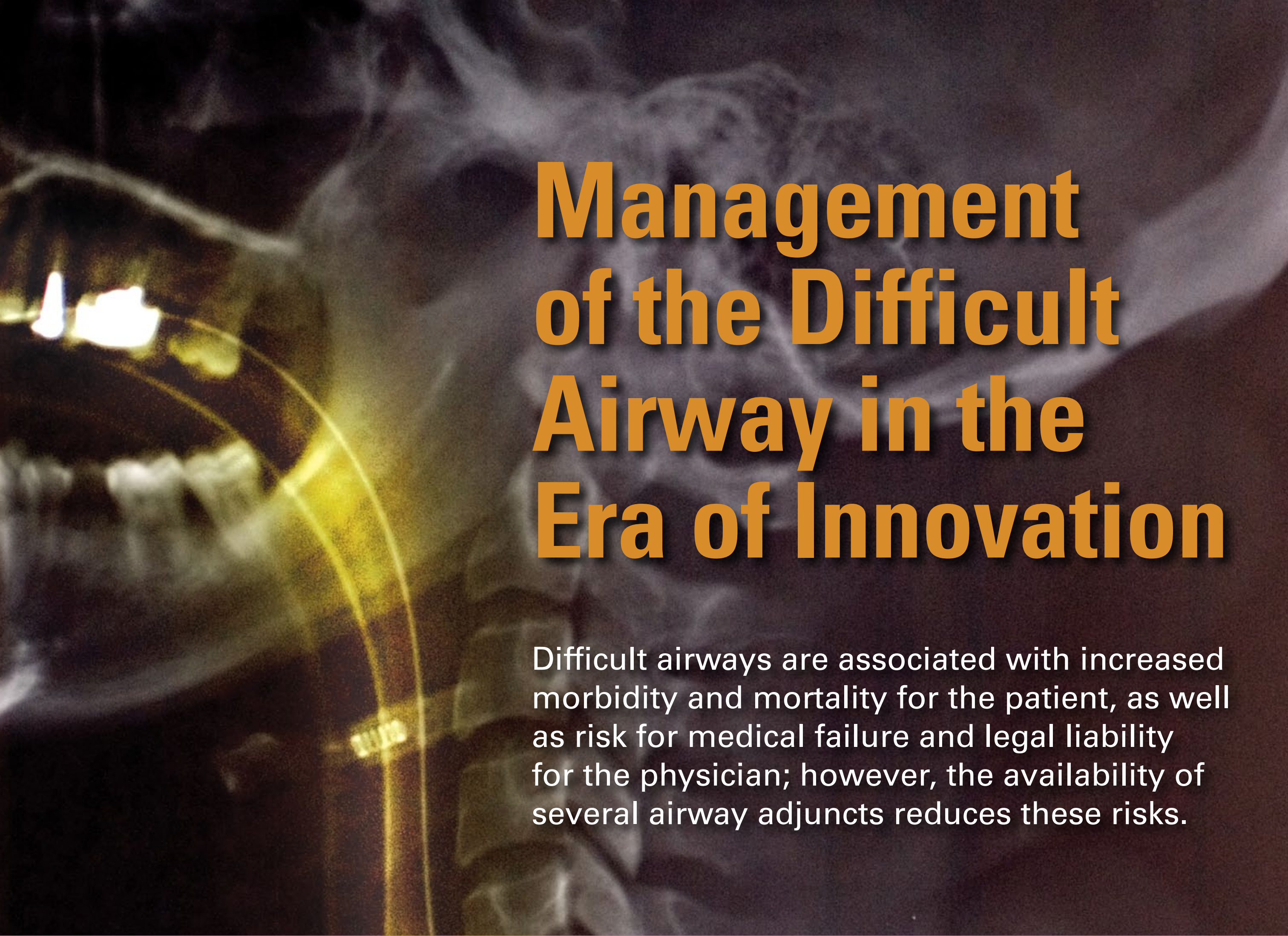

Management of the Difficult Airway in the Era of Innovation

Difficult airways are associated with increased morbidity and mortality for the patient, as well as risk for medical failure and legal liability for the physician; however, the availability of several airway adjuncts reduces these risks.

Donald Byars II, MD, FACEP, and David Evans, MD

Without breath, there cannot be life. Emergency physicians are experts in the emergent airway; they may perform more emergent airway procedures than members of any other specialty.

Typically, the physician has only minutes to plan an approach to securing an emergent airway. Regrettably, many physicians have historically relied heavily on direct laryngoscopy (DL) without consideration of the available airway adjuncts. This is likely due to many factors, particularly physician familiarity and comfort with the procedure. However, in this era of innovation, several new adjuncts provide additional options for emergent airways in difficult situations. The downside to this rapid advancement is that most providers have had little time to become familiar with these new techniques.

While DL using rapid-sequence intubation (RSI) carries a nearly 98% success rate, the remaining 2% of cases are concerning for emergency physicians.[1] These difficult airways expose the patient to increased morbidity and mortality risk and put the physician at risk as well, for medical failure and subsequent legal liability. The US legal system has zero tolerance for a missed airway. This article provides a simple algorithm for determining which airway adjuncts to use to secure the difficult airway (Figure).

TYPES OF DIFFICULT AIRWAYS

Before learning techniques for securing difficult airways, one must first understand the difference between a *crash airway* and a *failed airway*.

A patient with a crash airway is in such an altered state of consciousness that he or she will neither protect the airway nor respond to DL. Most pa-

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tients with a crash airway are in cardiopulmonary arrest or near cardiopulmonary arrest. If a crash airway is identified, immediate laryngoscopy with oral tracheal intubation should be performed. If this is unsuccessful, the patient can be oxygenated with a bag valve mask. The cause of the failure should be determined; if the crash airway is secondary to residual muscle tone, succinylcholine 2 mg/kg IV may be given. This higher dose is advocated secondary to the poor cardiovascular function.

A failed airway is most commonly defined by three failed intubation attempts by the most experienced operator. An airway is also considered failed if oxygen saturations cannot be maintained either prior to intubation or after an intubation attempt; this scenario is a true indication for surgical cricothyrotomy.

IDENTIFYING THE DIFFICULT AIRWAY

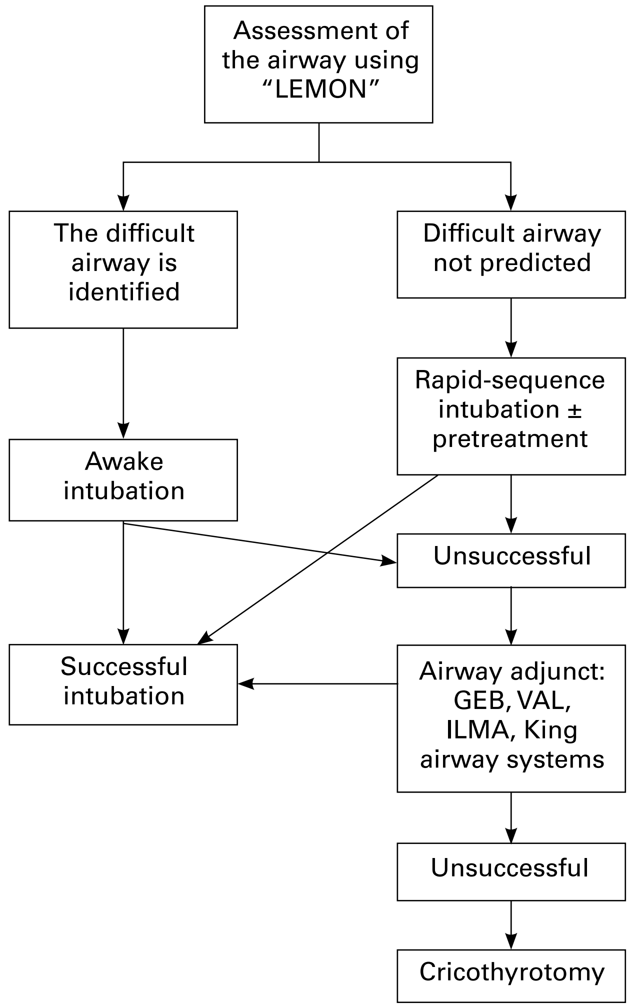
The first step in the management of the difficult airway is identifying the probable difficult intubation before a problem arises. While there is plenty of literature on this topic, it has largely been derived from the anesthesia literature and thus is of limited use to the emergency provider.

In the ED, often there are only seconds to identify the difficult airway and consider airway adjuncts. In the conscious, cooperative patient, the Mallampati classification system can prove useful.[2] The system is based on visualization of posterior pharyngeal structures and correlates well to the expected view of the laryngeal inlet during DL.

A glaring downfall of the Mallampati score is that the patient must be able to cooperate with the exam, which is usually impossible for a patient in acute respiratory distress. A simpler approach is the rule of "3-3-2," in which the examiner attempts to place three fingers between the mandible and the hyoid bone, three fingers between the upper and lower teeth, and two fingers between the thyroid cartilage and the hyoid bone. If two or more of these criteria are not met, particular attention to the difficult airway is justified. Of note, the finger distance in the 3-2-2 rule is based on the patient's—not the practitioner's—fingers.

Another helpful method of identifying difficult airways uses the acronym LEMON: look at the patient, evaluate with the 3-3-2 rule, Mallampati score, obstruction and/or obesity, and neck mobility. This

FIGURE. Algorithm for Management of the Difficult Airway



LEMON = look at the patient, evaluate with the 3-3-2 rule, Mallampati score, obstruction and/or obesity, neck mobility; GEB = gum elastic bougie; VAL = video-assisted laryngoscopy; ILMA = intubating laryngeal mask airway

simple tool can be deployed quickly and effectively in nearly all emergent airway situations. Since difficult airways cannot necessarily be predicted prior to the administration of paralytics, one must approach each airway as a potential difficult airway.

If the difficult airway can be identified before intervention is necessary, there may be enough time to call for backup. The decision of whether to request help depends on the practitioner's skill level, accessible equipment, and availability of surgical subspecialists. In most cases, these subspecialists are not readily available, particularly at night. Thus, it may be necessary to secure a difficult airway prior to patient transfer or while awaiting surgical backup.

ADJUNCTS FOR DIFFICULT AIRWAYS

Awake Intubation

If the patient is not a candidate for RSI, awake intubation may be attempted. The term *awake intubation* is a misnomer, since this uncomfortable procedure is performed with sedation. The purpose of awake intubation is to maintain a level of sedation that allows appropriate evaluation of the airway along with spontaneous respirations. This procedure is indicated in the presence of an airway that will rapidly deteriorate with paralysis. Sedation can be accomplished with any number of agents used for deep sedation (eg, etomidate, propofol, benzodiazepines, barbiturates). It can also be achieved with local anesthesia, such as nebulized lidocaine.

While not used frequently, ketamine has many properties that make it an ideal agent for awake intubation. As a dissociative agent, it maintains spontaneous respirations and muscle tone and has a favorable hemodynamic profile. Propofol and ketamine are sometimes administered simultaneously. This involves drawing 50 mg each of propofol and ketamine (5 cc each) into a 10-cc syringe and injecting 1 to 2 cc at a time until proper sedation is accomplished.

Once the patient has been sedated, visualization of the airway should be attempted. If intubation appears feasible, the practitioner can intubate at this time; however, if it appears that the airway cannot be secured using DL, one of the many airway adjuncts discussed in this article can be considered. The drawback to awake intubation is that the patient is not paralyzed, leaving him or her with some muscle tone, thus decreasing the ability to visualize the airway.

If the need for a definitive airway has been identified and the decision to use RSI has been made, the next step in the intubation algorithm is to begin the preoxygenation phase. This is usually done with a nonrebreather mask on high-flow oxygen, given for 3 to 5 minutes in order to obtain a saturation of 100% and to wash out any residual nitrogen.[3] This can also be accomplished with bag valve mask–assisted ventilation, especially in patients with insufficient respiratory drive, in order to obtain an FIO_2 level closer to 100%; however, this method is less desirable due to gastric distention.

Once the preoxygenation phase has been completed, it is important to consider the need for any pretreatment medication, such as lidocaine or fentanyl, in patients with head injuries. It should be noted that a defasciculating dose of any neuromuscular blocker is no longer recommended.[4] Once the patient has been appropriately pretreated and all necessary equipment is within reach, an induction agent should be administered, with a paralytic soon after (Table).[5] It has been proven that RSI is superior to intubating with sedation alone.[6] As mentioned previously, DL usually provides successful intubation, but if it does not work, the physician must have an alternate plan.

While DL has a proven track record, it does not solve all of the problems presented by the difficult airway. If the best view obtained with a first attempt of DL is a grade II or grade III Cormack and Lehane view, the gum elastic

TABLE. Rapid-Sequence Intubation Medications

Pretreatment Drug	Dose	Typical 80-kg Adult
Lidocaine	1.5 mg/kg	120 mg
Fentanyl	3 μg/kg	250 μg
Induction Agent	**Dose**	**Typical 80-kg Adult**
Etomidate	0.3 mg/kg	24 mg
Propofol	1.5 mg/kg	120 mg
Ketamine	1.5 mg/kg	120 mg
Midazolam	0.3 mg/kg	24 mg
Paralytic Agent	**Dose**	**Typical 80-kg Adult**
Succinylcholine	1.5 mg/kg	120 mg
Rocuronium	1 mg/kg	80 mg

Data extracted from Airway Management Education Center, LLC.[5]

bougie (GEB) can prove invaluable. The GEB is a 60-cm tube that is 5 mm wide and can accommodate an endotracheal tube (ETT) 6 mm or larger. The GEB is perhaps the one adjunct in the difficult airway management algorithm that most practitioners are familiar with.

When the grade II/III view is encountered, the GEB is placed under DL. As the GEB enters the trachea, palpable clicks should be noted as it passes over the tracheal rings; however, in practice, the clicks are usually not discerned. Instead, it is the failure of the GEB to pass the 40-cm mark that indicates proper location in the trachea. If the GEB is easily passed at 45 cm, it is likely in the esophagus and should be withdrawn and replaced. When the GEB is confirmed to be in the trachea, the ETT should be threaded over the bougie and into the trachea. This is facilitated by continuous DL, with an assistant threading the ETT over the proximal end.

Serious complications involving the GEB are exceedingly rare and probably due more to the difficult airway itself; however, the GEB has been associated with pharyngeal perforation, pneumothorax, and hemothorax.[7] There have also been some clinical reports of the GEB becoming impacted within the ETT, leading to complete failure.[8] Another problem with the standard GEB is that it can be used only with tubes larger than 6 mm; thus, it cannot be utilized in pediatric patients.

Supraglottic Rescue Devices

In some facilities, the standard laryngoscope and the GEB are the only two pieces of equipment that separate the patient from needing a surgical airway. For these centers, a supraglottic rescue device, such as the Laryngeal Mask Airway (LMA) systems (classic or unique) or King Systems' King LT-D, could prove invaluable. The King LT-D can be placed blindly into the esophagus. The insertion technique is simple; the device is placed midline until the lips of the patient meet the colored top. The port is inflated with the appropriate amount of air, and the patient is ventilated.

The advantages of devices such as the King LT-D and LMA (classic or unique) are that they are relatively inexpensive and, in some cases, can be autoclaved and reused. King airway systems and other similar products require virtually no learning time. In one study, residents and EMS personnel were given a supraglottic device with no additional training. Compared to ETT intubation with standard DL, use of the supraglottic device was proven to restore adequate oxygenation and ventilation faster and to have a higher success rate.[9]

The biggest disadvantages of supraglottic devices are that they are temporary and do not provide a definitive airway or protect the airway from aspiration. At some point, supraglottic devices need removal for placement of an ETT. Contraindications to the King airway systems include the presence of a gag reflex, known esophageal disease, or ingestion of a caustic substance. While tracheal intubation is theoretically possible, one study of more than 500 placements showed no tracheal intubations.[10] While the placement of the supraglottic device is not ideal, it is helpful in preventing the need for a surgical airway in the ED setting, especially in those facilities with limited budgets for more expensive airway adjuncts.

Video-Assisted Laryngoscopy Devices

In patients with limited neck mobility, such as those with ankylosing spondylitis or who require a cervical collar, adjuncts such as the video-assisted laryngoscopy device (VAL) may prove significantly more successful than traditional DL. Several companies, including LMA, STORZ, Verathon, and King Systems, manufacture these devices for use in differing clinical arenas. Despite their differences, these devices use the same basic concept: A small fiberoptic wire in the tip of the laryngoscope blade transmits a real-time video image to a video screen, thus affording the user a close-up view of the laryngeal inlet and increasing the success rate of intubation while decreasing the time spent securing the airway.[11] This also enables the user to "see around the bend," thus transmitting less displacement to the cervical spine and, in most cases, enabling the user to leave the cervical collar in place.[12] Another advantage of the VAL is that it allows laryngoscopy to be taught to the novice in a controlled fashion, with the teacher and the learner sharing the same view on the monitor.

The learning curve is relatively shallow for the VAL, and most physicians feel comfortable using the device after only a few intubations. The easiest insertion technique is to place the blade midline over the tongue while watching the monitor as the tip of the blade slides into the vallecular space to see the laryngeal inlet. The next step, which may be the most difficult for the novice, is to place the ETT using video guidance. At this point, the ETT should be inserted through the corner of the mouth horizontally from right to left and then rotated 90° until it is vertical, so that the tip is seen just above the glottis, facilitating placement. A specialized ridged stylet can be used and removed as the tube is passed between the vocal cords.

Despite its advantages, VAL has several drawbacks. As with the DL, VAL is difficult to use in the presence of blood, vomit, or other secretions, as they pool in the airway, obstructing the fiberoptics and making it difficult, if not impossible, to view the larynx. In addition, costing $8,000 to $10,000, VAL equipment is a relatively large investment; however, most experts agree that the standard of care will soon be VAL and that DL will be obsolete in the not too distant future.

Intubating Laryngeal Mask Airway

Failure of DL and/or VAL is likely due to poor visualization; if these interventions do not work, LMA's intubating laryngeal mask airway (ILMA) should be used. The ILMA was designed specifically for blind orotracheal intubation and is similar to the original LMA, with the exception of a larger tube, which can accommodate an ETT up to 8.0 mm in diameter, a handle to help with positioning, and an epiglottic elevator flap. The authors prefer to insert it midline with the tongue depressed by a tongue blade or practitioner's finger. Once the ILMA is in place, the cuff is fully inflated and the patient can be bagged to ensure oxygenation and ventilation.

>>FAST TRACK<<

Although the need to perform a cricothyrotomy may cause significant anxiety for the emergency physician, the procedure must be performed as soon as it is deemed necessary.

In practice, the ETT designed for the ILMA has proven superior to a traditional ETT.[13] The ETT should be lubricated and passed blindly into the trachea. For the novice, this method has proven superior to DL, with a first-time intubation rate improving from 50% with DL to 90% with the ILMA.[14] The biggest advantage of the ILMA is that it allows for blind intubation in patients with heavy oral secretions or blood in the airway.

An invaluable trick for success with this adjunct is using the fiberoptic intubating bronchoscope in conjunction with the ILMA. Once the ILMA has been placed, the ETT should be threaded into the device until it reaches the 16-cm mark; at this point, the ETT engages the epiglottic elevator flap. A flexible fiberoptic bronchoscope is then placed through the ETT and ILMA. Once the cords have been visualized, the flexible fiberoptic bronchoscope is advanced until the carina is seen, the tube is passed into the trachea, and the cuff is inflated. The flexible fiberoptic bronchoscope is then withdrawn under constant guidance, and the tube placement is visually confirmed. This technique has been shown to increase the success rate in the difficult airway.[15] This technique, while more complicated than the blind approach, enables the practitioner to place an immediate airway adjunct to oxygenate and ventilate the patient with a difficult airway before placing the definitive airway, thus avoiding the "cannot intubate, cannot ventilate" scenario.

The ILMA is associated with some major disadvantages. For instance, the ILMA is difficult to use in a patient with upper airway obstruction. Because the ILMA utilizes a supraglottic device, any moderate to large airway distortion will prevent the device from inserting properly, making intubation difficult. Another problem is the expense. The reusable ILMA and ETT cost several hundred dollars. Fortunately, a disposable ILMA, which is more cost-effective, has been introduced.

Surgical Airway

When an airway cannot be secured using DL with bougie assistance, VAL, or ILMA with or without fiberoptic assistance, surgery is necessary. There are two clear indications for surgery: (1) inability to oxygenate or ventilate a patient using a bag valve mask despite a proper two-person technique and (2) inability to secure an airway using another method in an adequately oxygenated patient. In the National Emergency Airway Registry II study of more than 6,000 ED intubations, only 1% ended in cricothyrotomy.[16] Although the need to perform a cricothyrotomy may cause significant anxiety for the emergency physician, the procedure must be performed as soon as it is deemed necessary, without the delay of summoning a surgeon or otolaryngologist to manage the failed airway.

Most airway carts have a drawer marked "surgical airway" that contains percutaneous kits, tracheostomy boxes, and other items such as the retrograde intubation kits. These options may cause confusion and exacerbate an already stressful situation. To improve the success of the cricothyrotomy, it is advisable to focus on one technique, particularly one that is rapid, simple, and easy to remember.

The authors recommend the rapid four-step technique, which has been shown to be simple and rapidly deployable.[17] This procedure requires a scalpel, tracheal hook, and cuffed Shiley tube and is typically performed from the head of the bed. The cricothyroid cartilage is palpated using the nondominant hand, and a scalpel blade is inserted horizontally into the cricothyroid membrane, just off center. The incision is slightly extended and, with the nondominant hand, the tracheal hook is placed in the distal trachea and traction is maintained caudally. The scalpel is then removed, and a 6.0 cuffed Shiley tracheal tube is put into the trachea with the obturator in place. The obturator is removed and the inner cannula is replaced and secured. Once tube placement has been confirmed, the Shiley tube is sutured into place.

Complications of cricothyrotomy include hemorrhage, pneumomediastinum, laryngeal injury, and subglottic stenosis. While the majority of complications are minor, the overall rate of acute complication has been reported to be between 9% and 31%.[18] However, given the grievous consequences of a failed airway, these complications are acceptable and should not prohibit the emergency provider from rapidly deploying the surgical airway when needed. Wasting time can only bring further harm to the patient and place the physician at greater risk for litigation.

CONCLUSION

Using an algorithm in the decision-making process for securing difficult airways saves lives, eliminates mistakes, and solidifies the practitioner's confidence. Emergency physicians must not depend too heavily on DL or on help from other subspecialists who may not be available quickly or at all. Innovative airway adjuncts provide numerous options in an area that previously relied on only DL and the surgical airway. There will undoubtedly be new devices available in the coming years; it is imperative that practitioners maintain a reliable level of competence with all proven airway options. □

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