	
SGA (i-gel) versus tracheal intubation **Modified Rankin Scale score range, 0 to 3, proportions** - Insignificant difference between the SGA group and the TI group - Adjusted risk difference (RD) = −0.6% (95% CI, −1.6% to 0.4%) **Initial ventilation proportions** - Significantly higher in the SGA group than the TI group - Adjusted RD = 8.3% (95% CI, 6.3% to 10.2%) **Secondary outcomes (regurgitation and aspiration)** - Not significantly different between groups **Regurgitation** - 1,268 of 4865 patients (26.1%) in the SGA group vs. 1,072 of 4,372 patients (24.5%) in the TI group - Adjusted RD = 1.4% (95% CI, −0.6% to 3.4%) **Aspiration** - 729 of 4,824 patients (15.1%) vs. 647 of 4,337 patients (14.9%), respectively - Adjusted RD = 0.1% (95% CI, −1.5% to 1.8%)	"*Among patients with out-of-hospital cardiac arrest, randomization to a strategy of advanced airway management with a supraglottic airway device compared with tracheal intubation did not result in a favorable functional outcome at 30 days*" (p. 779)

CI = confidence interval; RD = risk difference; SGA = supraglottic airway; TI = tracheal intubation.

Table 7: Summary of Recommendations in Included Guidelines

Recommendations	Strength of Evidence and Recommendations
Rehn et al., 2016[12] Scandinavian Society of Anaesthesiology and Intensive Care Medicine guideline	
Basic airway management Basic airway maneuvers and the use of adjuncts - "*We recommend that all EMS providers should apply basic airway manoeuvres and consider using adjuncts such as oropharyngeal (OPA) and nasopharyngeal(NPA) airways in cases with upper airway obstruction*" (p. 854)	Good practice recommendation
Unconscious non-trauma patients and the use of the recovery position - "*In unconscious patients, where there is no suspicion of trauma and where advanced airway management is not immediately available, we recommend that all EMS providers place the patient in the recovery position*" (p. 855)	Good practice recommendation
Unconscious trauma patients and the use of the lateral position - "*In unconscious trauma patients, where advanced airway management is not immediately available, we recommend that*	Strong recommendation, low quality of evidence

Recommendations	Strength of Evidence and Recommendations
all EMS providers turn the patient into a lateral position while maintaining spinal alignment" (p. 855)	
- "*When spinal precautions are warranted, chin lift or jaw thrust in combination with manual in-line stabilisation should be used to reduce the risk for exacerbation of any spinal injuries*" (p. 855)	No evidence level
Supraglottic airway devices **The use of SAD in out-of-hospital cardiac arrest** - "*We suggest that EMS providers with intermediate training use an SAD or basic airway manoeuvres in out-of-hospital cardiac arrest (OHCA)*" (p. 857)	Weak recommendation, low quality of evidence
The use of SAD as an alternative to ETI or as a rescue device in airway management - "*We recommend that EMS providers with advanced training use an SAD when it is appropriate, i.e. when an SAD is considered equally beneficial to ETI or as a rescue device after failed ETI*" (p. 857)	Good practice recommendation
Endotracheal intubation and videolaryngoscopy **Training level necessary for ETI** - "*We recommend that ETI should only be performed by EMS providers with advanced training*" (p. 859)	Strong recommendation, low quality of evidence
Use of videolaryngoscopy - "*We suggest that videolaryngoscopy be considered as an alternative method for ETI when direct laryngoscopy fails or is expected to be difficult*" (p. 859)	Weak recommendation, low quality of evidence
Emergency cricothyroidotomy - "*We suggest that EMS providers with advanced training perform cricothyroidotomy in 'cannot intubate, cannot ventilate'(CICV) situations*" (p. 859)	Weak recommendation, low quality of evidence
Schmidt et al. 2016,[13] US	
Cardiopulmonary resuscitation and prioritization of airway in drowning patients - "*Establishing an airway and providing oxygen are priorities in the initial resuscitation of a drowning patient*" (p. 239) - "*For the patient in cardiac arrest, provide positive- pressure ventilations in addition to chest compressions using the traditional Airway-Breathing-Circulation model of resuscitation*" (p.239) - "*If an advanced airway is available and properly placed, provide breaths at specified time intervals(every 6 to 8 seconds) while continuous compressions are administered*" (p. 239)	Recommendation grade: strong recommendation, low-quality or very low-quality evidence
Cervical spinal immobilization in drowning patients - "*Spinal immobilization should not take priority over initial resuscitation of a patient with severe respiratory distress who requires aggressive airway management*" (p. 341)	Recommendation grade: strong recommendation, low-quality or very low-quality evidence
Disposition in the wilderness **Decision to evacuate** - "*Any patient with abnormal lung sounds, severe cough, frothy sputum, or foamy material in the airway; depressed mentation;*	Recommendation grade: strong recommendation, low-quality or very low-quality evidence

Recommendations	Strength of Evidence and Recommendations
or hypotension warrants evacuation to advanced medical care if risks of evacuation do not outweigh potential benefit" (p. 243)	
Jeejeebhoy et al. 2015,[15] US Cardiac Arrest in Pregnancy	
Airway and breathing - "*Appropriate BLS airway management should be initiated*" (p. 1754) - "*a. A member of the first responder team should perform bag-mask ventilation with 100% oxygen flowing to the bag at a rate of at least 15 L/ min*" (p. 1754)	Class IIb (weak, benefit ≥ risk); Level of Evidence C (low-quality evidence)
- "*b. Two-handed bag-mask ventilation is preferred*" (p. 1754)	Class IIa (moderate, benefit >> risk); Level of Evidence C (low-quality evidence)
Airway management - "*I. 2. 3. 4. Endotracheal intubation should be performed by an experienced laryngoscopist*" (p. 1757)	Class I (strong, benefit >>> risk); Level of Evidence C (low-quality evidence)
- "*a. Starting with an ETT with a 6.0- to 7.0-mm inner diameter is recommended*" (p. 1757)	Class I (strong, benefit >>> risk); Level of Evidence C (low-quality evidence)
- "*b. Optimally no more than 2 laryngoscopy attempts should be made*" (p. 1757)	Class IIa (moderate, benefit >> risk); Level of Evidence C (low-quality evidence)
- "*c. Supraglottic airway placement is the preferred rescue strategy for failed intubation*" (p. 1757)	Class I (strong, benefit >>> risk); Level of Evidence C (low-quality evidence)
- "*d. If attempts at airway control fail and mask ventilation is not possible, current guidelines for emergency invasive airway access should be followed (call for help, obtain equipment)*" (p. 1757)	No evidence level
- "*Prolonged intubation attempts should be avoided to prevent deoxygenation, prolonged interruption in chest compressions, airway trauma, and bleeding*" (p. 1757)	Class I (strong, benefit >>> risk); Level of Evidence C (low-quality evidence)
- "*Cricoid pressure is not routinely recommended*" (p. 1757)	Class III (moderate, benefit = risk); Level of Evidence C (low-quality evidence)
- "*Continuous waveform capnography, in addition to clinical assessment, is recommended as the most reliable method of confirming and monitoring correct placement of the ETT (Class I; Level of Evidence C) and is reasonable to consider in intubated patients to monitor CPR quality, to optimize chest compressions, and to detect ROSC (Class IIb; Level of Evidence C)*" (p. 1757)	Class I (strong, benefit >>> risk); Level of Evidence C (low-quality evidence) Class IIb (weak, benefit ≥ risk); Level of Evidence C (low-quality evidence)
- "*Findings consistent with adequate chest compressions or ROSC include a rising P_{ETCO_2} level or levels >10 mm Hg*" (p. 1757)	Class IIa (moderate, benefit >> risk); Level of Evidence C (low-quality evidence)
- "*5. Interruptions in chest compressions should be minimized during advanced airway placement*" (p. 1757)	Class I (strong, benefit >>> risk); Level of Evidence C (low-quality evidence)

Recommendations	Strength of Evidence and Recommendations
Recommendations in Kleinman et al. 2015,[16] US Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality Systematic reviews in Singletary et al. 2015,[17] US Part 15: First Aid, Travers et al. 2015,[22] US Part 3: Adult Basic Life Support and Automated External Defibrillation, and Callaway et al. 2015,[21] US Part 4: Advanced Life Support	
Open the Airway: Lay Rescuer (FA 772) - "*For victims with suspected spinal injury, rescuers should initially use manual spinal motion restriction (eg, placing 1 hand on either side of the patient's head to hold it still) rather than immobilization devices, because use of immobilization devices by lay rescuers may be harmful*" (p. S421)	Class III: Harm (strong, risk > benefit), LOE C-LD (limited data)
Bag-Mask Ventilation - "*As long as the patient does not have an advanced airway in place, the rescuers should deliver cycles of 30 compressions and 2 breaths during CPR. The rescuer delivers breaths during pauses in compressions and delivers each breath over approximately 1 second*" (p. S421)	Class IIa (moderate, benefit >> risk), LOE C-LD (limited data)
Ventilation With an Advanced Airway (ALS 808, misidentified as BLS 808 in the article) - "*When the victim has an advanced airway in place during CPR, rescuers no longer deliver cycles of 30 compressions and 2 breaths (ie, they no longer interrupt compressions to deliver 2 breaths). Instead, it may be reasonable for the provider to deliver 1 breath every 6 seconds (10 breaths per minute) while continuous chest compressions are being performed*" (p. S421)	Class IIb (weak, benefit ≥ risk), LOE C-LD (limited data)
2015 Recommendations—New - "*We do not recommend the routine use of passive ventilation techniques during conventional CPR for adults*" (p. S422)	Class IIb (weak, benefit ≥ risk), LOE C-LD (limited data)
2015 Recommendations—New - "*However, in EMS systems that use bundles of care involving continuous chest compressions, the use of passive ventilation techniques may be considered as part of that bundle*" (p. S422)	Class IIb (weak, benefit ≥ risk), LOE C-LD (limited data)
Recommendations in Link et al. 2015,[14] US Part 7: Adult Advanced Cardiovascular Life Support Systematic reviews in Callaway et al. 2015,[21] US Part 4: Advanced Life Support	
Bag-Mask Ventilation Compared With Any Advanced Airway During CPR (ALS 783) - "*Either a bag-mask device or an advanced airway may be used for oxygenation and ventilation during CPR in both the inhospital and out-of-hospital setting*" (p. S446)	Class IIb (weak, benefit ≥ risk), LOE C-LD (limited data)

Recommendations	Strength of Evidence and Recommendations
- "*For healthcare providers trained in their use, either an SGA device or an ETT may be used as the initial advanced airway during CPR*" (p. S446)	Class IIb (weak, benefit ≥ risk), LOE C-LD (limited data)
Clinical Assessment of Tracheal Tube Placement (ALS 469) - "*Continuous waveform capnography is recommended in addition to clinical assessment as the most reliable method of confirming and monitoring correct placement of an ETT*" (p. S447)	Class I (strong, benefit >>> risk), LOE C-LD (limited data)
- "*If continuous waveform capnometry is not available, a nonwaveform CO_2 detector, esophageal detector device, or ultrasound used by an experienced operator is a reasonable alternative*" (p. S447)	Class IIa (moderate, benefit >> risk), LOE C-LD (limited data)
Ventilation After Advanced Airway Placement (ALS 808) - "*After placement of an advanced airway, it may be reasonable for the provider to deliver 1 breath every 6 seconds (10 breaths/min) while continuous chest compressions are being performed*" (p. S448)	Class IIb (weak, benefit ≥ risk), LOE C-LD (limited data)
Recommendations in Singletary et al. 2015,[17] US Part 15: First Aid Systematic reviews in Singletary et al. 2015,[2] US Part 9: First Aid	
Positioning the Ill or Injured Person (FA 517) - "*If leaving the person in the position found is causing the person's airway to be blocked, or if the area is unsafe, move the person only as needed to open the airway and to reach a safe location*" (p. S575)	Class I (strong, benefit >>> risk), LOE C-EO (expert opinion)
Recommendations in Wyckoff et al. 2015,[18] US Part 13: Neonatal Resuscitation Systematic reviews in Perlman et al. 2015,[23] US Part 7: Neonatal Resuscitation	
Laryngeal Mask Airway—Intervention (NRP 618) - "*We suggest the laryngeal mask may be used as an alternative to tracheal intubation during resuscitation of the late-preterm and term newborn (more than 34 weeks) if ventilation via the face mask is unsuccessful*" (p. S224)	Weak recommendation, low-quality evidence
- "*In the unusual situation where intubation is not feasible after failed PPV, the laryngeal mask is recommended for resuscitation of the late-preterm and term newborn (more than 34 weeks)*" (p. S224)	Strong recommendation, good clinical practice

ALS = advanced life support; BLS = basic life support; CICV = cannot intubate, cannot ventilate; CPR = cardiopulmonary resuscitation; EMS = emergency medical service; ETI = endotracheal intubation; ETT = endotracheal tube; FA = first aid; NPA = nasopharyngeal; NRP = Neonatal Resuscitation Program; OPA = oropharyngeal; OHCA = out-of-hospital cardiac arrest; PPV = positive-pressure ventilation; SAD = supraglottic airway device; SGA = supraglottic airway.

Appendix 5: Additional References of Potential Interest

Reviews without systematic literature searches

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Guidelines with unclear methodology or mixed populations

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