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Use of supraglottic airway devices by paramedics in the management of adult pre-hospital cardiac arrest patients: A literature review

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Review

Use of supraglottic airway devices by paramedics in the management of adult pre-hospital cardiac arrest patients: A literature review

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Abstract

Introduction
Current best practice for paramedic airway management of pre-hospital cardiac arrest is being continually reviewed following changes to the emphasis on intubation as a primary intervention within international resuscitation guidelines. Subsequently, there is increased enthusiasm for the use of next generation supraglottic airway devices. This review aimed to identify the current evidence for the safety and effectiveness of supraglottic airways for the management of pre-hospital cardiac arrest.

Methods
A search of the electronic databases MEDLINE, PubMed, Science Direct and Cochrane Library was conducted. Papers were excluded if they did not examine airway management in the pre-hospital cardiac arrest setting, involved the use of sedative or paralysing agents, or involved paediatric patients, animals or cadavers.

Results
Of the 689 articles identified, 22 peer-reviewed articles were included for analysis. All 22 articles were from the following countries: United States of America, United States of America and Canada, Australia, Austria, Finland, Germany, Korea, Japan, The Netherlands, Norway, Taiwan and the United Kingdom.

Discussion
This review revealed large variances in both device effectiveness and patient outcome, particularly between geographical locations. Second-generation supraglottic airway devices demonstrated considerable improvement in effectiveness over their predecessors. Interestingly, the use of bag-valve mask ventilation reported better outcomes than any other form of advanced airway intervention. Studies also highlighted the diversity of airway management techniques and devices across global emergency medical service systems.

Conclusion
Despite favourable indications of the effectiveness and safety of the next generation supraglottic airway devices, the paucity of pre-hospital specific research (particularly randomised controlled trials) challenges decision-making regarding pre-hospital airway management best practice.

Keywords:
supraglottic airway device, prehospital, effectiveness

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Introduction

Pre-hospital advanced airway management is controversial and varying in efficacy (1,2). Maintaining a patent airway during out-of-hospital cardiac arrests (OHCAs) is crucial for enhancing gas exchange and reducing the risk of aspiration. It is well known that endotracheal intubation (ETI) is the gold standard for airway management; however, recent pre-hospital research on supraglottic airway devices (SADs) is now questioning ETI as best practice for OHCAs (3-5). First generation SADs evolved from anaesthetic in-hospital practice and were rudimentary pre-hospital devices for protecting a patient's airway with limited effectiveness (6). Second-generation SADs have evolved in simplicity, speed of insertion, and in their ability to reduce air leaks and gastric insufflation. Since their introduction to the pre-hospital setting there has been growing enthusiasm for their use during OHCAs (7-9).

Supraglottic airway devices are an advanced airway adjunct, introduced into Australian and international paramedic practice for the purpose of securing a patient's airway. The insertion of a SAD in an OHCA facilitates continuous cardiac compressions without pausing for ventilation (9). This enables devotion of more time to increasing cardiac compression fraction (amount of time spent performing external cardiac compressions) and other advanced life support (ALS) interventions. Increasing cardiac compression fraction has been directly linked to increases in the likelihood of return of spontaneous circulation (10,11).

Current research is providing contradictory evidence for the use of SADs during OHCAs (1,12), furthermore, there remains a degree of uncertainty as to which airway management device provides the most favourable outcomes in the pre-hospital setting.

The follow-on study from this literature review focusses on the i-gel® SAD and its utilisation and effectiveness within an Australian ambulance service. As a consequence, this review represents an important element in developing the researchers' understanding and identification of any gaps in current research and underpins the proposed follow-on study.

The aims of this review are to identify what Australian-based research has been done, where the pre-hospital research originates from, what the common limitations between studies are, what associations the airway device and patient outcomes have, and whether the pivotal papers within the field provide a strong enough theoretical base for instrumental change.

Methods

A literature search was conducted using the electronic databases MEDLINE (January 2005 to July 2015), PubMed (January 2005 to July 2015), Science Direct (January 2005 to July 2015) and Cochrane Library. The following terms were used in differing combinations to retrieve published articles: 'pre-hospital', 'prehospital', 'ambulance', 'paramedic', 'laryngeal mask airway', supraglottic airway', 'igel' and 'i-gel'. The inclusion criteria were papers with a primary focus on SAD use by paramedics or emergency medical technicians (EMTs) and first responders during an OHCA. The article abstracts were screened for their relevance and included in the literature review. We excluded papers that used non-paramedic or non-EMT staff as their pre-hospital health care providers, did not focus on OHCAs, if sedative or paralytic drugs were utilised for the insertion of SADs; and papers where the primary focus was animal, manikin, simulation, paediatric, cadaver or toxic environment studies (Figure 1). Papers were also excluded if they were not published in a peer-reviewed journal, not available in English or not available as full text. We searched the literature between January 2005 and July 2015 as most second-generation SADs were introduced in the early 2000s (6), thus allowing suitable time for introduction and utilisation within ambulance services.

A thematic analysis of the literature was undertaken by grouping airway intervention devices together. All reviewed literature either focussed on one specific type of airway device or a comparison of two or more airway devices. Specific areas for review of each paper included device effectiveness when used in the pre-hospital setting. This was determined by success rate and number of insertions required. Also examined were pre-hospital return of spontaneous circulation (ROSC), patient survival and neurological outcomes, and reported adverse effects including reasons for failure of insertion or premature removal. Considering the plethora of airway devices and manufacturer brands used globally, some consolidation was required for the comparative studies to enable comparison and analysis. This produced six themes to focus the results and discussion: laryngeal tube (5); laryngeal mask airway (2); i-gel® (3); comparison between SAD and ETI (5); comparison between SAD and bag-valve mask (BVM) (2); and comparison between SAD, BVM and ETI (5). The i-gel® group included two single head-to-head comparative studies for simplicity.

Results

Of the 689 articles identified, 22 articles met our inclusion criteria after scrutiny of the abstracts and eliminating duplicates (Figure 1). All 22 articles were from the following countries: United States of America (three), United States of America and Canada (one), Australia (two), Austria (one), Finland (one), Germany (four), Korea (one), Japan (four), The Netherlands (one), Norway (one), Taiwan (one) and United Kingdom (two). All 22 studies were conducted from 2008 to 2015.

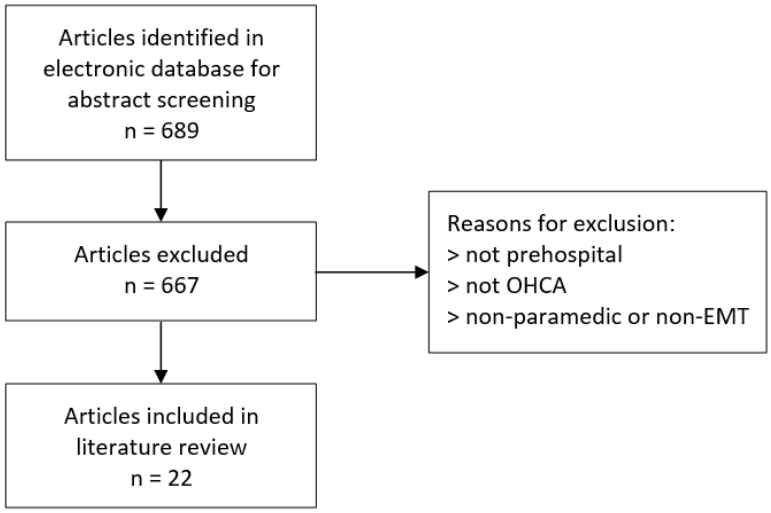

Figure 1. Study selection flow diagram

Laryngeal tube studies

Five studies were included in the laryngeal tube (LT) group (13-17), with a single study focussing on first responders (16). Reported are success rates, first and subsequent insertion attempt rates and adverse effects (Table 1). Overall success rates ranged between 85% (14) to 100% (13), and number of total attempts required ranged from two to three (13-17) with the first attempt success ranging between 71.9% (16) and 92.4% (13). Incidence of adverse effects ranged from 10% (13) of patients to 52.7% (15). Regurgitation of gastric contents was a common adverse effect in all studies, occurring prior to LT insertion in three studies (13,14,17). There were several limitations in each paper, with common areas being each study not having any comparators and the potentiality for self-reporting bias (13-17). One study did not report a study duration (14), two authors in one study were currently or previously employed by manufacturers of LTs (13), and one study poorly reported on their adverse effects, partially due to the paramedics not adhering to the study protocol for unknown reasons (16).

Laryngeal mask airway studies

Two studies were included in the laryngeal mask airway (LMA) group (12,18). An Australian study focussed on three different brands of first-generation LMAs: LMA-Classic™, Ultimate Laryngeal Mask, and Soft Seal® Laryngeal Mask, which were reported collectively throughout the paper (18). The Netherlands study only utilised the second-generation LMA-Supreme™ (LMA-S) device. Both studies reported on success rates, number of insertions and adverse effects (Table 2) (12,18). The Australian study reported first-attempt success rate of 45%, cumulative second-attempt success rate of 65%, and 16 patients required premature removal of the LMA (18). In contrast to this, the Netherlands study reported a 98% first-attempt success rate, with only one patient requiring three attempts. There was one report each of aspiration and dislodgement, and seven patients with air leakage from the LMA-S, however six of these seven patients did not require any change or further management due to stabilised vital signs (12). Although limited by small sample sizes and a lack of pre-hospital focussed LMA research, there does appear to be improvements between first and second-generation LMAs. There were limitations in both studies with the potential of self-reporting bias (12,18), whether LMA insertion attempts were the primary management, or secondary to failed intubations (18), and considering the study duration was absent in one study it remains unclear how the 50 patients were chosen and in what timeframe (12).

i-gel® studies

Three studies were included in the i-gel® group (9,19,20), two of which were comparisons with either the ETI (19) or LMA (20). All studies reported rates of successful insertion (Table 3) ranging 90–100% for the i-gel® (9,19,20) and 57% for a first-generation LMA in a randomised controlled trial (20). Two studies reported on required insertion attempts, first attempt success rates (Table 3), and a difficulty of insertion rating (9,20). A single study covered air leakage (9), which also found a positive correlation between i-gel® devices that were easier to insert were less likely to have an air leak (9). However, considering both ease of insertion and air leakage were self-reported by the operators at scene, this may be subject to potential bias. Reported adverse effects (Table 3) were two i-gel® devices being removed due to gastric insufflation that occurred prior to airway management (9), and a total of seven i-gel® attempts failed as a consequence of 'airway complications' (19).

Table 1. Pre-hospital laryngeal tube effectiveness

Study	Study design	Sample size	Overall insertion success	First attempt success	Maximum number of insertions for overall success	Reported SAD adverse effects
Wiese et al (13)	Single-centre, prospective observational	92	100%	92.4%	2	Cuff problems 7%, RG prior 3%
Heuer et al (14)	Prospective observational	39	85%	72%	2	Cuff rupture 7.5%, RG prior 7.5%
Sunde et al (15)	Dual-centre, retrospective observational	347	85.3%	74.4%	3	No auscultation sounds 28.8%, tube position 24.5%, air leak 17.6%, insertion time >30s 13.3%, RG 12.7%, tube dislodge 4.9%
Lankimaki et al (16)	Prospective observational	64	98.4%	71.9%	3	Unclear between FR and paramedic reporting
Muller et al (17)	Retrospective observational	130	93%	83%	2	Cuff problems 7.7%, RG prior 4.6%, tube placement 2.3%, morbid obesity 4.6%, tongue swelling 2.3%, laryngeal spasm 0.7%

Legend: SAD = supraglottic airway device, RG = regurgitation, FR = first responder

Table 2. Pre-hospital laryngeal mask airway effectiveness

Study	Study design	Sample size	Overall insertion success	First attempt success	Maximum number of insertions for overall success	Reported SAD adverse effects
Bosch et al (12)	Prospective observational	50	100%	98%	3	Aspiration 2%, tube dislodge 2%, air leak 14%, RG 8%
Hein et al (18)	Two retrospective clinical audits	164	74%	45%	6	RG 6%, increase GCS/gag reflex 2.4%, tube dislodge 3.6%

Legend: SAD = supraglottic airway device, RG = regurgitation, GCS = Glasgow Coma Scale

There were several limitations throughout all three studies, with a common limitation of potential self-reporting bias. The German study did not specify whether its 70 patients were a sample of the entire population for the study period, which could potentially introduce selection bias, and did not report why continuous external cardiac compressions with an i-gel® in-situ was only achievable in 74% of cardiac arrests (9). The UK study informed their operational staff about the first audit and the aims of the study prior to commencing the second audit, thereby potentially introducing bias and increasing device utilisation (19). The Australian study failed to achieve a statistically significant sample size, thereby reducing the power of that study (20).

Comparison of SAD and ETI studies

Five studies were included in the SAD and ETI group (21-25). Three studies primarily focussed on patient outcomes, neurological and survival (23-25), and the remaining two studies focussed on successful insertion rates (21,22). This enabled examination of the following subthemes: patient outcomes, and success rate outcomes.

Patient outcomes

Two studies were from Japan (23,25) and one study was from the USA and Canada (24). The latter study reported on satisfactory functional status at hospital discharge as the primary outcome (Table 4). In comparison with SADs (comprised of King Laryngeal Tube, Combitube™, and LMA), ETI was associated with increased odds of ROSC (Table 4) and 24-hour survival, but not associated with secondary airway or pulmonary complications. This study did not include failed attempts with either advanced airway (ETI or SADs), nor when the devices were inserted, the insertion times and number of attempts required, or for what reason the individual operator chose one device over another. Furthermore, this study had analytical limitations because the original trial was not designed for evaluating airway management (24).

Both Japanese studies reported neurologically favourable outcomes at 1 month, pre-hospital ROSC (Table 4), and 1-month survival (23,25). There was no statistical significance reported for neurologically favourable outcomes at 1 month, and 1-month survival (ETI 3.6%, SADs 3.6%; ETI 10.7%, SADs 9.8%, respectively). However, there was a statistical significance demonstrated for pre-hospital ROSC and ROSC in the emergency department for ETI compared to SADs (16.6% vs. 10.1%; 47.8% vs. 44.4%, respectively) (23).

The second Japanese study (25) reported a statistically significant association between ETI and 1-month survival in comparison to SADs. Only after adjustment for confounders was there a statistically significant association between ETI and 1 month neurologically favourable outcome. It should also be noted the ETI group were more likely to utilise adrenaline (epinephrine) compared to the LMA and oesophageal obturator airway (EOA) groups (11.3%, 2.5% and 3.2%, respectively) (25).

Table 3. Pre-hospital i-gel® effectiveness

Study	Study design	Sample size	Overall insertion success		First attempt success		Maximum number of insertions for overall success		Reported SAD adverse effects
			SAD	ETI	SAD	ETI	SAD	ETI	
Häske et al (9)	Non-random, single-centre, prospective observational	70	100%	NA	90%	NA	3	NA	Air leak 20%, RG prior 2.8%
Duckett et al (19)	Two retrospective clinical audits	185	94% and 92%	86% and 90%	NA	NA	NA	NA	NA
Middleton et al (20)	Single-centre, prospective parallel group, 'open label', RCT	48	LMA 57%, i-gel 90%	NA	i-gel 100%	NA	NA	NA	NA

Legend: SAD = supraglottic airway device, ETI = endotracheal intubation, LMA = laryngeal mask airway, RG = regurgitation, RCT = randomised controlled trial, NA = not applicable

Table 4. Pre-hospital SAD and ETI patient outcomes

Study	Study design	Sample size	P-ROSC		Favourable neurological outcome	
			SAD	ETI	SAD	ETI
Kajino et al (23)	Prospective, observational cohort	5,377	10.1%	12.2%	3.6%	3.6%
Wang et al (24)	Secondary analysis of prospective clinical trial ROC PRIMED	10,455	NA	NA	3.9%	4.7%
Tanabe et al (25)	Retrospective, nation-wide, observational	138,248	LMA 4.90%, EOA 4.41%	7.24%	LMA 0.99%, EOA 1.04%	1.14%

Legend: P-ROSC = prehospital return of spontaneous circulation, SAD = supraglottic airway device, ETI = endotracheal intubation, LMA = laryngeal mask airway, EOA = oesophageal obturator airway, ROC = Resuscitation Outcomes Consortium, PRIMED = Pre-hospital Resuscitation using an Impedance valve and an Early vs. Delayed analysis

Limitations for both studies include the potential for self-reporting bias, and specifically for the second study (25), if a failed ETI attempt occurred and a rescue SAD was used afterward, this was then counted toward the LMA or EOA group, depending on which type of SAD was used. Furthermore, the emergency medical service (EMS) system in Japan is relatively inexperienced with ETI use since its introduction in 2004, and advanced airway devices, including ETI and SADs, are only considered after initial BVM ventilation, when the patient's airway appears unsecure or there is an expected long transport time (25). Emergency medical technicians in Japan are unable to terminate resuscitation in the field and must transport all patients to hospital on whom resuscitation is attempted (23).

Success rate outcomes

Both studies were from the USA (21,22) and focussed on ETI and King LT, with the latter study using only basic life support (BLS) first responders for their LT group (22). Both studies report higher first attempt and overall success rates for SADs compared to ETI (21,22). The first study's (21) first attempt and overall success rate for the ETI group (Table 5) were higher than the second study (22), but lower for the LT group (21,22). Potential reasons for this may be the first study only having just over 70% of their patients in cardiac arrest, and paramedics were limited to a single size #4 of the King Laryngeal Tube, which may not have been appropriate for all patients in the LT group (21). Adverse effects (Table 5) were reported for both studies. The second study had 51 patients with no attempt made for either ETI or LT without any documented reasoning, and multiple attempts for ETI were not defined (22). Both studies were limited by the potential for self-reporting bias, small sample sizes (21,22), and the second study was not prospective or randomised (22).

Comparison of SAD and BVM studies

Two studies were included in the SAD and BVM group (26,27). The study from Taiwan focussed on the feasibility of implementing the intubating-LMA (I-LMA) to their developing EMS system, and therefore didn't include any successful insertion rates or number of attempts required for the I-LMA, and only listed their adverse effects as non-serious regurgitation (27). The incidence rate of ROSC and 24-hour survival (Table 6) for the BVM and I-LMA groups were extremely high, with the latter group also showing an improvement. Although the authors declare no significant difference in demographic data, the BVM group had a higher incidence of traumatic arrest (21.3% vs. 14.2%), and two key chronic co-morbidities (cerebrovascular 13.5% vs. 4.2%, and diabetes 28.1% vs. 16.9%) (27). The feasibility study from Austria (26) was similar to the feasibility Taiwanese study (27), looking at introducing the LT to their EMS system (26). The methods of this study indicate that the LT would be the primary airway device used in an OHCA, without any prior BVM ventilation, and also if the LT had two failed insertion attempts then BVM would be used instead. However, BVM was utilised initially on 74 patients, which was not comprehensively explained; 395 patients were managed in the LT group and 48 patients in the LT to BVM group. The success rates for the LT group did not include the twice-failed insertion attempts of the LT to BVM group (Table 5).

Table 5. Pre-hospital SAD and ETI effectiveness

Study	Study design	Sample size	Overall insertion success		First attempt success		Maximum number of insertions for overall success		Reported SAD adverse effects
			SAD	ETI	SAD	ETI	SAD	ETI	
Frascone et al (21)	Prospective, multi-centre, randomised clinical trial	204	80.5%	80.2%	68%	67.1%	2	3	No advance past OP 7%, no pharyngeal seal 7%, spatial limitations 4.6%
Gahan et al (22)	Retrospective pre-post analysis	351	92.9%	72.9%	87.8%	57.6%	*	*	Bleeding into LT 1.2%, RG 1.2%, air leak 0.6%, lung compliance 0.6%
Roth et al (26)	Prospective, multi-centre, observational	517	99%	NA	76%	NA	2	NA	RG 5.5%, LT related injury 1%, cuff rupture 4%

Legend: SAD = supraglottic airway device, ETI = endotracheal intubation, OP = oropharynx, LT = laryngeal tube, RG = regurgitation, GCS = Glasgow Coma Scale, NA = not applicable,* = multiple attempts were not defined

There was a high incidence of adverse effects throughout all groups, consisting of regurgitation, airway injury or cuff rupture (Table 5) (26). Successful ventilation was self-reported by the attending operators (EMTs who placed the device and an emergency physician that managed the patient afterward) and varied widely between the groups (26). Both studies have the potential of self-reporting bias, and both are restricted by limited training and relatively inexperienced operators (26,27).

Comparison of SAD, BVM and ETI studies

Five studies were included in the SAD, BVM and ETI group (1,2,5,28,29). The latter study focussed on one of the three arms (i-gel®, LMA-S, or usual practice) within the UK based REVIVE-Airways trial, the 'usual practice' arm (29). Out of 196 patients, 108 received BVM airway management, 39 received an LMA and 49 received an ETI. The airway intervention did not need to be changed in 16%, 44% and 76% of patients respectively. Adverse effects that instigated airway intervention abandonment and eventual change in the BVM and LMA group were regurgitation (28 cases and seven cases, respectively) and inadequate ventilation (15 cases and 16 cases, respectively), with a further three displaced LMAs occurring. This study uniquely highlighted how often airway devices can change with the same patient, and the differing reasons behind why devices were substituted (29).

Two studies occurred in Asian countries with basic life support ambulance services and limited experience with ETI (5,28). The first study from Korea employed propensity score matching to accommodate the different patient group sample sizes. After logistic regression and propensity score-based matched analysis, there was a favourable association between BVM and survival to hospital discharge with comparison to LMA (9.6% and 5.7%, respectively), but not ETI (6.9% and 8.1%, respectively) (5). It was unknown when advanced airway interventions took place during the OHCAs, and whether this had any effect on the results. Similarly, the reasoning for advanced airway interventions is not specified, and considering the large difference in group sizes between BVM, ETI and LMA, there is a potential that the advanced airway devices may have been reserved for more difficult patients (5). The second study from Japan reported no statistical significance in pre-hospital ROSC, survival to hospital discharge or favourable neurological outcome (Table 6) between the BVM and advanced airway groups. The advanced airway group of interventions were also associated with higher overall ROSC, and intensive care unit admission (28).

The nation-wide, prospective observational study from Japan with almost 650,000 patients occurred during January 2005 to December 2010 (1). Japan introduced ETI in 2004, 1 year

Table 6. Pre-hospital SAD, BVM and ETI patient outcomes

Study	Study design	Sample size	P-ROSC			Favourable neurological outcome		
			SAD	ETI	BVM	SAD	ETI	BVM
Hasegawa et al (1)	Prospective, nation-wide, observational	649,359	5.3%	8.4%	7%	1.1%	1%	2.9%
McMullan et al (2)	Secondary analysis of CARES registry	10,691	25,5%	33.8%	36.5%	5.2%	5.4%	18.6%
Shin et al (5)	Retrospective, observational cohort	5,278	NA	NA	NA	NA	NA	NA
Chien et al (27)	Before-and-after controlled	398	47.6%	NA	36%	NA	NA	NA
Nagao et al (28)	Retrospective observational	355	4%	NA	1.9%	1.5%	NA	1.5%

Legend: P-ROSC = pre-hospital return of spontaneous circulation, SAD = supraglottic airway device, ETI = endotracheal intubation, BVM = bag-valve mask, RG = regurgitation, CARES = Cardiac Arrest Registry to Enhance Survival, NA = not applicable

prior to this study commencing. The primary endpoint was 1-month favourable neurological outcome, and secondary endpoints of pre-hospital ROSC (Table 6) and 1-month survival. Bag valve mask was associated with a favourable neurological outcome compared to the advanced airway group. Twenty-seven percent of patients in OHCA were from non-cardiac causes (respiratory and cerebrovascular disease, and cancer); a further 18% were caused by trauma, hanging, drowning, intoxication or asphyxia (1). The secondary analysis of the Cardiac Arrest Registry to Enhance Survival (CARES) registry study (2) also yielded similar results to the Japan study (1), however with a much larger association. No advanced airway in comparison with SAD and ETI in this study reported a greater association with sustained ROSC (Table 6), survival to hospital admission and discharge and, notably, hospital discharge with good neurological outcome. Such large associations – unseen in other large studies – highlights the presence of confounders that are unmeasured or immeasurable, as mentioned by the authors. All remaining studies shared the similar limitation of potential self-reporting bias.

Discussion

We conducted a review of SAD use during OHCAs. For simplicity, the discussion has been focussed into device outcomes and patient outcomes, as these outcomes are inherently different from each other and are often studied in isolation.

The results from the SAD outcomes cannot determine which SAD is best for OHCAs, however they do collectively report that second-generation devices are safe and feasible options as alternative airway devices, even for first responders and particularly in developing EMS systems. Also, second-generation SADs have higher reported insertion success rates in comparison to their first-generation predecessors. Furthermore, all studies that compared the device outcomes of SAD and ETI report higher first attempt and overall success rates for their respective SAD groups (19,21,22).

The results for the patient outcomes section are conflicting, and report associations that are not congruent with the well-known airway management gold standard of ETI, with two large studies reporting more favourable patient outcomes for BVM in comparison to ETI (1,2). In comparison between SADs and BVM, three studies report that BVM ventilation was associated with greater patient outcomes (1,2,5), one study reported favourable patient outcomes were similar between advanced airway and BVM ventilation (28), and two studies reported higher successful ventilation and 24 hour survival rates of SADs over BVM (26,27). The majority of patient outcome focussed studies with large sample sizes originate from Japan or the USA, and to a lesser extent, Korea.

Overall, there are no consistent trends with patient outcomes relating to SADs and other types of airway management. The variances between results highlight common and unique limitations, associated with either the study methodology or the EMS systems themselves. This emphasises the need for a large, international, multi-centre, randomised controlled trial. Although the follow-on study from this literature review does not examine this aspect of airway management, it does however provide a foundation for Australian based research, allowing for future geographical diversity in pre-hospital airway management research.

Upcoming and ongoing trials that are of interest to the researchers include the Pragmatic Airway Resuscitation Trial (PART) based in the USA, and the AIRWAYS-2 trial based in the United Kingdom, both due to their comparative nature between SADs and ETI.

Limitations

The potential for self-reporting bias is difficult to mitigate, and even more so, the unmeasured and immeasurable confounders. It is likely that many of the clinical observational studies within this review, providing comparison between SADs and ETI (or BVM), are intrinsically confounded by the clinicians decision to use a specific airway device influenced by their understanding of the clinical presentation of the patient and potential ongoing need for airway support. Secondary analyses can also potentially influence results as access to all required data may not be possible, which was highlighted in the study by McMullan et al (2) that reported abnormally larger P-ROSC and favourable neurological outcome rates for all types of airway management. Finally, a lack of reporting on the quality and efficiency of external cardiac compressions are rarely documented or controlled.

Conclusion

The majority of research focussing on pre-hospital SAD use has originated in the USA, Germany or Japan, with little originating from Australia. There is a large variance in patient outcome associations and device success rates, particularly between differing geographical areas, emphasising the diversity in EMS systems and immeasurable and unmeasured confounders. Pivotal papers were also subjected to large variances and should be interpreted cautiously. The maturity of each EMS system, operator skill set and training requirements of paramedics must be taken into consideration before implementing any instrumental change.

The lack of pre-hospital focussed research, particularly high quality, randomised controlled trials, makes it impossible to infer what the best airway device is for OHCAs, which may differ between EMS systems. Therefore, we recommend further high quality research in differing geographical locations, as airway management forms a vital element during an OHCA and can contribute to the overall outcomes of patients.

Conflict of interest

The authors declare they have no competing interests. Each author of this paper has completed the ICMJE conflict of interest statement. Gavin Smith is an Associate Editor of the Australasian Journal of Paramedicine.

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