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The Airway Approach Algorithm: A Decision Tree for Organizing Preoperative Airway Information

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Anticipatory decision-making in airway management requires the integration of both history and physical examination findings. Though all airways can be managed along some branch of the American Society of Anesthesiologists' (ASA) Difficult Airway Algorithm, by predicting specific difficulties and integrating this information into an airway approach strategy, emergency branches of the ASA algorithm may be avoided. The Airway Approach Algorithm (AAA) consists of five clinical questions, with "yes" or "no" answers, to be addressed prior to the management of the airway. A positive answer to any question leads the clinician to the next, whereas a negative answer directs the operator to a root point of the ASA algorithm. The AAA is introduced with the anticipation that trainees in Anesthesiology, as well as others, will find it helpful in organizing preoperative information concerning the airway. © 2004 by Elsevier Inc.

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Introduction

In 1993, the American Society of Anesthesiologists' (ASA) Task Force on the Difficult Airway published an algorithm that is the foundation of airway management practice.[1] These guidelines have been recently updated. [2] The ASA-Difficult Airway Algorithm (DAA) gives clinicians a rational decision tree to follow when faced with the anticipated difficult airway, the cannot intubate/can ventilate nonemergency, and the cannot intubate/cannot ventilate emergency. [2] Based upon the clinician's preoperative evaluation, the airway management of all patients undergoing general anesthesia with tracheal intubation follows a branch of the DAA commencing at one of the two root points: awake intubation (*Figure 1, Box A*) or intubation after anesthetic induction (*Figure 1, Box B*) Though stressing that the clinician must make this initial root distinction, the Task Force provided little guidance to this end, noting that routine preoperative evaluation "rating systems exhibit modest sensitivity and specificity."[1,2]

Identifying the truly difficult airway can be problematic. An airway may be considered difficult for mask ventilation, supralaryngeal ventilation, direct laryngoscopy (DL), DL and tracheal intubation, or intubation by other means (e.g., fiberoptic bronchoscope, retrograde wire, intubating laryngeal mask, etc.). The profound effect that the utilization of supralaryngeal airways (SLA) has had

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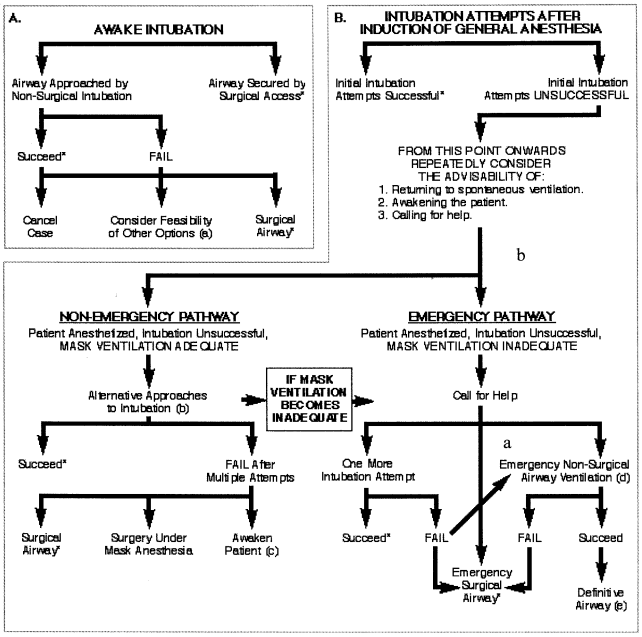
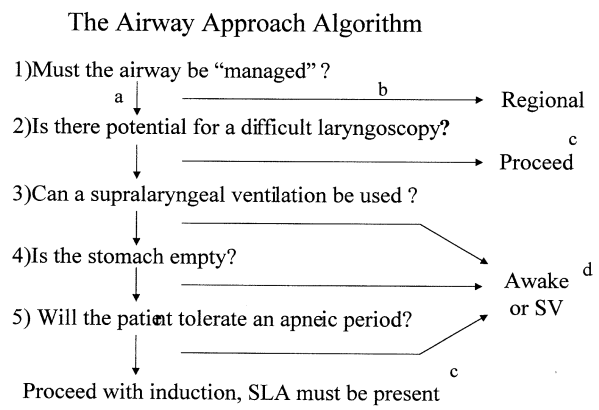


Figure 1. The Difficult Airway Algorithm of the American Society of Anesthesiologists.



Footnotes:

a. "Yes" answer: continue within AAA

b. "No" answer: leave AAA, Consider root point of ASA DAA

c. Enter ASA DAA at Box B

d. Enter ASA DAA at Box A

Figure 2. The Airway Approach Algorithm.

on routine, emergency, and rescue airway management has influenced the most significant change made in the 2003 revision—the removal of the LMA from the emergency pathway. The LMA is now considered within the algorithm to be a nonemergency mode of ventilation.*[,2,3]

The 2003 revision of the guidelines also recognized that the proliferation of routine supralaryngeal ventilation has altered many practitioners' views on what constitutes the difficult airway.[2,4] This concept was first broached by Tekenaka *et al.*[5] in 2000. In a letter, these authors proposed an algorithm for electively managing the patient who appears to have an airway that might be difficult but not impossible to intubate via direct laryngoscopy. They suggested that the induction of anesthesia could proceed as long as a laryngeal mask airway (LMA) was available for airway rescue should DL fail: this supralaryngeal airway offers the clinician a high success rate, even in patients with physical characteristics compatible with difficult laryngoscopy.[2] This brief report by Tekenaka *et al.* did not define which patients would be candidates for such an approach. In identifying these patients, the ability to ventilate with a supralaryngeal device and minimal aspiration risk would need to be assured to the best of the clinician's judgment. An evaluation of these factors, as well as the likely ease or difficulty of DL, and the risk to the patient of a judgment error could be integrated into preanesthetic airway assessment in a manner, which draws on the concepts of Tekenaka *et al.* Such an assessment protocol could aid not only in choosing an appropriate root of the DAA, but also in anticipating the course along the algorithmic tree. Anticipating a pathway, which leads to an undesirable branch, could allow reconsideration of the entry root. This report describes a decision tree approach to patient evaluation. The "Airway Approach Algorithm" (AAA) is meant to be used by the clinician prior to the induction of anesthesia to organize information vital to airway evaluation, choose an appropriate DAA entry root and avoid the emergency branch of the DAA.

*Rosenblatt W, Ovassapian A, Eige S: Use of the Laryngeal Mask Airway in the United States: a randomized survey of ASA members [Abstract]. *Anesthesiology* 1998;89,3A:A575.

Organization of the Algorithm

The AAA is a single-path algorithm comprised of five clinical questions (*Figure 2*): A negative answer to any question directs the clinician to a root point of the DAA. A positive answer leads the operator to the next question. Two important principles should be kept in mind as the clinician moves through the AAA. First, this is a cognitive exercise—the clinician is developing predicted-equivalents of DAA events and branches prior to managing the patient. This gives the clinician the advantage of considering possible outcomes and making decisions regarding not only how he/she would like to begin airway management, but also, which arms of the DAA he/she would prefer to avoid. For example, it might be determined that a patient's evaluation reveals a predicted-equivalent of a can not intubate/can not ventilate scenario (i.e., emergency pathway, past nonsurgical ventilation, *Figure 1, Box B, footnote a*). In this case, the DAA suggests using invasive procedures. If this possibility has been contemplated preoperatively, the patient need never be induced and the anticipated difficult airway root point can be chosen. Second, in answering each question of the AAA, the clinician relies on his/her past experience, clinical judgment, and knowledge of the literature.

The AAA does not suggest specific procedures or unique pathways, but rather is meant to organize the clinician's own opinions and preferences along the lines of the DAA. If, during management, this judgment should prove wrong and airway control should fail, placing the patient in imminent danger, the DAA emergency management branch is followed.

The Five Questions of the AAA (*Figure 2*)

1) Is airway control necessary?

Though possibly the most common physiologic function to be altered by the anesthesiologists, the induction of apnea can never be considered casually. By rendering the patient apneic, the anesthesiologist has placed the patient at significant risk. For this reason, the AAA commences by questioning the need for airway control. This decision may not be solely answered by the anesthesiologist: the proposed surgical procedure (including alternative procedures), the surgeon, and the patient may not be amenable to regional or infiltrative anesthetic techniques. Given these factors, as well as the individual's own comfort with specific regional techniques, the anesthesiologist must be the primary decision maker.

Of course, airways may need to be controlled in regional as well as general anesthetics. Regional block and local infiltration cases, and invasive procedures performed with or without sedation, may all require either a degree of airway manipulation or conversion to a general anesthetic. This illustrates the importance of contemplating all the questions of the AAA (e.g., all the information gathered) and an airway strategy developed even if a nongeneral anesthetic technique is chosen, an approach argued by the ASA Task Force.[1]

2) Is there potential for a difficult laryngoscopy?

Once the decision to use general anesthesia is made, difficulties with direct laryngoscopy are considered. Though other techniques used to facilitate tracheal intubation have become ubiquitous, and may be more versatile (e.g., flexible fiberoptic aided intubation), direct laryngoscopy and tracheal intubation remain a standard of care in the United States and elsewhere.[1,6-8] It is generally accepted that tracheal intubation provides the best protection from aspiration, and ability to ventilate with high airway pressures. In most hands, tracheal intubation is achieved faster with direct laryngoscopy than other techniques.

The question of ease of direct laryngoscopy and tracheal intubation is approached with a careful, and focused review of the patient's history, and a physical evaluation of the airway. Because no single airway exam or series of exams is universally accepted in describing the patient who may prove to be a difficult laryngoscopy, the AAA recognizes that the answer to question 2 is based largely on clinical experience. The commonly accepted methods of physical evaluation have low and variable sensitivity and marginal specificity when correlated with the view of the larynx achieved.[9-12] This is further complicated by high inter-observer variability.[13] The marginal positive predictive values, sensitivities and specificities of these exams might be improved when applied to specific populations.[14]

A record of previous airway management events is extremely valuable. Techniques employed, excessive time required to control the airway, documented difficulties, and other historical findings should be sought. Of course, time changes many things, including airways. A patient, who was managed easily months or years earlier, may not be as easily managed today. Weight gain, new onset snoring, arthritic disease, or the pathology that now requires surgical intervention, may all have led to a change in the airway. The anesthesiologist should be particularly wary in the patient who was managed successfully, but with difficulty, in the past. Small changes in a variety of systems may tip the balance of airway management: a history of previous difficult airway management is more revealing than a history of an "easy" airway.

For the above reasons the AAA, like the ASA's Task Force's statement, does not assign weight to the various clinical findings described in the literature. The experience of the clinician must guide the predicted difficulty of laryngoscopy. The AAA only demands that the clinician makes the delineation that the patient appears straightforward to manage by direct laryngoscopy, or that there may be any element of difficulty. As will be seen, answering AAA question 2 in the positive ("yes, there may be difficulty with laryngoscopy") does not exclude routine induction of anesthesia and a trial of laryngoscopy—but it will challenge the operator to consider the consequences of being in error, as well as assure that the appropriate rescue strategies have been evaluated.

If a definite decision is made that the airway can be managed with DL ("no, direct laryngoscopy will be straight forward"), the capable anesthesiologist should be able proceed with the induction of anesthesia, even if the plan calls for the use of an alternative airway technique (e.g., laryngeal mask airway).

Can a definite answer to question 2 ever be assured? Possibly not. But this pathway into the DAA is often followed in clinical practice, and is the typical extent of the evaluation that is performed when a rapid sequence induction is chosen in the full stomach patient.

3) Can supralaryngeal ventilation be used?

Failed tracheal intubation should be inconsequential if ventilation may be achieved by other means. Though the incidence of failed intubation/failed mask ventilation has been well established, few prospective studies have included airway rescue using alternative supralaryngeal devices, such as the LMA and Tracheal-esophageal Combitube.[15] Many of the factors that contribute to difficult mask ventilation are bypassed by these intraoral devices (Table 1).[16] Therefore, the incidence of total failure to control the airway can be expected to be lower than the 1:10,000 rate of cannot intubate-cannot facemask venti-

Table 1. Clinical Findings Associated with Difficult Face Mask Ventilation[17]

Facial hair
Edentulous
Body mass index > 26
Age > 55
History of smoking

late.[15] Ventilation with supralaryngeal devices is limited chiefly by the peak airway pressure that can be delivered.

As with question 2 of the AAA, the clinician should precede along the "yes" arm the algorithm only if he/she is satisfied that supralaryngeal ventilation will be adequate by either facemask, or other device. If the clinician doubts the ability to control the patient's airway by one of these means, the "no" arm is chosen, and operator is steered toward the anticipated difficult airway arm of the DAA (*Figure 1, Box A*), which recommends awake intubation or surgical airway.[1] When a patient is unable to cooperate with these choices (e.g., the young child or cognitively impaired adult) techniques utilizing spontaneous ventilation of inhaled anesthetic agents might be considered.

Following the negative arm of question 3 of the AAA, illustrates the juxtaposition of the AAA, the DAA and daily practice. Consider the clinical situation where a patient has been induced with a general anesthetic, cannot be intubated (with direct laryngoscopy), and cannot be ventilated (by face mask or other available supralaryngeal device)—the classic cannot intubate/cannot ventilate scenario. On choosing the negative arm of question 3, we have arrived at the same scenario, but in a predictive sense, before the patient has been placed at risk: the evaluation has reached the predicted-equivalent of "cannot intubate" (positive arm of question 2) and the predicted-equivalent of "cannot ventilate" (negative arm of question 3). If this had occurred during the induction of anesthesia, the emergency pathway of the DAA would be not only have been entered, but options short of invasive procedures exhausted (*Figure 1, footnote a*). Because the AAA is an assessment algorithm, the clinician still has the option of never entering the emergency pathway, and can choose awake pathway management with an alternative intubation technique, such as the fiberoptic-aided intubation. It is true that the clinician may be wrong in answering questions 2 and 3, resulting in unnecessarily undertaking awake intubation, but if one errs, it is in the direction of patient safety. It would be foolhardy to induce anesthesia in a patient you were not sure you could intubate (with direct laryngoscopy) or ventilate by any means.

4) Is the stomach empty? (Is there an aspiration risk?)

The nonfasted patient, the patient with delayed gastric emptying and the patient with severe, poorly controlled reflux should not be ventilated with supralaryngeal devices. During supralaryngeal ventilation the airway is relatively unprotected, and there may be an increased risk of regurgitation by virtue of gastric distension. Though the gold standard for tracheal protection is the cuffed tracheal tube, specific supralaryngeal airways may give some measure of protection.[17-21]

The patient who the clinician considers a "full stomach" or at high risk of regurgitation, should immediately be considered along the negative arm of AAA question 3. In this case, the evaluation has reached the predicted-equivalent of cannot intubate and should not ventilate, and therefore has no further option to follow in the DAA (*Figure 1, footnote b*). The clinician therefore should again consider the awake management pathway.

5) Will the patient tolerate an apneic period?

Once the clinician is satisfied that supralaryngeal ventilation would be effective and there are no factors that contraindicate its use, the clinician could proceed with the induction of anesthesia with the plan that if DL and tracheal intubation fail, ventilation by face mask or other supralaryngeal device should be possible and safe. Unfortunately, the incidence of cannot ventilate by any means including face mask, LMA, Tracheal-esophageal Combitube, or other supralaryngeal device is not known. As illustrated above, the available literature indicates that the occurrence should be far lower than that of cannot intubate/cannot ventilate (by facemask).[15,16] Still, the clinician has to be wary that in the event that the patient cannot be ventilated by any means and cannot be rapidly intubated, oxyhemoglobin desaturation may occur. Controlled human studies as well as computer simulation demonstrate that an adequately preoxygenated, healthy adult, or child should maintain oxyhemoglobin saturation for 5 to 9 or 2 to 4 minutes, respectively, after the onset of apnea.[22-25] Obesity, pregnancy, "illness," inadequate preoxygenation, and other patient factors will contribute to premature oxyhemoglobin desaturation.[22-27] Because anesthetic induction may produce an apneic period of 30 to 60 seconds without, and 4 to 7 minutes with succinylcholine, the clinician must consider whether the patient will tolerate this apneic period if his/her answer to question 3 (can supralaryngeal ventilation be used?) proves incorrect. If the clinician determines that the patient may not tolerate an error in judgment in question 3, then the awake intubation root of the DAA should be chosen. If, on the other hand, it is judged that the patient will tolerate the apneic period, the AAA recommends that the clinician proceed with the routine induction of anesthesia, assuring the immediate availability of those supralaryngeal devices that were taken into consideration when answering question 3 in the affirmative.

Summary

The AAA provides the anesthesiologist with a stepwise approach to decision making in the evaluation of the airway, and guides entry into the DAA. Though it may be impossible to anticipate every airway that is difficult to manage, the vast majority can be managed safely if the clinician approaches all patients in a rational manner. The choice of the difficult airway tool to be employed (e.g.,

flexible fiberoptic intubation scope *vs.* Fastrach-LMA) is often less important than decisions regarding how the airway is to be approached (e.g., awake intubation *vs.* intubation after induction of anesthesia). This is done through gathering of critical information: 1) the need for airway control, 2) the ease of laryngoscopy, 3) the ability to use supralaryngeal ventilation, 4) the aspiration risk, and 5) the tolerance that the particular patient may have to judgment error. By integrating this information into a systemic approach to the patient, a rational choice of DAA entry roots is made.

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