QUESTION

Advanced airway management during adult cardiac arrest	
POPULATION:	Adults in any setting (in-hospital or out-of-hospital) with cardiac arrest from any etiology
INTERVENTION:	A specific advanced airway management method (e.g. tracheal intubation or a supraglottic airway device) during cardiac arrest.
COMPARISON:	A different advanced airway management method (e.g. a supraglottic airway device) or no advanced airway management method (e.g. bag-mask ventilation) during cardiac arrest.
MAIN OUTCOMES:	Survival to hospital discharge; Survival to hospital discharge with a favorable neurological outcome;
SETTING:	Three setting were considered: 1) Out-of-hospital cardiac arrest with a low tracheal intubation success rate 2) Out-of-hospital cardiac arrest with a high tracheal intubation success rate 3) In-hospital cardiac arrest

ASSESSMENT

Problem

Is the problem a priority?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know	Cardiac arrest, both in the out-of-hospital and in-hospital setting, is relatively common and has a very high mortality. Identifying interventions that can potentially improve outcomes is therefore a key priority. Specifically, chest compressions alone do not provide adequate ventilation in prolonged cardiac arrest. Airway management is required to facilitate ventilation and protect the lungs if regurgitation of gastric contents occurs. The best airway strategy for improving patient outcomes is uncertain.	This topic was given a high priority rank by the ILCOR ALS Task Force. This followed the publication of three new RCTs since the 2015 CoSTR (Benger 2018 779, Jabre 2018 779, Wang 2018 769). Data from the AHA GWTG registry of IHCA shows that 60-70% of cardiac arrest patients have a tracheal tube in the first 15 minutes (Andersen 2017 494). In the US CARES registry of OHCA (Mcmullan 2014 617) 52% of patients had a tracheal tube, 29% a supraglottic airway, and 18% no advanced airway. In the AIRWAYS-2 RCT (Benger 2018 779) that compared i-gel with tracheal intubation for OHCA, 17.3% of patients required no advanced airway.

Desirable Effects

How substantial are the desirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Trivial ○ Small ● Moderate ○ Large ○ Varies ○ Don't know	The outcomes (i.e. survival and survival with a favorable functional/neurological outcome) are considered critical. Any anticipated effect size is moderate based on the available evidence (additional details are provided in the GRADE tables).	The impact on the number of survivors on a global scale could be large. There are no RCTs of IHCA.

Laryngeal tube compared to tracheal intubation (Wang, 2018)		
Outcome	**Relative risk**	**Risk difference**
Survival to hospital discharge	1.34 (1.07 to 1.68)	27 more per 1000 (from 6 more to 48 more)
Survival to hospital discharge with a favorable neurological outcome	RR 1.42 (1.07 to 1.89)	21 more per 1000 (from 3 more to 38 more)
i-gel compared to tracheal intubation (Benger, 2018)		

Outcome	Odds ratio	Risk difference
Survival to hospital discharge	0.95 (0.82 to 1.10)	4 fewer per 1000 (from 14 fewer to 8 more)
Survival to hospital discharge with a favorable neurological outcome	0.92 (0.77 to 1.09)	6 fewer per 1000 (from 16 fewer to 4 more)
Bag-mask ventilation compared to tracheal intubation (Jabre, 2018)		
Outcome	**Relative risk**	**Risk difference**
28-day survival	RR 1.02 (0.71 to 1.47)	1 more per 1000 (from 18 fewer to 21 more)
28-day survival with a favorable neurological outcome	RR 1.03 (0.68 to 1.55)	1 more per 1000 (from 13 fewer to 23 more)

Undesirable Effects

How substantial are the undesirable anticipated effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Large ○ Moderate ○ Small ○ Trivial ● Varies ○ Don't know	Undesirable effects that were reported in the studies identified included regurgitation/aspiration, difficult airway management, and some CPR quality measures including compression fraction and interruptions to CPR. In the Jabre RCT (Jabre 2018 779). there was an increased incidence of regurgitation of stomach contents, and difficult ventilation in the bag-mask group. There was however no consistent evidence to support an increase in undesirable effects. None of these outcomes were proposed *a priori* as important or critical by the ALS Task Force. There was no evidence that any of the undesirable effects listed adversely affected important or critical outcomes.	We assessed the evidence for harm reported in the 3 large RCTs of OHCA (Benger 2018 779, Jabre 2018 779, Wang 2018 769).

Certainty of evidence

What is the overall certainty of the evidence of effects?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS

● Very low ● Low ● Moderate ○ High ○ No included studies	The certainty of the evidence varied between very low and moderate depending on the outcomes and subgroup. Based on the GRADE tables, the certainty of evidence for the critical outcomes of survival and survival with a favorable functional/neurological outcome is provided below: **Comparison** / **Setting**: OHCA (low success*) / OHCA (high success*) / IHCA **Laryngeal tube vs. tracheal intubation**: ⊕⊕◯◯ LOW / ⊕◯◯◯ VERY LOW / ⊕◯◯◯ VERY LOW **i-gel vs. tracheal intubation**: ⊕⊕◯◯ LOW / ⊕◯◯◯ VERY LOW / ⊕◯◯◯ VERY LOW **Bag-mask ventilation vs. tracheal intubation**: ⊕⊕◯◯ LOW / ⊕⊕⊕◯ MODERATE / ⊕⊕◯◯ LOW *tracheal intubation success	There are no RCTs of IHCA.

Values

Is there important uncertainty about or variability in how much people value the main outcomes?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ Important uncertainty or variability ○ Possibly important uncertainty or variability ● Probably no important uncertainty or variability ○ No important uncertainty or variability	We have not identified any airway studies that specifically addressed how patients valued the different outcomes.	It is likely that most people value the outcomes survival and survival with a favorable functional/neurological outcome at hospitals discharge or 28-day days. The AIRWAYS-2 Study (Benger 2018 779) project group included patient representation. We know from the COSCA (Core Outcome Set for Cardiac Arrest) project that patients' value longer term outcomes (Haywood 2018 147). Longer term outcomes and HRQoL was not addressed in the available studies.

Balance of effects

Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS

○ Favors the comparison ○ Probably favors the comparison ● Does not favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention ○ Varies ○ Don't know	See above results: balance of effects varies depending on comparison and subgroup including intubation success rates.	We did not specifically study the impact of training and experience for a particular airway strategy.

Acceptability

Is the intervention acceptable to key stakeholders?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	We have not identified any research that assessed acceptability. In the absence of high certainty of evidence to support a particular approach, providers may be reluctant to change their approach, and systems may be reluctant to change/implement new training.	All three interventions considered (bag-mask ventilation, supraglottic airways, and tracheal intubation) are likely to be acceptable to stakeholders as they are currently used in clinical practice.

Feasibility

Is the intervention feasible to implement?

JUDGEMENT	RESEARCH EVIDENCE	ADDITIONAL CONSIDERATIONS
○ No ○ Probably no ● Probably yes ○ Yes ○ Varies ○ Don't know	The three identified RCTs illustrate that the success of tracheal intubation is setting and provider dependent – tracheal intubation success may vary widely between individuals and settings.	All three interventions considered (bag-mask ventilation, supraglottic airways, and tracheal intubation) are feasible, but the effectiveness in providing adequate ventilation is variable. The level of upfront and ongoing training is likely higher for tracheal intubation. Feasibility might vary depending on the providers, setting, patient factors, and resources.

SUMMARY OF JUDGEMENTS

	JUDGEMENT						
PROBLEM	No	Probably no	Probably yes	**Yes**		Varies	Don't know
DESIRABLE EFFECTS	Trivial	Small	**Moderate**	Large		Varies	Don't know
UNDESIRABLE EFFECTS	Large	Moderate	Small	Trivial		**Varies**	Don't know
CERTAINTY OF EVIDENCE	**Very low**	**Low**	**Moderate**	High			No included studies
VALUES	Important uncertainty or variability	Possibly important uncertainty or variability	**Probably no important uncertainty or variability**	No important uncertainty or variability			
BALANCE OF EFFECTS	Favors the comparison	Probably favors the comparison	**Does not favor either the intervention or the comparison**	Probably favors the intervention	Favors the intervention	Varies	Don't know
ACCEPTABILITY	No	Probably no	**Probably yes**	Yes		Varies	Don't know
FEASIBILITY	No	Probably no	**Probably yes**	Yes		Varies	Don't know

CONCLUSIONS

Recommendation

- **We suggest using bag-mask ventilation or an advanced airway strategy during CPR for adult cardiac arrest in any setting (weak recommendation, low to moderate-certainty evidence)**

- **If an advanced airway is used, we suggest a supraglottic airway for adults with out-of-hospital cardiac arrest in settings with a low tracheal intubation success rate (weak recommendation, low certainty of evidence).**

- **If an advanced airway is used, we suggest a supraglottic airway or tracheal intubation for adults with out-of-hospital cardiac arrest in settings with a high tracheal intubation success rate (weak recommendation, very low certainty of evidence).**

- **If an advanced airway is used, we suggest a supraglottic airway or tracheal intubation for adults with in-hospital cardiac arrest (weak recommendation, very low certainty of evidence).**

Justification

- Three RCTs published since the 2015 CoSTR (Benger 2018 779, Jabre 2018 779, Wang 2018 769) have enabled the ALS Task Force to provider more specific treatment recommendations. The 2015 Treatment Recommendation was based on evidence from observational studies and stated: 'We suggest using either an advanced airway or a bag-mask device for airway management during CPR (weak recommendation, very-low-quality evidence) for cardiac arrest in any setting'.
- This ILCOR CoSTR addresses airway management during CPR in adults. Once ROSC is achieved the optimal airway technique will depend on the patient's precise condition and skills of the rescuer. Survivors requiring mechanical ventilation are likely to eventually require tracheal intubation.
- There is currently no supporting evidence that an advanced airway (i.e. supraglottic airway or tracheal intubation) during CPR improves survival or survival with a favorable neurological/functional outcome after adult cardiac arrest in any setting when compared with bag-mask ventilation.
- An advanced airway strategy usually starts with a variable period of bag-mask ventilation. The optimal timing and reasons for transitioning to an advanced airway vary based on clinical context. In the 3 recent RCTs (Benger 2018 779, Jabre 2018 779, Wang 2018 769), patients treated with advanced airways had a period of bag-mask ventilation whilst preparing for device insertion. In some patients a supraglottic airway was inserted as the first airway intervention without bag-mask ventilation.
- ROSC and good survival are possible prior to advanced airway insertion, e.g. after early defibrillation for a shockable cardiac arrest.
- Depending on their particular skill set, providers may change to an advanced airway if bag-mask ventilation is difficult, and the advanced airway may be the easier technique for the provider.
- When an advanced airway is used, we suggest that a supraglottic airway is used if the setting or specific provider has limited training and experience in tracheal intubation (i.e. there is a [anticipated] low tracheal intubation success rate). In other settings, both supraglottic airways and tracheal intubation can be considered.
- We have not provided a precise value or range of values for low and high intubation success rate, nor an agreed definition. Studies have used different definitions of success. Using the individual study definitions, we considered the Wang and Benger RCTs (Benger 2018 779, Wang 2018 769) as having a low tracheal intubation success rate (51.6% and 69.8% respectively) and the Jabre study (Jabre 2018 779) as having a high success rate (97.9%).
- The preferred airway option will likely be provider dependent.
- There are insufficient data for us to express a preference for a particular supraglottic airway device.

- Effective bag-mask ventilation is not always straightforward and also varies according to provider skills. We have not specifically evaluated the optimal bag-mask technique and use of airway adjuncts (oropharyngeal or nasopharyngeal airways). For example, some training materials recommend a two-person technique for bag-mask ventilation (one rescuer using a two-handed technique to hold the face mask with a second rescuer squeezing the bag).
- Our recommendation regarding airway management in the in-hospital setting is based on extrapolation from out-of-hospital trials and one large observational study on in-hospital cardiac arrest (Andersen 2017 494). We assume that tracheal intubation success rates are high in the in-hospital setting but acknowledge that there is limited evidence to support this assumption and that it is likely to be site-dependent.

Subgroup considerations

The ALS Task Force had identified a number of subgroups of interest some of which are addressed in the recommendations. The Benger and Wang (Benger 2018 779, Wang 2018 769) studies found no subgroup difference according to pre-defined subgroups [1) the aetiology of the cardiac arrest (e.g. cardiac vs. non-cardiac, respiratory vs. non-respiratory, traumatic vs. non-traumatic), 2) the timing of the advanced airway (early vs. late), 3) shockable vs. non-shockable initial rhythm, 4) provider characteristics].

Implementation considerations

- A strategy of bag-mask ventilation followed by an advanced airway is commonly used as part of a stepwise approach to airway management.
- Providers should monitor airway management success rates to correctly identify and implement the most suitable airway management strategy in their specific setting. In case of implementation of a new airway strategy, providers should ensure that sufficient training is provided before implementation.
- Settings using tracheal intubation should use waveform capnography to monitor end-tidal CO_2 to confirm correct tube placement.

Monitoring and evaluation

As treatment recommendations are based on likely success of an intervention, providers are encouraged to continuously monitor success rates of the different airway management strategies. This will ensure that providers are able to choose the correct airway management strategy for their setting and to provide additional training if necessary.

Research priorities

Despite three recent large randomized trials, the optimal airway management strategy in adult cardiac arrest remains uncertain. Specifically, it is unknown whether supraglottic airways are inferior or superior to bag-mask ventilation in all settings and whether any airway management strategy is superior in the in-hospital setting where there are currently no randomized trial data.

In most cardiac arrests more than one airway technique is used and there is a need for studies on the optimal strategy regarding at which time points should there be a change to a different airway technique e.g. basic to advanced.

Is a supraglottic airway first strategy as opposed to a period of bag-mask ventilation prior to supraglottic airway insertion superior in terms of achieving effective ventilation and oxygenation and improving patient outcomes.

The impact of different advanced airway strategies on CPR quality (no-flow times) and oxygenation and ventilation during CPR requires further study.

The optimal airway strategy will vary according to provider training, experience and skills in the various airway techniques. This needs to be considered when designing airway trials.

Despite the (weak) recommendations made here, we believe there is generally clinical equipoise for additional trials examining airway management strategy for adult cardiac arrest.