The PERFECT View
How Video Laryngoscopy Is Changing the Face of Prehospital Airway Management

A supplement to JEMS (the Journal of Emergency Medical Services)
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Airway view and tube placement as seen with the GlideScope® Ranger Single Use.
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Endotracheal intubation has been considered the gold standard in airway management in EMS systems for decades. When I went through paramedic training in 1976, anesthesiologists—initially skeptical about endorsing the performance of this advanced airway skill in the prehospital environment—agreed to instruct us and allow us into the operating room (OR) to intubate their patients. Well, at least some of their patients.

I remember gowning up early in the morning and meeting with the assigned anesthesiologist to go over the OR schedule and being told whom I could and couldn't intubate. If the patient had a jutting jaw, a large neck, a history of cervical fracture or poor teeth, I wasn’t allowed to intubate them and was required to just watch the anesthesiologist manage these “difficult” patients.

The funny thing is that many of the patients I was later called on to intubate in the street met one or more of those exclusionary criteria.

Over time, anesthesiologists have become less willing to expose themselves to liability by allowing paramedic students to intubate patients they were contracted to manage. Therefore, many of today’s paramedics never intubated a live patient prior to being turned loose to intubate in the prehospital arena. That’s a frightening thought.

Laryngoscopy, as we’ve traditionally known it, is also being re-evaluated and reprioritized in protocols by EMS medical directors. The change comes in light of studies showing that all paramedics are not equally proficient at the skill, and because the emphasis in cardiac arrest resuscitation is now more directed at continuous and consistent compressions in the early stages of resuscitation than airway management by intubation.

The increasing number of paramedics deployed on fire apparatus and ambulances is also resulting in fewer opportunities in many EMS systems to place endotracheal tubes, with some placing only one or two tubes annually. This is presenting new challenges to medical directors and service training staff because they must more frequently review and refresh paramedics on this critical skill. This also increases service and municipality exposure to liability for misplaced endotracheal tubes by their paramedics.

Further, the current demand on hospitals to report and reduce medical errors has a significant ripple effect on prehospital providers transporting intubated patients to emergency departments (EDs), with more hospital scrutiny of prehospital airway care than ever before.

What this all means is that fewer ET tubes will be placed in many EMS systems, those that are placed will have to be accomplished with little or no interruption in compressions, and each tube will be carefully evaluated on arrival at an ED.

Placing an ET tube with standard eye-to-vocal cord visualization during compressions, in a moving ambulance, and in the tight confines and configurations presented in helicopters, is a difficult task that’s prompting hospitals, ground EMS systems and aeromedical programs to consider video laryngoscopy.

What started out as a creative training aid by innovators like Richard Levitan, MD, allowing students to observe the anatomy of patients and the process of intubation through video imaging, has evolved. It’s now refined and incorporated into compact video laryngoscopes, such as the Verathon® GlideScope® Ranger, which shows you an image on its screen that’s twice the actual anatomical size.

The clarity and utility of the video laryngoscope are so good that anesthesiologists, ED physicians and flight crews are using them on a regular basis. This trend has direct ramifications on the prehospital performance of intubation because, as in-hospital airway management processes and equipment changes, so too will prehospital processes and equipment.

This supplement to JEMS presents the advent of the device and how EMS systems are using the tool so you can understand the technology and its potential impact on you and your service in the future.

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She never saw the truck. She had just dropped the kids off at school and was hoping to run some errands before she had to be at work. She edged her Escort out of the school parking lot to make a left turn onto the four-lane, trying to see around the truck parked on the northbound shoulder. She pulled out, and an F-150 impacted the driver’s door on the Escort. The collision was over in micro-seconds, with both vehicles coming to rest in the southbound lane.

Start the clock.

‘60 PRECIOUS MINUTES’

The “Golden Hour” was first described by R Adams Cowley, MD, at the University of Maryland Medical Center in Baltimore. From his personal experiences and observations in post-World War II Europe, and then in Baltimore in the 1960s, Dr. Cowley recognized that the sooner trauma patients reached definitive care—particularly if they arrived within 60 minutes of being injured—the better their chance of survival.

Field hospitals, MASH units and medevac helicopters in the Korean and Vietnam Wars contributed to increasing survival rates. Improvements in medications, techniques and instruments were key to survival, but none of these were of any value if the patient remained separated from the surgeon.

Over the years, we’ve debated whether the Golden Hour is actually 60 minutes, but Dr. Cowley’s concept remains true. Thirty-eight years after Maryland State Police Helicopter I picked up its first patient on Falls Road in Baltimore County and delivered him to Dr. Cowley’s team, the focus of EMS remains bringing the severely injured trauma patient and physician together as quickly as possible.

In this effort, we’ve gone from “load and go” to “stay and play” and back again. The ideal level of street medicine versus scene time remains somewhere in the middle. Time spent on scene changes each year with the advent of new tools and techniques and the results of valid studies.

Our job in EMS is threefold: 1) get to the patient quickly, 2) fix what we can fix and 3) quickly get the patient to the right hospital. Anything we can do to compress each of these time periods is good for the patient. We’ve known this in the traumatically injured, and now we use it for STEMI and stroke patients; more are sure to follow.
AT 12 MINUTES
She was unconscious and unresponsive when the medic unit arrived. Her head slumped to the side and frothy blood came from her mouth with each shallow breath. While Rescue Squad 7 worked to free her, the medics brought her head into neutral alignment and tried to open her airway. With a clenched jaw and obvious facial fractures, both an oropharyngeal airway (OPA) and nasopharyngeal airway (NPA) were out of the question. Working together, the medics used a bag-valve mask, suction and cricoid pressure to optimize oxygenation and ventilation.

LOC: Unconscious; grimace to sternal rub with an occasional moan; GCS 6. Airway: Compromised by clenched jaw, poor gag reflex, blood in mouth. Breathing: Respirations shallow and rapid; frothy blood present; breath sounds full on right and slightly diminished on left; crepitus on left. Circulation: Radial pulse strong, regular, rapid; no major external bleeding noted. Vitals: HR 144, RR 42, BP 112/62, \( \text{SaO}_2 \) 85%.

IT’S ABOUT PERFUSION
I used to use the term “airway management,” but the words seem to imply our job is done when we successfully get air through the glottis and into the lungs. I tried “respiratory management.” Yes, that’s it; secure an air passage, inflate and deflate the lungs. No, that’s not it either.

I’ve settled, for now at least, on “perfusion management.” Our lifesaving job is to return and maintain our patient’s cellular perfusion, and then get them promptly to the right facility.

How are the Golden Hour and perfusion management related? Without prudent management of both, we fail our patient. Almost every lifesaving intervention we perform has to do with establishing or maintaining cellular perfusion. An AED allows the heart to return to a perfusing rhythm. Allowing the hypotensive patient to breathe on their own instead of paralyzing them encourages blood return to central circulation. Decompressing the chest, stopping bleeding, capturing the airway and ventilating patients with poor oxygen saturation all improves perfusion.

So, in the field, the burden of responsibility is on us. With the critically sick or injured patient, we must look at on-scene interventions with a cynical eye. Does the procedure enhance perfusion? Must it be done now?

PREHOSPITAL INTUBATION—A GOOD THING, SOMETIMES
We’ve all read and heard that paramedics shouldn’t intubate: “It’s a skill better left for those in the hospital.” But field intubation is a good thing. It secures our patient’s airway. It allows us to properly oxygenate and ventilate patients. It’s usually completed swiftly and appropriately.

But field intubation can be a bad thing. When we make poor decisions and fail to execute the skills we were taught, we extend scene time and create hypoxic patients. When we fail to give post-intubation management the proper attention, it leads to unrecognized misplaced tubes, inappropriate ventilation and poor oxygenation.

We intubate patients in the prehospital environment for three primary reasons: 1) establish and maintain an airway, 2) normalize oxygenation, and 3) establish appropriate ventilation.2 Although field intubation can be a good thing for the patient, it’s not always the right thing for them.

So, when do you intubate the patient? When it will make them better or keep them from getting worse. Do you intubate at the scene or during transport? Both. We should intubate when it’s most appropriate. Consider these factors:
How sick is your patient? Is the airway patent? What is their level of oxygen saturation? Are they adequately ventilated? Will they survive transport without intubation?

What's your transport time? If scene time exceeds transport time, will the intubation make a difference? Is good BLS and rapid transport a better option?

What's your intubation skill and experience? Do you have the resources and skills necessary? How are you making decisions—with your head or your ego?

If you get the patient to the hospital bagging them to sats of 96% with an OPA in place and no gastric inflation, you're my perfusion management hero. Ditto if you do it with an ET tube. But if you spend 20 minutes on scene, rooting and digging in a patient's throat, making multiple intubation attempts and letting their sats drop to 85%, we need to have a talk. “Do what's best for the patient,” says Maryland State Aeromedical Director Douglas Floccare, MD, “and you can’t go wrong.”

What if it's a difficult tube? Some of my colleagues say that the difficult intubation is the typical intubation, and an easy intubation is a gift. They're right. Anything that precludes our ability to see the cords or pass the tube has been broadly defined as a “difficult laryngoscopy” or “difficult intubation.”

Studies on the frequency of difficult intubations are almost completely limited to operating room (OR) or intensive care unit (ICU) patients. The number of studies regarding EMS and ED intubations pales drastically in comparison. Those that have been done focus primarily on the rate of undetected esophageal intubations received at EDs and complications associated with intubations done outside the OR.

Until we have studies that focus on difficult intubations in the prehospital arena, we have to rely on these OR and ICU reports. Do the results of these studies reveal poor intubation technique or poor post-intubation management? Are poor intubation outcomes the result of training, technique, tools, experience or conditions? And do these factors negatively affect the time to definitive care?

**AT 32 MINUTES**
The helicopter landed as the patient was freed from the car and moved to the medic unit. It was a 42-minute drive to the only hospital in the county or an 18-minute flight to the trauma center. Seemed like an easy choice, but she was now incredibly combative, so much so that the crew could hardly secure her to the backboard let alone safely fly her out.

As the minutes ticked away, the easy choice was becoming a tough decision. Tough, until the senior paramedic on scene was able to get an 18 gauge IV in the patient’s hand; holding it securely as lidocaine, etomidate and succinylcholine were pushed.

The intubation was performed using a GlideScope® Ranger video laryngoscope, with a clear view on first attempt. Her sats rose to 98% and EtCO$_2$ to 35. She was secured to the board and loaded in the aircraft. As the succinylcholine wore off, the two helicopter paramedics assisted her ventilations enough to maintain high sats, but didn’t over-ventilate her and drive blood from her central circulation.

**NOW VERSUS NEXT**
I’m a dinosaur. I look at new technology with a suspicious eye. I see no reason to change for the sake of change. For instance, I finally purchased a PDA cell phone recently, and I realized what everyone seems to have known for years—they’re amazing.

The first time I saw a video laryngoscope, I felt much the same way I initially did about the PDA: *That’s a lot of money for a camera and some lights.* I also thought, *I’ve done just fine with my bent metal stick for the past two decades, why should I change now?* However, having used the device, I know why. Because it’s a better way to deliver patient care, with less opportunity for physical trauma to the patient, quicker visualization of the glottis and enhanced verification of endotracheal tube placement.

Straight or curved direct laryngoscopy blades are designed to move the anatomy to obtain a line-of-sight glottic view. Head-neck manipulation, tongue displacement, direct contact with laryngeal structures, and impacting teeth are all opportunities to injure a patient.

Unlike classic laryngoscope blades, video laryngoscope blades are shaped to match the pharyngeal anatomy. The acute blade angle allows the blade’s tip (and camera) to follow the patient's anatomy to view the glottis. Multiple studies have found that 20–40 lbs. of force is required during direct laryngoscopy, and it takes about 45 lbs. of pressure to fracture a tooth during laryngoscopy.$^{4,5}$ My own, purely subjective, experience with video laryngoscopy is that much less force is needed to obtain a glottic view. I’d like to see studies that validate or dispute my experience.

If you’ve ever had to do a belly flop on the ground to see the cords of a patient, you’ll appreciate video laryngoscopy. The blade goes in the patient's mouth and the video monitor is placed where you can see it. This makes visualization easier in a moving ambulance or helicopter, and has the potential to save scene time by allowing you...
to intubate easier during transport. The image on the monitor is larger than the view afforded by direct visualization. The clear detail provided on the screen allows for confident and quick landmark identification.

So, what’s the role of video laryngoscopy in prehospital medicine? Time for my predictions. It will become the standard of care, just like AEDs and 12-lead monitors. When our EMS children visit us in nursing homes, we’ll tell them tales of wasting precious minutes lying on the floor of someone’s home, using a light bulb and a metal stick to intubate patients.

**AT 65 MINUTES**
The aircraft settled onto the roof, and its rotors slowed to flight idle. She was moved to the waiting stretcher and then down the elevator to the trauma room. Masked, gowned and gloved, the trauma team swarmed around her—65 minutes from impact to surgeon.

**CONCLUSION**
For video laryngoscopy to truly enter the world of prehospital medicine, a paradigm shift must occur—a shift away from direct visualization. Cliff Boehm, MD, an attending anesthesiologist and assistant professor of trauma anesthesia at the R Adams Cowley Shock Trauma Center, describes how it worked in his department: “There used to be two camps when direct laryngoscopy failed: the Bullard (rigid fiber-optic laryngoscope) and the LMA (laryngeal mask airway). Now there’s pretty much one camp—video laryngoscopy.”

Boehm adds that when video laryngoscopy first appeared as an anesthesia tool in his department, “that camera thing” was used when all other means failed. He and his colleagues now routinely use their GlideScope units as first-line tools, not just as a backup.

As video laryngoscopy continues to evolve, I’d like to see the ability to digitally record images for QA, patient records and education. I’d like to see the camera and light in a standalone handle, and the image beamed to the multi-function display on our vital signs monitor. Better yet, maybe we could have it recorded on our monitor and also transmitted to the heads-up display on our safety glasses, so we can view the glottis and simultaneously see the patient’s heart rate and oxygen saturation.

We live at an incredibly exciting time in history, especially in medicine. Da Vinci robotic surgery, STEMI intervention, laparoscopic surgery and a multitude of other tools and procedures are developed each week. Video laryngoscopy is one of them. It’s a great tool for us in medicine, and it’s an important tool for our patients. Although I’m not ready to put my 4 Mac or 3 Miller on eBay, I can’t wait to see what awaits us.

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In 1829, the first known device for direct laryngoscopy was invented by British physician Benjamin Guy Babington. Later, the work of the widely recognized father of laryngology, Manuel Garcia, led to the first mirror laryngoscope prior to 1849, with a light source later introduced by Alfred Kirstein in 1895.¹

In the century since then, the devices available to view the larynx have gone through many evolutions. Most devices have been difficult to use, and injuries related to failed or delayed tracheal intubation have resulted. Recognizing that optimal airway management involves the direct visualization of the airway during intubation, modern direct laryngoscopy has produced different blade lengths, prisms and fiber-optic light channels. However, the emergence of video capabilities in the surgical suite was perhaps the most significant step in laryngoscopy development.

Video laryngoscopy systems provide a clear picture of the larynx and vocal cords on a display monitor, enabling control of the endotracheal tube (ETT) in its trajectory toward the airway. This type of clearly displayed view facilitates fast, accurate ETT placement in difficult airways, preventing complications resulting from improper tube placement.

Other advantages of video laryngoscopy compared with older, fiber-optic systems are substantial. Video images are easily stored on servers and low-cost SD cards, and can be transmitted to other users, allowing for remote recording of activity, skills coaching and quality assurance reviews. The use of Internet display is easy either with real-time transmission or by display of the captured images, so that the captured sequences can be used for teaching purposes to improve the skills of many. As HDTV technology improves, so will the image quality of video laryngoscopy. Last, video laryngoscopic techniques are easier to master than those necessary for direct laryngoscopy, an important factor in its successful use by personnel working in less-than-optimal circumstances.

THE NEED IN THE FIELD

The literature shows that intubation performed in an out-of-hospital emergency environment carries with it a higher rate of complications and death.³ Rapid sequence intubation (RSI), called for by Rosen and others, initially appeared to be effective when coupled with direct laryngoscopy (97% in some reports).⁴ But optimism dissipated when a 2003 San Diego study reported that 45% of “easy” or successful intubations carried out on head-injured patients were associated with hypoxemia or bradycardia.⁵

In pediatric patients, the literature shows a need for improved methods. A 2000 San Diego study of 305 pediatric patients showed a success rate of 57%, esophageal intubation of 2% and displaced ETT of 15%.⁶ An older study, from 1989, reported a 50% success rate in children one year in age or younger.⁷

The reasons for these failure rates are obvious to anyone who has worked in the field: the variable intubation skill levels among EMS personnel and adverse conditions, such as weather, limited lighting, foreign bodies in the airway.
and trauma (leading to hemorrhage and distorted anatomy). Because direct laryngoscopy in these conditions continues to be fraught with difficulty, EMS medical directors are reconsidering their airway management protocols. Although it’s clear some EMS personnel are able to overcome the deficiencies of direct laryngoscopy and produce acceptable results, the failure rates have provoked questions of whether direct laryngoscopy has become a “legacy technique,” introduced when there were no alternatives.  

GLIDESCOPE IN USE

In 2001, the GlideScope® was introduced as the first commercially available video laryngoscope. The device was designed with the recognition that a camera positioned away from the tip of the device would provide the best perspective and enhance visualization. The 60º angle allows for 99% Grade 1 and 2 views. Another significant design feature is the device’s unique anti-fog component, which reduces lens contamination.

The GlideScope Ranger single-use laryngoscope—designed to eliminate the need for disinfecting the blade for fast-paced intubation settings—is being used in Iraq and Afghanistan. The backpack-sized, rugged and shock-proof version of the original device with an antiglare screen was trialed at the R. Adams Cowley Shock Trauma Center, Fort Sam Houston and Andrews Air Force Base. Following successful trials of the device at these world-renowned medical facilities, the Ranger was deployed in hospitals and combat settings.

In particular, a number of reports from the Canadian Expeditionary Hospital in Kandahar, Afghanistan, involve the management of bloody airways, intubation around expanding hematomas and other challenging ETT exchanges. The Ranger is also in trials with Whatcom County (Wash.) EMS, where the early results are encouraging, according to Medical Director Marvin Wayne, MD.

Aeromedical applications, notably in helicopter environments, are also under study with the GlideScope Ranger. It’s notable that first-time aeromedical users had a high success rate even in the most adverse conditions. Reports of Ranger intubation under unusual conditions include two intubations prior to extrication from crushed vehicles, in flight re-intubation, and in-flight primary intubation (where direct laryngoscopy use is limited).

A LOOK FORWARD

There’s considerable pressure on EMS to improve successful intubation rates, and the advent of video laryngoscopy designed for the field is poised to produce findings that support its use in this demanding context. How extensive a role this technology will play is complicated by the debate over whether intubation—considered the gold standard in anesthesia practice—is necessary for all compromised airways. EMS personnel work with patients who are often treated under adverse conditions, and there will always be a need for difficult airway management in the trauma setting. A growing amount of evidence supports the view that video laryngoscopy will be a standard in that setting, but more studies are needed before it’s an established reality.

As for speculation about the future of video laryngoscopy in the prehospital setting, aeromedical studies will likely continue to demonstrate the efficacy of RSI using video laryngoscopy. It’s felt that “time on the ground” can be significantly reduced by the use of video laryngoscopy-assisted RSI, either pre-flight or in-flight. Also, many feel RSI coupled with video laryngoscopy will be shown as the most effective strategy for prehospital intubation management, which will likely involve development of supraglottic airway technology.

The cost of failed or difficult intubation can be very high as reflected in a private settlement in excess of $15 million in 2002. There’s also the cost associated with emotional burden to the providers involved, who may face insurmountable obstacles to care.

The added value of video recording will allow medical directors to more accurately measure personnel competency and skill success rates, document the depth of ETT insertion and enhance education. Overall, these devices can aid emergency airway management and likely lead to better patient care—a universal goal of all EMS providers.

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Disclosure: The author is the inventor of the GlideScope, and president and research director for Verathon Medical Canada, the makers of GlideScope systems.

REFERENCES

Airway management is a basic and essential skill of anyone caring for an injured or a seriously ill patient. Although many patients can be managed with a non-invasive airway, many benefit from endotracheal intubation.

Much has been written about the hazards of endotracheal intubation, even in this latter patient group. Paralytics have been suggested, and utilized, by some ground and air EMS systems, but concern has arisen over the ability of crews to achieve effective intubation even with paralytics. One study, for example, showed esophageal intubation rates for all patients as high as 25%. The challenge for prehospital advanced life support (ALS) providers, then, is achieving a balance between the need for intubation and safely achieving that intubation.

Even in the most controlled circumstances, endotracheal intubation can be challenging. Although the addition of routine end-tidal CO$_2$ (EtCO$_2$) monitoring has reduced the incidence of esophageal intubation, it does not reduce the difficulty of the prehospital intubation process. In the field, poor lighting conditions, bad weather, the physical location of the patient, injuries to the neck and spine, and variations in skill levels of the operators contribute to that difficulty. But new technology may be able to provide some, if not all, of the solution to that dichotomy.

The goal of any new airway technology should be to reduce multiple attempts at intubation, as well as prevent dental, mouth and airway trauma, desaturation, intracranial hypertension, pneumothorax, pulmonary aspiration and even iatrogenic death from an unrecognized esophageal placement.

The advent of video laryngoscopy

For many years, direct laryngoscopy (DL) has been the gold standard by which to achieve intubation, performed with either curved or straight laryngoscope blades. However, DL often yields surprisingly poor laryngeal views. Alternatives have been explored, but most have proved to be difficult to master, time consuming, unreliable and costly. Even rigid fiber-optic laryngoscopes—the technology on which “modern” DL is based—hasn’t been widely used, despite its advantages. What has been needed is a device that provides a full view of the glottic airway during laryngoscopy and is easy to learn and master by medical personnel who may or may not frequently perform intubations.

A significant advance took place in this realm when the video laryngoscope (VL) was developed for use in the surgical suite. These devices have a camera lens incorporated into the handle or blade, allowing the image of the larynx/glottis to be displayed on a monitor that’s either directly attached to, or separate from, the blade/camera system. The ability to see the larynx while intubating, even in the most difficult patients, as well as being able to use the monitor as a teaching tool, are recognized as important advancements in airway management.

Although many of these devices (i.e., McGrath Series 5 from LMA North America, TruView from Truphatek, Storz DCI, AWS-S100 from PENTAX Medical Co., Video Macintosh Intubating Laryngoscope System from Volpi AG and GlideScope® from Verathon Medical®) have proved their worth in the hospital setting, a new design was necessary for use in the prehospital environment.
This new device would have to be rugged, small and easy to manipulate when working in difficult field conditions. Currently, the only product on the market that we believe meets all of the criteria for use in the prehospital environment is the compact GlideScope Ranger.

The Ranger has a digital camera lens incorporated into the center (versus the tip) of its specialized blade, which allows a wider view of the vocal cords on its monitor. A unique anti-fogging technology provides an unobstructed view of the larynx throughout the entire process of tube placement, a feature that’s especially valuable during emergency intubation. It weighs less than 2 lbs. and is engineered to be dependable in a variety of challenging field conditions, including very high or low temperatures, high humidity, and high altitude.

The Ranger is powered by a rechargeable lithium battery, which provides a minimum of 90 minutes of continuous use. A rigid stylet aids in the control of the endotracheal tube (ETT) as it enters the larynx. The blade has a 60° curvature in the midline to match anatomical alignment, so it doesn’t require a “line of sight” for a good view. The high-resolution color display monitor provides a clear picture of the larynx and vocal cords even in bright light, which, again, transforms it into a valuable teaching tool.

There appear to be special benefits to the GlideScope Ranger for trauma patients with limited mouth opening or in cervical immobilization. Very little force is required to expose the glottic opening with the blade so manipulation of the head and neck is reduced. It also functions well in situations where blood or other fluids are present, in mildly obese patients, and because direct visualization of the glottis is unnecessary during intubation, the GlideScope Ranger is less stimulating, an advantage for use in semi-awake patients.

### A NEW TECHNIQUE

The manner in which tracheal intubation is performed with the GlideScope is unique to its design. The handle is held in the left hand in the same way that one would hold a standard laryngoscope, while the blade is inserted between the teeth under direct vision. It’s important to start out in the midline of the tongue and to stay on the midline. (There’s no need to sweep the tongue out of the way, as is usually the practice with conventional laryngoscopes.) When the uniquely curved blade passes the teeth, the clinician can now follow the landmarks on the video monitor to the larynx. Identifying the glottis is generally easy. The only technical difficulty with the GlideScope may be guiding the ETT toward the image of the glottis seen on the screen. This difficulty is encountered because the camera is directed (by design) at a 60° angle.

The manufacturer recommends bending the ET tube to conform to the shape of the blade for a gentle curve of 60°. Still, the angle by which one inserts the tube is quite steep. A special stylet developed to lessen the difficulty of passing the tube into the trachea is available, but if advancing the tube presents a problem, withdrawing the GlideScope 1–2 cm will allow the larynx to drop down and reduce the angle required to insert it correctly.

The main limitation of the GlideScope is that there may be a physical resistance in the advancement of the ET tube; with a little practice this limitation is easily overcome. But once familiar with the steep angle of approach, the device is extremely easy to handle.

### CASE REPORTS

The following are examples from Whatcom (Wash.) Medic One of the type of cases in which the GlideScope Ranger may be extremely useful.

**Case 1:** EMS responded to a conscious 57-year-old female, a victim of a fire that started in her home. She had second-degree burns on her legs, buttocks and thighs greater than 30% of her body. She had redness of her face, but no obvious singeing of nares. There were questionable particulates in her oral cavity, but no voice change. Pulse oximetry was 93% on room air, rising to 95% on oxygen given by non-rebreather (NRB) mask. The patient had a history of smoking one pack per day. Respiratory rate was 30 but appeared unlabored. Blood pressure was 130/90, heart rate was 110. She was awake and talking.

Because she was 25 miles from a community hospital and 100 miles from a burn center, and although a major airway burn was not expected, it was elected to provide rapid sequence intubation (RSI) as a precaution prior to helicopter transport to the burn center. RSI was conducted, and the GlideScope Ranger was used to visualize the airway.

Surprisingly, the crew found she had soot in her pyriform sinuses, edema of her glottic opening and significant erythema of the entire region. The GlideScope made possible a quick (18 seconds) and easy intubation, and the video monitor provided an excellent teaching opportunity the prehospital personnel involved. In addition to direct visualization, 

**Case 2:** EMS responded to a 60-year-old male in severe respiratory distress. He was in the bed of a manufactured home. He suffered from severe Pickwickian syndrome related to morbid obesity, and had a body mass index (BMI) of 43. (His weight was approximately 656 lbs).

He was obtundent and had a pulse ox of 85%. Blood pressure could not be obtained in the patient’s current position, and moving the patient would require assistance.
that was not available at the time. His respiratory rate was 40, shallow and labored. Oxygen by NRB mask did not improve his condition.

In light of further deterioration, intubation was the only alternative. However, his BMI and body habitus were going to make it a difficult intubation. He was sedated with midazolam and, using the Ranger, was intubated within 26 seconds. Despite limited mouth opening and a difficult position, tube placement was assured via excellent visualization of his vocal chords.

Case 3: EMS responded to a 67-year-old male in cardiac arrest found in an alley behind a tavern. It was 2 a.m. and raining, and he was difficult to get to because vehicle access was blocked by construction in the area. The first responding basic life support (BLS) unit started CPR with bag-mask ventilation (BMV) performed with the GlideScope reversed. It took two attempts and 42 seconds to open windshield using a Ranger with the blade of the laryngoscope. The patient, who had probably sustained a primary respiratory arrest, was successfully resuscitated.

Case 4: EMS responded to a car struck by a semitruck at high speed. The driver of the car was trapped in the vehicle and had significant craniofacial trauma. His airway was compromised, and he had agonal respiration. To extricate him, extensive rescue operations were required.

A paramedic was able to intubate the patient from the open windshield using a Ranger with the blade of the laryngoscope reversed. It took two attempts and 42 seconds to place the tube, with suctioning required after the first attempt. Confirmation of tube placement was done via direct visualization on the GlideScope monitor and EtCO₂. The patient, who had probably sustained a primary respiratory arrest, was successfully resuscitated.

These case reports demonstrate the capabilities of a video laryngoscope, now available to EMS personnel, in performing emergency intubation. In the first case, without video visualization it would have been difficult to diagnose the glottic swelling that was unsuspected on initial examination. In the second case, this high-BMI patient with complex anatomy might not have been able to have any airway achieved. In the third, a dark night, aspiration and other factors made any airway extremely difficult. And in the fourth, it’s unlikely the intubation could have taken place at all until the patient was extricated from the vehicle.

The ability to successfully intubate critical patients in the field, especially those who present with difficult airways for a variety of reasons, is an important advancement in emergency airway management.

THE IMPACT ON PREHOSPITAL CARE

The potential impact of video laryngoscopy on prehospital medicine may be significant, especially for ground services that are often faced with difficult airways and air medical personnel who must work in tight quarters while airborne.

As previously mentioned, field intubations are by definition fraught with potential complications, such as esophageal intubation, pneumothorax, reduced ventilation and oxygenation, and pulmonary aspiration. Because of the ability to visualize the airway without distortion from fogging to, in effect, “see around the corner,” many of these complications can be avoided.

One study looked at Cormack-Lehane ratings (Grades 1–1V) of those obtained with the GlideScope in 15 patients with cervical collars. The Cormack grading in 14 of the 15 patients (93%) was reduced by one when using the GlideScope. Five Grade II patients became Grade I using the GlideScope. The average time of intubation with the GlideScope was 38 seconds without complications, including any damage to the teeth. This improvement in visualization of the glottis during intubation is a major factor in the conclusion of some that direct laryngoscopy for emergency intubation will become a relic.

The GlideScope has also become the method of choice for many in training of airway management. Currently, Whatcom Medic One is conducting a crossover study of video camera-assisted intubation versus traditional laryngoscopy. Although preliminary data is encouraging, many questions remain to be answered. These include cost versus benefit and skill maintenance of the traditional technique when a camera system isn’t available. Time and the marketplace, we believe, will help answer those questions. However, a new era of airway management may soon be on all of our horizons.

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In the prehospital setting, emergency care providers must anticipate difficult airways. Air medical crews in particular are routinely tasked with managing the most difficult airways—those complicated by concomitant head injuries, multisystem trauma or presumed cervical spine injury.

Ideally, an airway should be efficiently secured with the method that offers the greatest safety and the least morbidity. The standard advanced prehospital method in trauma patients has been rapid sequence induction (RSI) oral intubation with direct laryngoscopy, which has been shown to be a safe air medical practice.¹

In-flight airway management decision-making and practice are significantly influenced by practice setting and aircraft type, but the success rate of intubation in the air medical service is equal to the prehospital setting overall, with air medical personnel routinely contributing to the prehospital care of injured patients by establishing definitive airways.² We believe innovative technologies, such as video laryngoscopy, will improve the success rates and decrease the morbidity of prehospital intubation, as it is in our aeromedical practice at the University of Wisconsin Hospitals and Clinics.

IN-FLIGHT CHALLENGES

Difficult intubation is encountered in approximately 7–10% of patients requiring prehospital emergency endotracheal intubation.³ Stabilization of the cervical spine makes it more difficult to visualize the vocal cords using conventional direct laryngoscopy because optimal alignment of the airway axis requires neck extension.⁴ Further, cervical collars significantly reduce the ability to open a patient’s mouth, contributing to poor views on direct laryngoscopy.³ In addition, conventional laryngoscopy routinely causes movement of the unprotected cervical spine.⁶

The prehospital setting itself, particularly in limited workspaces (like that of a helicopter), further increases the difficulty of intubation. And yet, a 1998 study showed that air medical intubations, both pre-flight and en route, for scene calls and interhospital transports, are accomplished with a very high success rate.⁷

However, in-flight intubation takes approximately twice as long as intubation in a ground setting. This prolongation of intubation is primarily due to problems with positioning of the air medical crew and patient.⁸ Because a greater success rate is reported when intubation is performed before takeoff, there have been many documented cases in which the crew decided to perform an emergency landing and RSI rather than attempt in-flight intubation.⁹

PROMISING NEW TECHNOLOGY

Studies have proven the video laryngoscope as an effective device for tracheal intubation and shown it provides an improved view of the vocal cords compared with traditional laryngoscopy, even in difficult intubations.¹⁰ Although not yet extensively tested in the prehospital setting, case reports show that the video laryngoscope is a promising device for emergency intubation, leading experts to predict that video laryngoscopy will dominate the field of emergency airway management in the future.¹¹

The goal of the video laryngoscope is to facilitate the visualization and recognition of anatomical structures and to facilitate manipulation of airway devices. With its low weight, high-resolution screen and compact size, the portable video laryngoscope has the potential to be a useful device for air medical crews.

Intubation takes about twice as long in-flight due to the confined space, calling for a quick and reliable means to intubate while in the air.
Additionally, it provides significant benefit in situations where access to the patient’s head is limited, such as during automobile extrication or in air medical settings when the intubator may be placed adjacent to the patient instead of in line with the patient’s head. The intubator is not required to be “in line” with the patient and therefore can be easily applied in-flight and in other settings with limited space.12

CASE REPORT
No scientific studies have yet looked at intubation success rates in the air medical setting with video laryngoscopy or evaluated the benefit of intubation in-flight with video versus direct laryngoscopy on the ground. Until those studies have been conducted, we must look to case studies for anecdotal reports of this device’s impact on prehospital airway management, including a case report we have submitted to a peer-reviewed journal.13

Our air medical service was called to the scene of a high-speed motor vehicle crash, where the flight crew intubated a 26-year-old male driver pre-flight (in the ground ambulance). On first contact with the air medical crew, the immobilized patient had a Glasgow Coma Scale of three, with rapid, snoring respirations, a blood pressure of 106/60 and a heart rate of 118. Because of trauma to the head and possible cervical spine injuries, it was anticipated to be a difficult airway case.

While in the ambulance, the air medical crew secured the patient’s airway using RSI and oral-tracheal intubation with a GlideScope® Ranger video laryngoscope. In-line immobilization of the neck was provided by one of the paramedics and cricothyroid pressure held by the other. The GlideScope Ranger video laryngoscope provided an excellent, unobstructed view of the vocal cords and an endotracheal tube was easily passed. The patient was transported by helicopter to the regional Level 1 trauma center, where evaluation revealed extensive multisystem injuries.

We have utilized the video laryngoscope for simulated patients (manikins) in the patient care compartment of both an EC-135 and Agusta 109 Power aircraft. Intubation position varied, both from the head of the patient and next to the patient, during daylight and limited light settings. We found the device easy to use when standard direct laryngoscopy would have been difficult or impossible.

CONCLUSION
No single airway device offers a solution to all scenarios, but we consider the video laryngoscope a useful addition to the range of devices available to the air medical crew. The use of these devices has been suggested in recent guidelines as an alternative technique in difficult intubations, and case reports have suggested that it can be beneficial when managing a patient with cervical immobilization.13-14

However, no studies yet compare prehospital use of video laryngoscopy and direct laryngoscopy by ground EMS or air medical crews. One randomized, single-blinded study that compares different types of video laryngoscopes and traditional direct laryngoscopy with Macintosh laryngoscope was recently started.15 This study will hopefully provide guidance toward implementation of a video laryngoscope for prehospital difficult airway management.

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The Perfect View
JOURNAL OF EMERGENCY MEDICAL SERVICES

It’s 1800 HRS, and the radio calls for the Trauma Team to report to the emergency department STAT. The information coming across the radio continues: “Medivac inbound. Two urgent surgicals, one intubated. Ten-minute ETA.” Although it may sound like the initial report of an inbound helicopter at any urban trauma center in the U.S., the reality is that minutes before, the flight medic rolled out of a Black Hawk helicopter in Iraq to meet a combat medic who had just pulled two of his fellow soldiers out of their Humvee. Over the roar of the helicopter and small arms fire in the distance, the medic quickly gives a report, yelling, “IED. Patient One was unconscious. I intubated him. Has a loose dressing on his neck. Open neck wound, right side, bleeding controlled. Right leg is partially amputated at mid-thigh, and a tourniquet is in place. Patient Two is awake. Multiple fragment wounds on his face, right arm and leg.” The casualties are loaded into the Black Hawk and urgently flown to the nearest Combat Support Hospital.

Whether you’re a prehospital medic in the mountains of Afghanistan or the sands of Iraq, many of the same airway issues that challenge EMS here in the U.S. also challenge the prehospital providers in the combat zones of the Middle East. One North American airway study conducted in a large urban EMS system found that paramedics reported as many as 70% of laryngoscopies performed had poor glottic visualization and required multiple laryngoscopy attempts. Even data in the hospital/surgical setting shows that clinicians encounter poor glottic visualization in as many as 9% of laryngoscopies.

In the combat zone, more than 75% of surgical injuries presenting to a Combat Support Hospital (CSH, pronounced “CaSH”) result from either improvised explosive devices (IEDs) or gunshot wounds (GSWs). These patients frequently present with blast or penetrating fragment (shrapnel) injuries that disrupt the integrity of the oral, pharyngeal or glottic structures.

These injuries can make direct laryngoscopy (DL) even more challenging. Thus, airway management and optimal DL success in the combat setting require concise airway protocols and experience, as well as equipment that’s reliable, sturdy and enhances the provider’s proficiency.

In addition to the challenges of glottic visualization during endotracheal intubation (ETI) in the complex trauma airway, military medics and prehospital providers also face the constant task of minimizing the amount and size of equipment necessary to deal with these injuries.

With the advancement of technology, several video laryngoscope systems have been developed that enhance the view of the glottis with the goal of improving laryngoscopy success rates in the difficult airway. Verathon

The Military Experience
The GlideScope Ranger Improves Visualization in the Combat Setting

BY MICHAEL R. HAWKINS, MS, CRNA

CPT Michael R. Hawkins (left) and COL Thomas C. Broach (right) show their GlideScope® Rangers at the 325th CSH, COB Speicher, Iraq.
Medical® has developed the GlideScope® Ranger Video Laryngoscope (Ranger), a compact, sturdy system that can withstand the demanding operating environment of the military.

The blade of the Ranger is similar to a Macintosh blade but has a pronounced 60° angulation and incorporates a high-resolution color camera with the image displayed on a 3.5” LCD panel. Because of the size and durability of the Ranger, it was the ideal video laryngoscope system to test in combat.

SENDING THE RANGER ‘DOWN RANGE’ ... TO IRAQ!
An Army anesthesia team deployed to a CSH in Northern Iraq supplemented the standard “difficult airway” equipment with the Ranger (see Photo 1). The use of the Ranger was tracked during a six-month period, and data was collected on how the device functioned. In this study, Army providers utilized the Ranger as the primary “difficult airway” adjunct for any patient requiring ETI with predictive factors that would classify the patient as a difficult intubation. Some of the factors included a Mallampati score of two or higher, disruption or penetration of tissue in the neck or oral-pharyngeal region from IED or GSW fragments, facial and airway thermal injuries, or potential cervical spine trauma.

Even though the Ranger was utilized exclusively on difficult airway cases, providers reported the view seen on the LCD screen as equal to a Cormack-Lehane, Grade I view in 97% of patients. A partial view (Cormack-Lehane, Grade II) was reported in the remaining 3%. There were no reported cases of obstructed glottic view with the Ranger. Data collected from studies in North America had similar results.

Despite some combat casualties presenting with disrupted oral-pharyngeal tissue or blood in the supraglottic region, the recessed location of the optics in the Ranger’s blade allowed the view on the LCD screen to remain unobstructed by blood and tissue.

Paramedic/physician providers who had infrequent use of laryngoscopy skills reported that the device enhanced their ability to obtain a glottic view. As a result, these providers reported that the individual confidence level of obtaining an ETI in a difficult airway was greater.

And finally, despite the harsh operational environment of a combat zone, there were no mechanical/functional failures seen with the Rangers during the study period.

CASE 1: PENETRATING FRAGMENT INJURIES/BURN VICTIM
An Iraqi local national was driving a car that was hit by an IED and caught fire subsequent to the blast. The driver of the car, injured by both primary and secondary IED fragments, was pulled from the vehicle by U.S. soldiers...
and given initial emergency care. Prior to transport, a field medic established a peripheral IV and attempted oral laryngoscopy. Due to the IED’s blast wave and thermal effects, his oral and supraglottic tissue had swollen over the glottic opening and ETI was unsuccessful.

The patient received an emergency surgical cricothyrotomy and was transported to a CSH where he was evaluated and taken to the operating room for his initial surgery. After approximately 72 hours, the tissue swelling of both the patient’s face and airway had decreased significantly. Prior to removing the surgical cricothyrotomy, the GlideScope Video Laryngoscope system was utilized to assess the patency of the glottic opening (see Photo 2).

Despite mild swelling and sloughing of airway epithelial tissue above the glottis, it was determined that the glottis was patent. The trach tube was safely removed from the cricothyroid space, and an endotracheal (ET) tube was then placed from above through his glottic opening (see Photo 3).

**CASE 2: UNEXPLODED ORDINANCE LODGED IN THE LEG**

A patient presents with an explosive device embedded in his leg and any movement could trigger it. This was a dilemma faced by the medic of a combat unit in Iraq. His patient was awake and alert, had no airway distress, and minimal bleeding from the entrance wound of the unexploded ordnance (UXO). Once it was determined that there was no emergent surgical need to control bleeding, a plan was carefully devised to remove the UXO from the leg of this patient with minimal movement.

The area around the patient was cleared and secured. A surgeon and anesthetist responded from the CSH to assist the medic in removing the UXO. The team of three carefully removed enough clothing to establish an IV line, all the while cognizant that any movement could trigger the device. The patient required general anesthesia in order to remove the UXO from his leg, and the goal was to perform rapid sequence induction with minimal or no movement. Once the patient had an IV and was placed on oxygen, he was induced with general anesthesia. After the patient was asleep, the Ranger was used to perform the laryngoscopy and secure an ET tube. Once the airway was secured, the surgeon, medic and explosive ordinance team removed the UXO (see Photo 4).

The providers later acknowledged that the Ranger provided the quickest, clearest view of the glottis.

The patient presented to a medic in the field with an unexploded ordnance (UXO) in his leg, which could have been triggered by the slightest movement. The Ranger was used to perform laryngoscopy and secure an endotracheal tube in the exact position the patient was found and with minimal force.

**CONCLUSION**

Video laryngoscopy using the Ranger has simplified management of the difficult airway in the combat environment. It has given patient-care providers a compact and durable device to definitively secure ET tubes in complex airways. In addition, it may be the optimal way to secure endotracheal tubes in those patients with suspected cervical-spine injuries or traumatized airways. For EMS systems that struggle to maintain proficiency with ETI, the GlideScope may level the skill requirement enough to increase the overall success rates of ETI by providers who have infrequent intubation experience.

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Disclosure: The author has received no monetary support from Verathon Inc. His EMS system, U.S. Army, 325th CSH, has received support from Verathon Inc. in the form of a video laryngoscope for evaluation and research purposes.

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Recently, I attended a seminar where the keynote speaker recommended endotracheal intubation be abandoned as a prehospital skill. A great deal of discussion ensued, mostly regarding the complications and legal liability of failed intubations and misplaced tubes, as well as the implication of new adjuncts to replace intubation.

Although I believe we’ve seen great improvements in airway adjuncts in the past several years, they’ve all had limitations and complications, and oral tracheal intubation has remained the “gold standard” for airway control and maintenance. Thus, rather than discontinue this life-saving procedure, we should attempt to figure out why it’s problematic in the prehospital setting and develop ways to improve its success.

As an EMS supervisor, part of my job is to administer our agency’s quality assurance program. Because our department uses rapid sequence induction (RSI), failure to secure an airway isn’t an option, and this intervention is monitored closely. In November 2006, my colleagues and I noticed an increase in unsuccessful intubations and a series of multiple intubation attempts. We monitored this for several months to ensure we were seeing an actual trend and not just a “bad month.” In February 2007, we determined it was a trend, and we set out to resolve the problem.

Not only is it imperative to secure an airway, it must be accomplished with a minimal number of attempts. A 2004 study showed an increase in complications following the second attempt at oral tracheal intubation. The study reported that hypoxemia occurred in only 11.8% of patients intubated within two attempts; however, hypoxemia was seen in 70% of patients on whom more than two attempts were made. Aspiration went from 0.8% within two attempts to 13% after more than two attempts, and bradycardia occurred in only 1.6% of twice-attempted intubation patients versus 21% for patients undergoing more attempts.

Our department was on track with these complications, and we needed a solution.

**A NEW WAY**

In March 2007, several members of Martin County (Fla.) Fire Rescue, attended the EMS Today conference, where we were introduced to the GlideScope® Ranger. I arranged to have a representative present the device to our department for a more in-depth evaluation. A regional sales rep brought a unit to our training office and we had several of our rescue lieutenants (EMS supervisors) and paramedics use the unit to intubate our training mannequins. Intubation with the Ranger is slightly different than what paramedics are used to. So there was a small learning curve, but after 10–15 minutes of practice, everyone was comfortable with the equipment and able to intubate effortlessly. We easily intubated the difficult airway head and a mannequin with a cervical collar in place. In all cases, we were able to intubate on the first attempt and in an acceptable timeframe.

Because it was the middle of our budget year, it took some juggling of funds, but by fall 2007 we were able to purchase four Rangers. We weren’t able to purchase enough units for every ALS truck, so we decided to place one on each of the rescue lieutenant’s vehicles and one on our medical helicopter. Rescue lieutenants and flight medics are the only ones who perform RSI and they respond to most of the critical calls. With this strategy, we felt the Rangers would be quickly available anywhere in the county.

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**Using Is Believing**

Highlights from 72 Cases Involving Video Laryngoscopy at Martin County (Fla.) Fire Rescue

**BY DAVID ZARKER, EMT-P**

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Rescue lieutenants, who carry the Ranger in this special response bag, have additional training and are authorized by the medical director to perform retrograde intubations, intraosseous infusion and RSI.
CASE STUDY #1

Early one morning, one of our stations responded to a motor vehicle crash (MVC) in which a motorcycle struck a pickup truck broadside at a high speed. The driver of the motorcycle was lying approximately 75 feet from the point of impact and was unconscious and unresponsive. No helmet had been worn (they’re optional in Florida) at the time of the accident.

Physical assessment revealed unequal pupils and blood in the patient’s ears, nose and mouth. He had shallow respirations at four to six a minute and uneven chest rise. Examination of the extremities revealed bilateral femur fractures. His other vital signs were: Pulse 130, weak and regular; blood pressure 88/54; and $\text{SaO}_2$ 86.

Initial treatment included manual C-spine stabilization while crew members attempted to assist ventilations with bag-mask ventilations (BMV). Because his jaw was clenched, the ventilations were ineffective. It was obvious that if the patient was to have any chance of survival, an airway needed to be secured quickly. Due to the severe head injury and the clenched jaw, few options were available.

The crew decided to perform RSI and orally intubate the patient. The patient was sedated and paralyzed, and oral tracheal intubation was attempted. The first attempt was unsuccessful, and the patient’s pulse dropped to 52. The patient was then ventilated by BMV, bringing his pulse back to 120.

A rescue lieutenant arrived on scene with a video laryngoscope, and the patient was successfully intubated on the first attempt. The patient was air lifted to the local trauma center, and after several months of recovery, he was released to a rehabilitation facility to undergo physical therapy. A full recovery is expected.

CASE STUDY #2

Whenever a difficult airway is mentioned, we naturally think of trauma patients, but some of the most challenging airway problems can arise from medical calls. Recently, one of our rescue crews responded to an “unknown medical” in a mobile home park. On arrival, they found an extremely obese woman in her 50s in the back bedroom of a small mobile home and in severe respiratory distress. An initial exam revealed her skin to be pale and diaphoretic, and rales were noted in all lung fields. Her pulse was 140, BP was 74/48, $\text{SaO}_2$ was 54%, and respirations were six a minute, with cyanosis noted around her lips.

CPAP was attempted but discontinued within a few minutes because the patient was too weak and tired. Respirations were assisted with BMV while an IV was established. Lasix 80 mg was administered, but morphine and nitroglycerine were withheld due to her hypotension.

A second IV was established, and a dopamine drip was started with the hope of increasing her BP enough to allow for the administration of additional medications.

The patient’s condition continued to deteriorate, and an attempt at nasal intubation proved unsuccessful. A supervisor dispatched on the call decided, in conjunction with the scene paramedic, to use RSI and attempt to orally intubate the patient. The crews realized it would be a difficult intubation, but the patient needed an airway, and with video laryngoscopy available, team members felt confident they would be successful.

The patient was paralyzed and successfully intubated using the Ranger on the first attempt.

OTHER CASES & IMPRESSIONS

Our crews have also used the video laryngoscope successfully to clear airway obstructions in two children. Visualization was quick, and the design of the blade allowed more room in the mouth to maneuver the Magill forceps.

In instances when a supervisor arrives on scene where a patient has already been intubated, but the crew is unsure if the placement is correct, we have used the Ranger to quickly and easily verify tube placement by inserting the blade/camera into the airway. Within a few seconds, several providers at once can confirm placement on the video screen. Our flight medics also frequently use this technique to verify tube placement before loading intubated patients into the helicopter.

Many of our paramedics have said they also prefer the Ranger over traditional methods because they don’t have to put their face down by the patient’s. This decreases the possibility of bloodborne exposure from secretions or blood coughed up by a trauma patient.

After we put the Rangers in service, we took them to local emergency departments for demonstrations. The physicians were impressed, and on several subsequent occasions, called for a rescue lieutenant when they had a difficult intubation and an anesthesiologist wasn’t available.

During the past nine months, we’ve used video laryngoscopy on 72 prehospital patients and successfully
intubated all but one. When I performed a quality assurance review on the failed intubation, I determined it was most likely due to an inexperienced operator error. After that case, our rescue lieutenants provided refresher training for all crews, and the problem hasn’t happened since.

GETTING STARTED

I can’t stress enough the importance of training for anyone who may have the opportunity to use this equipment. The procedure isn’t difficult; it’s just different than the way paramedics were originally trained to intubate with a traditional laryngoscope. The design and shape of the blades actually make intubation easier and require much less force to visualize the vocal cords. However, if you aren’t comfortable with the equipment, you can feel awkward during your initial attempts.

I recently had a discussion with a physician who was concerned that paramedics may become too reliant on the Ranger and felt it could reduce their ability to intubate the “traditional way” if the device was unavailable. I definitely understand this concern, especially if every ALS unit carries a video laryngoscope, but I strongly urge departments, especially those using RSI, to find a way—through grants, private donations or fundraisers—to obtain units and place them strategically within their service area. The results of your efforts, in terms of improved patient care, will be priceless.

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David Zarker, EMT-P, is a rescue lieutenant with Martin County (Fla.) Fire Rescue. He previously served as the program coordinator for LifeStar, Martin County’s air medical program, and was involved in creating a public/private partnership in order to bring an affordable air medical program to Martin County. He’s also active in protocol development, research and development. Contact him at dzarker@martin.fl.us.

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Teaching the Airway
Designing Educational Programs for Emergency Airway Management

BY MICHAEL F. MURPHY, MD; RON M. WALLS, MD; & ROBERT C. LUTEN, MD

Among all emergency care providers, competency in managing the airway is essential to managing patients who are acutely ill or injured. Generally, the situation is emotionally charged, the circumstance is urgent, and the stakes are high. The practitioner must know what to do and when to do it.

Having committed the past two and a half decades of our professional careers to teaching airway management, it still strikes us how difficult it is to effectively teach airway management skills and to have students demonstrate learning. So much so that in the mid 1990s, we (with Dr. Bob Schneider) created a dedicated educational program for emergency practitioners to provide a comprehensive immersion experience in emergency airway management, with a special emphasis on the identification and management of the difficult and failed airway.

This program, which has trained more than 3,000 emergency providers, has undergone progressive improvement and innovation, and is now called The Difficult Airway Course: Emergency. It’s one of a family of educational programs that now includes The Difficult Airway Course: EMS, and The Difficult Airway Course: Anesthesia.

In the development of these programs, we recognized the importance of both cognitive and skill components in training clinicians on airway management, and incorporated those components into a comprehensive and effective curriculum. So what does it take to successfully educate EMS providers on airway management?

HOW WE APPLY LEARNING

When a clinician encounters an airway emergency, each step of the assessment and intervention process is potentially challenging. The cognitive piece of response—
the “what”—involves a multitude of parameters, including knowing the anatomy, physiology and pathophysiology of the airway; knowing how to evaluate the airway; understanding the what, how and when of medications used in airway management; and deciding the best method of management and the best time to intervene.

The competent, well-trained provider has the ability to apply this knowledge to actual cases in such a manner that the most appropriate action is taken. Thus, the training must involve acquiring the technical and cognitive skill sets needed to manage the airway and knowing how to rescue the situation (and the patient) “if the wheels come off.”

Essentially, practitioners deal with critical incidents with one of two basic mechanisms—by either a rule-based solution or a knowledge-based solution.\(^1\)\(^2\)

To reach a rule-based solution, the practitioner recognizes the event for what it is. They identify and apply a solution that experience has shown will likely be useful in solving the problem. Recognizing the event involves a process called “similarity matching” or “pattern recognition,” which means we recognize characteristics of a current event as being similar to those of past events. This process assumes they’ve had sufficient experience with both the situation and the application of the rule to immediately recognize the problem and to know which rule to apply.

This ability constitutes what’s called “expertise.” Unfortunately, difficult and failed airways are encountered infrequently in practice, and the individual experiences of the vast majority of practitioners is unlikely to have been sufficient to earn them “expert” status.

A knowledge-based solution is a ground-up, first-principles strategy whereby the practitioner, without substantial past experience with similar situations, attempts to find an appropriate solution. Not surprisingly, such strategies are time-consuming, and, if forced under pressure, are more likely to result in failure.

However, most emergency airway managers don’t have sufficient clinical experience with difficult airways to have in their minds a rule-based, organized approach to these airway dilemmas, nor the time to build one from first principles. For this reason, a variety of tools, such as mnemonics and pre-formulated airway algorithms, have been crafted to aid rapid decision-making and increase the odds of making appropriate treatment decisions.

Mnemonics are useful in guiding the practitioner in rapidly evaluating the airway for difficulty with respect to management options, including bag-mask ventilation (BMV), the use of extraglottic devices (EGDs), laryngoscopy and intubation, and surgical airway management. Two of the mnemonics used in The Difficult Airway Courses are shown in Figure 1.\(^3\)

**VICES TO DISCUSS**

Some techniques and devices for airway management are so established that they constitute the standard of care and must be taught in any program. Examples include BMV, laryngoscopy and orotracheal intubation, and cricothyotomy. That’s not to say they must be taught as first-line interventions, but simply that they must be taught within the scope of the educational program.

The marketplace is flooded with airway management devices. The reason is clear: Airway management is difficult, and the ideal device that’s easy to use and guarantees near 100% success has yet to be invented. So it’s left up to those with expertise in the field to select the devices perceived to deliver an advantage over what currently exists—decisions that are, where possible, backed up by good scientific evidence. Some of these devices and techniques include the intubating stylet, EGDs, rigid and semirigid optical stylets, video laryngoscopes, and flexible fiber optics.

Sometimes, a device or technique has particular relevance to the practice environment of one audience and not another. The best example is the prehospital environment, where sterilization of reusable devices isn’t ordinarily possible, rendering an advantage to single-use devices (e.g., disposable versus reusable EGDs, or the GlideScope® Cobalt instead of the GlideScope Ranger).

Importantly, there are devices that are not taught because they may require high-frequency use to maintain competence, are too expensive or confer little advantage over simpler devices or techniques.

**SKILLS INSTRUCTION**

Part of the reason health-care providers find airway management stressful is that some of the fundamental skills are difficult to master and, generally, poorly taught.

BMV is one of those skills. It’s at least as difficult to master as laryngoscopy and intubation. It requires a
substantial amount of manual dexterity and practice to become proficient, and remain proficient. Because of this skill difficulty, it’s worth considering why BMV hasn’t been relegated to a subsidiary position in the basic airway management of the unresponsive patient in favor of easily taught and learned EGDs, such as the Combitube, King LTS or the LMA Fastrach.

Laryngoscopy and orotracheal intubation together are renowned as a difficult technique to master. Roughly 50 orotracheal intubations are necessary to establish “competence” in the technique, defined as a 90% chance of success.4 It’s a highly nuanced technique that requires detailed step-by-step teaching. The program of instruction must emphasize those nuances (e.g., the importance of exerting pressure on the hypoepiglottic ligament when performing a curved blade intubation, employing an intubating stylet to facilitate intubation, how BURP is correctly performed). Even the specific motions of the endotracheal tube during insertion are critical to master.

An educational program must identify the “tricks” that enhance success—that little maneuver that makes “the last 5%” successful. At the same time, the program must reinforce true principles of management (e.g., leave the structures in to bag ventilate, but remove them to intubate) and debunk well-established but incorrect dogma (e.g., smearing K-Y Jelly on a beard makes BMV easier). Virtually all the devices mentioned in the “Devices” section require detailed step-by-step instruction with respect to patient selection, standard technique and modifications in specific situations to achieve success—some more so than others. For example, optical stylets and video laryngoscopes may be of limited value in the bloody airway, and it’s force true principles of management (e.g., leave the den-

EDUCATIONAL PLATFORMS

It’s clear from the literature that no single method of education—classroom lecture alone, case studies alone, skills labs alone—adequately teaches complex cognitive and technical skills, such as airway management, and is consistent with our experience over decades of education of health-care providers at all levels. A method of instruction that integrates didactic teaching, case studies and skills development provides the best educational experience.

Simulation has emerged as a key educational resource in areas where cognitive and technical factors combine to force the participant to judge the best course of action. The evidence from the literature suggests that simulation enhances performance and that this performance enhancement is sustained.5 Evidence also supports the idea that simulation enhances skills development in airway management, reducing the need for actual live patient training.6,7

SUMMARY

Gas exchange is fundamental to airway management. Programs that teach airway management must embrace this dictum and design objectives to achieve this program goal. Airway management has important and interrelated cognitive and skill components. Thus, educational programs that provide an element of didactic teaching, case studies that apply and reinforce the didactic content, and skills teaching in a realistic simulated environment are best suited to the acquisition and long-term retention of airway-management skills.

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