2.1 INTRODUCTION

2.1.1 What is the challenge of difficult and failed airway management?

Airway management is fundamental to the practice of anesthesia, emergency medicine, critical care medicine, and other areas of care. The focus of this chapter is the management of the difficult and failed airway in an emergency or urgent situation. Management of the predicted difficult intubation is dealt with in Chapter 3 and in Section II of this book.

The challenge for the airway practitioner is to be able to accurately predict when a difficult airway is more likely to be present, to recognize when an intubation failure has occurred, and to be able to reliably and reproducibly achieve timely and effective oxygenation and ventilation in both of these unnerving circumstances. Appropriate planning, selection of the correct device and technique, and calm execution based on learned methods and experience enhances success even in these most difficult cases. In an airway crisis, there is no question that having a logical and simple approach based on a planned strategy is most likely to be successful.

2.1.2 How reliably can we predict a difficult airway?

In airway management, there are two areas in which difficulty may be encountered: intubation and ventilation. Ventilation most commonly is performed using a bag and a mask, though in more sophisticated settings more advanced devices may be selected (eg, extraglottic devices or EGDs).

In elective situations, difficulty with mask-ventilation is uncommon. Langeron prospectively reviewed the management of 1502 patients undergoing elective surgery under general anesthesia. Difficult mask-ventilation was defined as (1) an inability to maintain \( \text{S}_\text{ao}_2 > 92\% \) while using 100\% O\(_2\) via the anesthesia circuit bag-mask unit; (2) significant gas leak via the face-mask; (3) a need to increase the fresh gas flow to rates > 15 L-min\(^{-1}\) and to use the flush valve more than twice; (4) no perceptible chest wall movement during ventilation; (5) the need to perform a two-handed mask technique; or (6) to change the operator. The anesthesia practitioner was asked to consider ventilation as difficult only if the difficulty was perceived to be clinically relevant, ie, potentially leading to a patient threat. In 5\% of the patients ventilation was considered difficult, and in one patient ventilation was impossible. Following multivariate analysis, five criteria were recognized as independent factors for difficult mask-ventilation: age > 55 years; BMI > 26 kg-m\(^{-2}\); lack of teeth; presence of a beard; and a history of snoring (see Section 1.6.1).

In the emergency situation, other scenario-specific factors may become relevant when considering whether difficulty with mask-ventilation is more likely to be encountered. Trauma to the face with resultant edema, bleeding or debris in the airway, and the need to maintain in-line C-spine immobilization where required may increase the degree of difficulty with mask-ventilation. In addition, the use of cricoid pressure, often perceived to be necessary in emergency intubations, spare is recognized to increase the likelihood of difficult mask-ventilation. Petito and Russell evaluated the impact of cricoid pressure on lung ventilation during bag-mask-ventilation (BMV). Fifty patients were randomized to either have or not have cricoid pressure applied during a 3-minute period of standardized mask-ventilation. Patients who had cricoid pressure applied were considered more difficult to ventilate (36\% vs. 12\%).
and these patients tended to have more air in the stomach than those patients considered easy to ventilate with applied cricoid pressure.

The bulk of the literature dealing with assessment of the airway in anticipation of tracheal intubation using a laryngoscope, including Cass’ landmark paper in 1956,3 and the Mallampati classification in the mid 1980s,4,5 has little applicability to currently available alternative devices (eg, rigid fiberoptic devices, intubating EGDs, video laryngoscopes, etc.). Modification of Mallampati’s original schema,6 as well as alternate strategies to assess the airway (see Section 1.6.2) have been proposed. These have ranged from using simple anatomical descriptors, ranking and summatting anatomical scoring systems, and using logistic regression to create predictive scales and to derive performance indices. These different strategies share some common characteristics: they have a high sensitivity but low specificity and low positive predictive value with respect to predicting failure. Additionally, many of the tests have only moderate interobserver reliability.7 These limitations may help to explain why the tests often fail to predict difficult tracheal intubation, and why perhaps some practitioners question the value of performing preanesthetic airway assessments.8

A number of new schemes and techniques used to predict potential airway difficulty have been described; their accuracy and widespread applicability are not yet determined. However, it is likely that they will continue to be characterized by a low positive predictive value, similar to current strategies, because of the low incidence of airway difficulty.9 Further more, we knew that even with careful evaluation, difficulty will not be predicted in many instances. Therefore strategies to manage the unanticipated difficult airway should be preformulated and practiced to minimize adverse outcomes resulting from false negative predictions.

2.2 AIRWAY EMERGENCIES

2.2.1 How is airway management in an emergency setting different?

Airway management in an emergency setting may be complicated by a multitude of factors. Trauma to the face and neck may distort anatomical features or obscure them with blood and debris. The requirement for in-line stabilization in patients with spinal injury or perceived to be at-risk for a spinal injury may make laryngoscopy more difficult. Unprepared patients are often associated with a full stomach and are at a higher risk of regurgitation and aspiration of gastric contents. The use of cricoid pressure to reduce the risk of regurgitation and aspiration also may make tracheal intubation more difficult. Smith evaluated the ease of rigid fiberoptic (WuScope System™) intubation in anesthetized adults receiving cricoid pressure.9 Each patient had their trachea intubated under two conditions: with and without cricoid pressure. An easy intubation occurred in 91% of patients without cricoid pressure and in 66% of patients with cricoid pressure applied. Cricoid pressure compressed the vocal cords in 27% of patients and impeded tracheal tube placement in 15%. In three patients (9%), pressure had to be released in order to successfully intubate their tracheas. Hodgson assessed the effect of cricoid pressure on laryngoscopy intubation success in 60 adult female patients presenting for abdominal hysterectomy.10 All 30 patients allocated to intubation without cricoid pressure were intubated successfully on the first attempt with a median time of 28 seconds. Laryngoscopy with cricoid pressure was successful in 26 of 30 patients on the first attempt, but the median time to successful intubation was significantly longer at 48.5 seconds. Three patients required two attempts for successful intubation, and one could not be intubated with the laryngoscope while cricoid pressure was being applied. Shulman compared the Bullard laryngoscope (BL) with the flexible fiberoptic bronchoscope (FFB) in a cervical spine injury model, using in-line stabilization with and without cricoid pressure.11 The times for laryngoscopy and intubation were longer in the FFB group than in the BL group. Further, there was a significantly lower rate of adequate laryngoscopic view in the FFB group in the presence of cricoid pressure than in either of the BL groups, or in the FFB no cricoid-pressure group. Shulman concluded that the BL is more reliable, quicker, and more resistant to the effect of cricoid pressure than is the FFB when used in the setting of in-line stabilization with cricoid pressure applied.

In summary, cricoid pressure has a limited, though negative, impact on the success rate of airway interventions.

An emergency and hemodynamic instability may mitigate against the use of drugs that are ordinarily employed to facilitate laryngoscopy, resulting in intubation conditions which may be less than ideal. Finally, a chaotic emergency environment may distract the practitioner making it more difficult to concentrate on the task at hand at a time when focus may be essential.

2.3 DIFFICULT AND FAILED AIRWAY

2.3.1 What does experience tell us about rescuing the difficult airway?

Evidence has emerged that having automatic “default-to” strategies improves the success of rescue airway interventions and reduces the occurrence of adverse outcomes. Conversely, there are also data demonstrating that persisting with failing techniques rather than defaulting to rescue strategies results in higher rates of morbidity and mortality. Rose and Cohen reported that difficult laryngoscopy in anesthesia practice was most often managed with persistent attempts at direct laryngoscopy, and the use of alternative approaches to tracheal intubation was uncommon.12 Mort, in reviewing the airway management of 2833 critically ill patients outside of the operating room, noted that the most common strategy implemented for managing difficult intubations was, again, repeated direct laryngoscopy.13 There was a significantly increase in the rate of airway-related complications as the number of laryngoscopic attempts increased (≥2 vs. >2). These complications included hypoxemia, regurgitation, aspiration, bradycardia, and cardiac arrest.

Contrary to the experiences reported by Rose and Cohen and Mort, Hung noted that immediately choosing an alternate technique (lighted stylet) when direct laryngoscopy had failed was typically rewarded with rapid tracheal intubation.14 Complications were both rare and minor and generally attributable to the preceding attempts at direct laryngoscopy. Recently, Heideger reported on a protocol for
management of both anticipated and unanticipated difficult intubations that emphasized defaulting to the fiberoptic bronchoscope early when difficult laryngoscopy was anticipated or observed. Applied in 13,248 intubations, the protocol failed in only 6 patients (0.045%); again this strategy was associated with minimal morbidity. Combes reported on the efficacy of an institutional protocol employing the intubating laryngeal mask and Eschmann tracheal introducer. One hundred cases of unanticipated difficulties occurred among 11,257 tracheal intubations. There were three deviations from the protocol and two patients were wakened without further airway management. All patients managed by the protocol were successfully ventilated and intubated. Finally, Mort compared the outcomes of patients undergoing emergency tracheal intubation in his institution before and after the application of the American Society of Anesthesiologists (ASA) guidelines. The rate of cardiac arrest during emergency intubation was reduced by 50%.

It is tempting to conclude from these latter reports that early conversion to adjuncts and alternatives to direct-vision laryngoscopy when direct laryngoscopy proves difficult may result in a high salvage rate with low patient morbidity. The emerging evidence is that the choice of the alternative may be less important than the fact that it is a practiced alternative and chosen early in a planned approach when direct laryngoscopy has proven to be difficult or has actually failed.

2.3.2 Is there a pattern to the way airway practitioners behave in the face of a difficult or failed airway?

Tracheal intubation is still predominantly performed orally by direct laryngoscopy. Difficulties related to airway management largely involve failure to achieve tracheal intubation due to difficult direct laryngoscopy. A number of innovative new tools for tracheal intubation have been presented in recent years, which address many of the factors that give rise to difficulties during direct laryngoscopy. The direct laryngoscope is designed to facilitate tracheal intubation by establishing a line of view from the mouth to the larynx. As has already been noted, there are multiple patient factors, which individually or in combination may conspire to obstruct a laryngeal view. The ability to predict all patients in whom it will be impossible to establish a line of view during laryngoscopy is sufficiently imprecise that sole reliance on the laryngoscope to perform tracheal intubation is a precarious strategy.

It is likely that reliance on limited conventional airway techniques that are less than optimum for the task at hand is a risk-enhancing behavior, which predisposes patients to increased rates of morbidity and mortality. There is evidence that such behavior is common among anesthesiologists. Rosenblatt surveyed a random sample of the active membership of the ASA. The survey presented difficult airway scenarios involving cooperative adult patients who required tracheal intubation. Physicians were asked to identify their preferred management technique. In a scenario described as a patient with a history of previous difficult intubation, 60% of practitioners would induce general anesthesia and 59% would proceed with direct laryngoscopy. Experienced practitioners tended to use higher risk induction techniques and were more likely to use the laryngeal mask airway in situations commonly agreed to be unconventional or contraindicated. Use of alternative devices including the BL, lighted stylet, and other adjuncts was uncommon, occurring in <5% in all scenarios.

Jenkins surveyed 833 Canadian anesthesiologists to assess difficult airway management, training, and access to airway equipment. Respondents were asked to indicate their management choices in 10 difficult airway scenarios. The direct laryngoscopy was the preferred technique overall, with FFB being the second most commonly used device. More experienced, male, and older practitioners were more likely to choose asleep induction for high-risk scenarios, a finding similar to that of Rosenblatt. Respondents were not asked to indicate their degree of comfort in using the alternatives that were chosen to manage the clinical scenarios described in the survey.

Kristensen similarly assessed airway management behavior, experience, and knowledge among Danish anesthesiologists by surveying all members of the Danish Society of Anesthesiologists. Respondents were asked if they had experienced situations during anesthesia in which insufficient oxygenation had caused serious problems that could have been prevented by different airway management. About a quarter of those surveyed answered in the affirmative with 20% of registrars and 26% of specialists agreeing. When asked whether they would perform awake intubation if they expected a difficult intubation, 34% of registrars, 50% of senior registrars, but only 25% of specialists said that they would. Only 48% of registrars and 59% of specialists agreed that a previous difficult intubation was a reliable predictor of difficult intubation in the future. These high-risk attitudes and behaviors are especially concerning. Among the specialists, only 21% use a lighted stylet at least once a year, 11% a BL, and 7% a retrograde technique. Forty percent of specialists had intubated the trachea of an awake, spontaneously breathing patient 10 times or less in their career, and 23% of specialists had never done so using an FFB. Finally, about half the registrars and a third of the specialists reported that they did not routinely have immediate access to an LMA when providing anesthesia. Ezri’s more recent survey of American anesthesiologists suggests that there may be an increasing willingness to use alternatives to the direct laryngoscope in airway scenarios perceived as high risk. However, Ezri also observed that such a willingness persisted even when the anesthesiologists acknowledged that they were neither comfortable nor experienced with the alternate technology that they proposed using in these difficult situations.

2.3.3 What is the medical–legal experience with respect to airway management failure?

The largest series of published medical-legal cases involving airway management is that of the ASA Closed Claims Project. Data from the airway cases reviewed in the ASA Closed Claims Project were originally published in 1990, with a revised publication in 2000. In the 1990 report, Caplan noted that respiratory claims accounted for 34% (522/1541) of all claims. Inadequate ventilation was the most common single event overall, accounting for 12.7% of all claims and more than a third of the respiratory claims. In the original report, esophageal intubation and difficult intubation claims occurred each at about half the rate of those for inadequate ventilation. Caplan speculated that improved monitoring would be the most important intervention needed to reduce the incidence of inadequate ventilation.
and esophageal intubation. Further, it was stated that enhanced training would be the most important intervention to reduce the occurrence of difficult intubation and its sequelae.

In 2000, a Closed Claims data update was published in the ASA Newsletter. Respiratory claims now accounted for 17.9% of total claims (798/4459), half the original proportion. Inadequate ventilation accounted for 7% of claims and esophageal intubation for 4.5% of claims, both considerably less than in the first report. However, claims for difficult intubation accounted for 6.4% of total claims, 14% higher than in the original report. In 48% of the difficult intubation claims, some difficulty was anticipated preoperatively by the anesthesiologist. Despite this expectation of difficulties, the most common (69% of instances) management strategy employed in these situations was induction of anesthesia followed by persistent attempts at oral laryngoscopic intubation. A similar strategy of multiple attempts orally was employed in scenarios in which difficulty was not anticipated but encountered. Of the cases in which difficulty was anticipated, 69% eventually deteriorated into a “can’t intubate, can’t ventilate” (CICV) situation.

Airway management was deemed to be below the accepted “standard of care” in 49% of the cases reported in the update. This is significantly higher than that seen for other claims in the database. Claims involving airway management are more likely to be associated with a permanent adverse outcome than others, and it is recognized that such severely adverse outcomes can affect the judgment as to the “appropriateness of care.” However, a preoperative airway review was not conducted (or recorded as having been conducted) in 25% of cases, 28% of practitioner’s had no explicit plan for dealing with anticipated difficulties, and 25% did not alter their conventional method of airway management despite recognizing the potential for difficulty. Furthermore, when difficulties were encountered, the most common management strategy was persistent nonsurgical attempts at tracheal intubation. In 69% of cases where difficulties were anticipated, a CICV situation arose. Finally, and significantly, no strategy for extubation was outlined in almost half of the cases in which the practitioner encountered difficulties intubating the trachea.

2.4 AIRWAY ALGORITHMS

2.4.1 Why are algorithms useful in airway management?

Fundamental to successfully managing the airway, particularly in an emergency, is the development of a systematic approach (“decision trees” or “algorithms”) to clinical situations encountered in day-to-day practice. These algorithms must be evidence based and must be quickly and easily applied. It is fair to say that after years of formal medical education and practice, most of us harbor an aversion to “algorithms.” Memorized by rote and seldom used, most algorithms have been forgotten. While it is recognized that rigidity stifles innovation and constrains personal preference, adherence to sensibly constructed decision trees minimizes variation, conserves valuable time, and has been shown to provide the greatest chance for success.

Decision aids such as algorithms are meant to inform the practitioner rather than dictate to the practitioner. The practitioner is required to correctly identify the clinical problem (ie, a failed airway) before choosing the algorithm. The algorithm should be designed and validated to ensure a high degree of success, provided that it is applied to the correct clinical problem. Many of these situations occur relatively infrequently in a clinical practice, and it is unlikely that practitioners will have an opportunity to generate rules for managing the situations based on experience alone. By providing a limited number of likely-to-be successful options, the algorithm can increase the likelihood of a good outcome.

Reason has defined two basic mechanisms whereby practitioners deal with critical incidents. The first is a rule-based solution, whereby on recognizing the event for what it is, one identifies and applies a solution that has shown will likely be useful in solving the problem. Recognizing the event involves a process called “similarity-matching”, based on identifying that the characteristics of the events are similar to those of past events (in a sense, “pattern recognition”). The practitioner then decides upon a particular solution that is likely to be effective in solving the problem and resolving the threat. This presupposes that the practitioner has had sufficient experience with both the situation and the application of the rule to both immediately recognize the problem and to know which rule to apply. This ability constitutes what is called “expertise.” Unfortunately, difficult and failed airways are encountered infrequently in practice, and the individual experiences of practitioners may have not been sufficient to earn them “expert” status.

The second mechanism for dealing with critical incidents is to apply a knowledge-based solution. This is a ground-up, first-principle strategy whereby the practitioner, without important past experience with similar situations, attempts to find an appropriate solution. Not surprisingly, such strategies are time consuming, and when made under pressure of time, are more likely to result in failure.

Many airway practitioners will not have sufficient experience with difficult and failed airway scenarios to have, of themselves, created a rule-based, organized approach to these airway dilemmas in which knowledge-based solutions may be inadequate. For this reason, preformulated airway algorithms are helpful in these situations and deserve to be considered by all airway practitioners.

Coincident with the development of the “decision trees” (“strategies”) and vital to airway management success is skill in the application of an array of devices and techniques (“tactics”) that can optimize clinical outcomes. Techniques and devices advocated in this chapter, as in the case of the decision trees, are anchored by evidence, rather than personal preference.

Algorithms meant to be used in crisis situations must exhibit the following design elements:

- Entry and exit points are easily recognized
- They are based on the best available evidence
- Branch points are binary
- There is a limited number of actions at each step
- They are easy to remember and represent graphically

2.4.2 What are the strengths and weaknesses of the ASA difficult airway algorithm?

The ASA, in an attempt to avert airway management disasters, has produced the “ASA Difficult Airway Algorithm” first in 1993 (Figure 2-1) and a revision in 2003 (Figure 2-2).26,27 The ASA Difficult Airway
FIGURE 2-1. 1993 ASA Difficult Airway Management Algorithm.
FIGURE 2-2. 2003 ASA Difficult Airway Management Algorithm.
Algorithm is derived from the “Practice Guidelines for the Management of the Difficult Airway,” developed by the ASA Task Force on Difficult Airway Management.

In both iterations, Panel A is directed at anticipating the “Difficult Airway” and managing it awake, and Panel B deals with the “Failed Airway.” The algorithms guide management strategies when difficulty is predicted and recommend rescue tactics in the event of failure. They emphasize the importance of possessing expertise in more than one airway management technique and that each time an airway is managed the practitioner formulate a variety of backup plans should the primary plan fail (“Plan B and Plan C”).

As the ASA guidelines evolved from the first to the second iteration, a number of significant changes were made. Guidance is offered to those anatomic elements that may prove useful in the evaluation of the airway (Table 2-1), although no direction is given as to how to interpret the findings. The concept of a “reassuring” versus “nonreassuring” examination is now included, with the recommendation that a “nonreassuring” examination be a relevant factor in the plan for airway management. The need for the continuous application of oxygen to the patient during management of the difficult airway is emphasized in the second iteration. Finally, the laryngeal mask airway for ventilation has been moved from the emergency pathway of Panel B to an entry point determining whether the emergency pathway is entered. This change is likely due to the worldwide recognition that the laryngeal mask airway is an effective rescue-ventilating device.

A number of other groups have generated evidence-based consensus guidelines for the management of the difficult airway. They differ from the ASA guidelines in being relevant only to the unanticipated difficult airway. They are similar to the ASA package in that they recognize the utility of alternatives to both BMV and the direct laryngoscopy for intubation as well as emphasizing the role of salvage plans and physician training with the alternative devices. The essential messages of the ASA “Difficult Airway Algorithms” are:

- If difficulty is anticipated (a nonreassuring airway examination)—secure the airway awake. While recognizing that even with a careful assessment, some airways perceived to be “unlikely to be difficult,” in fact may be difficult to manage.
- If difficulty is encountered under anesthesia—awaken the patient. This is an option in an elective situation but clearly may not be an option in an urgent or emergency situation or a case in which airway management is the clinical end point rather than a diagnostic or therapeutic intervention.
- Think ahead—have Plans B and C immediately available or in place. This implies that one has evaluated the airway for difficulty in performing Plans B and C before embarking on Plan A, as stressed in Chapter 1.

Additional essential messages from the ASA Closed Claims Project and the medical–legal experience accumulating in anesthesia include:

- If the airway evaluation is nonreassuring, the plan for airway management should be constructed reflecting this finding.
- When faced with a variety of effective intubation choices, do what you do best!!
- If the technique you do best has not worked, and is not working, after no more than three attempts, use some other technique. Do not persist with a technique already demonstrated to be inadequate for the task at hand.

The ASA Guidelines and Algorithm have served to highlight the importance of predicting and managing the difficult airway and have probably led to a reduction in adverse events related to airway management disasters in the operating room setting. However, several limitations are identified in a detailed study of the algorithm:

- The algorithm actually addresses both difficult and failed airway management, but does not explicitly identify the two pathways. Identifying when a “difficult airway” has progressed to a “failed” one is crucial in selecting management options that will avert a bad outcome.
- The nonbinary nature of the decision matrices and the multiplicity of pathways have limited the clinical usefulness of the

### TABLE 2-1

<table>
<thead>
<tr>
<th>AIRWAY EXAMINATION COMPONENT</th>
<th>NONREASSURING FINDING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length or upper incisors</td>
<td>Relatively long</td>
</tr>
<tr>
<td>Relation of maxillary and mandibular incisors during normal jaw closure</td>
<td>Prominent overbite (maxillary incisors anterior)</td>
</tr>
<tr>
<td>Relation of incisors during protrusion of mandible</td>
<td>Overbite remains present</td>
</tr>
<tr>
<td>Interincisor distance</td>
<td>Less than 3 cm</td>
</tr>
<tr>
<td>Visibility of uvula (Mallampati class)</td>
<td>Not visible with tongue protruded, patient sitting (&gt;II)</td>
</tr>
<tr>
<td>Shape of palate</td>
<td>High arched or narrow</td>
</tr>
<tr>
<td>Compliance of mandibular space</td>
<td>Stiff and indurated</td>
</tr>
<tr>
<td>Thyromental distance</td>
<td>Less than 5 cm</td>
</tr>
<tr>
<td>Length of neck</td>
<td>Short</td>
</tr>
<tr>
<td>Thickness of neck</td>
<td>Thick</td>
</tr>
<tr>
<td>Range of motion of head on neck</td>
<td>Limited</td>
</tr>
</tbody>
</table>

algorithm in guiding day-to-day practice, particularly in a crisis posed by an airway management failure (ie, Plans B and C).

- Often, in real life, rescue maneuvers are (and perhaps ought to be) contemplated and executed concurrently (eg, inserting an LMA at the same time preparations are underway to perform a surgical airway). The algorithm is silent in this regard.
- The algorithm does not provide for uncooperative patients (children, mentally challenged, and patients who refuse to cooperate with the planned airway management) and different patient populations (eg, obstetrical and pediatric patients).
- While surgical airway management is the cornerstone of failed airway management, anesthesia practitioners are often reluctant to undertake surgical airway management. Most experts agree that all airway practitioners ought to be able to perform such an intervention. Failure of the practitioner to expeditiously perform a surgical airway is often leveled as a criticism by plaintiff experts in medico-legal actions. It follows then, that when faced with a failed airway, preparations for a surgical airway must begin immediately. Neither the 1993 nor the 2003 ASA algorithm reflects this thinking. Furthermore, the 2003 ASA algorithm inserts an additional LMA step, potentially delaying the performance of a surgical airway.
- The medico-legal context.

The algorithm is intended to facilitate the management of the difficult airway and to reduce the likelihood of adverse outcomes. Although the determination of whether or not a practitioner met the standard of care will be judged in law, it is likely that reference to existing guidelines will be made in such determination.

The guidelines and algorithm are silent with respect to whether or not they ought to apply outside the operating room. The performance of a defendant may be expected to comply with the algorithm no matter where the airway management is undertaken.

The option of "awakening the patient" is often not possible in a failed airway situation, particularly if the intubation is an emergency and the intubation is the actual and necessary clinical end point. This may seem elementary in concept, but the statement may pose a problem in medico-legal proceedings when the simplicity of "awakening the patient" is positioned by the plaintiff as the solution in the face of airway management failure, making the failure to do such a simple maneuver inexplicable and arcane. A simple statement by the Task Force that "awakening the patient" is not always feasible would go a long way in legally defending the appropriate actions of a practitioner in emergency airway situations.

Despite any disclaimer, this document is likely to be referenced by medical experts in establishing the "standard of care" for difficult and failed airway management in anesthesia practice.

### 2.5 THE EMERGENCY AIRWAY ALGORITHMS

#### 2.5.1 Why do these algorithms work best in emergency situations?

The Emergency Airway Management Algorithms that follow adhere to the design elements of effective algorithms and are specifically intended to be applied in crisis situations in which actions must be intuitive and automatic to increase the chances of a good outcome. They are derived loosely from the ASA algorithm and based on the same evidence. They describe a logical progression of "thinking" and "doing" when faced with the "crash" situation, the difficult airway, and the failed airway. An algorithm dealing with extubation of the difficult airway is also presented.

These algorithms are shown in Figures 2-3 to 2-6. The reader is encouraged to refer to the figures while reading the text descriptions below. The Emergency Airway Algorithms do not address the indications for intubation and do not deal with the decision to intubate. Therefore, the entry point for each one is immediately after the decision to intubate has been made.

![Airway management overview](image)
These algorithms, though consistent with the thinking imbedded in the ASA algorithm, are tailored for urgent and emergency clinical situations and adhere to the principles fundamental to such clinical situations. Importantly, the algorithms presented in this chapter are not meant to be memorized and followed slavishly, as with a recipe. They are the ways of rapidly thinking through urgent clinical situations and helping to make crucial decisions and actions.

The practitioner may fail to appreciate the “failed airway” and subsequently fail to move quickly to a salvage strategy or to secure a surgical airway. It must be emphasized that there ought to be no hesitation in performing a surgical airway or cricothyrotomy in the face of airway management failure.

2.5.2 The overview algorithm

The Overview Algorithm (Figure 2-3) presents the way most practitioners approach the issue of airway management. Most of the time, it is routine, elective, controlled, and deliberate. Most intubations are not “crash” or emergency situations. So the first real question faced in daily practice is “Is this a difficult airway?” If not, it is handled in a routine fashion as preferred by the individual.

If it is deemed to be difficult (based on a nonreassuring airway examination, an awkward environment, poor patient condition, etc.), an awake intubation procedure may be indicated depending on the judgment of the airway practitioner. There are a number of considerations that will inform and influence this decision.
Is direct laryngoscopy likely to be difficult? If so, is the airway practitioner skilled in an alternative technique that is likely to be effective in the situation or is the skill set limited to direct laryngoscopy? If the latter statement most accurately describes the situation, then awake intubation is likely the most prudent course. If the former statement most accurately describes the case, consideration may be given to induction of anesthesia, with muscle paralysis, followed by tracheal intubation using an alternate strategy, provided that there is no anticipated difficulty in ventilation using BMV or an EGD.

Is there a need to protect the airway from gastric contents? If so, it should be recognized that the ability to protect the airway with cricoid pressure is limited and that multiple attempts at direct laryngoscopy over a prolonged period of time are associated with regurgitation and aspiration. The combination of difficult laryngoscopy and a full stomach in a cooperative patient may best be managed with an awake intubation (see Chapters 3 and 5).

In the event the patient is unresponsive or near death, a “crash” intubation is indicated and the “Crash Algorithm” is employed. “Unresponsive” means that the patient does not respond adversely to oral laryngoscopy (“the newly dead or nearly dead”). Failure to meet the criteria for a crash intubation does not mean that the intubation is not an emergency. Intubation is urgently indicated in the event when a patient is unable to:

- maintain reasonable oxygenation,
- protect the airway,
- maintain the airway,
- is faced with intubation to manage some other condition, or is to be paralyzed.

Once the decision is made that this is an urgent or emergency intubation, the next question is “Will this be a difficult intubation?” This decision must be made quickly, and Chapter 1 presents efficient strategies for assessing the airway quickly for difficulty. If the urgent/emergency intubation is not judged to be difficult, a Rapid Sequence Induction/Intubation (RSI) is indicated as the method most likely to rapidly and safely secure the airway.

In the event the airway is judged difficult, the Emergency Difficult Airway Algorithm should be employed. Should any of these approaches fail, the “Failed Airway Algorithm” is used to rapidly and definitively gain control of the airway.

Four algorithms emerge from this conceptual approach to the airway and its management:

- The Crash Airway Algorithm (Figure 2-4)
- The Emergency Difficult Airway Algorithm (Figure 2-5)
- The Failed Airway Algorithm (Figure 2-6)
- The Extubation Algorithm (Figure 2-7)

2.5.3 The crash airway algorithm

Entry at this point requires an unconscious, unresponsive patient with immediate need for airway management. The first step in the crash algorithm is to attempt oral intubation immediately by direct laryngoscopy without pharmacologic assist. If the oral intubation is successful, then the practitioner proceeds with postintubation management. If oral intubation is not initially successful with direct laryngoscopy, then a decision point is reached and several questions must be asked.

2.5.3.1 Is BMV Successful?

If BMV is successful, then one has time and further attempts at oral intubation are possible. If BMV is unsuccessful in the context of a failed oral intubation with a “crash” airway, then a failed airway is present. BMV should be optimized with the use of oral and nasal airways and include maneuvers such as jaw thrust, chin lift, or a head tilt if appropriate. A two-hand mask hold may improve mask seal. Additionally, if cricoid pressure is being applied, consideration should be given to relaxing the force being applied or temporarily discontinuing it and assessing airway patency in its absence. One further attempt at intubation may be indicated, but no more than one, because intubation has failed and the failure of BMV places the patient in serious and immediate jeopardy. This is a CICV situation, and in such circumstances, the “Failed Airway Algorithm” (see Figure 2-6) mandates immediate surgical airway management. If surgical airway management is not immediately possible, temporizing methods, such as the placement of an EGD (eg, LMA or Combitube™), should be attempted, but such attempts should not delay preparation for, and the creation of, a surgical airway. The successful use of an EGD in permitting adequate gas exchange may obviate the need for a surgical airway.
2.5.3.2 Is the Patient Completely Relaxed and Flaccid?

During the first attempt at orotracheal intubation in the unconscious, unresponsive patient, the patient is assessed for degree of relaxation to permit intubation. If the impression is one of absolute, complete skeletal muscle relaxation, then further intubation attempts are indicated. If the patient is felt to be exhibiting any resistance whatsoever to intubation, then a single dose of succinylcholine, 2.0 mg·kg\(^{-1}\), should be given and oral intubation attempted again. Usually, only one dose is indicated. It should be noted that this dose of succinylcholine is higher than the 1.0–1.5 mg·kg\(^{-1}\) recommended elsewhere in this text. This is an empiric judgment of the authors related to the fact that these patients often have no spontaneous circulation needed to get the medication to the motor endplate. Further, in this situation no induction agent is indicated.

2.5.3.3 Have There Been Three Attempts at Intubation by an Experienced Airway Practitioner?

If the answer to this question is yes, then consistent with the definition above, the situation represents a “failed airway” (Figure 2-5). The futility of further attempts may be evident after the first attempt dictating an immediate move to a different device or technique. If fewer than three attempts have been made by an experienced airway practitioner, and it is the opinion of the practitioner that it is possible to be successful by this route, a repeat attempt at oral intubation is justified. No more than three attempts at direct laryngoscopy can be supported. As detailed above, the evidence suggests that there is a low likelihood of success with persistent use of the direct laryngoscope after three failed attempts and an increased likelihood of patient morbidity and cardiac arrest. Between each intubation attempt, defined by a single laryngoscopy, the patient should receive ventilation and oxygenation through a bag-mask.

2.5.3.4 Is It Appropriate to Repeat Laryngoscopic Intubation Until Three Attempts Have Failed?

As stated above, it is often apparent after a single attempt that further attempts at orotracheal intubation will be futile. In such cases, move to Plan B if oxygenation can be maintained; the “Failed Airway Algorithm” if it cannot be maintained.

2.5.3.5 Were Repeated Efforts Successful?

If intubation is achieved, then proceed to postintubation management; if not, cycle back to make another attempt or to proceed to the failed airway algorithm, depending on the number of attempts which have already been made. The failure of three attempts indicates a very low likelihood of ultimate success with oral intubation. There is a diminishing return with subsequent attempts and an increased risk of hypoxia, aspiration, and cardiac arrest. After three attempts, efforts to ensure oxygenation should be the priority while preparations are being made to perform a surgical airway.

2.5.3.6 Postintubation Management

This is undertaken in the event of a successful intubation.

2.5.4 The emergency difficult airway algorithm

This algorithm (Figure 2-5) is specifically designed to guide airway management in an emergency. Decisions are binary by design. It incorporates the notion of the failed airway. Though a fairly busy-appearing figure with some 13 boxes, in reality it simply poses a series of simple questions:

1. Is the airway difficult (MOANS, LEMON, RODS, and SHORT)? (See Sections 1.6.1–1.6.4.)
2. Do I have time (is the oxygen saturation within a normal range)? Or can I make time (with BMV)?
3. On reconsideration, is an RSI technique reasonable?
4. Failing that, what is my best option?

Bearing in mind that patients presenting in an emergency should almost always considered having a full stomach, some points deserve emphasis.

2.5.4.1 Is a Difficult Airway Predicted?

If, for whatever reason, airway management is predicted to be difficult, nothing should be taken from the patient that the airway practitioner cannot replace. This particularly applies to the administration of paralytic drugs. Furthermore, the ability to protect the airway with cricoid pressure is limited, and multiple attempts at laryngoscopy over a prolonged period of time have been associated with regurgitation and aspiration. Therefore, careful consideration should be given to awake intubation in the setting of dual concerns of difficult airway and full stomach.

2.5.4.2 Is BMV or EGD Ventilation Predicted to Be Successful (MOANS and RODS)? (See Sections 1.6.1 and 1.6.3.)

In other words, if intubation fails, will BMV or rescue with some other device (commonly an EGD) be possible? One must have a high degree of certainty that this question is answered in the affirmative, particularly if one is contemplating the use of paralytic agents. The fact that one is operating within this algorithm presupposes that there is a sense of urgency to the situation and the airway practitioner is suspecting difficulty. In this situation, planning for and being prepared to undertake rescue maneuvers (Plans B and C) are crucial, as is the preemptive evaluation for difficulty. As an example, if one is planning to perform a rapid cricothyrotomy (Plan B) should induction and paralysis (Plan A) fail, then an evaluation for difficult cricothyrotomy must be performed (SHORT, see Section 1.6.4) before embarking on Plan A.

2.5.4.3 Is Intubation Deemed Reasonably Likely?

The decision to proceed with an RSI technique in the patient with a predicted difficult airway must be associated with the likelihood that it will be successful. Airway practitioners must be confident in their abilities and must possess a broad array of equipment and skills to rescue the airway in the event that conventional direct vision orotracheal intubation fails.
2.5.4.4 Should an “Awake Look” Employing Topical Anesthesia and Sedation Be Attempted to Assist in Decision Making?

A variety of techniques are available to obtund the airway, the patient, or both, without “burning any bridges.” The condition of the patient and the clinical situation will dictate the aggression of this maneuver (ie, how much does one need to see?). It may be that the airway practitioner simply needs to verify that the epiglottis is in the midline to make the decision to back off and move to a rapid-sequence technique. At other times, it may indicate that an awake intubation is appropriate.

The value of the “awake look” as a maneuver to reassure oneself that oral intubation is likely to be possible following the administration of induction and paralytic medications ought to be tempered by the findings of Sivarajan and Fink. These authors measured the position of larynx in lateral radiographs of necks taken in human volunteers when they were awake, and after induction of general anesthesia and muscle paralysis. They found that the hyoid bone and epiglottis were shifted anteriorly and the extraglottic region or the vestibule of the larynx was enlarged with the onset of general anesthesia and muscle paralysis. In addition, the larynx was also stretched longitudinally with wide separation of the vestibular and vocal folds.

The authors concluded that consciousness is associated with tonic muscular activity that folds the larynx and partially closes it and that onset of general anesthesia and muscle paralysis opens the larynx wider and shifts it anteriorly, which might make visualization of the larynx difficult during direct laryngoscopy in some patients.

2.5.5 The Failed airway algorithm

The failure to intubate is rarely accompanied by the failure to ventilate and oxygenate. This situation has variously been termed CICV or “can’t intubate, can’t oxygenate” (CICO), the latter being the more precise term. It is a clinical emergency of such magnitude that it leads to neurologic compromise and death if not rectified rapidly. Decisive action in selecting a technique most likely to lead to a secure airway (ie, an emergency surgical airway) is essential to success in such a situation. It cannot be overemphasized that a failing technique (eg, direct laryngoscopy) cannot be considered as an appropriate salvage technique and there is no defence for persistent attempts with a failing technique.

More often the failure to intubate is associated with some degree of success with BMV/oxygenation, giving the airway practitioner time to consider alternative techniques. This CICV/O situation is amenable to nonsurgical rescue techniques. In this scenario, practiced alternatives to the direct laryngoscope such as the lighted stylet, or a rigid or flexible endoscope, may be used or an EGD may be placed to provide a more secure, bridging airway. In the latter case, these EGDs may be used to facilitate intubation (eg, LMA-Fastrach®, Cook ILA®) or provide time to prepare for a more definitive solution (surgical airway).

The Failed Airway Algorithm is presented in Figure 2-6. The essential message from this algorithm is that the decision to move to a surgical airway must be taken early once the failure to maintain oxygenation is recognized. Wasting valuable time attempting a variety of devices or techniques is to be avoided at all costs, unless it is while the practitioner is concurrently preparing to perform a surgical airway. There is little or no value at this time in making attempts with tools or techniques with which the practitioner has no experience.

2.5.5.1 Failed Airway Criteria Have Been Met

This is the entry point to the “Failed Airway Algorithm.” The criteria are either three failed attempts at intubation via oral laryngoscopy by an experienced practitioner or a single failed attempt at oral intubation with inability to maintain SpO2 ≥ 90% using a bag-mask. A mandated intubation in a patient with a difficult or crash airway in whom BMV also fails represents a failed airway. As with the difficult airway, it is advisable to call for assistance when a failed airway has occurred. This is especially true if BMV has also failed and qualified help is immediately available.

2.5.5.2 Is BMV Possible and Adequate?

In the circumstance of a failed airway, if BMV is not adequate, then immediate cricothyrotomy is mandatory. The only exception to this recommendation is the use of a temporizing technique, such as the I-LMA or Combitube™, if cricothyrotomy is not immediately possible. Further attempts at intubation or use of alternate devices will merely prolong the patient’s hypoxemic state. If surgical airway management is itself relatively contraindicated (in a life and death situation all contraindications to cricothyrotomy are relative), then alternative methods may be tried first. For example, if the patient has known laryngeal pathology in the area of the anticipated surgical intervention, such as a tumor or hemotoma, then alternative techniques may be preferred. However, if these methods are not immediately successful, cricothyrotomy should be performed, even in the presence of relative contraindications. SHORT (see Section 1.6.4) identifies conditions that present difficulty and should not be thought of as contraindications.

2.5.5.3 Consider Combitube™, Fiberoptic, I-LMA, Lighted Stylet, Trans-Tracheal Jet Ventilation, Retrograde, or Some Other Method

If ventilation and oxygenation by bag-mask can maintain SpO2 ≥ 90% (or some acceptable number), then a number of different devices and procedures may be attempted to rescue the patient with the failed airway. At all times, the patient must be monitored for adequate oxygenation. If oxygenation becomes inadequate at any time and cannot be restored via BMV, then cricothyrotomy is mandatory. Likewise, if there is failure of each of the techniques considered appropriate, then cricothyrotomy should be undertaken. Videolaryngoscopic (eg, the Glidescope®) and fiberoptic methods, including the FFB, and the rigid fiberoptic laryngoscopes (eg, Shiakani, Bonfils, Bullard) have all been shown to be effective and safe rescue techniques. The choice of the tool should be governed primarily by the practitioner’s experience and expertise. The application of a tool with which the practitioner has little experience is difficult to defend as a prudent intervention.

2.5.5.4 Time Allows and Successful?

If there is sufficient time to achieve oxygenation and ventilation using one of these devices or techniques, proceed down the main path of the algorithm. If not, cricothyrotomy is mandated.


### 2.5.5.5 Was an Endotracheal Tube Placed?

If an endotracheal tube is successfully placed at any time, postintubation management may be undertaken. If a Combitube™, King LT Airway, or percutaneous transtracheal ventilation have been employed successfully, then the airway should be considered to be temporary, at best and arrangements for a definitive airway be made. If the airway placed is unable to provide adequate ventilation and oxygenation, then immediate cricothyrotyotomy is indicated.

### 2.5.6 The extubation algorithm

The Extubation Algorithm (Figure 2-7) is specifically intended to be employed in those situations in which reintubation, if needed, is judged to be difficult or impossible (eg, patient was initially intubated awake because intubation was judged to be impossible). At the core of the algorithm is a trial of extubation over a ‘tube exchanger’ (TE) (eg, Cook Endotracheal Tube Exchange Catheter). It is important to note that a failure to reintubate should be immediately followed by an assessment of the ability to maintain oxygen saturations. If oxygen saturation can be maintained by jet ventilation through the catheter or by BMV, there is likely some time to use alternative methods of intubation, such as lighthwands and fiberscopes. On the other hand, the failure to maintain oxygenation should be immediately followed by attempts to employ rescue devices such as Combitube™, Intubating Laryngeal Mask, and Trans-Tracheal Jet Ventilation while preparations are undertaken to perform a surgical airway.

### 2.6 SUMMARY

The failure to adequately manage the airway is a major contributor to poor outcomes in anesthesia, emergency medicine, critical care, and Emergency Medical Services. Adverse respiratory events constitute the largest cause of injury in the ASA Closed Claims Project. The single most important factor leading to a failed airway is failure to predict the difficult airway.

Emergency airway management is always stress provoking. Crucial decisions must be made in a timely manner, and the airway practitioner is expected to possess expertise in a variety of primary (Plan A) and backup (Plans B and C) maneuvers.

Well-designed algorithms based on the best available evidence are intended to improve the outcome of difficult and failed airway emergencies. However, it is incumbent on the airway practitioner to identify which algorithm to employ, particularly in the event that a “difficult airway” has progressed to a “failed airway.”

### REFERENCES


SELF-EVALUATION QUESTIONS:

2.1. All of the following are features of well designed, clinically useful algorithms EXCEPT
   A. They are designed by reputable organizations
   B. They have clear entry and exit points
   C. Decision points are binary
   D. They are easily remembered in crisis
   E. They are easy to represent graphically

2.2. All of the following are true of the ASA Difficult Airway Algorithm EXCEPT
   A. It is evidence based
   B. It has likely helped to reduce the rate of airway management failure in anesthesia practice
   C. It is meant to represent the ’standard of care’ in medico-legal proceedings
   D. It has two sections: one for the difficult airway and one for the failed airway
   E. The use of the LMA is a discrete step

2.3. All of the following are identified weaknesses of the ASA Difficult Airway Algorithm EXCEPT
   A. The algorithm actually addresses both difficult and failed airway management, but does not explicitly identify the two pathways.
   B. The nonbinary nature of the decision matrices and the multiplicity of pathways have limited the clinical usefulness of the algorithm in guiding day-to-day practice.
   C. The algorithm does not provide for uncooperative patients (children, mentally challenged, and patients who refuse to co-operate with the planned airway management) and different patient populations (e.g. obstetrical and pediatric patients).
   D. The algorithm is silent with respect to whether or not they ought to apply outside the Operating Room.
   E. The algorithm is clear that awakening the patient is not always possible.