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Prehospital Emergency Care

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ipec20

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To cite this article: John W. Lyng, Kimberly T. Baldino, Darren Braude, Christie Fritz, Juan A. March, Timothy D. Peterson & Allen Yee (2022) Prehospital Supraglottic Airways: An NAEMSP Position Statement and Resource Document, Prehospital Emergency Care, 26:sup1, 32-41, DOI: 10.1080/10903127.2021.1983680

To link to this article: https://doi.org/10.1080/10903127.2021.1983680

Published online: 10 Jan 2022.

Prehospital Supraglottic Airways: An NAEMSP Position Statement and Resource Document

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Abstract

Supraglottic airway (SGA) devices provide effective conduits for oxygenation and ventilation and may offer protection from gastric aspiration. SGA devices are widely used by EMS clinicians as both rescue and primary airway management devices. While in common use for more than four decades, major developments in SGA education, science, and technology have influenced clinical strategies of SGA insertion and use in prehospital airway management for patients of all ages.

NAEMSP recommends:

- SGAs have utility as a primary or secondary EMS airway intervention. EMS agencies should select SGA strategies that best suit available resources and local clinician skillset, as well as the nature of their clinical practice setting.
- EMS agencies that perform endotracheal intubation must also equip their clinicians with SGA devices and ensure adequate training and competence.
- In select situations, drug-assisted airway management may be used by properly credentialed EMS clinicians to facilitate SGA insertion.
- Confirmation of initial and continuous SGA placement using waveform capnography is strongly encouraged as a best practice.
- When it is functioning properly, EMS clinicians should refrain from converting an SGA to an endotracheal tube. The decision to convert an SGA to an endotracheal tube must consider the patient's condition, the effectiveness of SGA ventilations, and the clinical context and course of initial SGA insertion
- SGA training, competency, and clinical use must be continuously evaluated by EMS agencies using focused quality management programs.

Key words: supraglottic airway; RSA; EMS; SGA; airway management

PREHOSPITAL EMERGENCY CARE 2022;26:32–41

Received August 10, 2021 from Department of Emergency Medicine, University of Minnesota School of Medicine, Minneapolis, MN, USA (JWL); National Association of EMS Physicians®, Overland Park, KS, USA (JWL, KTB, DB, CF, JAM, TDP, AY); St Joseph's University Medical Center, Hackensack Meridian School of Medicine, Rowan University School of Osteopathic Medicine, Patterson, NJ, USA (KTB); Departments of Emergency Medicine and Anesthesiology, University of New Mexico, Albuquerque, NM, USA (DB); Beth Israel Deaconess Medical Center EMS Division, Boston, MA, USA (CF); Division of EMS Department of Emergency Medicine Brody School of Medicine, East Carolina University, Greenville, NC, USA (JAM); Southeast Region EMS Council, Sitka, AK; Capital City Fire & Rescue, Juneau, AK; Assistant Clinical Professor, University of New Mexico School of Medicine, Albuquerque, NM, USA (TDP); Chesterfield Fire and EMS, Virginia Commonwealth University Health System, Richmond, VA, USA (AY). Revision received September 7, 2021; accepted for publication September 17, 2021.

Approved by: National Association of EMS Physicians – 20 July 2021

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doi:10.1080/10903127.2021.1983680

Introduction

Supraglottic airways (SGAs) are advanced airway devices intended to be inserted into the oropharynx without the use of laryngoscopy. While varying in design, SGAs are devised to situate in the hypopharyngeal space overlying or outside of the glottic opening, providing indirect oxygen delivery to the trachea. SGAs have also been referred to as "blind insertion," "extraglottic," "periglottic," and "infraglottic" airway devices. While these terms are technically more precise, they are functionally synonymous, and "supraglottic airway" is the more widely used term. While traditionally used as a rescue device after failed intubation attempts, several factors have resulted in increasing use of SGAs in the prehospital setting (1–3).

Utility and Selection of SGAs

SGAs have utility as a primary or secondary EMS airway intervention. EMS agencies should select SGA strategies that best suit available resources and local clinician skillset, as well as the nature of their clinical practice setting.

The decision to use an SGA as a primary or secondary prehospital airway intervention depends on several factors including clinician skills and

opportunities to perform airway interventions. Although older SGAs like the Combitube were developed as primary airway devices, historically paramedics were typically instructed to prioritize use of ETI and only used SGAs as rescue devices. Several studies support use of SGAs as rescue airways in the setting of failed ETI (4, 5).

Over the past decade three factors have helped to shift use of SGAs from a role as rescue devices for failed ETI to a role as the primary airway intervention in the EMS setting: 1) newer, functionally superior devices (King LTS-D, i-gel, and various LMAs), 2) better recognition of the pitfalls of ETI in the EMS setting, and 3) several randomized controlled trials that demonstrated better outcomes and faster processes of care with SGA over ETI in out-of-hospital cardiac arrest (OHCA).

There is mixed evidence that using SGAs may be more easily and rapidly placed than ETTs (6, 7). In contrast to Frascone et al. who found no difference in success rate or time to insertion when comparing the King LTS-D to ETI, Russi et al. identified that placement of a Combitube is faster than ETI (8, 9). The ease and speed of SGA insertion is likely dependent on features of the device and the competency of the EMS clinician as shown by Russi et al. who showed that insertion of a Combitube is slower than that of a single lumen SGA and by March et al. who showed that i-gel insertion was faster than the King LT (8, 10). Studies by Jarvis et al., Bernhard et al., and Middleton et al. have also shown that the success of SGA placement, including both first-pass and overall success rates, varies between different SGA devices (11–13). Though these studies suggest that various device-specific factors may affect training needs and successful use, no studies have demonstrated the superiority of any particular SGA device.

Factors that may influence EMS agency use and selection of SGAs include the skillset and scope of practice of the clinicians (e.g., ALS vs BLS); whether the clinicians also perform ETI, including how often and how well they perform it; integration with neighboring first responder, rescue, and transport agencies; whether the clinicians can perform drug-assisted airway management; and whether the agency intends for SGAs to be used as a primary or secondary airway.

SGAs and EMS Clinician Scope of Practice

In the United States, the *NHTSA 2019 National EMS Scope of Practice Model* establishes insertion of SGAs as one of the minimum competencies for Advanced EMT (AEMT) and Paramedic level clinicians. However, the guidelines exclude use of SGAs as a minimum competency from Emergency Medical Technician (EMT) and Emergency Medical Responder (EMR) practice (14). This decision was based on concerns regarding added time and expense of educating EMTs and EMRs in SGA use and in the technology needed to ensure appropriate SGA placement and function. However, the *National Scope of Practice Model* defines the minimum competencies, not the highest-permitted skillset for each clinician type. In fact, several studies have demonstrated successful use of SGAs by basic-level clinicians and use of SGAs by EMTs and EMRs might be reasonable if certain conditions are met (15–19).

Patients who might be appropriate for use of an SGA by a BLS clinician include OHCA patients and patients who are severely obtunded by severe head trauma or severe sedative-hypnotic toxicity. Other patients may require use of drug-assisted airway management by ALS clinicians to facilitate placement of an SGA. It must be recognized, though, that training and use of SGAs cannot substitute for training and competent use of bag-valve-mask ventilation by all types of EMS clinicians (15).

The decision to include or exclude SGA use ultimately falls upon more local levels of EMS governance. Several states, regional EMS authorities, and local EMS agencies have included SGAs within EMR and EMT scope of practice. Outside the U.S. SGAs are included as a minimum competency for basic level EMS clinicians though their use by such clinicians is predicated on use of end-tidal capnography to confirm device placement (20, 21).

Availability of SGA Devices

EMS agencies that perform endotracheal intubation must also equip their clinicians with SGA devices and ensure adequate training and competence.

EMS ETI success rates range from 53% to 90%, indicating that a substantial portion of cases will require management with rescue airway interventions (22–25). Though all EMS clinicians should be facile with manual ventilation using a bag-valve-mask device, there are circumstances where BVM use may prove difficult (26). Historically some EMS agencies have also used surgical airway techniques as a backup strategy for failed ETI; however, these are difficult to perform, even for the most experienced clinicians. Many studies have described

successful use of SGAs after failed ETI, and SGAs are recommended as rescue devices for failed ETI by several organizations (4, 22, 23, 27).

Use of SGAs should be protocolized and integrated with ETI strategies, such as in the algorithmic approach to airway management suggested by Wang et al. (28). Planning for failed intubation, including ensuring availability of both BVM ventilation and supraglottic airways, should always be part of the pre-intubation briefing. Further, a 2020 joint organizational position statement regarding essential equipment for ground BLS and ALS ambulances recommends that ALS ambulances should be stocked with supraglottic airways in sizes to fit neonates to adults (29).

Drug Assisted SGA Insertion

In select situations, drug assisted airway management may be used by properly credentialed EMS clinicians to facilitate SGA insertion.

Drug-assisted airway management, which includes more commonly known rapid sequence intubation (RSI), also includes Rapid Sequence Airway (RSA), the concept of using sedative and paralytic medications to facilitate SGA insertion by ALS clinicians. Series reported by Frascone and Braude affirm the safety and effectiveness of RSA (30–33). The most recent and largest case series published by Braude et al. reported a success rate of 94% and aspiration rates equivalent to other methods of emergency airway management (33). The potential ease and speed of SGA insertion vs ETI may make it easier to achieve first-pass success with RSA than RSI and may help reduce hypoxemia and airway trauma associated with prolonged and repeated intubation attempts (34).

The potential disadvantages of RSA include more difficult ventilation via an SGA if high airway pressures are required, inability to access the airway reliably for suction, and perceptions that SGAs are less effective in protecting against aspiration than endotracheal tubes. The risk of aspiration with SGA is lower than previously thought. Several studies suggest that if aspiration occurs it likely happens before invasive airway placement rather than during or following insertion (35–41). Second-generation SGAs with gastric aspiration lumens allow for evacuation of gastric contents, further reducing the risk for aspiration. The need for an Emergency Department (ED) exchange of the SGA to an endotracheal tube has also been suggested as a disadvantage of RSA; however, the controlled exchange to an ETT in the ED setting is likely not a major risk to the patient.

Prior to embarking on RSA, EMS clinicians should assess for risk factors of unsuccessful SGA placement and ALS clinicians should plan for potential failed RSA attempt by preparing for manual ventilation, ETI, or surgical airway procedures if a can't intubate/can't ventilate situation develops (42). Though RSI and RSA are used in nearly identical patient populations and clinical environments, there are no published direct comparisons of RSA and RSI strategies in the EMS setting. More research comparing RSA with RSI and other EMS-based drug-assisted airway management strategies is necessary to further describe the utility of this approach in the EMS setting and to define its effects on patient outcomes.

Confirmation of SGA Placement

Confirmation of initial and continuous SGA placement using waveform capnography is strongly encouraged as a best practice.

Extensive data inform the requirement for independent confirmation of ETT placement using waveform capnography and other subjective and objective measures of successful placement (43–45). Despite this emphasis on ETT confirmation, and possibly because of the simplicity of most SGA insertion techniques, many programs have placed relatively little attention on confirmation of SGA placement. However, emerging case reports and series highlight the pitfalls of SGA placement, including airway malposition or misplacement (1, 46, 47). Though initial confirmation of device location is important SGA dislodgement after initial successful placement is possible. These considerations motivate the recommendation for SGA placement confirmation both immediately after insertion and on a continuing basis.

Common methods for confirming SGA placement include auscultation of breath sounds, visualization of chest rise, and observation for presence of exhaled condensation in the lumen of the SGA, though these techniques vary in reliability and availability. Waveform capnography represents the most reliable method to confirm initial and ongoing placement of advanced airways and is recommended as a best practice for SGAs. Vithalani et al. were the first to use capnography to objectively describe the incidence of unrecognized misplaced supraglottic airways in the EMS setting. They identified a two-fold problem when subjective means of placement confirmation were used in isolation by clinicians: failed recognition of misplaced SGAs in

35% of cases, and unnecessary removal of properly placed SGAs in 1.5% of cases. Use of capnography would have helped correctly identify SGA placement in both of these situations. Though this study's findings are limited to a single EMS agency and evaluation of a single SGA device, the study highlights the importance of using objective measurements to confirm initial and ongoing SGA placement (1).

An important issue with requiring capnography to confirm SGA placement is that though both ALS and BLS clinicians may use SGAs, typically only ALS clinicians are trained in $ETCO_2$ interpretation and use. BLS clinicians who are inserting SGAs should ideally use waveform capnography for initial and ongoing airway placement confirmation, however lack of resources to train BLS clinicians to interpret waveform capnography as well as lack of funding to purchase waveform capnography equipment are barriers to adoption of this practice. In cases where waveform capnography is not included in local EMR or EMT scope of care, we recommend that BLS clinicians cautiously use alternative methods to assess SGA placement.

While recommended by some experts, colorimetric end-tidal carbon dioxide detection is unreliable for confirming SGA placement. First, it is possible to qualitatively detect enough residual carbon dioxide through an SGA to result in a "positive" colorimetric result even when the position of the device is suboptimal. Second, colorimetric $EtCO_2$ devices can give false-positive results in some settings and are not reliable if they become contaminated with liquids (48–50). Therefore, qualitative colorimetric $EtCO_2$ detection should not be used in isolation to assess the proper position and function of an SGA on either an initial or ongoing basis. The use of devices that provide continuous quantitative capnometry may help avoid these pitfalls of colorimetric devices, though there are no focused studies on use of such technology by BLS clinicians.

Although pulse oximetry is typically accessible to both BLS and ALS clinicians, determination of SGA placement should be based on assessment of adequate ventilation, not oxygen saturation. Poor oxygenation in the setting of adequate ventilation through an SGA usually indicates a failed oxygen supply or respiratory pathology resulting in a shunt, V/Q mismatch, or disordered diffusion, not dysfunction of the SGA itself. Additionally, pulse oximetry is limited by a significant lag-time between onset of inadequate ventilation and drops in pulse oximetry values (51–54). Also, failure to recognize that an SGA may be properly placed and providing appropriate ventilation despite low pulse oximetry values may lead to premature removal of a functioning invasive airway (55).

Ideally proper SGA placement is determined by any EMS clinician by using waveform capnography in addition to assessment for effective chest rise, presence of symmetric lungs sounds, and absent signs of major air leakage (56).

Conversion of an SGA to an ETT

When it is functioning properly, EMS clinicians should refrain from converting an SGA to an endotracheal tube. The decision to convert an SGA to an ET tube must consider the patient's condition, the effectiveness of SGA ventilations, and the clinical context and course of initial SGA insertion.

If functioning properly, prehospital SGAs should not be exchanged for an ET tube in the prehospital setting. If an SGA is not properly ventilating and the function of the SGA cannot be improved via immediate troubleshooting the EMS clinician should remove the SGA and begin manual ventilation using a bag-valve-mask. In very rare circumstances exchange of a SGA for an ETT may be considered.

Clinical scenarios that might favor exchange include the need for high ventilation pressures, the need for tracheal suctioning, presence of copious oropharyngeal secretions, bleeding, or emesis, and anticipated swelling below the level of the SGA that might eventually render it ineffective for ventilation. While SGAs have been associated with significant airway swelling after prolonged placement, development of this complication typically requires several hours and prolonged transport is rarely an indication for SGA exchange. Complications related to duration of SGA placement have been reported by Gaither et al. for the King LT at 3 hours and by Gerstein et al. for the LMA-Fastrach at 5 hours. Braude et al. reported there were no complications associated with an LMA-Supreme SGA being left in place for 9 hours (57–59).

Any clinician considering SGA-ETT exchange should first determine why the SGA was originally placed. This is especially true if an SGA was placed as a rescue device after failed ETI attempts because if the patient underwent multiple unsuccessful intubation attempts, additional intubation attempts will likely be unsuccessful (23).

Regardless of the clinical setting, if an SGA-ETT exchange is determined to be necessary, clinicians

considering exchange should assess for potential difficulty in mask ventilation, intubation, or challenging surgical airway access in case exchange attempts fail (60–65). Further, the procedure should be tailored to the patient condition, clinician experience, available tools, and the specific SGA in situ. Inappropriately or prematurely performing an SGA-ETT exchange while a patient is hypoxic may result in further desaturation and anoxic injury or cardiac arrest. Prior to exchange clinicians should maximize patient oxygenation, decompress the stomach, consider use of drug-assisted airway management, and prepare contingency airway management plans.

Depending on the type of SGA being exchanged, several general approaches can be used including extraluminal, endoluminal, and bougie-assisted blind techniques, Exchange of an SGA via an extraluminal approach by displacing or removing the SGA and performing intubation via direct or video laryngoscopy may result in inadvertent loss of airway control. One endoluminal approach includes use of a fiberoptic bronchoscope and is best suited for exchanging most LMA-style SGAs, however this technology is not typically available in the prehospital setting (66, 67). Endoluminal bougie-assisted blind exchange has been described for the King LT, i-gel, and LMA-style SGAs, though use bougie-exchange of the King LT is discouraged due to significant risk for airway perforation (68–72). Blind direct passage of an endotracheal tube has been described for two devices, with success rates ranging from 15% to 90% (73–76). These techniques have been further well-described by Braude et al. and Driver et al. (56, 77).

SGA Training and Clinical Use

SGA training, competency, and clinical use must be continuously evaluated by EMS agencies using focused quality management programs.

Supraglottic airway use is a low-frequency, high risk intervention that should be subject to the same rigorous quality management practices that are used to oversee endotracheal intubation in the EMS setting, including use of high-quality training sessions and focused application of quality management programs to help reduce risk and improve patient outcomes. SGA quality management programs must ensure that clinicians receive appropriate training, that they are periodically assessed for their cognitive, psychomotor, and affective competencies related to SGA use, and that clinical use is providing appropriate patient benefit while minimizing patient harms. The principles of prehospital airway management training and education and quality management of prehospital airway programs, including pediatric-focused topics, are discussed in companion documents to this manuscript, but certain SGA-specific concepts deserve further discussion.

Training and Competency. In order to safely and correctly utilize an SGA an EMS clinician must first demonstrate competency in several domains. These include the cognitive domain pertaining to recognition of SGA indications, contraindications, and complications; and the psychomotor domain pertaining to delivery of oxygen via nasal cannulas and facemasks, manual bag-valve-mask ventilation, oro/nasopharyngeal airway placement, and upper airway suctioning.

A number of studies have investigated the ability of EMS clinicians to perform SGA insertion, though many of these studies are limited to manikin-based training encounters (78–86). Notably, not all training manikins are alike, as some models are easier or harder for SGA insertion depending on the make/model of SGA being used (87). Further, successful SGA placement in a manikin may not translate to successful use on actual patients. A few studies have evaluated insertion of various SGA devices by different EMS clinicians on anesthetized patients in the operating room, however access to such clinical settings for purposes of EMS clinician training has become increasingly limited (12, 88, 89).

Training in the use of SGAs requires more than developing a psychomotor skill. EMS clinicians must also receive education in cognitive and critical thinking domains including knowledge of indications and contraindications for SGA use as defined in local protocol, recognition of and mitigation strategies for SGA malfunctions, and awareness of potential complications related to SGA use. Competency in less-invasive airway management strategies must also be demonstrated as entry-level proficiencies prior to embarking on SGA education and clinical use. Unfortunately published studies have typically focused only on the psychomotor component of SGA insertion in artificial environments and also have not assessed EMS clinician cognitive aptitudes pertaining to SGA use. This makes it difficult to extrapolate whether these studies support whether clinicians can perform SGA insertion in actual clinical practice. Further, attrition of cognitive knowledge and decay of psychomotor skill are significant issues that affect the successful use of

SGAs by EMS clinicians. However, studies by Fischer et al., Ruetzler et al., and Maddocks have shown that rates of skill decay may be affected by which type of SGA is being used and may be slower than decay of ETI skills (90–92).

Complications Associated with SGAs. In addition to establishing robust training and monitoring performance of EMS clinicians in successfully inserting SGAs, quality management programs should also maintain surveillance for potential complications of SGA use. A case series by Bernhard et al. describes several complications associated with King-style SGAs including airway obstruction due to inadvertent tracheal intubation, massive tongue and pharyngeal edema, air-leak associated hypoventilation, and device obstruction by foreign material (93). Other case reports of SGA-related injuries occurring in the prehospital and surgical settings include hypopharyngeal perforation, pneumomediastinum, subcutaneous emphysema, pneumoperitoneum, pneumothorax, upper airway bleeding, esophageal laceration or perforation, and pressure-related tissue injuries of the tongue, pharynx, and hypopharyngeal structures. (47, 94–98). Notably the Combitube has been shown to have up to a 40% complication rate (95–98).

One other important concern related to SGAs is the potential to impair cerebral blood flow. Two swine studies by Segal et al. and Kim et al. that measured carotid artery blood flow during induced cardiac arrest found that the King LTS-D, LMA, Combitube, and i-gel SGAs each significantly reduced carotid blood flow relative to the ETT (99, 100). However, several human studies evaluating the effect of SGAs on the cervical vasculature and blood flow have shown mixed results. Radiographic studies of SGAs by Niell et al. (MRI), and White et al. (CT scans) found no significant compression of the internal carotid artery. (101, 102). In several device-specific studies, Rasulo et al. (LMA-Unique) did not demonstrate significant reductions in cerebral blood flow, Eismann et al. (King LTS-D and LMA) showed no impairment of internal carotid artery blood flow, and Nandwani et al. (LMA) found no evidence that either the carotid artery or the internal jugular vein was compressed significantly (103–105). In contrast, Colbert et al. and Zhang et al. showed several different SGAs caused anatomic displacement of the cervical vessels and reduced the velocity of blood flow through them (106, 107). The variable findings of these studies suggest that the effect of SGAs on blood flow through the cervical vessels may be influenced by the design of the SGA (e.g., cuffed vs uncuffed) as well as individual patient-specific factors. Unfortunately, this body of evidence only informs our understanding of the effect of SGAs on the cervical vessels and blood flow in hemodynamically stable patients, not on patients with low flow states such as shock or cardiac arrest. There is a significant need for prospective evaluation of cerebral perfusion in both hemodynamically stable and unstable patients whose airways are managed with SGAs.

Patient Outcomes. Medical directors should understand how SGA use may impact clinical outcomes of different patient populations and use this understanding when developing SGA-related protocols.

Cardiac Arrest. Studies by Abo, Wang, and others have shown significantly shorter interruptions in chest compressions during OHCA resuscitation when airways were managed with SGAs compared to ETTs (82, 108). Further, the Pragmatic Airway Resuscitation Trial (PART) by Wang et al. demonstrated that 72-hour survival was greater in patients receiving SGAs compared to ETTs (109). Secondary outcomes from PART also found increased rates of return of spontaneous circulation, hospital survival, and favorable neurologic exam with SGA management. However, a subsequent systematic review performed by Carney et al. showed no difference in outcomes when comparing bag-valve-mask manual ventilation, SGAs, and ETT use in OHCA patients (34). Yet another study by Benger et al. also failed to show a survival benefit in OHCA when comparing use of the i-gel SGA to ETI (110). Finally, the AIRWAYS-2 trial by Benger et al. did not identify a more favorable 30-day functional outcome for SGAs vs ETI in OHCA (110).

Trauma. Limited studies regarding use of SGAs in the trauma setting have shown potential associations of SGA use with worse patient outcomes, though it is unclear whether this is a reflection of the severity of patient injuries or if there is a more direct connection between outcomes and SGA use (111, 112).

Future Research

Future research should attempt to identify which, if any, SGA devices are easiest to use by all levels of EMS clinician, and more importantly, whether any SGA device is superior to others with respect to positively affecting patient outcomes. Research is also needed to help identify techniques to assess SGA function and placement that are accessible to all levels of EMS clinician. Further, studies

investigating the best methods for exchanging SGAs for ETTs in the emergency department should also be conducted. Finally, there is a critical need for prospective research regarding the safety of SGAs in the EMS setting, especially their effect on cerebral blood flow in low-flow states such as shock and cardiac arrest.

CONCLUSION

In summary, SGAs can be used as a reasonable alternative to ETT by ALS clinicians and may expand the ability of BLS clinicians to perform better ventilation and oxygenation of certain patients. However, data regarding patient-based outcomes of SGAs compared to use of a bag-valve-mask or ETT remains mixed, and optimal SGA utilization strategies have yet to be fully defined.

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