The Supraglottic Airway Device: Its Role as an Intubating Conduit

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The authors reported no relevant financial disclosures.

The reasons for acceptance of the FOB-SAD airway rescue method as a viable and worthy choice in the OR and NORA settings are clear.

Introduction

In 1981, Archie Brain invented the first supraglottic airway device (SAD), which now is referred to as the LMA Classic (cLMA, Teleflex). The prototype device was crafted with a Goldman nasal mask fused with an obliquely cut endotracheal tube (ETT).[1] Dr. Brain's main objective for inventing the SAD was to have a device that would improve the airway manager's ability to maintain a patient's airway as compared with a face mask.[2]

The first laryngeal mask (LM) airway was fashioned from plaster casts of a cadaver's pharynx coupled with a 10-mm tube that was inserted into the cast. The Dunlop Rubber Company worked with Dr. Brain to develop the silicone mask component. Eventually, epiglottic bars were added to the mask–tube interface to prevent the epiglottis from obstructing the airway. The FDA approved the use of the SAD in 1991.[3]

Over the years, the cLMA has been altered by several clever design adaptations, leading to a multitude of SADs (cLMA, LMA Flexible, LMA Fastrach intubating, LMA Flexible and LMA ProSeal, both reusable and disposable [LMA Supreme] models, all by Teleflex. Moreover, other manufacturers have produced differing SADs to meet a variety of needs.

The original cLMA is now considered a first-generation SAD (1st-gen SAD) for its simplistic design (simple airway tube with a cuff). Recently introduced SADs

have characteristics that improve their performance over the cLMA with the potential benefit of improved patient safety by attention to difficult SAD insertion, portal access to remove esophageal and gastric contents, and cuff–pharyngeal wall occlusion limitations.[4-6]

The design improvements in these second-generation SADs (2nd-gen SAD) would likely benefit the elective OR population, plus potentially improve the safety margin for use in emergent/urgent rescue deployment, particularly in the nonfasted, critically ill patient in non–operating room airway (NORA) management encounters.

Many 2nd-gen SAD models now outperform the 1st-gen devices with the aim to improve patient care by providing 1) built-in bite block construction to reduce airway occlusion, 2) improved cuff design to boost pharyngeal occlusion seal pressures to enhance ventilation at higher airway pressures, 3) improved cricopharyngeal/esophageal sealing to potentially lower the likelihood of regurgitated matter entering the upper airway, and 4) access to the gastrointestinal tract, with the potential of advancing a smaller-caliber suction tube or Salem Sump equivalent to evacuate the esophagus and/or stomach of its liquid contents, and potentially allow gastric contents to passively exit via the portal (Table 1).[4]

SADs have long held a prominent position in airway algorithms around the world for their rescue oxygenation and ventilation capabilities, with the crossover ability to be employed as an intubation conduit, either blindly—for example, with the Fastrach intubating LMA (ILMA), air-Q (Cookgas), or Aura-i (Ambu)—or with the assistance of a fiber-optic bronchoscope (FOB).[7-10]

Moreover, the SAD may be used electively or emergently in the known or suspected difficult airway (DA) or in the unrecognized DA patient. Topical local anesthesia airway preparation can support awake SAD placement to provide an intubation conduit, either blindly or FOB-assisted. Conversely, the SAD serves a prominent role in the emergency airway algorithm, whereby a SAD may be used as a conduit for emergency rescue ventilation and/or intubation.

Table 1. Features of Ideal Second-Generation SADs

Built-in bite block to reduce airway occlusion
Improved pharyngeal occlusion seal pressures
Improved seal to lower risk for regurgitated material entering the airway
Portal access to GI tract for catheter advancement to remove contents
Portal to passively allow liquid GI contents to exit
Optimal centered position and angle of cuff bowl to optimize visualization and access for FOB
Widened and shortened airway tube to optimize SAD-assisted intubation

FOB, fiber-optic bronchoscope; **SAD,** supraglottic airway device

The cLMA was originally conceived as a general airway device but is now considered to have an established role in DA management. LM airways have a long clinical record of successful use in DAs, in both adults and children.

As before, the usefulness of the LM airway is predominantly due to the ease and reliability with which it can be inserted. This insertion is usually accomplished on the first attempt and tissue trauma tends to be minimal. Regarding its position in the hypopharynx and air exchange, the LM airway is forgiving as it affords effective air exchange even when it is displaced laterally or off center. Its final position, barring pharyngeal or laryngeal distortion or pathology, however, is important to optimally view the laryngeal structures for patency and access.

The LM airway serves in five prominent roles in the ASA Difficult Airway algorithm, and includes:

1. the awake intubation limb of the algorithm as a conduit for fiber-optic intubation,
2. the nonemergency pathway, as a ventilatory assistance device,
3. as a conduit for elective fiber-optic intubation after induction,
4. the emergency pathway, as both a ventilatory device and
5. as a conduit for rescue fiber-optic–assisted tracheal intubation.[11]

Role of the SAD as an Emergency Rescue Device

The role the SAD plays in general anesthesia is impressive. Its adaptation in its role for emergency situations in the OR, NORA sites—for example, radiology, cardiac catheterization suite as well as for urgent/emergent NORA management on the hospital floor, ICU or emergency department—and outside the hospital has saved tens of thousands of lives.

Regardless of the location of its use, in situations where it is difficult or impossible to ventilate or intubate via direct or indirect means (video-assisted laryngoscopy [VL] or FOB), a SAD may offer rescue oxygenation and ventilation to allow time to stabilize the patient, gather other personnel, acquire and set up additional advanced airway equipment or to allow a controlled awakening, if possible or appropriate.

If SAD-supported ventilation is successful, there are five options recommended by published airway guidelines and schema (Table 2).[11-20] The focus of this article, however, is to review the SAD and its subsequent role as a conduit for intubation.

Taking advantage of the SAD position in the hypopharynx with the tip of the SAD abutting the cricopharyngeus muscle in most insertions, a lubricated FOB

may be inserted down the airway tube of the SAD to inspect access to the airway, its overall condition and patency. The epiglottis may sit on the epiglottic bars of the LMA airway but may be manipulated via SAD adjustment or bypassed by the advancing FOB.[5] Most often, the periglottic structures are recognizable, barring pathology, distortion, secretions and edema.

Suction clearance of secretions may be performed by the FOB or by passing a flexible 12 Fr/14 Fr suction catheter down the lumen of the airway tube. Further, the glottic opening is typically partially or fully visible, often depending on preexisting airway conditions and any subsequent alteration, disruption, injury or damage inflicted by the preceding airway manipulations. In fact, such inflicted periglottic damage and any subsequent damage—for example, from swelling, bleeding, edema or distortion—appears unpredictable since some airways are resilient while others worsen rapidly. Thus, most societal airway schemas recommend minimizing intubation attempts and supporting early deployment of the SAD.

If the airway has preexisting edema and swelling or its presence is the result of airway manipulation, establishing a "closed system" between the SAD and reservoir ventilation bag may be appropriate.

Placing a bronchoscopic adapter in-line (self-sealing diaphragm of the adapter affords FOB passage) will allow the application of positive pressure ventilation and may assist the airway team in two potentially dramatic ways: 1) ongoing oxygen delivery during intubation attempts, and 2) pressure-based lateralization of airway tissues to improve viewing of the glottic opening.

When placing the SAD with the intention to secure the airway via intubation, the airway team has several options (Table 3). Some are established methods (FOB-ETT, FOB-AIC [Aintree Intubation Catheter, Cook Medical], ILMA) while other creative methods appear less popular (FOB-assisted bougie passage, FOB-guide wire passage). All are possible yet vary by the number of steps, equipment requirements, maneuvers and practitioner's skill set. Blind ETT advancement via the cLMA and its equivalent SAD have an unsatisfactory success rate, and is not recommended.

Conversely, the LMA intubating Fastrach or its equivalent has an impressive track record of being highly successful for both rescue ventilation and blind ETT insertion as well as FOB-assisted intubation (60%-90% success on first attempt, >94% within three attempts) in the OR and NORA settings.[7,9,10]

Despite this impressive record, FOB-SAD–assisted intubation is the recommended method of the Difficult Airway Society (U.K.) and others.[12-14,21] This report will focus on fiber-optically guided tracheal intubation via the SAD, with emphasis on 1) FOB-assisted advancement of a proper caliber and length ETT via the SAD (FOB-ETT), and 2) the FOB-AIC for intubation assistance.[21]

Caveats regarding each technique are useful to comprehend and practice prior to their deployment in an urgent/emergent intervention. Table 4 lists some of the drawbacks and obstacles for FOB-SAD–assisted intubations.

If SAD-assisted intubation does fail, ongoing SAD-assisted ventilation/oxygenation may provide lifesaving support when facing the creation of a surgical FONA airway.[14,21]

Consideration for advancing an ETT via the SAD relies on being familiar with the SAD airway tube diameter, the ETT's external diameter and the overall ETT length.[22] Simply grabbing an ETT and a SAD may result in likely failure. For example, the airway tube diameter of the cLMA varies by the LMA size (3 and 4 vs. 5) (Figure 1). The small luminal internal diameter (ID) of

Table 2. Options Following Successful SAD Ventilation

1. **Continue airway management with the SAD (applicable in OR setting for low-risk circumstances)**
2. **Tracheal intubation via the SAD (FOB assistance preferred, blind)**
3. **Wake up patient if clinically appropriate or possible**
4. **Proceed to establish airway access surgically (FONA)**
5. **"Bridge" prior to attempting advanced adjunct intubation (if not previously attempted, e.g., VL)**

FOB, fiber-optic bronchoscope; **FONA,** front-of-neck access; **SAD,** supraglottic airway device; **VL,** video laryngoscope

Table 3. SAD-Assisted Tracheal Intubation

FOB-ETT
FOB-AIC
Blind intubation (e.g., with ILMA)
Trach light/light wand–assisted via SAD
FOB-wire with or without airway catheter (over wire)
FOB-assisted passage of bougie or NGT via SAD
Retrograde wire-FOB combination via SAD
Surgical airway with SAD in situ

AIC, Aintree intubation catheter; **ETT,** endotracheal tube; **FOB,** fiber-optic bronchoscope; **ILMA,** intubating laryngeal mask airway; **NGT,** nasogastric tube; **SAD,** supraglottic airway device

Table 4. Limitations and Other Factors Affecting SAD-Assisted Intubation

Angle of approach (cuff-airway tube in relation to periglottic structures)
Airway tube diameter/length influencing ETT choice (e.g., cLMA vs. ILMA vs. i-gel)
Occlusion cuff pressure threshold (1st-gen vs. 2nd-gen models)
Multiple methods: blind, FOB, FOB-AIC, FOB + bougie, FOB + wire, FOB + wire + catheter
Multipart SAD construction→obstacles/ridges in airway tube-cuff pathway (cLMA, SLMA)
Secretions, edema, swelling, distortion, airway tissues misaligned by cuff abutment
Insufficient lubrication of any component: AIC, FOB or ETT
SAD malposition (ineffective ventilation, suboptimal view)
Ensure rapid access to airway adjuncts in OR and NORA management settings
"Easy concept" yet requires training and competence to implement successfully
Distal FOB tip curvature→impede AIC advancement and/or damage FOB's outer jacket cover

AIC, Aintree intubating catheter; **cLMA,** LMA Classic; **ETT,** endotracheal tube; **FOB,** fiber-optic bronchoscope; **ILMA,** intubating laryngeal mask airway; **NORA,** non–OR airway; **SAD,** supraglottic airway device

Figure 1. Standard 7.0-mm ETT in a size 5 cLMA.

Note the shallow distal tip/cuff available for securing the airway. Final resting position of the ETT likely would place the cuff between or above the glottic opening.

cLMA, LMA Classic; **ETT,** endotracheal tube

All photos courtesy of the author.

the LM airway tube, for example, size 3 or 4, prevents an adult full-sized ETT (≥7.0 mm) from passing.

Although it is commonly cited that a standard 7.0-mm ETT can be paired with the size 5 LM airway, it remains a tight fit, cuff damage may accompany passage and the available length of the distal cuff-tip is suboptimal (Figure 1).

Moreover, the length of the standard ETT may be too short to reach mid-trachea.[22] This is especially true for the smaller-caliber ETT, for example, 6.0 mm (31.5 cm

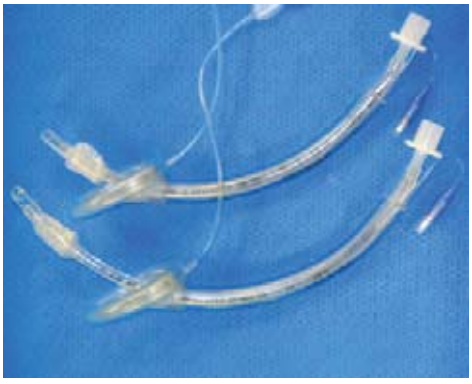

Figure 2. Standard versus MLT ETT.

Standard 6.0-mm ETT (top) versus the Mallinckrodt MLT (6.0-mm, bottom) ETT in a size 4 cLMA. Note difference in length, allowing distal ETT advancement into the trachea with the MLT ETT via FOB-assisted LMA intubation.

cLMA, LMA Classic; **ETT,** endotracheal tube; **FOB,** fiber-optic bronchoscope; **MLT,** microlaryngeal tube

Table 5. Length of ETT Beyond Airway Tube Opening[a]

SAD, Size	Standard 6.0 ETT, cm	Standard 7.0 mm ETT, cm	MLT 6.0 ETT, cm
i-gel 3	11.2	12.5	15
i-gel 4	11.2	12.5	14.5
i-gel 5	9.5	11	13.5
cLMA 3	10	–	14.5
cLMA 4	9	–	13
cLMA 5	7	9	11

[a] Approximate length of ETT past LMA grill bars and i-gel airway tube–bowl junction.

The "best" length of ETT that protrudes beyond the airway tube opening will be influenced by the patient's height, depth of SAD seating in the hypopharynx and neck length (orohypopharyngeal to mid-trachea corridor). To minimize the risk for ETT cuff positioning just at or below the glottis, the length of ETT protrusion is likely >9 cm.

cLMA, LMA Classic; **ETT,** endotracheal tube

from tip to end of 15-mm adapter) versus standard 7.0 mm (33 cm). Thus, in pairing the FOB and ETT, one must be cognizant of the SAD's size (airway tube diameter, hence cross-sectional area) and its length. This is particularly true of the length of the standard 6.0- or 6.5-mm ETT. Their maximal depth of ETT passage via the cLMA may only allow advancement to the point the cuff is just past the glottis or within the glottic opening.[22]

The final depth of the ETT tip-cuff will be influenced by several factors: 1) SAD airway tube diameter, 2) SAD airway tube length, 3) ETT size and model, 4) patient's height, and 5) length of the orohypopharyngeal to mid-tracheal corridor (Figure 2). The length of ETT protruding from the SAD's cuff bowl should be maximized. Several factors affect proper placement, but a length more than 9 to 10 cm of exposed ETT should be a minimum (Table 5).

The length of the i-gel airway tube varies by its size (3 vs. 4 vs. 5), yet is several centimeters shorter than its cLMA counterpart. Having access to a variety of ETT sizes for an elective intervention is convenient but may lead to confusion and delay in an airway emergency. Therefore, ensuring rapid access to an ETT with a diameter and length that may be universally used is more efficient and timely in the acute setting.

A valuable option would be the size 6.0 MLT, which is 4 cm longer than a comparable 6.0-mm ETT. This ETT should be stocked with the SAD in the DA cart for rapid accessibility (Table 5; Figures 3-5).

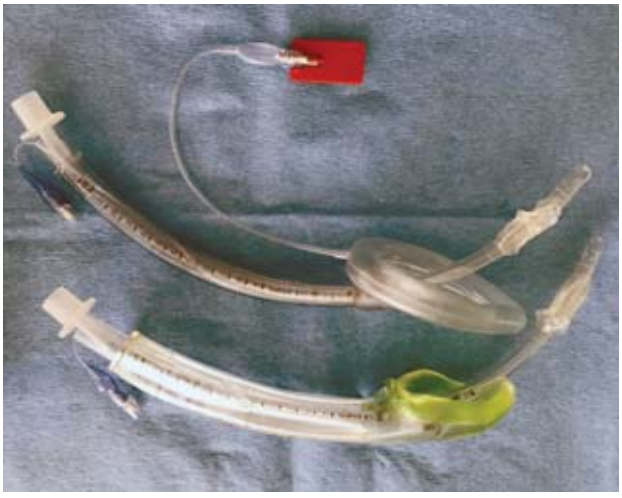

Figure 3.

The 6.0-mm MLT ETT placed in a size 5 cLMA (top) and size 5 i-gel (bottom). The extended length (4 cm) of the MLT ETT provides the needed length to afford cuff-tip advancement toward the mid-trachea region.

cLMA, LMA Classic; **ETT,** endotracheal tube; **MLT,** microlaryngeal tube

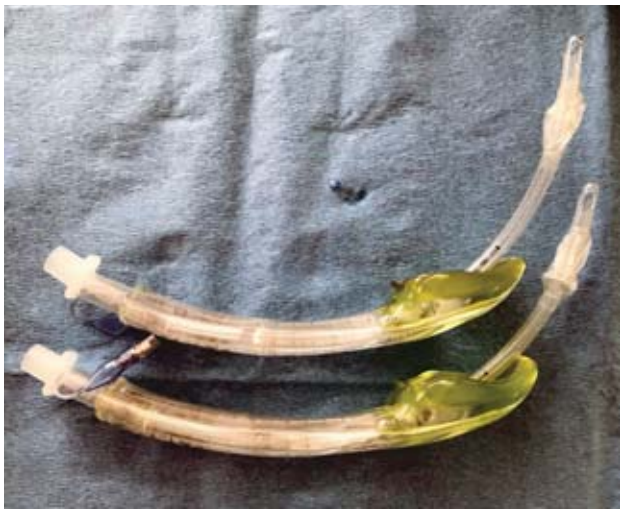

Figure 4.

Microlaryngeal tube (6.0 mm) in a size 4 i-gel (top) and size 5 i-gel (bottom). The shorter airway tube of the i-gel model affords more ETT length and so allows more definitive placement into the mid-trachea.

ETT, endotracheal tube

Figure 5. Two size 4 i-gel SADs.

A standard 6.0-mm ETT is within the upper i-gel displaying the length of ETT that is available for securing the airway. The longer 6.0-mm MLT is shown in the lower i-gel. The shorter length and more generous diameter of the i-gel airway tube, compared with the cLMA, gives the airway team the option of FOB-ETT intubation using either a standard 6.0-, 6.5- or 7.0-mm ETT or the MLT 6.0-mm ETT or FOB-AIC–assisted intubation.

AIC, Aintree intubation catheter; **cLMA,** LMA Classic; **ETT,** endotracheal tube; **FOB,** fiber-optic bronchoscope; **MLT,** microlaryngeal tube; **SADs,** supraglottic airway devices

FOB-ETT-SAD Intubation

Direct FOB advancement of the ETT via the SAD, in most instances, is a short-term solution for securing the airway. Several options have been suggested for removing the SAD over the indwelling ETT, but they can be difficult to execute and risk the loss of the airway. This would be disastrous given the reason for deploying this rescue adjunct in the first place. Attempting to remove the SAD by a novice is ill-advised.

Nonetheless, FOB-ETT-SAD is an excellent rescue adjunct method. The general steps of FOB-ETT-SAD intubation are outlined in Table 6. It may be adequate in the OR setting where an extubation trial will be considered. Conversely, the in situ SAD-ETT combination is unacceptable long term, for example, more than a few hours, in the NORA setting, given the likelihood of ongoing mechanical ventilation support. Although removal of the shorter ILMA model over the ETT is an excellent and key feature of its design, most other SAD models may be fraught with explantation difficulties.

If the ETT-SAD combination is controlling the airway, it may be best exchanged to an appropriate size and model ETT (for the ICU patient) or left in place (in the OR) if a trial of extubation at the conclusion of the operative case is appropriate. If the ETT has been delivered via FOB guidance, its depth should be assessed to ensure the trachea is securely intubated with a reasonable ETT depth below the glottis. The depth of the ETT will depend, again, on the length of the SAD airway tube and the ETT model and its size and length, as well as the patient's height and neck dimensions. Deflation of the SAD cuff may provide an additional 1 to 1.5 cm depth of the ETT. If a trial of extubation is deemed warranted, the ETT may be carefully removed while the LM airway remains in place.

The indwelling SAD serves two purposes for airway control: 1) continued effective ventilation and oxygenation, and 2) as a reintubation conduit, if needed.[22] If a trial of extubation is not appropriate, then a controlled and orchestrated ETT exchange of the ETT-SAD combination over an AEC to a properly sized ETT may be the best strategy.[23,24]

If the NORA intervention takes place on the floor or other non-ICU setting, it is a reasonable decision to transfer the patient to a higher level of care, stabilize their cardiopulmonary status, and then proceed to the planned exchange or FONA. Ensuring adequate sedation and analgesia with or without paralysis to minimize self-extubation is prudent prior to transporting the patient, as well as at the time of the proposed ETT exchange.

A SAD-ETT exchange to an appropriate ETT is optimized when maintaining continuous access to the airway via AEC-VL assistance.[23,24] Communicating with the surgical airway/difficult airway response team (DART) back-up support should be considered given the DA circumstances. If the supraglottic/glottic/subglottic tissues are deemed narrowed due to tumor burden, swelling, edema, trauma, subglottic narrowing or anatomic distortion, the exchange placement of a smaller-caliber ETT may be warranted.

Table 6. General Outline of Steps for FOB-Assisted SAD Intubation

FOB-ETT Intubation (Rescue)	FOB-AIC-SAD Intubation (Rescue)
SAD placed, effective oxygenation/ventilation	SAD placed, effective oxygenation/ventilation
Call for help, rapid access to advanced adjuncts[a]	Call for help, rapid access to advanced adjuncts[a]
Choose proper FOB, ETT, i.e., 6.0-mm MLT	Load lubed AIC on FOB[b]
Load lubed ETT on FOB, lube outside of ETT[b]	With/without bronchoscopic adapter to SAD and reservoir bag
Advance FOB-ETT→SAD to best depth within the trachea[c]	Advance lubed FOB-AIC subglottically, advance AIC
Inflate cuff, carefully remove FOB, secure SAD-ETT combination	Carefully remove FOB and SAD
Stabilize vitals, sedation, transport to higher care level, i.e., ICU	Load ≥7.0-mm ETT on AIC, laryngoscopy to open pathway[d]
Decision: Maintain (short term) vs. exchange: ETT or FONA	Advance new ETT, confirm with $EtCO_2$, FOB check

[a] Once the SAD is placed as rescue, think ahead, call for help, request advanced adjuncts to be delivered to bedside. if not already present, stay one step ahead if contemplating the need for surgical airway access (FONA).

[b] One may pass FOB for surveillance check of glottic access, patency, secretions, etc., then continue oxygenation via reservoir bag assistance while loading ETT-AIC on FOB. Airway may be suctioned via the FOB or by passing a 12 Fr/14 Fr suction catheter.

[c] Bronchoscopic adapter will assist during surveillance check but may not allow FOB-ETT depending on your choice of FOB and ETT size.

[d] If decision is made that a smaller-caliber ETT is required, a 14 Fr Cook AEC or equivalent may be passed via the AIC into the trachea; carefully explant AIC, then perform laryngoscopy to assist with intubation over AEC.

AEC, airway exchange catheter; **AIC,** Aintree intubating catheter; **cLMA,** LMA Classic; **ETT,** endotracheal tube; **FOB,** fiber-optic bronchoscope; **FONA,** front of neck access; **ILMA,** intubating laryngeal mask airway; **MLT,** microlaryngoscopy tube; **SAD,** supraglottic airway device

Alternatively, in extreme airway conditions due to trauma, edema, distortion or limited cardiopulmonary reserve, creation of a surgical airway in a controlled setting may be the best option.

When exchanging out the ETT + SAD combination, it is encouraged to employ the largest-caliber AEC available ("mind the gap").[25] Thus, if a 6.0-mm ETT is in place via the SAD, a 14 Fr Cook AEC (or equivalent, external diameter 4.7 mm) is a good choice.

The passage of a larger 7.0 to 9.0-mm ETT, particularly the EVAC (evacuation) style ETT with subglottic suction (larger external diameter than a conventional ETT—for example, a 7.0 EVAC ETT is equivalent to a standard 8.0-mm ETT—over the 14 Fr AEC increases the risk for ETT tip hang-up, abutment or impingement on the periglottic structures, compared with the larger 19 Fr AEC [external diameter, 6.3 mm]) (Figure 6). If the new ETT to be placed is of a larger caliber, a higher first-pass success rate may be obtained by passing a lubricated Aintree catheter (19 Fr) over the smaller-caliber AEC (11 Fr, 14 Fr).[25] This will bolster the cross-sectional diameter of the exchange catheter ("mind the gap") to facilitate the Seldinger advancement of the new, larger-caliber ETT.[25]

Figure 6. 19 Fr, 14 Fr and 11 Fr AEC in 8.0-mm ETT (left to right).

Note difference in the "gap" in this side-by-side comparison.

AEC, airway exchange catheter; **ETT,** endotracheal tube

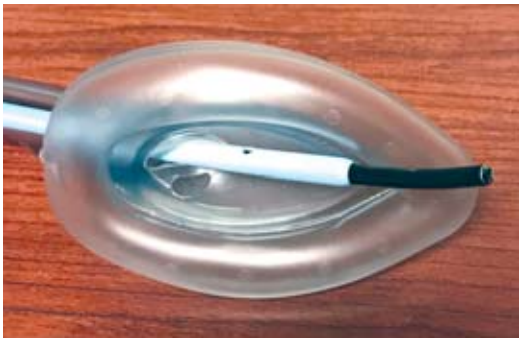

Figure 7.

The AIC's length allows the FOB's flexible distal tip to be "unjacketed" to enable maneuverability.

AIC, Aintree intubation catheter; **FOB,** fiber-optic bronchoscope

FOB-AIC-SAD Intubation

If the airway team is properly equipped and trained to incorporate the SAD as an intubation conduit, perhaps a more versatile technique to use would be FOB-assisted intubation via an AIC through the SAD. The AIC is a semirigid 19 Fr hollow catheter that is 56 cm long coupled with a widened, more spacious ID of 4.7 mm, as opposed to its manufactured cousin, the Cook 19 Fr AEC. The length (56 cm) is appropriate for pairing with a small adult FOB (about 4.5 mm).

The AIC's length affords the distal portion of the FOB to be unsheathed for continued distal tip maneuvers by the proximal manipulation of the thumb lever (Figure 7).[26-29] However, during forward advancement of the AIC over the FOB and into the trachea, great care needs to be exercised regarding the curvature of the flexible distal tip (Figure 8).

The AIC will not advance forward unless the distal FOB tip is straightened and the outer flexible jacket covering of the distal tip may tear or stretch the outer jacket to form a collar that will not permit advancement of the AIC. Reusable FOB equipment is prone to this obstacle. The "turtleneck collar" may inhibit on-loading and off-loading of the AIC. Careful inspection of the distal tip is recommended and the collar may be flattened out to allow AIC passage.

The general steps of FOB-AIC-SAD intubation are outlined in Table 6. A well-lubricated FOB (paired with a double-gloved operator) can be placed through the AIC and the FOB-AIC combination, also lubricated, is then passed down the SAD airway tube to locate the glottic opening. Subsequent placement of the AIC in the trachea is followed by careful removal of the FOB and SAD. The indwelling AIC, when combined with laryngoscopy (optimally), may then facilitate passage (railroading) of a

Figure 8.

The maneuverable distal FOB tip will need to be straightened prior to AIC advancement into the trachea. The leading edge of the AIC tip may "catch" and then stretch/tear the outer flexible jacket. This will prevent AIC advancement and render the FOB damaged and unusable. If the outer jacket is stretched and misshaped, it may lead to a "turtleneck" collar on the flexible end of the FOB. This will prevent loading or unloading the AIC unless the turtleneck collar is flattened.

AIC, Aintree intubation catheter; **FOB,** fiber-optic bronchoscope

new ETT. The 19 Fr AIC affords placement of a large-bore ETT (≥7.0 mm), which is more appropriate for continued controlled ventilator support of the patient.[26,27]

If you suspect or know that airway narrowing is present, incorporating the AIC (external diameter, 6.3 mm) would not be the best solution when a smaller-caliber ETT, such as 6.0 mm, is warranted. Conversely, the AIC may also serve as a conduit to advance a smaller-caliber AEC (14 Fr, 11 Fr) into the trachea (Figure 9). Once placed to an adequate depth, the AIC may be carefully explanted from the smaller AEC to then assist the advancement of a smaller ETT, for example, 5.0 to 6.0 mm.

Using the FOB + AIC combination is adaptable to nearly all SAD models available.[26-29] Although praised in several publications as a worthy and useful conduit for intubation, the LMA Supreme (SLMA, the disposable version of the LMA ProSeal [PLMA]) is best used as an intubation conduit with the FOB-AIC method.[28,29] The construction design, as opposed to that of the PLMA, is less than optimal, due to 1) a narrow airway channel, 2) a small ridge in the distal portion of the airway tube opening, and 3) epiglottic fins within the airway channel, all of which may lead to entrapment of the FOB-AIC combination, limiting its forward advancement, reducing maneuverability, and thus hindering insertion of the AIC[6] (Figure 10).

Moreover, the airway channel in the size 3 SLMA model is particularly limited. Similarly, the cLMA has a small ridge located in between and slightly under the epiglottic bars that may impinge on smooth advancement of the FOB, ETT or AIC (Figures 11 and 12). Of note, the epiglottic bars by themselves do not interfere, as they are pliable. Damage to the ETT cuff is a possibility when advancing an ETT through the cLMA airway tube (6.0 mm via size 3 cLMA).

Conversely, the design of the i-gel offers a smooth distal airway tube bowl, affording an unobstructed pathway for advancement of the FOB-AIC or FOB-ETT (Figures 13 and 14). Its wider diameter and shorter airway tube length affords use of a size 7.0-mm standard ETT in the three adult sizes. Again, the authors advise that liberal application of lubricant is a key component of smooth advancement for the FOB-ETT or FOB-AIC unit via the SAD airway tube. *Tip:* Team members may benefit by donning two pairs of gloves, which allows rapid removal of the outer glove layer if one is unable to grip due to lubricant or secretions.

Figure 9.

The 11 Fr and 14 Fr Cook AEC may be passed via a 19 Fr AIC.
AEC, airway exchange catheter; **AIC,** Aintree intubation catheter

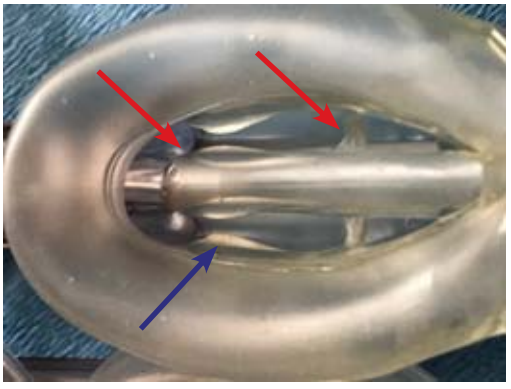

Figure 10.

Cuff bowl of the size 3 SLMA (disposable model of the original LMA ProSeal). The red arrow points to the ridge present in each of the SLMA models and the blue arrow points out the epiglottic fins (most prominent in the 3 size). The narrowed channel available for advancement of a well-lubricated FOB-AIC unit is not as generous as in other SAD options. The narrow channel will not easily admit an ETT.

AIC, Aintree intubation catheter; **ETT,** endotracheal tube; **SAD,** supraglottic airway device; **SLMA,** LMA Supreme

Figure 11. Grille of the cLMA.

Note the epiglottic bars that are flexible and stretch to accommodate the advancement the FOB-AIC or the ETT. The proximal "step-up" (red arrow) and the distal "ridge" (blue arrow) may hinder FOB, ETT or AIC advancement. While this is important to mention to the reader, the incidence of problematic advancement was uncommon or was overcome.

AIC, Aintree intubation catheter; **cLMA,** LMA Classic; **ETT,** endotracheal tube; **FOB,** fiber-optic bronchoscope

What Role Does the SAD Play In the DA Algorithm?

If a patient is deemed to have a known or suspected DA, many airway algorithms and airway management schema throughout the world recommend the option to perform an awake intubation.[11-21] Although the awake approach typically conjures the association with an awake FOB approach, the awake/aware approach in a properly prepared patient with topical/supplemented local anesthesia nerve blocks may allow a variety of methods and techniques to be performed comfortably and successfully (DL with/without bougie, VL, VL + FOB, nonhyperangulated VL + bougie, SAD placement followed by FOB-ETT or FOB-AIC intubation).

Benumof elegantly and comprehensively reviewed the cLMA's role and position in the ASA DA guidelines and algorithm in 1996.[22] Three decades later, its impact remains. Predating the development of the Aintree catheter, Benumof outlined an extensive review of methods and techniques using the SAD as an intubating conduit.[22] The potential power of the SAD is clear.

The ASA Closed Claims Project analysis for tracheal intubation and the NAP4 (U.K.) strongly suggest that a significant number of judgment failures and elements of poor management were observed in the majority of airway complications and most deaths. Failure to use an SAD as a bridge for oxygenation/ventilation during a "can't intubate, can't oxygenate" emergency accounted for many of these failures.[30,31]

The SAD holds a prominent position inside and outside the OR by assisting with 1) difficult or impossible conventional bag-mask-valve (BVM) ventilation, 2) airway support/rescue after failed intubation, 3) airway rescue after both failed ventilation and intubation, 4) primary or secondary deployment during cardiac arrest, 5) anticipating difficult ventilation-oxygenation and/or intubation when used "primarily."

The SAD offers rapid deployment with minimal preparation time, combined with a high rate of placement success by both experts and novice user. Its ability to serve as an intubation conduit by a properly prepared and knowledgeable airway team is attractive, hence its position in many airway schema as a "go to" adjunct.[26-29]

Figure 12. FOB-AIC advancement via a cLMA.

The AIC may, at times, meet resistance to advancement if it gets hung up on the proximal or distal "ridge" of the cLMA grille (arrow). Although burdensome when it occurs, it was relatively uncommon during NORA cLMA deployment.

AIC, Aintree intubation catheter; **cLMA,** LMA Classic; **FOB,** fiber-optic bronchoscope; **NORA,** non-OR airway

Figure 13.

Note the wide opening of the cuff bowl of the i-gel. The smooth construction and ample size minimize obstacles to advancement of airway adjuncts.

Figure 14.

Note the wide airway tube bowl opening of the i-gel model. Hindrance to FOB-ETT or FOB-AIC is minimized due to its wide diameter and smooth joint construction. Liberal lubrication to ease advancement is key.

AIC, Aintree intubation catheter; **ETT,** endotracheal tube; **FOB,** fiber-optic bronchoscope

The 2013 iteration of the ASA DA guidelines mentions the use of the SAD as an intubation conduit as an option for rescuing the DA. The recently updated Difficult Airway Society (DAS-U.K., 2015) and the 2018 guidelines for intubation of critically ill adults (U.K.), as well as guidelines from societies across the globe,[11-21] place emphasis on the early use of the SAD for both ventilation/intubation options. Most recommend FOB-assisted intubation as the best option.

A recently offered cognitive aid for emergency airway management is the Vortex airway management concept. It is a simplified concept that is easily adaptable and suitable for airway managers from all disciplines and levels of training. It is designed to support team function and communication when specific interventions succeed or fail. It sets thresholds for the three common/basic methods of airway support (mask ventilation, SAD insertion, laryngoscopy) at three attempts maximum (by a skilled team member).

Team members should declare their "best effort" at one of the three methods and then move to another basic method in the case of failure. Further, if failure occurs with any method, it encourages the team to commence with preparation for a "can't intubate, can't oxygenate" situation (FONA, surgical airway).

It also encourages the team to rotate back and forth among the three interventions rather than completely exhausting efforts on a single method over three attempts. In essence, limit the basic elements of management to three attempts (or fewer) each for BVM, SAD and laryngoscopy, avoid perseveration, and encourage SAD backup/rescue as a key for oxygenation/ventilation support and as a conduit for intubation.[32]

Review of the Hartford Hospital NORA Database

This extensive database (1990-2021, >26,000 patients) provides a foundation for the discussion regarding SAD in the urgent/emergent setting outside the OR. There were 1,484 patient encounters in which an SAD was used in some form. A large number were successfully ventilated with the SAD (within three attempts)—that is, 1,412/1,484; 95.4% overall—representing both the cLMA and ILMA. Individually, the cLMA (94.7%) was edged out closely by the ILMA (97.2% overall).

The SAD was the first and primary adjunct for management in 50 NORA patients (40 ILMA and 10 cLMA; ventilation successful in 49 of 50 [98%]; 48 of 49 were successfully intubated within 3 attempts). When used as a vehicle for rescue ventilation alone (n=164; 90% success by the second attempt; 95% by the fourth attempt), the SAD was incorporated while preparing for another advanced adjunct intervention. Rescue ventilation with subsequent SAD-assisted intubation accounted for the remaining encounters (ILMA and cLMA; n=1,280). The ILMA was used for intubation employing one of three methods: 1) blind ETT insertion (n=767; 91% success by the second attempt; 96% overall), 2) elective FOB-assisted intubation (n=5; 95% success), and 3) rescue FOB-assisted intubation use when blind insertion failed (typically after the first attempt; n=171; 82% success). These results are similar to the results reported by Ferson et al, although their report involved mostly OR rescues.[9]

Use of the cLMA as an intubation conduit always employed FOB assistance to facilitate tracheal intubation. Similar to the findings reported by Berkow et al, this method was very successful in its role as a rescue ventilation device and intubation conduit.[33] A total of 283 patients underwent attempted intubation via the cLMA serving as a conduit. Of the patients, 94% (266/283) were successfully intubated by one of two methods: 1) passing an AIC over the FOB (FOB-AIC-SAD method; n=268) or 2) passing a size 6.0 ETT via the cLMA (FOB-ETT-SAD method; n=15), which included a Mallinckrodt MLT (n=11) or a standard 6.0 ETT (n=4).

The appeal of the second method (FOB-ETT-SAD) is essentially the fewer steps to initially secure the airway. To reiterate, this may be apropos in elective OR environments when an extubation trial is planned following a relatively brief intubation period. If either the AIC or the properly sized FOB is not available at the time of the rescue encounter, the second method would suffice. Since these patients were NORA encounters, each of the 15 cLMA-ETT-FOB patients required subsequent exchange of the cLMA-ETT unit over an AEC with laryngoscopic assistance. ETT exchange is a high-risk procedure, particularly in a patient who already has proven to be challenging to manage.

The cLMA-AIC-FOB method was successful on the first attempt in 70.1% of the encounters, 89% by the second attempt and 94% overall by the third attempt. Secretions, altered anatomy and periglottic swelling were the primary factors leading to additional attempts. Of note, the failures numbered 17 of 283 cLMA-FOB procedures due to poor visualization, inability to advance the AIC, AIC kinking or difficult ETT passage. Manipulation of the cLMA itself or extension of the patient's neck was occasionally used to improve passing of the FOB-AIC.

The current database has several cases involving a 2nd-gen SAD (PLMA, SLMA) used as a rescue ventilation adjunct. However, the database contains no cases of SAD-AIC-FOB–assisted intubation employing any 2nd-gen SAD in the NORA setting.

The presence of secretions, regurgitated material or blood was very common during those cases that presented difficulty leading to the deployment of the SAD during NORA encounters. Of the 1,484 SAD deployment cases, nearly half were complicated by plentiful secretions, blood or regurgitated material (n=717) (Table 7).

Providing a closed system for oxygenation/ventilation via the SAD using a bronchoscopic adapter (Figure 15) allowed both passing of the lubricated FOB-AIC and providing positive pressure ventilation (PPV) for ongoing oxygenation during the procedure, plus assisted with lateralization of swollen, boggy and edematous periglottic tissue (similar to CPAP in obstructive sleep apnea) (Figure 16). This was recorded to have been used in 32 cases and found to be helpful in 70%.

Tip: If one encounters an edematous boggy periglottic area that is difficult to discern exactly where the airway hole is located, the application of PPV may improve visualization of the glottic opening. A colleague then provides ongoing PPV support while FOB intubation takes place. The AIC package (Figure 17, Cook Medical) includes a bronchoscopic adapter. Otherwise, this valuable accessory should be available in the DA cart or FOB tower.

Data Analysis of Utilization Trends

Review of the NORA database regarding practice trends over the past two decades raises great concern. The use of FOB-SAD, ILMA and FOB-AIC-SAD, once the cornerstone of NORA airway rescue at our institution, has been falling precipitously since our acquisition and distribution of VL became hospital-wide. We currently have VL accessibility in the OR, our NORA travel bag with portable VL, and mobile VL on wheels.

NORA intubation encounters currently number approximately 1,000 to 1,100 annually. During 2000-2006 (pre-VL), we averaged 80 to 110 cases of SAD rescue per year; from 2007 to 2014, the average SAD rescue cases numbered 35 to 40 annually; and currently, in 2015 to 2020, the use of FOB-SAD, ILMA and FOB-AIC-SAD has decreased to less than five cases per year.

We have no doubt about the value of VL regarding elective and NORA patient care, but we fear that maintaining expertise in a variety of airway management adjuncts and techniques is diminishing rapidly

Table 7. Airway Soilage: Preexisting or Present During Airway Encounters (N=1,484)

Condition	Patients, n
Preexisting blood	136
Preexisting vomitus	93
Moderate/significant secretions	449
Regurgitation during intubation	27
Aspiration during intubation	12
Regurgitation/aspiration with SAD support	0

SAD, supraglottic airway device

Figure 15. Bronchoscopic adapter.

A well-lubricated, properly sized ETT may be passed into the SAD. If concurrent oxygen delivery is needed, then a ventilation bag attached to a bronchoscopic adapter atop the 15-mm ETT adapter affords ventilation support. Of note, the Aintree Intubation Catheter (Cook Medical) will not advance through a 6.0-mm ETT (AIC, 6.3-mm external diameter).

AIC, Aintree intubation catheter; **ETT,** endotracheal tube; **SAD,** supraglottic airway device

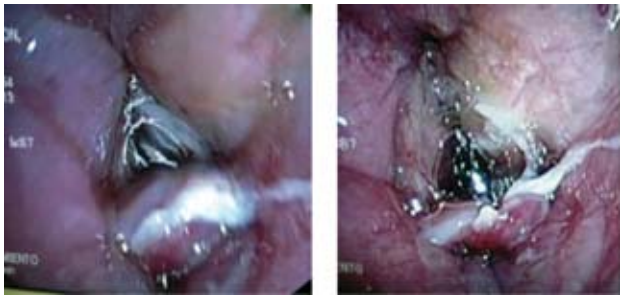

Figure 16. Bronchoscopic view via the SAD: the effect of positive pressure.

Left, ambient pressure versus right, sustained positive pressure maintained with manual bag squeezing to assist in pressurized lateralization of boggy, edematous periglottic tissues, affording more accurate FOB advancement.

FOB, fiber-optic bronchoscope; **SAD,** supraglottic airway device

Figure 17.

A bronchoscopic adapter (elbow) is an important accessory device for advanced airway management. Portal access via the rubber diaphragm allows the FOB-AIC combination to be advanced while providing oxygen delivery and positive pressure ventilation. The rubber diaphragm may be removed to allow the FOB-ETT to be advanced (small caliber).

AIC, Aintree intubation catheter; **ETT,** endotracheal tube; **FOB,** fiber-optic bronchoscope

due to excessive reliance on VL as a panacea for the dilemma of the DA. Teaching VL and incorporating it at the exclusion of nearly all other methods and adjuncts will lead to marked skill deterioration in other methods, or possibly lead to not teaching or exposing the trainee to them at all (e.g., FOB, bougie, FOB-SAD-AIC).

Accelerated VL utilization has led to a lower rate of SAD rescue in the NORA setting, and this may reflect improved care for our patients. However, the staff and trainees (anesthesia residents, student registered nurse anesthetists, critical care fellows) have a dwindling exposure to this particular rescue method. Use of VL in the NORA setting has a 5% failure rate (per the Hartford database); thus the airway team must have several effective modalities to rescue these DA challenges.

Many trainees will graduate without experiencing FOB, FOB-SAD or FOB-AIC deployment in the elective or urgent setting. Ongoing review, discussion and training must continue so our current and future airway care providers will become and remain familiar with this life-saving rescue method.

Is It Time to Abandon the Vintage LMA and Adopt the 2nd-Gen Device as First Choice?

The elective environment has benefited greatly from deployment of the SAD. Likewise, the track record of the SAD is exemplary, given the circumstances for when the SAD is used in the urgent/emergent setting in the OR, NORA and by emergency medical services outside the hospital. The challenges that present themselves to the airway team for urgent/emergent interventions differ significantly outside the elective setting.

Acute illness, airway soilage, hemodynamic perturbations, poor or challenged cardiopulmonary status, and altered airway characteristics combined with the acuity level all suggest that patients' needs do differ and may benefit by SAD refinements and improved design.[22]

Table 8. Desired Traits of a Supraglottic Airway Device

Consistent first-time placement success
Provide higher oropharyngeal seal pressure to accommodate the critically ill patient
Access to the esophagus with the ability to drain the upper GI tract to reduce risk for aspiration
Serve as an intubating conduit with fiber-optic–assisted intubation
Built-in mouth guard to limit tube occlusion from biting (advantageous but not required)
Improve the bowl cuff–airway tube interface to reduce obstacles to FOB-AIC advancement

AIC, Aintree intubating catheter; **FOB,** fiber-optic bronchoscope

The wish list for the ideal SAD in the NORA setting (where challenges might include, e.g., obesity, volume overload, not NPO, low pulmonary compliance) would strongly consider consistent first-time placement, provide high oropharyngeal seal pressure to accommodate and ventilate in the setting of poor lung compliance and increased peak airway pressure, the ability to potentially separate the respiratory tract from the esophagogastric tract with the opportunity to drain the upper GI tract and lower the risk for aspiration (Table 8).

Moreover, the feature of acting as an intubating conduit via FOB could perhaps be improved by optimizing the design of the airway tube diameter and length as well as reducing the obstacles to FOB-AIC-ETT advancement noted in several SAD models at the cuff–airway tube junction. The 1st-gen SADs (cLMA, ILMA) serve admirably in the emergency NORA setting. The upgraded 2nd-gen SAD models do offer attractive improvements that could and should improve the SAD legacy further. Although individual performance and design characteristics vary among the available 2nd-gen SAD devices, the Difficult Airway Society has tailored its recommendation of the SAD to include only 2nd-gen devices.[14,21]

The critically ill patient may benefit from the improved design in terms of oxygenation, ventilation and the application of PEEP.[21] Judging by the most effective SAD seal pressures, so valuable in the case of less-compliant lungs, obesity and pulmonary pathology in the critically ill patient, the 2nd-gen SADs perform better than the 1st-gen devices. The reusable PLMA is capable of providing the most effective seal pressure, followed by the disposable SLMA and then the disposable i-gel.[34] Each is capable of acting as an intubation conduit using a bronchoscope but not for blind intubation.

The SLMA, however, received poor marks for "success of guided intubation" due to its narrow channel within the airway tube.[34] The PLMA and i-gel were judged to be the top two SADs overall. Their high ranking was followed closely by the ILMA, which received the highest overall marks for "success of guided intubation" and "success of blind intubation."[34] Despite high marks for an intubating conduit, the ILMA lacks the GI drainage portal present in the 2nd-gen SAD.

The PLMA received the highest rank overall, yet its appeal is severely restricted since it is a reusable device at a time when many institutions have transitioned completely to the disposable SAD because of concern about disease transmission or overall cost. Its near equivalent, the SLMA, is an excellent 2nd-gen SAD, yet is limited by its narrow airway channel affecting its capacity as an intubating conduit.[28,29]

The i-gel has a wider diameter and is shorter in length, and so is a more accommodating airway tube connected to a preformed bowl instead of an inflatable cuff (Figures 13 and 14). This SAD has a smooth, obstruction-free interface where the airway tube and bowl are fused, reducing the chance for impedance to advancing

the FOB-ETT or FOB-AIC combination as well as 7.0-mm ETT (well lubricated, of course).

Arguments have been raised that it is time to abandon the cLMA in favor of a 2nd-gen SAD, based on opinion and research that many of the newer 2nd-gen SADs have performance characteristics that improve efficacy compared with the "vintage cLMA" and have the potential to increase safety.[34] This would apply to both elective and emergency SAD utilization.

Currently, information supporting the use of the FOB-AIC-SAD method is impressive in demonstrating its high success rate during elective use and as an emergency rescue adjunct. The largest patient collections that have reported intubation via the SAD have used the cLMA and ILMA models.[7,9,10,33]

In experienced hands, blind intubation via the ILMA is reliable, yet recent societal recommendations suggest fiber-optic guidance via the SAD is the most desirable in a DA rescue. Blind ILMA intubation, however, has an excellent track record in experienced hands and may be lifesaving if FOB malfunctions or is not readily accessible.[7,9,10] The shorter airway tube construction and its accommodating curved design are characteristics that make the ILMA markedly different from the cLMA, yet it is not a 2nd-gen model since it lacks an access portal to the GI tract. Interestingly, the ILMA does not seem to have the same support currently as it did a decade ago, even though its track record of success remains impressive.

The rate of successful deployment for ventilation and a conduit for intubation may differ among varying SAD models and styles. Most investigations are evaluations in elective OR patients and not in the emergency deployment for rescue in the OR or NORA settings. Case reports, non–randomized controlled trials and retrospective data collections of several types of SAD devices account for most of the background support for their utility.

The larger reported series of FOB-SAD-AIC for DA rescue reflect the success of the 1st-gen SADs:

- Berkow et al: cLMA for OR rescue, 119 of 128 successful, 93%[33];
- Mort: cLMA for NORA rescue, 266 of 283 successful, 94%[9,10];
- Ferson et al: ILMA for 257 encounters, 96.5% blind success, 100% FOB success[7]; and
- Mort: ILMA for 973 cases; 97.2% successful ventilation by the third attempt, 95.7% blind intubation by the third attempt, 90% FOB-assisted by the third attempt).[9,10]

We can concede that the 2nd-gen SADs, in many ways, outperform the 1st-gen SADs.[28,29,34] Currently, however, there are limited large-scale data regarding the use of the 2nd-gen SAD as an emergency rescue intubation conduit. Practitioners who currently use a 1st-gen SAD in both the elective and emergency rescue settings may be reluctant to alter their practice and move to the 2nd-gen SADs due to their comfort level and personal track record of success with the older devices.

Those who practice with the ILMA as a rescue option may not feel motivated or persuaded to alter their rescue schema, supported, in part, by its high success rate of intubation, either blind or FOB-assisted.

We believe we all would favor a refined SAD design that would improve patient care. Yet to this point, for those who prefer science or research to support their practice patterns, currently the 2nd-gen SADs have not been investigated, even retrospectively, to a great extent for emergency rescue.[29] Concerning a 2nd-gen SAD serving as an intubating conduit, one must then assume the updated 2nd-gen devices will provide the same or an improved level of success.

Change may be problematic for some practitioners, and switching to an updated model may be met with reluctance as old habits may be difficult to change. Offering both models is reasonable, as one model may serve as a rescue for the other. However, using both models may have its detractors. One should not reserve a 2nd-gen SAD for emergency use only since frequent use is quintessential to comfort and experience with optimal use.

Incorporating a 2nd-gen SAD as a regular component of airway care appears to be warranted and should be encouraged. It is best used on a regular basis in the elective setting by all staff.[34]

Complete transition to the 2nd-gen SAD model with removal of the 1st-gen SAD from anesthesia care areas has been suggested.[34] We have experienced that, in emergencies, the availability of several SAD size and style choices may be quite beneficial. The Hartford Hospital database has 100 NORA cases in which direct access to both LMA models, cLMA and ILMA, afforded airway rescues as the team switched from one model to the other following difficulty or failure.

Likewise, the 2nd-gen i-gel has been occasionally unsatisfactory in the OR, with elective rescue using the cLMA, and vice versa. As the utilization in the rescue setting declines, it will be more difficult to evaluate the potential advantages of the 2nd-gen devices over the 1st-gen offerings.

Ongoing Education Initiatives For Optimizing FOB-SAD-AIC Deployment

The art and practice of advanced airway management requires several key components to ensure one's best chance of securing an airway. Poor judgment and inadequate training and education appear to be significant contributory or causal factors for patient care leading to severe airway management–related morbidity or mortality. Ideally, several educational approaches may be pursued to familiarize and then train the student to be able to correctly, appropriately and optimally deploy the advanced airway technique in an acute, emergent setting.

Introduction to an advanced adjunct (e.g., FOB-SAD-AIC)—its working parts, indications, role, limitations and where it sits in the management schema—presented by an experienced instructor is optimal but may be prohibitively difficult in a fast-paced clinical practice.

One or more of the following options may be useful for teaching a specific airway rescue technique (Table 9):

1. a structured lecture and discussion with a group or a one-on-one mentor–student sitdown as an excellent approach to the technique's introduction, its role in airway management guidelines, algorithms and schema, and presentation of cognitive aids (e.g., the Vortex)
2. understanding the steps of effective utilization (visual reenactment of its deployment via an instructional video or step-by-step instructions of its use, or both)
3. hands-on instruction of its deployment incorporating a static mannequin to experience the adjunct's deployment in a relaxed teaching environment
4. high-fidelity simulation of deployment in a DA scenario using a dynamic mannequin (with moving parts and vital signs) for individuals, a small group, the "stat airway team" and the SMART (Some kind of Management Airway Response Team)[35] or DART[36]
5. elective deployment in an OR setting in a normal airway patient to experience its use in a step-by-step teaching format in a relatively relaxed atmosphere
6. use in elective OR situations with a suspected DA patient or a patient with DA characteristics
7. team debriefing following its deployment in the urgent/emergent setting with a constructive critique of a team's performance
8. assembling a high-fidelity simulation drill involving a multidisciplinary airway team consisting of physician, nursing and respiratory therapy personnel.

Table 9. Steps in Establishing Competency for FOB-SAD-AIC Utilization

Didactic lecture with review of equipment, technique, role, limitations
Hands-on demonstration and practice with static/dynamic mannequin
DA rescue scenario with airway team in a simulation laboratory
Use in elective situations in the OR with a normal airway patient
Use in elective OR situations with a suspected DA patient or one with DA characteristics
Debriefing/review of its use following emergent deployment in real-life patient care
Frequent review and training to limit decay of procedural skills and airway schema competency
Distribution/replacement system for rapid acquisition of airway equipment in the OR and at bedside

DA, difficult airway

Frequent reviews and retraining to limit the team members' decay of procedural skills and ensuring airway schema competency is a lofty yet attainable goal.

Practicing a rescue technique or method on an elective, normal airway patient has its own limitations and may include complications, increased mentor workload, distractions from patient care, varying teaching/educational methods coupled with a lack of standardization among mentors, reduced OR efficiency, prolonged induction time, financial implications of equipment utilization (FOB, SAD, AIC), and ethical considerations regarding using the patient as a training model with or without their consent. Deploying the rescue technique on an elective basis in the patient with DA characteristics may be a more sound rationale for its practice in an elective OR setting.

For this educational endeavor to be fulfilled, a concerted effort by the mentoring staff is required. Implementing a comprehensive and repetitive airway training program that highlights and reviews airway management guidelines, algorithms and its associated schema serves as a foundation. A clearly visible, laminated cognitive aid attached to the anesthesia cart in the OR may provide a recurring source of airway management review. Discussion and debriefing following a challenging airway intervention may include highlighting other useful rescue equipment and methods, even if not deployed during the most recent event.

Deployment of the FOB-SAD-AIC is certainly not a "see one, do one, teach one" rescue modality. However, an inexperienced trainee may observe or assist a more experienced airway manager during a challenging airway rescue intervention and garner valuable on-the-job experience. Such an introduction to the trainee may provide vivid mental imagery as a perceptual experience, and more easily allow them to backtrack to learning the details of the given procedure since they have experienced firsthand its application in a real-life scenario.

On-the-job experience remains an excellent tool for learning, but the trainee should be encouraged to backtrack to learn the essentials of the technique and become familiar with the advanced airway rescue in a comprehensive fashion, as outlined above. Encouraging the student to present their experience and lead a supervised discussion with their training colleagues may be a valuable avenue in strengthening and emphasizing the importance of DA training. It should be highlighted that a single FOB-SAD-AIC exposure, while educational and eye-opening, is not a "one and done" educational triumph.

Fortunately for the patient, but unfortunately for the airway team, these critical airway events are not plentiful enough that all trainees and seasoned staff will be involved on a frequent basis. In fact, the deployment

of this lifesaving adjunct has diminished to the point where it is used only rarely, perhaps two to four NORA rescue cases per year in our institution, plus the occasional use during rescue of OR patients. This does not bode well for exposure for the anesthesia resident over a three-year training stint. Thus, sharing in the experience may reignite interest in discussion and relearning this valuable technique.

Given the international interest that is backing its role in airway rescue, training for the inevitable DA patient is warranted and encouraged. Training and providing the needed equipment, at a moment's notice, is key to delivering a rescue adjunct when laryngoscopy—direct or indirect—fails to secure the airway or if mask ventilation is difficult or impossible, despite a concerted effort by the airway team.

The key component of FOB-SAD-AIC starts with past experience with each of its several parts. Gaining bronchoscopic experience is a key element of successful deployment. This author (Mort) has observed a concerning shift in the emphasis and use away from FOB as the gold standard for airway management in the elective and NORA settings. Its overall use has decreased significantly due to the transition to and now near total reliance on VL as the go-to alternative for nearly all DA encounters.

Although VL may serve as a valuable and efficient method for securing the airway, its use is not ubiquitous and not applicable when confronted by certain anatomical restrictions, e.g., trismus, nor without failure. Deployment of FOB by a beginner or novice in a true emergency may not be avoidable but certainly is not optimal.

The concept of combining the FOB with an SAD seems straightforward and relatively simple, but the conditions under which they are typically deployed—in an urgent or emergent fashion under less than optimal clinical conditions and settings—suggest that pretraining and familiarization is most favorable for patient care. Deploying an unfamiliar advanced airway method by a beginner or novice unacquainted and inexperienced with FOB, a 2nd-gen SAD and/or the AIC in an emergency is not recommended. Calling for airway back-up and a DART summons is more appropriate.

A seasoned airway manager may mentor the beginner in an urgent or emergent setting, but strict adherence to maintaining a low threshold for the seasoned colleague to step in and salvage the rescue failure by the less experienced student is imperative. (The reader is encouraged to review *Hagberg & Benumof's Airway Management*, 4th edition, Elsevier; 2017).

Future Directions for SAD-Assisted Intubation

The LMA CTrach (Teleflex), similar to the reusable LMA Fastrach intubating model, offers video-assisted visualization of the airway to aid the operator with ETT placement. It can be easily handled by a single operator and takes much less time and effort to set up than a FOB. Its widespread acceptance and use is mixed and seems underwhelming. We could not find it as a product for sale on the internet or through the LMA Teleflex website.

Upgrading and eliminating the potential obstacles and shortcomings of the cLMA are welcome and encouraging. The LMA Unique EVO Airway (Teleflex) is a fixed-curve 1st-gen SAD design, similar to the SLMA and disposable ILMA, and is designed to support FOB-assisted intubation. Its shortened and widened airway tube affords the use of larger-caliber ETTs (7.0-8.0 mm). It has a built-in bite block, yet remains a 1st-gen SAD since it lacks a GI tract drainage portal. These upgrades sound encouraging, but further study and investigation will be needed before any recommendations or endorsements for its use are put forth.

The TotalTrack VLM (Video Laryngeal Mask, Medcom Flow) is a newcomer that will require investigation and scrutiny to determine if it may have a role in video-assisted SAD intubation in the rescue realm. It offers the ability to visualize the airway via a small video screen attached to the SAD, similar to the C Trach. Intubation can be performed while ventilating with positive pressure. The system can aspirate laryngeal and gastric secretions, and it allows passage of larger-caliber ETTs.

New airway devices have increased, in many cases, the effectiveness and care of airway management procedures, but there remains room for improvement. Carrying out studies on clinically relevant measures for a new airway device may afford us the opportunity to choose the appropriate device for a patient.

Further studies with mannequins, in an elective setting with normal airway patients, and on normal patients altered to mimic a DA trait (in-line stabilization, etc.), and then addressing screened patient groups with identified DA characteristics, will partly help to answer the perplexing and important question: "Is this the right device for me to use in my patient?"

Novel upgrades of established and previously tested devices should be evaluated to ensure the upgrade is actually helpful and not harmful to patient care.[29,37] Comparing one SAD with another is encouraged so we, as practitioners, may make educated decisions about the devices we deploy in the elective setting.

Harnessing and using these findings for the old devices (1st-gen) and novel upgrades of the 1st-gen devices and 2nd-gen devices, and then applying them in an urgent and emergent crisis situation, particularly for NORA, is a fairly common process in medicine. The clear answer for the crashing patient in the OR or the NORA may never be answered directly due to the difficulties of applying randomized controlled trial criteria. We must do our best to provide guidance for our airway providers.

Unfortunately, many of the current recommendations, as justly guided and best intended, have not actually met the highly efficacious scrutiny of the randomized controlled trial to determine their overall

worthiness for our decision to include them in the care of our most critically ill patients under the worst circumstances.[29,34] Expert and consultant opinion remains an important source of guidance for urgent and NORA patients, for example, the critically ill, who may never directly undergo scientific evaluation and scrutiny in the quest to answer patient care questions.

Summary

The reasons for acceptance of the FOB-SAD airway rescue method as a viable and worthy choice in the OR and NORA settings are clear. However, its relatively rare deployment, except in high-risk circumstances, endangers the training of our current and future airway care providers. There are a variety of educational methods to support and encourage the trainee to understand and comprehend the background, role, technique and limitations of FOB-SAD intubation. Exposure of members of the airway team to this rescue modality and the assurance of rapid acquisition of the needed equipment are both keys to success. Early SAD deployment is encouraged to optimize airway conditions before they worsen and upend the lifesaving potential that this device offers to our patients.

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