In 1878, William Macewen was the first to use endotracheal intubation for a patient who had cancer of the base of the tongue rather than tracheostomy, as was routine at that time. Subsequently, Macewen guided metal tubes into the airway with his fingers, honing his skills on cadavers, and then packed the pharynx with oil-soaked gauze to achieve a seal.

The first direct laryngoscope was described by Kirstein in 1895. It was a straight blade design with a light electrically powered and positioned at the tip. The original laryngoscopic technique with a straight blade was no different than it is today. The tip of the laryngoscope blade was passed posterior to the epiglottis, which was then elevated directly to expose the vocal cords. Chevalier Jackson is credited as being the first to place batteries in the handle of the laryngoscope. Jackson also recommended that the head be placed on a pillow in full extension rather than in the “sniffing position” (flexion of the neck and extension of the head) now recommended and that the tip of the laryngoscope be inserted sufficiently beyond the tip of the epiglottis to elevate it out of the line of sight (LOS). He postulated that the epiglottis must be identified for successful intubation, cautioned against using the teeth as a fulcrum, and emphasized that the force applied to the laryngoscope was designed to lift the hyoid and epiglottis. He recommended that the laryngoscope blade be advanced along the right side of the tongue (ie, paraglossal approach).

Magill also recommended a paraglossal approach, particularly if laryngoscopy proved difficult. He postulated (correctly) that positioning the laryngoscope blade as
far lateral as possible improved the laryngeal view. Bonfils later described this technique as "retromolar," although the terminology is inaccurate because the laryngoscope is almost never passed posterior to the molar teeth. Henderson maintains that the key feature of the techniques of Magill and Bonfils is passage of the laryngoscope along the paraglossal gutter, a position that facilitates optimum lateral displacement of the entire tongue. He also states that "paraglossal" is a more accurate description for this technique. Even today, moving the blade from the midline to the paraglossal position during laryngoscopy may rapidly convert an intubation failure to a success, particularly with adjunctive use of an endotracheal tube introducer (ETI), such as an Eschmann introducer (EI). It is a maneuver that may improve the laryngeal view so substantially that every airway manager ought to be aware of it.

Sir Robert Macintosh described the curved laryngoscope blade in 1943, in large measure, to subvert the addition of bulky balloons to rubber endotracheal tubes (ETTs) in the 1940s, which hindered, or even made impossible, their passage through the flange of the Magill blade. This blade was designed to control the tongue and sweep it to the left side of the mouth, creating sufficient room to pass the bulky tube-ballon combination. Macintosh’s key innovation was not the curved blade design but the technique, which involved inserting the blunt tip of the blade into the vallecula and actively depressing the hyoepiglottic ligament to flip the epiglottis anteriorly to expose the glottis. The importance of the technique is often overlooked, but it is the key to understanding the success of the Macintosh laryngoscope—and its limitation. By the late 1940s, Macintosh tired of his design and reverted to the Magill blade, having invented the intubating stylet (gum elastic bougie, EI) to get around the problem. Macintosh inserted the EI down the flange of the paraglossally inserted Magill blade into the trachea and then moved the blade to the center of the mouth and guided the ETT into the trachea over the EI.

LARYNGOSCOPY AND INTUBATION

Laryngoscopic oral intubation is a difficult skill to master. Using a statistical model to study the learning curve of novice intubators, Mulcaster and colleagues determined that 47 intubations were required to ensure a 90% probability that a laryngoscopic intubation would be successful. Laryngoscopy is a multifaceted procedure that requires a solid knowledge of the relevant anatomy in addition to dexterity and creativity to align the oral, pharyngeal, and laryngeal axes of the airway so that the laryngoscopist gains the best possible view of the glottis.

Benumof describes a “best attempt” at laryngoscopy as having six components: (1) performance by a reasonably experienced laryngoscopist, (2) no significant muscle tone (paralysis), (3) optimal positioning of the airway (eg, sniff position), (4) the use of external laryngeal manipulation, (5) appropriate length of blade, and (6) type of blade. With this definition and no other confounding considerations, the optimal attempt at laryngoscopy and intubation may be achieved on the first attempt and should take no more than three attempts. Because there are different techniques of laryngoscopy, the laryngoscopist needs to choose one method that works best and use or practice it often, although not to the exclusion of the others.

The laryngoscopist must recognize the anatomy of the laryngeal inlet revealed at direct laryngoscopy. Beneath the epiglottis, a view is sought of the whitish vocal cords in their triangular orientation (Fig. 1). Below the cords, the rounded paired posterior (cricoid) cartilages may be seen. Between and slightly beneath these cartilages, the small vertical interarytenoid notch appears, and in a restricted view situation, it may be the only landmark identifying the more superiorly located glottic opening. When
seen and recognized, an endotracheal introducer can easily be placed above the notch or cartilages to gain access to the trachea.

Cormack and Lehane\textsuperscript{13} devised a scoring system that, although limited by an element of intra- and interobserver variability, provided an objective descriptive measure of the glottic view during laryngoscopy. The definitions they used are as follows:

- Grade 1: most of the glottis is visible.
- Grade 2: only the posterior extremity of the glottis is visible.
- Grade 3: no part of the glottis but only the epiglottis is visible.
- Grade 4: not even the epiglottis can be seen.

Perhaps the most useful modification of this basic system is one that parses a grade 3 view into a grade 3a, in which the epiglottis can be lifted off the posterior pharyngeal wall, and grade 3b, in which it cannot be lifted (Fig. 2).\textsuperscript{14} Persistent attempts to intubate a patient with a grade 3b view while using a curved blade and intubating stylet cannot be justified.

Although there are many different types of laryngoscopic blades, they are all essentially straight or curved. Typically, the straight blades are intended to pick up the epiglottis to optimize visualization of the glottic opening. The curved blades are used to
negotiate around the base of the tongue to make contact with the hyoepiglottic ligament. Depressing this ligament with the blunt (and usually beaded) tip of a curved blade produces elevation of the epiglottis and exposure of the glottis. Although these devices are effective and safe, they all have limitations. Straight blades seem to provide better visualization of the larynx, whereas tracheal intubation seems to be easier with curved blades. The choice of these blades largely depends on the airway manager’s training, experience, and the clinical situation. Airway managers need to be familiar with both techniques so that if one fails, the other can be used.

Positioning of the Head and Neck for Laryngoscopy and Intubation

Laryngoscopy is more successful if the laryngoscopist assumes or creates a comfortable intubating position that allows in-line visualization of the airway. This can be accomplished by adjusting the height of the patient or the height of the intubator (e.g., stool, kneeling) to bring the airway into the laryngoscopist’s central field of vision. Uncomfortable contorted body positions lead to fatigue and unnecessarily complicate laryngoscopy.

The optimal position for direct laryngoscopy and intubation is controversial. Jackson advocated full head extension, and Magill recommended the “sniff” position, whereby the neck is flexed on the torso and the head is slightly extended on the neck (the flex–extend position). The triple-axis alignment was first proposed by Bannister (an anesthetist) and MacBeth in 1944. There is clinical evidence of the value of the sniff position. Head extension facilitates insertion of the laryngoscope, reduces contact between the laryngoscope and the maxillary teeth, improves the view of the larynx, and is essential for full mouth opening. Adnet and colleagues compared the view achieved during laryngoscopy in patients in the sniff position (neck flexion) with simple head extension. They concluded that the sniff position was particularly beneficial in patients who are obese or have limited neck mobility. The sniff position improved glottic visualization in 18% of patients and worsened it in 11%. In those patients in whom the sniff position improved the view, the grade was improved from 4 to 3 in 2 patients, from 3 to 2 in 16 patients, and from 2 to 1 in 66 patients. These improvements are clinically important.

Although there has been some controversy as to whether or not the sniffing position is best, it is generally accepted that when not contraindicated by cervical spine precautions, this is the best starting position. It is crucial that the airway manager treat laryngoscopy as a two-handed procedure. Holding the laryngoscope in the left hand, the right hand can be used to lift and tilt the patient’s head back during laryngoscopy or to manipulate the thyroid cartilage externally in an attempt to visualize the glottis optimally. Once the airway manager has obtained the “best view” of the glottis, the assistant is asked to reproduce the corresponding maneuver while the laryngoscopist passes the ETT.

Laryngoscopy

The purpose of direct laryngoscopy is to facilitate tracheal intubation under vision. Successful direct laryngoscopy depends on achieving an LOS from the maxillary teeth to the larynx. Management of the tongue and epiglottis is crucial to successful direct laryngoscopy. While holding the laryngoscope in the left hand, the right hand is used to extend the head on the neck, provided there are no contraindications to moving the cervical spine. This motion causes the mouth to open a moderate amount. The blade is inserted into the partially open mouth, and the little finger of the left hand then retracts the lower lip from between the mandibular teeth and the blade. This maneuver prevents injury to the lower lip and also serves to open the mouth more fully. The
A laryngoscope blade is further advanced into the right side of the mouth and then moved to the middle of the mouth to displace the tongue to the left and into the mandibular space. The tip of the blade is used to move the epiglottis out of the LOS. A straight blade is ordinarily inserted to the point where the epiglottis can be picked up (“look as you go” or “insert and withdraw”), whereas the curved blades are designed to be inserted into the vallecula to contact the underlying hyoepiglottic ligament, which flips the epiglottis forward out of the LOS. Forward movement of the hyoid bone and epiglottis out of the LOS with both types of blades is achieved by applying a significant lifting force along the long axis of the handle.

The amount of lifting force required to expose the glottis maximally is related to some known variables: the heavier the patient, the greater is the force required; the McCoy laryngoscope blade requires less lifting force; and the lifting force required is 30% less with a straight blade than with a curved one. The amount of lifting force required to expose the larynx optimally while minimizing the risk for trauma to fragile tissues is gained with experience.

The key differences between the curved and straight laryngoscope blade techniques relate to better tongue control by the broader curved blade together with indirect epiglottis elevation achieved by stretching the hyoepiglottic ligament, as opposed to the direct elevation of the epiglottis with the straight blade.

Many factors may cause difficulty with direct laryngoscopy. Failure to displace some of the tongue to the left of the blade occurs when there is increased tongue size, reduced volume of the mandibular space, reduced volume of the mouth (eg, “high arched palate”), or a fibrotic postinflammatory tongue (eg, postradiation therapy). Additionally, reduced access to the oral cavity (ie, mouth opening) is postulated to lead to trapping of the tongue between the blade and the hyoid. In the event that one is using a curved blade, this prevents the tip of the blade from entering the vallecula and depressing the hyoepiglottic ligament. This is probably the final common pathway of many causes of failure to see the vocal cords with the Macintosh laryngoscope.

The Macintosh laryngoscope blade works well in most patients. Insertion is usually easy, because the curved blade follows the natural curve of the tongue through the mouth and into the vallecula with a sliding radial wrist deviation (“rocking”) kind of motion. The laryngoscope is inserted to the right of the tongue, moving it to midline as it is advanced, helping to locate the epiglottis and glottis in most patients. Nevertheless, there are the inherent limitations as described, and it is necessary to be skilled in alternative techniques.

The straight blade has the potential to provide glottic visualization in most patients for whom a curved blade has failed to do so. Some researchers have suggested that the mechanism of the greater efficacy of the straight laryngoscope is an improved LOS, because there is no laryngoscope curve to intrude into the LOS. Further, the paraglossal approach reduces the distance from the near point (the teeth) to the far point (the glottis), improving the LOS. This is akin to moving an object just beyond the visual horizon closer so as to bring it into view. Additional mechanisms include more effective displacement of the tongue and more reliable elevation of the epiglottis. Coupling this technique with an ETI further improves intubation success rates.

There is evidence to support the contention that the straight blade provides tracheal intubation success when the curved blade has failed. The first series that defined the efficacy of the straight laryngoscope in patients in whom the larynx could not be visualized with the Macintosh laryngoscope was published in 1983. Six further series were reviewed by Henderson in 1997.

Many variations of the curved laryngoscope blade have been described, most without significant data about their efficacy, and few have stood the test of time.
levering tip McCoy curved blade deserves special mention, however. This Macintosh-type laryngoscope blade was introduced by McCoy and Mirakhur\textsuperscript{29} in 1993 and features a hinged tip that flexes when a lever on the handle is depressed. The mechanism of displacement of the tongue and elevation of the epiglottis is similar to that of the Macintosh laryngoscope in that the tip of the laryngoscope blade is inserted into the vallecula and the epiglottis is elevated indirectly by stretching the hyoepiglottic ligament. There have been many reports of conversion of grade 3 views to grade 1 or 2,\textsuperscript{30–39} particularly in series of patients with applied neck immobilization.\textsuperscript{34–36} There have also been reports of failures, however.\textsuperscript{37–40}

A variety of prisms and mirror modifications of the curved blade have come and gone over the years. For the most part, prisms and mirrors have been superseded by alternative devices that give better views and are easier to use. Nevertheless, the Truview EVO2 blade (Truphatek International Ltd., Netanya, Israel) (Fig. 3) and the Viewmax (Rusch Inc., Duluth, Georgia) (Fig. 4), the recent players in this field, are relatively easy to use and may find a place in the armamentarium of some practitioners. Although these devices may provide an improved view of the larynx compared with Macintosh blade laryngoscopy, clinical experience with these devices is presently limited.\textsuperscript{41,42}

A variety of straight laryngoscope blades have been introduced over the years, but only three bear elaboration: Miller, Phillips, and Henderson. Two early straight laryngoscopes were designed by Jackson and Magill. Others include the Flagg, Guedel, Wisconsin, Wisconsin-Forreger, and other straight blades. Generally speaking, the design modifications (reduced proximal cross section,\textsuperscript{43,44} angulation,\textsuperscript{28,45,46} or others) are intended to reduce contact with the maxillary teeth.

The Miller\textsuperscript{47} laryngoscope blade is the most popular straight laryngoscope blade. It has a lower cross-sectional dimension than other straight-blade laryngoscopes, facilitating its insertion and positioning features. This design advantage is also its major disadvantage in that an ETT cannot easily and safely (without lacerating the balloon) be passed through its channel. One's inability to see the tip of the blade hinders the ability to ensure precise placement on the epiglottis. This factor, coupled with the sharpness of the tip, has the potential to lead to tissue trauma and unstable epiglottic

Fig. 3. The Truview EVO2 laryngoscope.
Additionally, there is a tendency for its light source to become obscured by tissues or secretions. This problem has been resolved in some of the most recent fiberlight models.

The other two straight blades (Phillips and Henderson) are specifically designed to be used with a paraglossal technique and to permit introduction of an ETT through the channel of the blade. The Phillips laryngoscope blade has a semitubular cross section that tapers, with the wider diameter being proximal. The tip is similar to the tip of the Miller laryngoscope. The Henderson blade was designed to overcome the drawbacks of the Miller laryngoscope by incorporating several important design modifications. The cross section of the laryngoscope allows steering of the tip of the tracheal tube during passage so that the tip emerges at the larynx. The illumination site from the fiberlight lies within the lumen of the laryngoscope so that it cannot be easily obscured by soft tissue or secretions. The blade has an atraumatic tip that remains in vision during passage and positioning of the laryngoscope. Finally, the uniform semitubular cross section of the Henderson laryngoscope is slightly wider than that of the Miller laryngoscope and is designed to facilitate visualization of the larynx and passage of an 8-mm (internal diameter [ID]) tracheal tube down the lumen of the laryngoscope. To date, no head-to-head comparisons of the Henderson blade with older established straight blades have been published.

Optimizing the Laryngoscopic View

The most important maneuver used to bring more of the glottic opening into view during direct laryngoscopy is external laryngeal manipulation, which should be an integral part of direct laryngoscopy. Wilson and colleagues were the first to quantify the value of laryngeal pressure (Fig. 5) when they used it to reduce the incidence of grade 3 and 4 views from 9.3% to 5.9%. Benumof and Cooper found that the technique, which they called optimal external laryngeal manipulation (OELM), could consistently improve the laryngeal view by one Cormack-Lehane grade. They stressed the importance of the manipulation being performed with the right hand of the airway practitioner, who then guides an assistant to provide identical manipulation. Knill termed the maneuver BURP (backward upward right pressure), and Levitan and
colleagues coined the term *bimanual laryngoscopy*, although, conventionally, the term *bimanual laryngoscopy* has been used to describe the use of one hand to manipulate the laryngoscope while the other manipulates the head and neck into an optimal position. External laryngeal manipulation should be an integral part of direct laryngoscopy and should be the first maneuver used to improve the view of the larynx.

Alternative maneuvers that have been demonstrated to improve the laryngeal view include the following:

- Increased neck flexion, achieved by head elevation, can make intubation under vision possible in some patients who initially have a Cormack-Lehane grade 3 view of the glottis.
- Laryngeal lift by an assistant may improve the view.
- Manual forward displacement of the mandible by an assistant can improve the view of the vocal cords.

**Intubating the Trachea**

A malleable ETT stylet ought to be used for all emergency intubations. Although the angle to which the ETT-stylet combination is bent is an individualized decision, it has been shown that an angle of less than 35\(^\circ\) seems to facilitate passage of the ETT beyond the glottis.

Once the glottis has been identified, it is important that the laryngoscopist not lose sight of the target. In preparation for passing the ETT, the individual assisting the airway manager, standing at the patient’s right side, should pull open the right side of the patient’s mouth with the left index finger, providing generous access to the oropharynx and, most importantly, providing room for unimpeded passage of the ETT. The ETT should be inserted into the right side of the mouth and advanced with the tip of the ETT in gentle contact with the hard and soft palates to keep it in the periphery of the LOS. It is positioned just posterior to the glottic opening, and with a “pill-rolling” counterclockwise motion, the ETT is then rotated 90\(^\circ\) from a horizontal to a vertical plane and up into the glottic opening. The narrowest dimension of the bevelled ETT tip is now aligned with the vocal cords. Alternatively, if a Phillips or Henderson straight blade is used, the ETT may be guided directly through the channel of the blade into the trachea.

**Endotracheal Tube Introducers**

ETIs are devices that are passed (introduced) into the trachea and then used as a guide over which the tube is advanced (“railroaded”) into the trachea. They are
a fundamental piece of airway management equipment that must be part of every airway manager’s skill set.

These introducers are ordinarily used in two circumstances in which direct laryngoscopy is undertaken: when a poor grade 2 or grade 3 view (see Fig. 2) is obtained with a curved blade or when a Miller blade passed paraglossally exposes a portion of the glottis but there is insufficient room to pass the ETT because it cannot be passed down the narrow channel of the Miller blade. They are also commonly used with video-assisted techniques, such as the video laryngoscope, or in blind techniques, such as digital intubation. For most of these approaches (except the video laryngoscope), a blind technique is used (the ETT is not seen directly to enter the trachea).

ETIs are ordinarily plastic or spun nylon, are 60 to 70 cm in length, and incorporate a 30° deflection of the distal tip ("coudé tip") (Fig. 6). The tip deflection enhances the anterior movement of the distal tip underneath the epiglottis, maximizing the chance of it passing into the glottis, and hence the trachea; it also permits the tactile appreciation of tracheal rings once placed in the trachea. Seventy-centimeter devices are easier to use than those 60 cm in length. A standard ETT is 30 cm in length, such that 60 cm is exactly twice the length of an ETT; the added 10 cm of the 70-cm device facilitates grasping the proximal end of the ETI as the ETT is advanced into the trachea. One manufacturer supplies a device with a hollow lumen to permit some degree of oxygenation in the event that tube passage over the ETI fails (Frova Intubation Introducer; Cook Critical Care, Bloomington, Indiana). Some ETIs are reusable, whereas others are intended as single-use devices.9

The ETIs are labeled in centimeters, depicting the distance from the tip. The print on the ETI is aligned on the same side of the ETI as the tip deflection. Positioning the 25-cm mark of the ETI at the patient’s lip correlates with the tip of the ETI at midtrachea. It is important to keep the writing, and hence the deflected tip, up (anterior), because the ETT is passed over the ETI to minimize the chance of forcing the ETT posteriorly in the trachea, risking a posterior tracheal perforation.

When using the ETI, some laryngeal structure (epiglottis or better [grade 2 or 3]) must be visible. Under direct vision, the ETI is inserted beneath the epiglottis (Fig. 7) and an attempt is made to insert the tip through the glottis into the trachea. In a grade 2 view, the ETI may be seen to enter the glottis. In a grade 3 view, the tip of the ETI is not seen to enter the glottis or trachea. Once in the trachea, the ETI tip can often transmit a subtle “click, click, click” sensation to the practitioner’s fingers, generated by rubbing the tracheal rings as it is moved gently in and out of the airway.61 A more horizontal (rather than vertical) insertion angle enhances the chance of the

Fig. 6. Intubating introducers. (A) EI with a coudé tip (arrow) at the distal end. (B) Frova intubation introducer is an intubating catheter with a hollow lumen and a coudé tip at the distal end. (C) ETI is similar to the EI in size and shape with a coudé tip, but it is 10 cm longer.
coudé tip “rubbing” against the anterior tracheal rings. Feeling this sensation enhances confidence that the ETI is in the trachea; failing to sense it does not mean that the ETI is not in the trachea. The tongue or other airway structures contacting the shaft of the ETI may insulate against the transmission of the corrugated vibrations. In the case in which tracheal rings cannot be felt, the ETI should be gently advanced. If it is in the trachea, it should “hold up” at some point, usually when the 30-cm mark is adjacent to the lips.61 Hold up does not occur if the ETI is in the esophagus. In the study by Kidd and colleagues,61 the hold-up sign seemed to more reliable than clicks, because hold up was observed in 100% of tracheal placements of the ETI, whereas the clicks were present in only 90%. In the event that hold up occurs, the ETI should be withdrawn to 25 cm at the lips before advancing the ETT over the ETI.

Failure of the ETT to pass easily over the ETI into the trachea is most often attributable to the failure to maintain a “best laryngoscopic view” during the ETT insertion. Keeping the laryngoscope in place minimizes the angle the ETT-ETI combination must negotiate and enhances the chance of successfully intubating the trachea (Fig. 8).62

With an assistant holding the ETI, the ETT is passed over the ETI. A gentle clockwise or counterclockwise twist of the ETT as the bevel of the ETT reaches the glottis...
enhances passage. Should the ETT get hung up, the tube should be rotated through 90°, first counterclockwise (ETT bevel faces downward) and then clockwise (ETT bevel faces upward) if necessary. The tip of the ETT may be caught on the posterior commissure of the glottis, the anterior commissure of the cords, the cord or aryepiglottic fold, or the cricoid cartilage, although it is impossible to know the exact location. A similar experience may occur when the ETI is passed. The possibilities and remedies are identical.

Once the ETT is in place, the intubating ETI is removed and tube position is confirmed.

The ETI is not a failsafe device and there are case reports of failure of this technique. It does enjoy a high success rate, however. Among the 2000 incidents reviewed by the Australian Incident Monitoring Study, 85 (4%) indicated problems with endotracheal intubation. The most successful intubation aid in this series was the EI. In a prospective study, Latto and colleagues reported a high success rate of tracheal intubation using the EI (99.5%, or 199 of 200 intubations), with most achieved in a single attempt (89%, or 178 of 200 intubations). In another prospective study, Combes and colleagues reported a 90% success rate for tracheal intubation using the EI in unanticipated difficult airways after two attempts. The technique works less well when the laryngeal view grade is 3b or only the tip of the epiglottis can be seen.

Complications related to the use of this device are rare, although mediastinitis after use of the introducer technique has been reported in closed claims analyses of anesthetic cases and in a review of emergency medicine cases. These studies identify the association of persistent intubation attempts with pharyngeal and esophageal perforation, mediastinitis, and death. Persistent attempts at tracheal intubation can lead to increasing difficulty with mask ventilation and to pharyngeal or esophageal perforation that results in mediastinitis.

SUMMARY

Although they are not truly “tricks” so much as maneuvers basic to successful orotracheal laryngoscopic intubation, the following ought to be incorporated into the skill sets of individuals called on to manage the airway in an emergency:

- Use both hands when performing laryngoscopy: one to hold the laryngoscope and the other first to manipulate the head into position and then to perform external laryngeal manipulation (BURP).
- Gain familiarity with curved and straight blade (particularly by a paraglossal approach) techniques.
- Ensure that batteries are charged and that illumination is adequate.
- Place a malleable stylet in all ETTs to be used.
- Do not obscure the LOS when the ETT is inserted.
- Have an ETI immediately available and know how to use it; most importantly, remember to leave the laryngoscope in place while railroading the ETT into place over the ETI.

REFERENCES