The High-Risk Airway

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• Emergency • Airway • Difficult • Failed • Intubation

There are few conditions in emergency medicine as potentially challenging and high-risk as the difficult or failed airway. Time is often limited, the patient's condition may be critical, and a failed airway has the potential for significant morbidity or death. The emergency physician must be able to rapidly identify the potential for a difficult or failed airway and plan accordingly. Underlying cardio-respiratory compromise or the acute condition itself may predispose the patient to physiologic insults during airway management. Anticipation and management of these risks can prevent worsening of the existing medical condition. Fortunately, there are methods to quickly identify the potentially difficult or failed airway. Preparation and pretreatment strategies may mitigate the potential risks of airway management in some conditions. Finally, there are a myriad of airway devices, many of which are new to emergency medicine, that can assist with the identification, management, and rescue of the high-risk airway. Once a difficult airway is anticipated, the clinician can choose a strategy and technique based on the reason for the airway being potentially difficult and on whether oxygenation can be maintained.

IDENTIFICATION OF THE HIGH-RISK AIRWAY

The first step in the management of the high-risk airway is recognizing its potential presence. Although all emergency airway management could arguably be considered high risk, the vast majority of emergent airways are managed successfully, with good outcomes, particularly when using established principles and techniques, such as rapid sequence induction (RSI). Airways that could be described as being at higher risk of failure or complication generally fall into 3 categories: the difficult airway, the failed airway, and the physiologically compromised patient's airway.

The 3 conditions can be defined as follows: (1) The difficult airway is defined by anatomical characteristics that predict, through pre-intubation assessment, the

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potential for difficulty with bag-mask ventilation, difficult laryngoscopy and intubation, or difficulty with placement of a rescue airway; (2) The failed airway is defined by difficulties encountered after airway management has been attempted. In emergency airway management, the failed airway has been defined as failure to maintain acceptable oxygen saturations following laryngoscopic attempts or 3 failed attempts by an experienced provider, even when saturations can be maintained; (3) The physiologically compromised patient is one whose underlying medical condition potentially increases the risk of morbidity from airway management.[1]

It is critical that providers assess the potential for a high-risk airway before initiating any emergency airway management. By definition, these airways can be associated with significant urgency; however, this assessment and identification can be performed rapidly in almost all situations, the rare exception being the arrested or near-arrest patient. Once a high-risk airway is identified, an understanding of why it is high risk can help define the optimal management, mitigate potential morbidity, and identify appropriate rescue strategies.

The Difficult Airway

The difficult airway has been defined by the American Society of Anesthesiologists (ASA) as difficulty with mask ventilation, difficulty with tracheal intubation, or both.[2] This has been further defined as follows: (1) more than 2 attempts at intubation with the same laryngoscopic blade have been made; (2) a change in blade or use of intubation stylet is required; or (3) an alternative intubation technique or rescue is required. Although these criteria are helpful at quantifying the presence of the difficult airway in anesthesia practice, the actual incidence of difficult airways in emergency practice is less clear. Difficulty visualizing the vocal cords during laryngoscopy (Cormack grade 3 or 4 view) has been estimated to occur in 14% to 25% of trauma patients intubated in the emergency department (ED).[3,4] First-attempt failure during RSI in the ED occurs about 10% to 23% of the time, however the need for more than 2 attempts is about 3%.[5–7] The failure rate for RSI in the ED is approximately 1%.[7–9]

More important to the clinician is the ability to predict a potentially difficult airway before the initiation of a paralytic agent. Although the presence of a potentially difficult airway is not an absolute contraindication to RSI, early identification allows for appropriate planning and a rescue strategy. In some cases, anticipated difficulty may present too great a risk for paralytics and require an “awake look” or fiberoptic intubation to avoid the rare but dangerous “cannot intubate, cannot ventilate” scenario in a paralyzed patient. Before any attempt at airway management, an assessment of potential difficulties with bag-valve-mask (BVM) ventilation, laryngoscopy and intubation, and possible rescue must be performed. It is important that the clinician consider the difficulty with direct laryngoscopy and the potential for successful bag-mask ventilation and airway rescue.[10] Once the potential for difficulty is identified, optimal management can be determined based on airway difficulty and anatomy, operator experience, and availability of alternative devices.

The ability to successfully perform BVM ventilation should be considered before proceeding with RSI. The presence of two of the following 5 factors is predictive of difficult BVM: facial hair, obesity, edentulous patient, advanced age, and snoring.[11,12] In most circumstances, bag-mask ventilation is the primary rescue following a failed attempt. It is critical for the emergency physician to master this important skill and have facility with techniques to overcome difficulties.

Multiple external features are also associated with difficult laryngoscopy and intubation. These features include facial hair, obesity, a short neck, small or large chin, buckteeth, high arched palate, and any airway deformity due to trauma, tumor, or inflammation. In some cases, particularly when there is anatomic disruption from injury, the difficulty is obvious. However, a focused clinical examination of the airway anatomy is needed to identify the more common, subtle predictors of intubation difficulty. In the emergency setting, a practical, systematic, and rapid evaluation of the airway is needed to predict a potentially poor laryngoscopic view before the initiation of neuromuscular blockade, and from this evaluation, a management plan is established.

The "LEMON" mnemonic represents one such assessment that is simple, quick, and can be performed on any emergency patient.[1] This approach, based on known independent predictors, was first introduced by Murphy and Walls[13] as a tool for the identification of difficult laryngoscopy and intubation. Subsequent studies have demonstrated that this approach can be performed successfully in the emergent setting and has proven to have predictive value.[14] The "LEMON" mnemonic has also been recommended as a method of evaluating airway difficulty in the most recent Advanced Trauma Life Support (ATLS) guidelines.[15] The LEMON mnemonic represents the following 5 elements requiring assessment.

Look externally

The initial impression of potential airway difficulty is based on obvious anatomic distortion or external features associated with difficulty.

Evaluate airway geometry (the 3-3-2 rule)

Measuring the geometry of the airway can predict the clinician's ability to align the oral, pharyngeal, and tracheal axes. The mandibular opening in an adult should be at least 4 cm, or 2 to 3 fingerbreadths. The ability of the mandible to accommodate the tongue can be estimated by the distance between the mentum and the hyoid bone, which should be 3 to 4 fingerbreadths. A smaller mandible is less likely to accommodate the tongue, which can impair visualization during laryngoscopy. An unusually large mandible can elongate the oral axis. A high, anterior larynx may be present if the space between the mandible and top of the thyroid cartilage is narrower than 2 fingerbreadths.

Mallampati score

The degree to which the tongue obstructs the visualization of the posterior pharynx on mouth opening has some correlation with the visualization of the glottis.[16] Simply put, the less posterior pharynx seen, the less likely it is that the cords may be fully visualized.

Obstruction or obesity

Obstruction is often readily apparent and may be the indication for emergent airway management. It is important to appreciate where the obstruction is occurring, because this will dictate the airway management options. The speed of progression is another important consideration in determining a management strategy.

Neck mobility

Neck immobility also interferes with the ability to align the visual axes by preventing the desired "sniffing position." Neck immobility may be imposed by the presence of a cervical collar. If there is no suspicion of cervical injury, atlanto-occipital extension should be assessed, even in the uncooperative patient.

If difficulty with bag-mask ventilation or laryngoscopy suggests the potential for a failed airway, the clinician must then consider the likely success of rescue techniques, such as supraglottic blind insertion devices or a subglottic surgical airway.

Airway devices that may serve as alternatives to RSI or as rescue devices in the failed airway, are discussed later, as are strategies in management and device selection.

The Failed Airway

The failed airway in emergency management has been defined as (1) inability to maintain adequate oxygenation following a failed intubation attempt; or (2) three failed attempts at intubation by an experienced provider, even if oxygenation can be maintained.[1] The rate of failed airways in the emergent setting is approximately 1%, and may be higher in trauma patients.[7,8] Ideally, the failed airway is prevented through assessment of airway difficulty and appropriate patient selection for RSI. However, despite optimal evaluation and preparation, failed airways are likely to occur, particularly in the emergent setting. Therefore any clinician providing emergent airway management must have facility with rescue devices and surgical airways.

The Physiologically Challenging Airway

There are patients in whom airway management poses a high risk because of their underlying chronic or acute medical condition, regardless of their airway anatomy. Although the technical aspect of intubation is predicted to be successful and a failed airway is unlikely, the procedure itself poses an increased risk of hypoxia, hypotension, or exacerbation of an underlying condition. Patients who have respiratory or hemodynamic compromise before the procedure are at particular risk. There are also certain conditions that may be exacerbated by the drugs used to facilitate rapid sequence intubation and by the physiologic effects secondary to the procedure itself. Many of these undesirable effects may be prevented or mitigated through recognition of the risk, adequate preoxygenation, and attention to drug selection.

Patients with raised intracranial pressure, reactive airways disease, and cardiac ischemia may suffer exacerbation of the condition from the direct physiologic effects of laryngoscopy. Although there remains some controversy over the true impact on outcome, the clinician should consider the use of pretreatment agents that may potentially mitigate the undesirable effects of intubation when the underlying condition calls for it.[17] A discussion of the individual pretreatment agents and their specific indications is beyond the scope of this article. Of greater importance is adequate preoxygenation, which should begin as soon as intubation becomes a consideration. Preoxygenation is recommended in all patients being intubated, including those with no apparent hypoxia. The displacement of nitrogen with oxygen in the alveolar space creates a potential reservoir of oxygen, which may prevent hypoxia for several minutes of apnea. This varies with the physiologic state of the patient, and hypoxia develops quicker in children, pregnant women, obese patients, and associated hyperdynamic states.[18] Optimal preoxygenation is particularly critical in patients with high-risk airways, because of underlying respiratory compromise or need for more "apnea time" when the potential for failed intubation exists.

TOOLS TO MANAGE AND RESCUE THE HIGH-RISK AIRWAY

The number of airway tools available to the emergency physician has exploded in the past decade. In some cases, this represents an adoption of devices that have had a long history of use and success within the specialty of anesthesia. This explosion may follow some modification that enhanced the effectiveness in the emergency setting, such as lower cost, increased durability, or ability to protect the airway. The disposable intubating laryngeal mask airway (I-LMA; Laryngeal Mask Company, Henley on Thames, UK) is a good example of this. The proliferation of lower-cost, durable, and easy-to-use fiberoptic devices is another recent phenomenon that is changing the approach to high-risk airway management in the ED. Finally, the development of educational courses focused on teaching these skills to emergency providers have probably played an important role.

Although several devices are listed in this section, it is not possible for emergency physicians to have facility with all techniques, nor is it likely that all these devices would be available because of the associated cost. The first “rescue” from failed intubation or bag-mask ventilation should usually be better laryngoscopic and bag-mask ventilation technique. Following that, the emergency physician should be comfortable using an intubating stylet, and have at least 1 supraglottic rescue device and 1 surgical airway technique in their armamentarium. Facility with a fiberoptic or video laryngoscopic device is becoming increasingly desirable.

Airway Management Tools

1. Bag-mask ventilation
2. Direct laryngoscopy
    a. Endotracheal tube introducers
3. Supraglottic rescue devices
    a. Blind insertion devices
        i. Double-balloon esophageal airways
        ii. LMAs
    b. Direct visualization
        i. Video laryngoscopy
        ii. Flexible fiberoptics
        iii. Fiberoptic stylets
4. Subglottic rescue devices
    a. Retrograde intubation
    b. Transtracheal jet ventilation
    c. Percutaneous cricothyrotomy
    d. Open surgical cricothyrotomy

Bag-Mask Ventilation

Bag-mask ventilation is a critical skill for the emergency provider and remains the first-line rescue in a failed intubation attempt. Maintaining oxygenation should take priority over repeated attempts at laryngoscopy.[19,20] An inability to adequately ventilate with a BVM is usually solved by better positioning, and if possible, exaggerating the head tilt, chin lift, and jaw thrust into the mask. A tighter seal with 2-person bagging and the use of oral and nasal airways to improve patency are often all that is required to achieve ventilation. A poor seal due to a beard may be improved with a lubricant, and keeping dentures in place can facilitate BVM ventilation. Cricoid pressure (Sellick maneuver) has been shown to impair bag-mask ventilation in some patients and may need to be eased or released when bagging is difficult.[21]

Direct Laryngoscopy

The most common reasons for intubation failure in direct laryngoscopy are inadequate equipment preparation and poor patient positioning. Optimizing patient position and laryngoscopic technique should be the first step following a failed attempt. Direct cricoid pressure in the unconscious or paralyzed patient has been recommended to prevent passive regurgitation of gastric contents and reduce gastric insufflation during active bag-mask ventilation. However, its effectiveness in RSI is in question, and cricoid pressure has been shown to impair laryngoscopic view and insertion of the tube over an endotracheal introducer. Therefore, in the case of difficult laryngoscopy, cricoid pressure should be released.

A maneuver to enhance visualization of the anterior glottis involves the application of backward-upward-rightward pressure on the thyroid cartilage (not the cricoid ring).[22,23] In a technique called bimanual laryngoscopy, the intubator manipulates the larynx with the right hand until ideal visualization is achieved, and then an assistant maintains this position. Attempts at blind passage are usually met with failure and anoxia and should be discouraged. When the emergency provider experiences a failed intubation attempt, measures should be taken to improve the chance of success on repeat attempts, and simultaneously, preparation for a possible rescue airway must be considered. Just as important is the ability to recognize when further attempts at laryngoscopy are unlikely to succeed or should be abandoned in favor of an alternative management strategy. Persistence in laryngoscopy beyond 3 attempts has been associated with low success and increased morbidity and mortality and should be discouraged.[20,24]

ENDOTRACHEAL TUBE INTRODUCER

An important and underused aid to intubation with direct vision is an endotracheal tube introducer or intubating stylet. Also called the "gum elastic bougie," the endotracheal tube introducer, is a semirigid or malleable, blunt-tipped stylet, which can assist with tube placement in the emergent intubation. These introducers are typically 70 cm long and made of plastic, and they use a deflection of the distal tip to facilitate insertion when the glottis cannot be fully visualized, specifically in Cormack grade 2 (arytenoids) and grade 3 (epiglottis only) views.[25] The introducer is inserted into the trachea with the right hand while maintaining visualization with the laryngoscope. Insertion in the trachea can also be appreciated through the tactile sensation of the tip moving over the tracheal rings. Using a Seldinger technique, the endotracheal tube (6.0 mm inner diameter or greater) is then threaded over the introducer into the trachea, and the introducer is removed. Difficulty in passing the tube through the glottis, usually reflects a failure to maintain the best possible laryngoscopic view throughout the procedure. Gentle 90° clockwise and counterclockwise rotation of the endotracheal tube may overcome resistance to passing the tube through a more favorable alignment of the beveled tip.

Supraglottic

Blind

There are several extraglottic devices that can be used as rescue airways in the failed intubation or as an alternative to emergency endotracheal intubation for less experienced providers, such as prehospital providers. These devices share a steep learning curve, are inserted blindly, and, because of their extraglottic placement, do not provide a definitive protected airway.

The laryngeal mask airway (LMA), and some similar devices are truly supraglottic in their placement, which is distinct from the double-balloon devices that are sometimes considered retroglottic, because they enter the upper esophagus. Initially introduced in 1981, the LMA has enjoyed widespread use in anesthetic practice because of its ease of use, and it is considered less invasive than an endotracheal tube. The primary drawback to the traditional LMA in the emergent setting is that it does not provide a definitive, protected airway in the nonfasted emergency patient. However, the advent of the disposable LMA Fastrach (Laryngeal Mask Company, Henley on

Thames, UK) or I-LMA represents a device that is easy to insert, is very successful at achieving ventilation, and can be converted to a protected airway by the placement of an endotracheal tube through the I-LMA.[26,27] The intubation success rate is about 95%; however, the highest success rates are achieved when the endotracheal tubes provided with the device are used in conjunction with fiberoptics.[27–29] Because of its high success and the ability to convert to an endotracheal intubation, the I-LMA is the preferred extraglottic rescue device in the ED.

Double-balloon airways represent the other type of blindly inserted, extraglottic airway device. The Combitube (Kendall-Sheridan Catheter Corp, Argyle, NY, USA) and the King LT(King Systems Corporation, Noblesville, IN, USA) are the most common types used in the emergency setting; however, other similar devices include the Rüsch Easytube (Teleflex Medical, Kernen, Germany), the Laryngeal Tube (VBM Medizintechnik, Sulz, Germany), the Airway Management Device (AMD; Nagor Ltd, Douglas, Isle of Man; Biosil Ltd, Cumbernauld, UK), and the Cobra Perilaryngeal Airway (Cobra PLA; Engineered Medical Systems, Indianapolis, IN, USA). Designed to be placed into the esophagus, one balloon seals it and the other balloon is inflated in the oropharynx. Ventilation takes place through an outlet positioned between the 2 balloon cuffs, which have effectively sealed off the larynx. Most of the experience with these devices is in the prehospital setting, because they are relatively inexpensive and disposable and have a high success rate and a quickly learned technique.[30,31] These devices are not considered a definitive airway and do not provide optimal protection from aspiration, which, however, seems to be a rare event.[32] The King LT differs from the Combitube in that it uses a single pilot balloon to inflate both cuffs, and the newer designs allow gastric aspiration through an open distal tip. There is a more extensive literature on the Combitube, but the King LT seems promising and has been rapidly adopted in many prehospital settings.[33,34]

Direct vision

Video laryngoscopy represents the most promising recent addition to the airway tools available in the management of the high-risk airway.[35] The operator, using a blade and handle similar to the traditional laryngoscope, performs the intubation watching a video screen, rather than looking into the oropharynx. Through the placement of a micro video camera in the tip of the blade, the distal image is transmitted to an external monitor. This magnified view enhances visualization and, in some cases, provides views that cannot be obtained through direct laryngoscopy. Video laryngoscopy can be performed in a neutral neck position and in patients with reduced oral opening. This is a particular advantage in patients with potentially difficult airways or restricted cervical spine mobility.[36,37] There are educational advantages in shared visualization and in the ability to record the video-assisted intubation for future viewing. Video laryngoscopy is a technique for the high-risk airway and for low-risk emergent intubations, thus allowing the operators to gain experience and skill. Other video laryngoscopes incorporate a smaller video monitor onto the handle of the device similar to conventional laryngoscopes, and they may represent a more intuitive design.

Several studies have demonstrated high success rates and improved Cormack-Lehane views with video laryngoscopy compared with direct laryngoscopy.[38,39] Despite the relative paucity of studies, the popularity and rapid adoption of video laryngoscopy suggests that these devices will play an increasingly important role in emergent airway management. Devices that incorporate an antifog mechanism are desirable for improved visualization. Some video laryngoscopes offer a single-use disposable blade, which reduces the downtime needed for sterilization and may be preferred in the emergent setting. Several devices now have blade sizes available for all ages. There are limited data comparing different products, however one study demonstrated a first-attempt success difference between devices when no stylet was used.[39] When a stylet was used, the difference was not significant and success of all the devices went up. There was significant improvement in the Cormack-Lehane view and in the success of all devices when compared with direct laryngoscopy.

The technique for video laryngoscopy differs from traditional laryngoscopy, in that a midline insertion is preferred and a tongue sweep is not needed. The ideal view is usually obtained by insertion into the vallecula, much like a Macintosh blade, and gentle tilting of the handle.

Flexible fiberoptics are a useful option for the assessment of airway difficulty and for facilitating intubation when there are anatomic limitations that may prevent visualization of the vocal cords using traditional laryngoscopy. Although the fiberoptic scope requires some facility and practice, it is an increasingly important skill for the emergency physician that can be mastered through instruction and simulation.[40,41] The most common role for flexible fiberoptics in the ED should be in the evaluation of airway difficulty, which also creates opportunity for operator experience. Intubation over the scope in a difficult airway crisis can be life-saving but requires a higher degree of technical skill. Timely assistance from consultants with fiberoptic skills may also be needed in the absence of equipment or a skilled provider in the ED.

Clinical indications for flexible fiberoptics include conditions that prevent opening or movement of the mandible, massive tongue swelling from angioedema, upper airway infections, congenital anatomic abnormalities, and cervical spine immobility. The most common relative contraindications to fiberoptic intubation are insufficient time and impaired visualization from blood or secretions. The procedure requires preparation and usually a compliant, spontaneously breathing patient. Patients in need of an immediate airway, patients with near-complete obstructions, and those who cannot be ventilated to maintain saturations are poor candidates for this procedure.

Topical anesthesia, an antisialogogue, sedation, and if the nasal route is used, a topical vasoconstrictor are all essential pharmacologic adjuncts to a successful fiberscopic procedure. The nasal route is usually preferred, because the scope is easier to keep in the midline and it enters the glottis at a less acute angle. Because oral obstruction is a common indication for fiberoptic intubation, the nasal route may be required. However, if the oral route is used, a breakaway bite block, such as a Berman intubating airway, is recommended to prevent damage to the scope and keep it midline.

Flexible fiberoptics can be useful in converting a rescue airway, such as an I-LMA, to an endotracheal intubation. In the case of the I-LMA, the success rate approaches 99%.[29] Recent advances, such as enhanced visualization with complementary metal-oxide semiconductor video technology, improved antifogging, and better durability, have made this technology more accessible to the emergency environment. Ease of use, the absence of available consulting expertise, and growing indications all contribute to an increasingly important role for flexible fiberoptics in emergency airway management.

Fiberoptic stylets are devices that incorporate fiberoptics into a hand-held rigid or malleable stylet. The endotracheal tube is mounted on the stylet and indirect visualization of the glottis is achieved through an eyepiece on the handle. The operator sees from the perspective of the tip of the stylet or tube. Although their diagnostic capabilities do not replace those of a flexible fiberoptic scope, these devices can be useful when direct visualization of the larynx is impossible due to neck immobility, reduced oral opening, or an anterior larynx, and they are usually much less expensive than traditional fiberoptics.[42–44] Blood and excessive secretions can impair visualization.

Subglottic

Although the need to perform a surgical airway in an emergent setting is rare (about 1% of emergency airways), there are clinical circumstances, specifically the "cannot oxygenate, cannot intubate" scenario, where a surgical airway may be the only option and the final end-point in all difficult airway algorithms. Therefore all emergency airway managers need to have immediate access to and familiarity with a surgical airway technique. Regardless of the technique used, all emergent surgical airways access the subglottic airway through the cricothyroid membrane.[45,46]

Cricothyrotomy, using either an open surgical technique or an over-the-wire Seldinger technique, is the recommended surgical airway in the emergent setting. Individual experience is limited; however, case series, cadaveric studies, and simulation models all suggest that this is a technique that can be successfully learned and translated into clinical practice. Both techniques can be performed in less than a minute and have similar learning curves and success rates.[47,48] The open technique may be more successful in obese patients. There are commercially available kits that have the necessary equipment to perform an open or Seldinger cricothyrotomy.[45]

Needle cricothyrotomy with percutaneous transtracheal jet ventilation can be performed emergently as a temporizing surgical airway. This technique can be effective at providing oxygenation, is easy to perform and does not have an age restriction, and therefore is the surgical airway of choice in young children. There are several disadvantages compared with the cricothyrotomy techniques described earlier. Ventilation may not be possible unless supraglottic patency can be maintained. Airway protection is not present and suctioning is not possible. Barotrauma is common and displacement or obstruction of the catheter is more likely. Retrograde tracheal intubation is another option that has been used when conventional airway approaches fail. This procedure is time-consuming and is not an alternative to cricothyrotomy in the patient who cannot be intubated or ventilated. Because of this limitation and the recent advent of alternative airway devices, retrograde tracheal intubation is rarely used in the emergent setting.

APPROACH TO THE MANAGEMENT OF THE HIGH-RISK AIRWAY

The number of airway rescue devices available continues to grow at a staggering pace. It is important for clinicians to stay abreast of these technological advances and invest when investment is needed. Even more vital is the notion that the emergency physician must develop and use a well thought-out plan for managing the difficult airway and failed airway. A thoughtful strategy based on patient characteristics that incorporates appropriate preparation and uses the optimal technique is always more important than the tools themselves.

Because ED failed airways are low-frequency events that almost always unfold rapidly and without the luxury of time to plan, it makes sense to use decision-making tools to help frame one's thinking. Several algorithms have been proposed to address this vexing problem. The ASA's difficult airway algorithm works well in the controlled, operating room setting but is difficult to apply in the ED.[2] Another approach geared to the emergency setting uses vertically oriented algorithms that provide a logical framework for dealing with the difficult and the failed airway.[49]

There are elements common to most recommended algorithms that are critical to successful airway management. Despite the urgency often associated with emergent airway management, appropriate preparation and attention to optimal oxygenation are important. This includes an assessment of airway difficulty, a preconceived strategy, and the identification of an appropriate rescue device if a failed airway

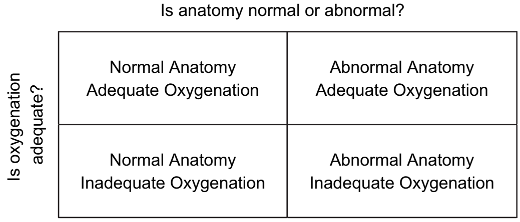

Fig. 1. Difficult airway grid.

occurs. The use of an awake look, commonly used in anesthesia, is an increasingly important technique in emergent difficult airway assessment, and it is becoming easier to perform with the increased availability of fiberoptic airway devices. Recognizing the need for help from other consultants or colleagues, if available, can be the key to success in some circumstances. Finally, the ability to anticipate and perform a subglottic, surgical airway is an important skill that all airway managers must possess.

It can be challenging to determine the most appropriate airway device for the particular airway scenario. To some degree, the selection of the tool to use will be determined or at least limited by what is available and the skill set of the clinician. Despite the large number of airway devices beyond traditional laryngoscopy that are available to the airway manager, they tend to fall into a few categories. There are supraglottic devices, which can be further divided into blind insertion devices, such as the I-LMA, and direct visualization, fiberoptic devices; and there are subglottic techniques, which are invasive airways, usually obtained through the cricothyroid membrane. One of the authors, M.A. Gibbs, has developed an approach using a 4-box grid (**Fig. 1**) and a series of principles and solutions that apply to each patient category. Using this approach can help develop an appropriate plan and potential rescue device. Patients with difficult or failed airways can be categorized by the answers to 2 basic questions:

1. Is airway anatomy normal or abnormal?
2. Is oxygenation adequate (ie, O2 saturations>90%)?

In the context of this grid, an abnormal anatomy implies disrupted or altered anatomy, not just an anticipated difficulty in visualizing the glottis. Causes of a difficult airway with abnormal anatomy include trauma, burns, hematoma, cancer, abscess, foreign body, and angioedema. Causes of a difficult airway with normal anatomy include obesity, a small mouth, and a high anterior larynx.

Principles and solutions for each box on the grid are listed below followed by illustrative case examples. It is important to recognize that although these principles are generalizable, the solutions will vary based on skill level and equipment availability.

Table 1
Normal anatomy + adequate oxygenation

Principles	Solutions
You have time	Hand-held fiberoptics are available:
No need for a surgical airway	Any of these should work
Blind-insertion devices appropriate	Hand-held fiberoptics are not available:
Hand-held fiberoptics ideal	First choice, I-LMA[25–29]; second choice, intubating stylet
Cuffed tube the goal	

Table 2
Normal anatomy + inadequate oxygenation

Principles	Solutions
No time	Hand-held fiberoptics are available:
Multiple attempts with blind-insertion devices inappropriate	Limited attempts with these, then surgical
Use what is known best	Hand-held fiberoptics are not available:
Surgical airway if first rescue plan fails	Limited attempts with I-LMA, then surgical

Case Example 1

Consider a morbidly obese patient who presents to the ED after an overdose. He has stable vital signs but is obtunded and not protecting his airway. Airway dimensions and anatomy are normal. Oxygen saturations are greater than 95% on supplemental oxygen. Following sedation and paralysis, the glottis cannot be visualized despite 3 attempts with repositioning. Oxygenation can be maintained with BVM ventilation.

This case illustrates 2 key features (**Table 1**): First, because oxygenation can be maintained, one has some time. Second, there is nothing anatomically wrong with the airway; it just cannot be seen. Blind insertion devices are therefore safe and would be a reasonable choice. Hand-held fiberoptic devices that provide a direct view of the glottis are an even better choice.

Case Example 2

Now consider the same overdose patient who has been paralyzed and sedated. Aspiration is evident after the first attempt at laryngoscopy, and it is difficult oxygenating the patient even with adequate positioning and an oral airway.

The key difference between this scenario and Case 1 is that one no longer has time (**Table 2**). One's "device menu" is essentially the same, but multiple attempts with any of these rescue devices are neither possible nor appropriate. In this situation, limited attempts (1–2 at most) using the rescue device with which one has the most experience and therefore the highest likelihood of success, should be one's first move. If this is unsuccessful, a surgical airway is the next step.

Case Example 3

Consider a patient with Ludwig angina in the setting of a severe dental infection. The patient has stable vital signs and an oxygen saturation of 98%. On physical examination, there is significant trismus and a large submandibular abscess. Because of progressive swelling, a decision is taken to intubate the patient before transfer to a tertiary center.

Table 3
Abnormal anatomy + adequate oxygenation

Principles	Solutions
Blind insertion device risky	Hand-held fiberoptics are available:
Direct airway visualization preferred	Limited attempts with fiberoptic
Fiberoptic okay if not obscured by blood	Surgical airway if unsuccessful
Surgical airway backup	Hand-held fiberoptics are not available:
	Surgical airway

Table 4 Abnormal airway + inadequate oxygenation	
Principles	**Solutions**
No time	Hand-held fiberoptics are available:
Blind insertion devices contraindicated	One attempt with fiberoptic
Fiberoptic okay if not obscured by blood	Surgical airway if unsuccessful
Surgical often the best first choice	Hand-held fiberoptics are not available:
	Surgical airway

This case illustrates several important concepts (**Table 3**): First, one has some but not much time. Second, blind insertion devices are not recommended in the setting of significantly altered airway anatomy, because these are unlikely to be successful and may cause additional injury during insertion attempts. Third, a direct view of the glottis using a fiberoptic device is preferred. Fourth, if fiberoptic devices are to work, the airway must be reasonably clear of blood and secretions.

Case Example 4

Consider a patient with a gunshot wound to the mouth. The mandible is blown apart and blood is pouring into the airway. Oxygen saturations are dropping and the patient is impossible to bag.

The key message here is not to outsmart oneself. Because the likelihood of failure with most techniques is so high, it can be easily argued that an immediate surgical airway is the only answer in this case (**Table 4**).

SUMMARY

The high-risk airway can be anatomically difficult, at risk of intubation failure, and physiologically challenging. By anticipating these challenges and planning accordingly, the emergency physician can increase the likelihood of a successful outcome. Facility with some of the alternative airway devices is an integral part of high-risk airway management. However, thoughtful preparation, knowing when to avoid RSI, using fiberoptics and video laryngoscopy when appropriate, and finally, choosing the correct rescue strategy in the failed airway, remain the key elements in managing the high-risk airway.

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