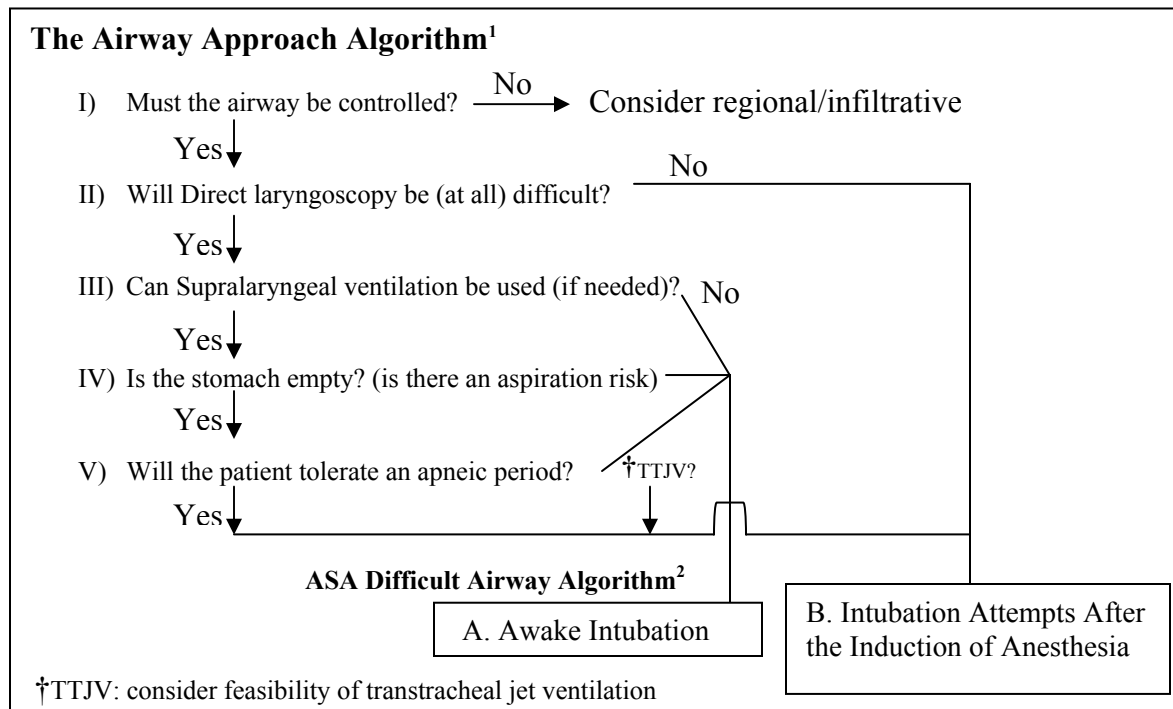


Figure 1 describes a decision tree approach to the preoperative assessment of the patient airway: the Airway Approach Algorithm (AAA).¹ The AAA is an amalgamation of the salient issues of total airway assessment.



Two important characteristics of the AAA should be apparent from the most casual appraisal: First, each branch-point-question calls on the clinician to apply his or her own experience and judgment, and second, the true role of the AAA is to help guide entrance into the American Society of Anesthesiologist's Difficult Airway Algorithm (ASA-DAA).² This calls attention to the misnomer of the ASA-DAA – it is not an algorithm for only difficult airways. The ASA-DAA applies to all airways. In 2003, a revision of the ASA-DAA was published.² Apart from the evidence-based medicine format of the new practice guidelines, the 2003 publication introduced a significant change to the graphic algorithm. In this revision, the Laryngeal Mask Airway (LMA) was removed from the emergency pathway, to be placed in the “routine” pathway, i.e., success or failure with the LMA or face mask (after failed laryngoscopy) defining the urgency of the situation.² This change reflects the worldwide experience with the LMA since 1992. Takenaka took this concept a step further.³ In 2000, this author asked, if a patient is identified preoperatively as a possible difficult laryngoscopy, is he a “difficult airway” if there is no indication that LMA ventilation will be difficult? As the reader will see, these two developmental lines of thought contributed to the concepts of the AAA. The following discussion will examine the five questions of the AAA, and how, after preoperative assessment, it guides the clinician into the ASA-DAA.¹

I. Is airway management required? The clinician must consider the magnitude of the peril in taking control of the patient's breathing. Though many surgical procedures and clinical conditions require airway management, we must never forget that to electively blunt a patient's ventilatory drive, takes the patient from a state of self-preservation into one of dependence upon the success of the clinician's procedures. Likewise, when a diagnostic procedure or therapeutic intervention demands an action that entails the use of sedation or the risk of untoward drug effects, a similar concern must be paramount. It is a risk that must often be taken, but should never be taken lightly. Factors including the patient's disease and opinion, consultation with other healthcare givers, and the anesthesiologist's own opinion weigh heavily on this question. It is this author's opinion that the assessment by the clinician who assumes responsibility for airway management procedures, far outweighs other opinions.

In some cases, avoidance of airway manipulation can be achieved through the use of regional anesthesia. When a decision is made to proceed with a regional anesthetic, or when no regional or general anesthesia is deemed necessary, it is helpful to consider a full evaluation of the patient's airway should conversion to a general anesthetic be required.

II. Will direct laryngoscopy be (at all) difficult? Though there is a multitude of ways to secure an airway, the vast majority of clinicians recognized direct laryngoscopy to be a standard of care.² Until this standard is redefined, the ease of direct laryngoscopy and intubation must be evaluated in all patients about to undergo interventions that may affect the airway. Many authors have attempted to delineate the factors that describe the difficult patient airway. **Table 1** lists the most prominent techniques in use today. Also included in this table are the results of sensitivity and specificity testing of these indices. It should be carefully noted that these standard methods of evaluation have been shown to have **low and variable sensitivity and marginal specificity** when used to predict the ease of laryngoscopy in terms of the Cormack and Lehane's view.⁴⁻⁸ In other words, though each of these indices may be useful in particular patients, and for the particular clinician who employs them, their overall **predictive** values have been shown to be **poor**.

Table 1: Commonly cited physical exam indices of laryngoscopy

Physical exam index	Sensitivity	Specificity
Interincisor gap	0.26	0.94
Thyromental distance	0.65	0.81
Chin protrusion	0.29	0.85
Atlanto-occipital extension		
Oropharyngeal grade	0.4- 0.67	0.52-0.84

Evaluation of the airway for the purpose of definitively identifying the difficult to intubate patient remains an enigma. As noted, the variety of tests suffer from relatively poor to modest sensitivity, specificity and predictive power.

As investigators search for new predictive exams, it is appearing that the nemesis of each test is simply related to other anatomic findings: though the indexes tend to treat each finding in isolation (this is still true of multivariate indexes) they are really interdependent. For the moment, it may be more elucidating to consider a "functional" assessment of the airway – that is, consider all the anatomic relationships in terms of what needs to be achieved during laryngoscopy.⁹

The aim of laryngoscopy is to create a line of sight from the operators eye to the larynx. This must be achieved through a system that consists of 2 axes, normally at right angles to each other – the **oral axis** and the **pharyngeal axis**. Extension of the head on the neck can typically change this relationship from **90** degrees to **120** degrees. Of course, light can only travel in a **straight** line (180 degrees), so this angle is still not adequate for the operator practicing direct laryngoscopy. A **new** axis must be created. This is accomplished by **displacement** of the **tongue** (the job of the laryngoscope!). There are several factors which will affect the ability to displace the tongue. First: the thyromental space (the area boarded by the mentum anteriorly, hyoid bone posteriorly and rami of the mandible laterally. Commonly, **6cm** measure from the mentum to the superior aspect of the thyroid cartilage has been considered adequate. Ayoub et al., have recently made an interesting observation regarding this space.¹⁰ This group found that the **size** of this **space** becomes critical when **less than 4cm**. When larger than this, the Mallampati grade of relative tongue/oral cavity size was non-predictive. But at **< 4cm**, the **Mallampati** became an **important** measure. Other factors affecting the thyromental space include previous surgery, trauma or local radiation therapy.

Other factors which will affect tongue displacement include the rotational and translational function of the Temporal Mandibular Joint (**TMJ**). A functioning TMJ allows relaxation of the insertion of the tongue, further allowing tongue displacement.

Lastly, the oral aperture must be wide enough to accept instrumentation. The cross-sectional diameter of the laryngoscope blade increases as its long axis is angled off the plane of the oral cavity. Interestingly, the **oral aperture**, which of course is related to the rotational function of the TMJ, is also **dependent** on **extension** of the neck

on the head. Calder et al., have noted the **interincisor distance** is **increased** when the atlanto-occipital joint is moved from the neutral to the **extended** position.¹¹

This discussion highlights the **interdependence** of the variety of airway physical findings. This author believes that more studies such as those by Ayoub et al., and Calder et al, will further our understanding of the **interdependence** of these “independent” measures.^{10,11}

If the clinician is satisfied that direct laryngoscopy will be straightforward (the answer to question I is “no”), then he or she may proceed as clinically appropriate (e.g. routine induction and intubation or LMA if there is no aspiration risk, rapid sequence induction, etc). This is equivalent to the root point of the ASA-DAA box “B” (figure 1).² If the answer to question II is “yes”, then the AAA proceeds to question III.

III Might supralaryngeal devices be used (if needed)? Until recently, little data was available to aid the clinician in this evaluation. Morbidly obese patients, those with a history of sleep apnea or an airway mass, and those with significant restrictive pulmonary disease were assumed to comprise the bulk of patients who might present with this difficulty. A recent study gave some surprising information by highlighting an expanded range of patients who might present problems (minor or significant) with facemask ventilation. Langeron et al., investigated the incidences of difficult mask ventilation and delineated factors that described these patients.¹² Among fifteen hundred patients, the authors found that 5% could be characterized as having a modestly to severely difficult mask ventilation course. Only one patient was impossible to mask ventilate. Having two of five clinical factors was predictive of difficulty with mask ventilation (**Table 2**).

Table 2: Clinical factors predictive of difficulty with mask ventilation¹²

Age greater than 55
Body mass index >26
History of snoring
Edentulous
Facial **hair**

Some of the criteria used by these authors to define a problem with mask ventilation (e.g., a mask leak, or need for more than one operator) might be considered too minor to be significant. The study did heighten our awareness that there are a significant number of patient situations where we should be suspicious of a problem.

Other prominent supralaryngeal devices include the laryngeal mask airway (LMA) and the Combitube. Both of these devices were introduced in the 1980s, the LMA as a routine airway device to be used during elective general anesthesia and the Combitube as a failed airway rescue device. Both devices are now considered to serve in both elective and rescue arenas.¹³ Since the initial dissemination of the ASA difficult airway algorithm, the LMA has become a commonly accepted device for routine and rescue airway management, with up to 23% of all surgical procedures in the United States employing it electively, and thus is more familiar to the anesthesia practitioner.¹⁴ Though there is a large body of anecdotal and series reports, only one study has investigated the LMA in “Cannot intubate/cannot ventilate” situations. **Parment, et al., were able to rescue 16 of 17 “cannot intubate/cannot ventilate” patients.**¹³ The one patient who could not be rescued was found to have intratracheal blood clots, believed secondary to attempts at transtracheal jet ventilation. The **Combitube** has been shown to have **97% to 99% success rate in prehospital airway rescue when patients could not be intubated.**^{15,16} Factors which preclude the use of the Combitube and LMA include small oral aperture, oropharyngeal, pharyngeal or hypopharyngeal mass, and an aspiration risk (though the Combitube and possibly the **new Proseal- LMA** offer some protection in this regard¹⁷). Esophageal pathology, including caustic ingestion, contradicts use of the Combitube. In situations where the clinician judges that direct laryngoscopy with the aim of tracheal intubation is likely to be difficult, these three supralaryngeal airways, the facemask, the LMA and the Combitube, will be adequate for managing the vast majority of patients. New SGAs (e.g., the Laryngeal Tube) have also been successfully used in the can not intubate/can not ventilate situation. As this, and other new SGAs gain popularity, it is likely that they will supplement the SGA armamentarium.

If the clinician’s assessment leads him or her to a significant suspicion that supraglottic ventilation may be difficult, then we must consider where one’s assessment stands in relation to the ASA-DAA. We have already decided that this patient may be a difficult laryngoscopy (the preoperative equivalent of “cannot intubate”), and now we have

determined that a possible “cannot ventilate” scenario might occur. Within the ASA-DAA we have reached the definition of the emergency pathway. Because we never want to place our patient into danger, and because, as a preoperative tool the AAA gives us the luxury of choice, “box A” (awake intubation) is chosen (figure 1).²

If it appears that supraglottic ventilation will be possible, we proceed to the next AAA question. Recognizing that the decision regarding supraglottic ventilation adequacy may be a difficult one, question V will later address the problem of error.

IV Is there an aspiration risk? This is a difficult topic to discuss. Currently, opinions vary greatly as to what patient’s conditions define a risk. Research regarding gastric emptying times and the development of new propulsive and acidity reducing pharmaceutical agents have changed the meaning of “aspiration risk.” When making this decision, each clinician must weigh-in in light of their personal experiences as well as currently available evidenced-based information. The aspiration risk stratification becomes most important when a clinician has determined that the use of a supralaryngeal airway is a viable alternative to tracheal intubation. The face mask offers no protection from the aspiration of gastric contents. Whereas the original LMA was not designed to protect the patient from the aspiration, it has proven to have a low rate of this complication in moderate and high risk patients.¹⁸ Because the Combitube is designed to sit within the esophagus, has a sealing cuff and an esophageal lumen, it is protective during gastric contents regurgitation.

If there is an aspiration risk then the we have reach a potential scenario of “can not intubate” and “should not ventilate.” In this case, an impasse is reached in the ASA-DAA. Once intubation has failed, the ASA-DAA branches to mask ventilation. Because mask ventilation is contraindicated in the current assessment, we have once again found ourselves in the emergency pathway, and so, will preoperatively choose “box A” (awake intubation) (figure 1).²

If there is no aspiration risk we can proceed in a routine fashion (“box B” of the ASA-DAA).² But because of the possibility of unforeseen difficulty with supralaryngeal ventilation, one more consideration must be made.

V) Will the patient tolerate an apneic period? If our assessment of the patient regarding difficulty of intubation is correct, but our assessment of ventilation is erroneous, the patient will suffer an apneic period after the induction of anesthesia. The duration of this apnea will be dependent upon many factors including a variety of patient health issues, and co-administered drugs. Similarly, the time to critical oxygen desaturation will vary with these same factors as well as the adequacy of preoxygenation (a discussion of each of these factors is beyond the scope of the current lecture¹⁹). Should it be determined that the patient would not tolerate a misjudgment in question III, “box A” (awake intubation) is chosen.² If the patient should be able to tolerate a duration of apnea which will allow the resumption of spontaneous ventilation, or provide the clinician enough time to institute alternative rescue means, routine induction is undertaken (“box B”) (figure 1).²

The experienced clinician may consider an advanced exception in the “failure in judgment” decision branch (question V, answer “No”). As can be seen in Figure 1, a footnote on the “awake intubation” branch indicates that the clinician may “consider the feasibility of transtracheal jet ventilation.” TTJV can rapidly correct hypoxemia when used correctly and in a timely fashion. Location (e.g., operating room vs radiology suite), available equipment (e.g., high pressure oxygen source and Sanuders valve, vs angiocatheter and ambu bag), patient habitus (e.g., accessible cricothyroid membrane vs. the patient with morbid obesity), and the physician’s experience will dictate the practicality of preparing to use TTJV if apnea or airway obstruction occur and result in oxyhemoglobin desaturation.

The “unknown” airway: The preceding analysis assumes that whenever the clinician does not feel comfortable with the adequacy of his or her evaluation of the airway, a conservative approach, that is, in the favor of awake management, should be undertaken (e.g., the cervical spine trauma patient who can not be fully evaluated). The population of patients who present for otolaryngologic surgery represent a special case. This group may present with a history, signs and/or symptoms that indicate pathology that could interfere with direct laryngoscopy and/or the use of a supralaryngeal airway. Traditional methods of airway evaluation will not afford adequate assessment of this pathology. The AAA would therefore dictate entrance into the ASA-DAA at “Box A”, awake intubation (answer to question 2 is “yes” and answer to question 3 is “no”). The clinician who has cared for these patients is well aware that the vast majority can be managed by routine induction. But this clinician is also aware that a small population of

these patients will be at risk for entering the emergency pathway of the ASA-DAA. It is the opinion of this author that this small group of at-risk patients justifies a conservative approach to all such patients. Though awake intubation must be part of the anesthesiologist's basic skill set, few will deny that it does demand more time, more patient and staff cooperation, more equipment and pharmaceuticals, and more skill than the routine induction of anesthesia. It would be helpful, then, to find a method by which we may reduce the number of otolaryngologic patients who undergo this procedure, whilst maintaining the safety of the AAA assessment.

First, it should be noted that inquiring into the otolaryngologist's preoperative exam may not be adequate. Though many otolaryngologists employ indirect techniques to examine these patients preoperatively, their assessment may not be helpful, and may be misleading. Differences in the information sought in the exam by the otolaryngologist and the anesthesiologist account for this departure. (Table 3)

Table 3: Otolaryngologist's vs. Anesthesiologist's assessment goals on exam of the larynx

<u>Otolaryngologist</u>	<u>Anesthesiologist</u>
Extent of disease (staging)	Risk of obstruction at induction
Preservation of function	Impediments to SLA use
Risk of obstruction with delay to surgery	Impediments to direct laryngoscopy
	Impediments to indirect laryngoscopy

Though the surgeons' assessment may not be adequate for the anesthesiologists, we may learn much from their techniques. The preoperative surgical exam often occurs with a small nasal fiberscope, in a clinic setting, with minimal preparation of the airway, no intravenous access, and with the patient (and physician) in street clothes!²¹ What we as anesthesiologists consider a "high tech" operating room procedure is undertaken thousands of times a day in practitioners' offices! The fiberscopes used in these exams may be as small as 2mm. Though the intubating fiberscopes used in the operating room are typically larger ($\geq 4\text{mm}$ in the adult population), modest efforts in patient preparation (over-the-counter nasal vasoconstrictors and topical local anesthetics) are typically adequate.

The preoperative endoscopic exam may take place in the nursing admission area, holding area, or in the operating room. Monitoring and IV access is not required for this exam. This may need to be modified based on the decision to use antisialogogues or sedation, or the clinical status of the patient. Once the fiberscope is advanced from the nasal cavity to the naso- or oral-pharynx, the clinician makes a multileveled assessment. (Table 4) Once this minimal exam is complete the fiberscope is removed and management decisions can be reconsidered.

Table 4: Assessment of the airway on preoperative fiberoptic exam

Can the larynx be visualized?
Is there adequate space for a supralaryngeal airway?
Is there anything to prevent or contraindicate direct laryngoscopy?

Though on first appraisal it might appear that preoperative fiberoptic exam would increase the rate of awake intubations, the intent is the opposite. By deciding that the otolaryngologic patient should present no difficulty with direct laryngoscopy, question 2 of the AAA may be answered "no" (figure 1). Likewise, this exam may allow the clinician to answer question 3 as "yes". In both cases, awake intubation can be avoided. If the findings on the preoperative endoscopic exam lead the clinician towards awake intubation, partial airway preparation has been completed.

Summary

Airway evaluation should be aimed at developing a plan to manage all aspects of the patient's airway, and not only by direct laryngoscopy. Every time we are asked to manage an airway, or to use pharmaceuticals or procedures that might compromise the patient's ability to maintain a patent and competent airway, we must consider alternatives. The ubiquitous use of the Laryngeal Mask Airway and similar devices, provide new possibilities in the approach to the airway. By asking the correct questions, all information regarding management of the airway is delineated. The "cannot intubate" or the "cannot intubate-cannot ventilate" condition may still arise, but even in this situation, the clinician should be better prepared, having concisely gathered the critical information. In the oft-time confusing world of new ventilation devices and reflux reducing medications, the AAA aids steers the clinician into the appropriate starting point of the ASA-DAA.

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