OUT-OF-OPERATING ROOM AIRWAY MANAGEMENT FOR EMERGENCY AND HUMANITARIAN MEDICINE
A Survey of Current Techniques

Ben H. BOEDEKER, W. BOSSEAU MURRAY T.A. NICHOLAS IV, M. BARAK BERNHAGEN and J. JOHNSON
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# Table of Contents

## Chapter 1: Review of Anatomy and Airway Evaluation  
8
- Introduction ............................................. 8
- Preoperative Evaluation ................................. 8
- Preoperative Evaluation of the Upper Airway ............. 9
- Size of Tongue Versus Pharynx ............................ 9
- Airway Assessment (Mallampati Classification) .......... 9
- Atlanto-Occipital Joint Extension .......................... 12
- Anterior Mandibular Space .............................. 12
- Dental Examination ...................................... 12
- Patients with Recent Trauma .............................. 12
- References .............................................. 13

## Chapter 2: Masking and Supraglottic Airway Support  
14
- Mechanics of Upper Airway Obstruction .................. 14
- Techniques to Relieve Upper Airway Obstruction ......... 14
  - Simple Airway Maneuvers ............................... 14
  - Oral and Nasal Airways .................................. 15
  - Use of Nasal Airway ..................................... 15
  - Steps for Insertion of Nasal Airway .................... 15
  - Use of Oral Airway ........................................ 15
  - Steps for Insertion of Oral Airway ..................... 16
- Masking Techniques ..................................... 16
  - One-Handed Masking ....................................... 16
  - Two-Handed Masking ..................................... 17
  - Use of Laryngeal Mask Airway (LMA) .................. 17
  - Steps for Insertion of Laryngeal Mask Airway ......... 18
  - Use of Laryngeal Tracheal Airway (LTA) ............... 19
  - Steps for Insertion of LTA ............................... 19
  - Use of Intubating Laryngeal Mask Airway (ILMA) ...... 20
  - Steps for Insertion of ILMA .............................. 20
  - Intubation and Bronchoscopy through the LMA or ILMA .. 21

## Chapter 3: Basic Intubation  
23
- Preparation of Equipment and Workspace for Orotracheal Intubation ............................................. 23
- Preoxygenation ............................................. 24
  - Types of Laryngoscopes .................................. 24
  - The Curved (MACINTOSH) Blade .......................... 24
  - The Straight (MILLER) Blade .............................. 25
- Intubation Sequence ..................................... 25
  - Place the Patient’s Head in the ‘Sniffing Position’ .... 25
  - Insertion of Laryngoscope ............................... 26
  - Confirmation of Endotracheal Tube Placement .......... 27
- Further Steps After Intubation ............................. 28
- Conclusion .............................................. 28
- References .............................................. 29
<table>
<thead>
<tr>
<th>Chapter 4: Intubation Using the Videolaryngoscope</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>30</td>
</tr>
<tr>
<td>The Problem</td>
<td>30</td>
</tr>
<tr>
<td>Why is Airway Management and Intubation so Difficult?</td>
<td>31</td>
</tr>
<tr>
<td>A Possible Solution</td>
<td>31</td>
</tr>
<tr>
<td>Advantages of Video Laryngoscopy</td>
<td>32</td>
</tr>
<tr>
<td>Tips on the Use of the Video Laryngoscopy</td>
<td>34</td>
</tr>
<tr>
<td>Summary of Tips for Video Laryngoscopy</td>
<td>35</td>
</tr>
<tr>
<td>Teaching Direct Intubation with a Video Laryngoscopy</td>
<td>35</td>
</tr>
<tr>
<td>Conclusion</td>
<td>35</td>
</tr>
<tr>
<td>References</td>
<td>36</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 5: Difficult Airway Management</th>
<th>37</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of the Intubating Stylet with a Video Laryngoscope</td>
<td>37</td>
</tr>
<tr>
<td>Intubating through a Supraglottic Device</td>
<td>38</td>
</tr>
<tr>
<td>Intubation with a Video Stylet</td>
<td>38</td>
</tr>
<tr>
<td>Conclusion</td>
<td>39</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 6: Videolaryngoscopy for Nasal Intubation</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasal Intubation</td>
<td>40</td>
</tr>
<tr>
<td>Use of the Video Laryngoscope for Nasal Intubation with an Intubation Bougie</td>
<td>41</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 7: Video Laryngoscopy for Foreign Body Removal</th>
<th>42</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem</td>
<td>42</td>
</tr>
<tr>
<td>Solution – Videolaryngoscope with Curved Intubation Forceps</td>
<td>42</td>
</tr>
<tr>
<td>References</td>
<td>43</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 8: Airway Management in Unusual Environments</th>
<th>44</th>
</tr>
</thead>
<tbody>
<tr>
<td>References</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 9: Training for Out-of-OR Airway Management</th>
<th>47</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>47</td>
</tr>
<tr>
<td>Importance of Out-of-Operating Room Airway Management</td>
<td>47</td>
</tr>
<tr>
<td>Standardizing Out-of-OR Airway Training</td>
<td>48</td>
</tr>
<tr>
<td>Specific Course Structure</td>
<td>48</td>
</tr>
<tr>
<td>I. Online Web-Based Training</td>
<td>49</td>
</tr>
<tr>
<td>II. Simulation Training</td>
<td>49</td>
</tr>
<tr>
<td>Learning and Evaluation Objectives</td>
<td>49</td>
</tr>
<tr>
<td>III. Clinical Training Curriculum</td>
<td>50</td>
</tr>
<tr>
<td>References</td>
<td>51</td>
</tr>
</tbody>
</table>
Chapter 10: Telementoring for Airway Training – A Cost Effective Method for Airway Training at Remote Sites

The Need for Virtual Training
Method of Telementoring to Distant Sites
Training
Summary
References

Chapter 11: Airway Management Tips to Support Emergency Airway Management

Rescue Breathing Position
Jaw Lift
Nasal Airway
Oral Airway
Masking Techniques
Laryngeal Mask Airway / Laryngeal Tracheal Airway
Intubation Using Videolaryngoscopy
Use of Bougie

Chapter 12: The Surgical Airway

Emergency Surgical Cricothyrotomy
References
Review of Anatomy and Airway Evaluation

Ben H. Boedeker, DVM, MD, PhD, MBA* and W. Bosseau Murray, MD**

Introduction

There are two openings where air can enter the upper airway. Mask ventilation forces air/oxygen through both openings. These openings are the nasopharynx and the oropharynx.

- The nasopharynx begins just posterior to the internal nasal cavity and extends to the soft palate.
- The oropharynx begins at the soft palate and extends to the hyoid bone. The oropharynx serves as both a food and respiratory passageway.
- The laryngopharynx begins at the level of the hyoid bone and connects posteriorly with the esophagus and anteriorly with the larynx.
- The glottic opening is covered by the epiglottis. The epiglottis moves freely to prevent aspiration of food from the oropharynx into the trachea. During swallowing, it covers the glottic opening.

Preoperative Evaluation

Preoperative evaluations are performed on patients before receiving an anesthetic (including conscious sedation). The preoperative evaluation includes an assessment of anatomic characteristics that may make mask ventilation or intubation of the trachea difficult. Basic standards for pre-anesthesia care (to include preoperative evaluations) have been outlined by the American Society of Anesthesiology.1,2 These standards would be applicable to any patient whose airway is being managed, including conscious sedation.
Preoperative Evaluation of the Upper Airway

Preoperative evaluation of the upper airway includes dental examination, determination of the size of the tongue versus pharyngeal size; atlanto-occipital joint extension; and anterior mandibular space (thyromental distance). These steps are described in Chapter 2.

During evaluation, the following points need to be specifically examined (labelled as 1–4 in Fig. 3) as each could cause difficulty with exposure of the larynx during intubation:

- Anterior larynx
- Prominent upper incisors
- Large posteriorly located tongue
- Micrognathia (small mandible)

Size of Tongue Versus Pharynx

The size of the tongue versus the oral cavity can be visually graded by assessing how much the pharynx is obscured by the tongue. This is the basis for the Mallampati classification.

Airway Assessment (Mallampati Classification)

The Mallampati test is performed by asking the patient to sit with the head in a neutral position, the mouth opened maximally (normal opening of 50 to 60 mm) and the tongue protruded as far as possible. The examiner classifies the patient’s airway according to what pharyngeal structures are visible. Patient phonation during the examination was shown to falsely improve the view. When the entire uvula is visible (Class I airway), the laryngoscopic view is expected to be classified as Class I (tracheal intubation by direct laryngoscopy expected to be easy) in contrast to the Class IV score where only the hard palate is seen, which is expected to be technically difficult or impossible.

### Mallampati Airway Classification System

<table>
<thead>
<tr>
<th>Class</th>
<th>Direct visualization with patient seated</th>
<th>Expected laryngoscopic view</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Soft palate, fauces, uvula, and tonsillar pillars</td>
<td>Entire glottic opening</td>
</tr>
<tr>
<td>II</td>
<td>Soft palate, fauces, and uvula</td>
<td>Posterior commissure</td>
</tr>
<tr>
<td>III</td>
<td>Soft palate and uvular base</td>
<td>Tip of epiglottis</td>
</tr>
<tr>
<td>IV</td>
<td>Hard palate only</td>
<td>No glottic structures</td>
</tr>
</tbody>
</table>

Table 1

Figs. (a) and (b) show examples of Mallampati Class I. Patient sits upright with head in neutral position, opens mouth as wide as possible and protrudes tongue. Direct visualization of:
- soft palate,
- fauces,
- uvula,
- anterior and posterior tonsillar pillars

Figs. (a) and (b) show examples of Mallampati Class II. Tonsillar pillars and tip of uvula are hidden by base of tongue.
Chapter 1  Review of Anatomy and Airway Evaluation

Figs. (a) and (b) show examples of Mallampati Class III.
- Only the soft palate is visible, which is why a difficult intubation is predicted.
- Consider awake intubation.

Figs. (a) and (b) show examples of Mallampati Class IV.
- The soft palate is not visible, which is why a difficult intubation is predicted.
- Consider awake intubation.
Out-of-Operating Room Airway Management for Emergency and Humanitarian Medicine

Atlanto-Occipital Joint Extension

Preoperative evaluation of cervical spine mobility (atlanto-occipital joint extension) can be performed by having the patient sit with the head erect facing the examiner and then extending the joint as much as possible. Normal extension is 35 degrees. Decreases in this range of motion may be associated with difficulties in aligning the oral and laryngeal axes during intubation.4,7

Anterior Mandibular Space

The anterior mandibular space is evaluated by asking the patient to maximally extend the head and measuring the distance from the notch of the thyroid cartilage to the tip of the mentum (thyromental distance, see Fig. 9).4 If the thyromental distance is less than 6 cm, the laryngeal axis will make a more acute angle with the pharyngeal axis. This will make atlanto-occipital extension more difficult and create problems in aligning the laryngeal and pharyngeal axes. This is typically encountered in patients with a receding mandible or short neck with large neck circumference.2,3,8

Dental Examination

A preoperative dental examination is needed to ascertain the presence of loose teeth, dental prostheses or other teeth or dental abnormalities.4,8 Loose dental prosthesis may be dislodged during the intubation process and result in aspiration. Protruding incisors (buck teeth), may make it difficult to obtain an adequate laryngeal view during intubation.

Patients with Recent Trauma

In patients who have sustained a recent trauma, assessment of the stability of the cervical spine is critical. In appropriate patients, the presence of pain on movement should be assessed. Otherwise, radiographic examination may be required.2 The subject of airway exam with recent trauma will be the subject of a separate module. If the patient is wearing a neck brace it will lead to a lack of extension and possible increased difficulty in visualization of the airway.
References


Masking and Supraglottic Airway Support

Ben H. Boedeker, DVM, MD, PhD, MBA*, Thomas A. Nicholas IV, MD*, Mary Barak Bernhagen, BS* and Thomas Magruder, BS*

Initial airway management typically begins with the manipulation of the oropharynx, hypopharynx, or supraglottic structures. This manipulation can vary between simple airway maneuvers such as the jaw thrust to placement of an intubating LMA. We discuss in this chapter the varying techniques.

Mechanics of Upper Airway Obstruction

- Upper airway obstruction is mainly due to posterior displacement of the soft palate and the tongue.

Techniques to Relieve Upper Airway Obstruction

Simple Airway Maneuvers

- The head tilt/chin lift maneuver can relieve an upper airway obstruction by anteriorly displacing the soft palate and tongue.

- The head tilt/chin lift maneuver is performed by gently extending the head while lifting the chin. Suspected spinal injury is a contraindication to its use. Over extension of the head in pediatric patients may obstruct the airway.

- The jaw thrust maneuver is performed by displacing the mandible and subsequent oropharyngeal tissues anteriorly.
Oral and Nasal Airways

- Oral airways are available in several different sizes and colors. These are typically made of hard plastic.

Nasal airways are available in several different sizes. Soft mediprene or rubber construction is superior to plastic since these may cause less epistaxis.

Use of Nasal Airway

- Correct position of a nasal airway. The end of the airway should be 1–2 cm above the epiglottis. The flange of the airway must rest on the nasal opening.

Steps for Insertion of Nasal Airway

- Nasal airway insertion requires adequate lubrication. Direction of insertion must be horizontal to the base of the nasal floor (as demonstrated in the figure).
- Nasal airway insertion is complete when flange rests upon nares (see superimposed image). May need to adjust size if adequate ventilation is not present.

Use of Oral Airway

- The oral airway must come to rest approximately 1–2 cm above the epiglottis. This airway may not be tolerated in the semi-conscious.
Steps for Insertion of Oral Airway

- In this figure, one can see that the tongue is depressed anteriorly and inferiorly to allow insertion of the oral airway.

- Using an arching motion, place the oral airway into the mouth while maintaining displacement of the tongue. The airway will obstruct if the tongue is forced backward during insertion.

- The oral airway should rest against the lips. At this point one must assess adequacy of ventilation. Replacement with correct size may be required if inadequate ventilation present.

Masking Techniques

One-Handed Masking

- One-handed masking requires a good mask fit. Oral or nasal airway may be helpful to reduce pressure required to ventilate a patient. The hand assumes a “C” formation gripping the mask. The remaining fingers lift the mandible up to the mask as shown in the figure. This method is difficult to perform on bearded patients.
Two-Handed Masking

Two-handed masking is a more aggressive mode of masking. May be needed to provide adequate seal when facial hair is present or other anatomical factors. Requires another assistant to provide airway pressure with resuscitation bag.

Use of Laryngeal Mask Airway (LMA)

Laryngeal mask airway (LMA) is blindly advanced to base of hypopharynx allowing the mask to surround the glottis opening. It is not reliable to prevent aspiration.

A provider may be faced with problems using supraglottic rescue devices such as the LMA. Potential problems are as follows:

- Inability to insert the device secondary to restricted mouth opening.
- Inability to properly position the device in the hypopharynx secondary to airway anatomy or inadequate sedation.
- Inability to maintain a seal or to ventilate which may be secondary to a disrupted trachea, decreased lung compliance, or obstructing pathology either at or below the vocal cords.

Mechanism of the LMA involves the formation of a low-pressure seal around entrance into larynx at the base of tongue, pyriform sinuses laterally, and the upper esophageal sphincter inferiorly.
Steps for Insertion of Laryngeal Mask Airway

- Open the mouth with a scissor motion or by extending the head with nondominant hand. Insertion of the LMA may be facilitated by placing the head in an extended or sniffing position.

- LMA may be inserted either inflated or deflated. The extent of the mouth opening may dictate which method is used to place the LMA.

- Place the patient’s head in a sniffing position. Apply lubricant to non-luminal side. Press the mask against hard palate. Force should be directed toward top of head. Advance blindly until mask is seated in the hypopharynx.

- Inflate LMA with adequate volume as described below in Table 1. Cuff should be inflated to allow a 20 cm H₂O airway pressure. The most common insertion error is applying pressure with a posterior vector instead of a vector directed towards the top of the head. This can result in catching the tip of the LMA on the posterior pharyngeal wall, causing folding and resultant misplacement.

**Table 1**

<table>
<thead>
<tr>
<th>LMA Size</th>
<th>Patient Weight</th>
<th>Increase in Size (%)</th>
<th>Test Inflation Volume</th>
<th>Maximum Inflation Volume (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Neonates/infants up to 5 kg</td>
<td>——</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>1.5</td>
<td>5–10 kg</td>
<td>21</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>10–20 kg</td>
<td>21</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>2.5</td>
<td>20–30 kg</td>
<td>18</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>3</td>
<td>&gt; 30 kg</td>
<td>15.7</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>Small adults</td>
<td>14.4</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>5</td>
<td>Normal adults</td>
<td>13.8</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>6</td>
<td>Large adults</td>
<td>8.1</td>
<td>40</td>
<td>60</td>
</tr>
</tbody>
</table>

Table 1
Use of Laryngeal Tracheal Airway (LTA)

- LTA has similarities to the LMA in that it provides a seal around the glottic opening to allow for positive pressure ventilation. However, the LTA is based upon esophageal tip intubation. As well, it separates the respiratory tract from the alimentary tract. A high-volume cuff is utilized to provide a seal above and below the glottic opening.

Steps for Insertion of LTA

- Deflate cuff completely. Apply scant amount of water-soluble lubricant to cuff.

- With head in neutral position, open mouth with ‘scissor’ motion or chin lift. Insert LTA along midline with luminal surface facing forward. The LTA may also be inserted in the corner of the mouth. In this case, as the LTA is advanced, it may shift towards the midline.

- Insert LTA until resistance is felt or the base of the connector is at the oral entrance. Fully inflate cuff to 60 cm H₂O pressure. The LTA may need to be pulled back to achieve optimal airway patency. Inability to advance tip around corner in posterior pharynx may be alleviated by:
  - using a lateral approach instead of a midline approach,
  - applying adequate chin lift/jaw thrust,
  - assist mouth opening with tongue depressor,
  - use a laryngoscope to facilitate tip placement in esophageal entrance.

<table>
<thead>
<tr>
<th>LTA Size</th>
<th>LTA Inflation Volume (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>45 – 60</td>
</tr>
<tr>
<td>4</td>
<td>60 – 80</td>
</tr>
<tr>
<td>5</td>
<td>70 – 90</td>
</tr>
</tbody>
</table>

Table 2
Use of Intubating Laryngeal Mask Airway (ILMA)

- Intubating LMA components include: a handle to facilitate one-handed intubation, a cuff with pilot balloon, epiglottic elevating bar allowing displacement of epiglottis during endotracheal tube insertion.

Steps for Insertion of ILMA

- Lubricate ILMA with water-soluble lubricant on non-ventilating side. Place head in slight extension. Insert ILMA (inflated or deflated cuff) with force directed towards top of head.

- Advance ILMA until resistance is met in hypopharynx. Attempt ventilation with resuscitation bag. Maneuver ILMA with handle by gently rotating in and out and side to side until adequate airway patency is achieved.

- Insert endotracheal tube. A standard endotracheal tube may be used, but there will be improved success if the endotracheal tube is inserted with its curvature in a reversed position. One may need to maneuver ILMA with handle by lifting anteriorly similar to a laryngoscope blade until endotracheal tube easily advances. This maneuver is called the Chandy maneuver.

- Insert endotracheal tube until adequate depth for patient size. One may check adequate positioning by ventilating through the endotracheal tube at this point. Remove the endotracheal tube connector.
Deflate the ILMA cuff completely. Place an ILMA stabilizing rod (or another endotracheal) into the end of the patient’s endotracheal tube. Gently swing the ILMA out of the mouth while stabilizing the patient’s endotracheal tube.

Use the stabilizing rod or another endotracheal tube to stabilize the patient’s endotracheal tube until the ILMA is completely out of the mouth. Caution must be exercised to not inadvertently shear the pilot balloon of the patient’s endotracheal tube while displacing the ILMA. Verify bilateral breath sounds and adjust tube depth as needed once the ILMA has been removed.

**Intubation and Bronchoscopy through the LMA or ILMA**

This technique has several indications: it may be used to simply verify endotracheal tube placement or may be utilized when a patient is difficult to mask and does not tolerate periods of apnea. This technique can utilize a standard LMA or ILMA. This technique has been utilized in adult as well as pediatric patients.\(^3,4\)

Once the LMA is placed and the patient is adequately ventilated, then insert a fiberoscopic bronchoscope which has been loaded with an endotracheal tube proximally (as shown in the previous figure). The endotracheal tube cuff must be lubricated to allow passage through the LMA. One may need to decrease the size of the endotracheal tube due to diameter restriction of the LMA.

This figure demonstrates the view seen through the bronchoscope with an LMA in place. Once the endotracheal tube is placed, then the LMA may be deflated and removed or left in place for future use.
References


Basic Intubation

Ben H. Boedeker, DVM, MD, PhD, MBA* and W. Bosseau Murray, MD**

Preparation of Equipment and Workspace for Orotracheal Intubation

Equipment needed for endotracheal intubation include a properly sized tracheal tube, a stylet, laryngoscope, functioning suction catheter with Yankauer tip, appropriate anesthetic drugs and facilities to provide positive pressure ventilation of the lungs with oxygen. (During a mass casualty, oxygen may be in short supply and the patient will have to be ventilated with air.)

Table 1 shows the sizes and lengths of endotracheal tubes to be used for each age as modified from refs.2,9

<table>
<thead>
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<th>Age of Patient</th>
<th>ET Tube Size (mm)</th>
<th>Distance from lips to mid trachea (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premature</td>
<td>2.5</td>
<td>8</td>
</tr>
<tr>
<td>Full Term</td>
<td>3.0</td>
<td>10</td>
</tr>
<tr>
<td>1–6 months</td>
<td>3.5</td>
<td>11</td>
</tr>
<tr>
<td>6–12 months</td>
<td>4.0</td>
<td>12</td>
</tr>
<tr>
<td>2 yrs.</td>
<td>4.5</td>
<td>13</td>
</tr>
<tr>
<td>4 yrs.</td>
<td>5.0</td>
<td>13</td>
</tr>
<tr>
<td>6 yrs.</td>
<td>5.5</td>
<td>15</td>
</tr>
<tr>
<td>8 yrs.</td>
<td>6.5</td>
<td>16</td>
</tr>
<tr>
<td>10 yrs.</td>
<td>7.0</td>
<td>17–18</td>
</tr>
<tr>
<td>12 yrs.</td>
<td>7.5</td>
<td>18–20</td>
</tr>
<tr>
<td>14 yrs. and older</td>
<td>8.0–9.0</td>
<td>18–20</td>
</tr>
</tbody>
</table>

Table 1
Size and length of endotracheal intubation tubes.

An alternative method of calculating the size of the endotracheal tube is to divide the age by 4 and add 4 to give the size of the tube in millimeters.

- A 4 year old child 4 divided by 4 equals 1, then add 4 = 5 mm tube
- An 8 year old child 8 divided by 4 equals 2, then add 4 = 6 mm tube
- A 12 year old child 12 divided by 4 equals 3, then add 4 = 7 mm tube

An alternative method of calculating the length of an oral endotracheal tube for a child is to measure the distance from the corner of the mouth to the ear and add half that length.

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Preoxygenation

Preoxygenation (also known as denitrogenation) should be performed in all cases before intubation, if time permits. Preoxygenation allows the replacement of the nitrogen volume of the lung (around 69% of the functional residual capacity [FRC] when the patient is breathing room air) with oxygen, to provide a reservoir for diffusion into the alveolar capillary blood after the onset of apnea. Preoxygenation with 100% O₂ and spontaneous ventilation with a tight-fitting face mask for 3–5 minutes can furnish up to 10 minutes of oxygen reserve following apnea (in a patient without significant cardiopulmonary disease and a normal oxygen consumption).

Types of Laryngoscopes

- All common types of laryngoscopes consist of a handle and a blade which has a light source allowing the intubator to see the larynx. There are two major types of blades used with laryngoscopes, curved (MACINTOSH blades) or straight (MILLER blade).

The Curved (MACINTOSH) Blade

Principle of Use: When intubating with a curved (MACINTOSH) blade (Fig. 2), the tip of the curved blade is placed into the space (vallecula) between the base of the tongue and the pharyngeal surface of the epiglottis. While holding the laryngoscope in the left hand, the MacIntosh blade is inserted by opening the patient's mouth and inserting the laryngoscope into the mouth. The mouth opening is usually achieved by extending the patient's neck. This prevents the gloved hands from becoming contaminated with oral secretions from the patient's mouth. An alternative technique to open the mouth is by 'scissoring' the mouth open with the thumb and index finger of the right hand. However, this technique contaminates the right hand and necessitates removal of the glove on the right hand to prevent contamination of equipment with the patient's oral secretions.

The blade is inserted along the right lateral aspect of the tongue to displace the tongue to the left. With an abnormal anatomy often encountered in casualty patients with distorted anatomy, it is a good idea to find the uvula which indicates where 'midline' structures might be found. Following this
line for about an inch (2.5 cm), the epiglottis will readily be found. (Note: the tendency to insert (or ‘sink’) the laryngoscope blade to the hilt, and then start looking around, is not advisable in patients with potentially distorted anatomy of the upper airway.)

The blade is inserted into the vallecula and then lifted with an anterior movement, away from the upper teeth. This movement is sometimes described as ‘lifting towards the patient’s feet’, which stretches the hypo-epiglottic ligament, thereby elevating the epiglottis and exposing the glottic opening.

**The Straight (MILLER) Blade**

**Principle of Use:** When using the MILLER blade (Fig. 3), the tip of the straight blade is passed beneath (posterior to) the laryngeal surface of the epiglottis, (thereby ‘picking up’ the epiglottis). Anterior movement of the blade ‘lifting towards the patient’s feet’, away from the upper teeth, directly elevates the epiglottis and exposes the glottic opening.

**Intubation Sequence**

If intubating from an operating table, the table height should be adjusted so that the patient’s face is approximately at the level of the standing intubator’s xiphoid process.

**Place the Patient’s Head in the ‘Sniffing Position’**

- Flex head forward on a pillow to place the plane of the face on the same level as the anterior chest wall (sternum).
- Extend the neck, or ‘point the chin towards the ceiling’.
- Align pharyngeal (PA) and laryngeal (LA) axes.

The sniffing position is based on the concept of: ‘the elderly gentleman sniffing the early morning air.’ The person is standing and ‘pushes the head forward’ while ‘lifting the chin up.’

**Note:** The head is vertical or perpendicular to the ground.

To optimize the intubating position, the patient’s head should be elevated 8 to 10 cm with pads under the occiput and the shoulders remaining on the table. The neck is therefore lifted forward, while the head is flexed. The plane of the face is now horizontal or parallel to the ground. In obese subjects, the pillow under the head must be enlarged, until the plane of the face is at the same height as the anterior chest wall (sternum, not skin, especially in obese subjects).

**Note:** In this position, the laryngoscope blade is pulled towards the subject’s feet, i.e. downwards, and not towards the ceiling as in the extension position described in many textbooks.

The flexion position serves to align the pharyngeal and laryngeal axes.

Next, the patient’s head is extended at the atlanto-occipital joint, which aligns the oral axis (OA) with the pharyngeal (PA) and laryngeal axes (LA) (Fig. 5). This will allow a straight line for passage of the endotracheal tube from the lips to the glottic opening. This position is known as the sniffing position.

**Figure 5** shows the intubating position with all three axes aligned:

- extension of head
- aligns oral cavity with conjoint pharyngeal-laryngeal axis
- blade can expose glottis in this position
Insertion of Laryngoscope

Using the right hand, an index finger is placed on the patient’s upper central incisors; place the thumb on the lower incisors, in front of the index finger. Push the thumb away from you (a scissoring action) thus opening the patient’s mouth.

Holding the mouth open with the right index finger and thumb, carefully insert the blade of the laryngoscope into the mouth with the left hand, avoiding contact with the exposed teeth and moving from the right corner of the mouth toward the midline of the mouth and pharynx to move (sweep) the tongue to the left side of the mouth and pharynx.

Laryngoscopy using a curved blade (Fig. 6)
- blade tip advanced into space (vallecula) between base of tongue (anterior) and pharyngeal surface of epiglottis (posterior);
- forward / upward movement of blade, i.e., away from upper teeth
- ‘lift toward patient’s feet’

Once the laryngoscope blade has been inserted, rotate the blade within the mouth counterclockwise (i.e., from right to left), thus further sweeping the tongue out of the way. Avoid contact of the laryngoscope with the teeth during the intubation process.

Note: Do not use the teeth as a point of leverage for the laryngoscope; pull the laryngoscope blade away from the upper teeth, i.e. pull towards the feet.

Using the heel of the right hand on the patient’s forehead to extend the head, open the patient’s mouth further to expose the epiglottis and vocal cords by lifting up on the laryngoscope handle. Lift in the same direction as the plane of the handle as shown by this diagram below. Do not use the front upper teeth as a fulcrum for the laryngoscope. This will cause breakage of the teeth. Pull the laryngoscope away from the upper teeth.

Visualize the structures of the pharynx. Look for the epiglottis. If you do not see the epiglottis, but see only mucosal folds, the laryngoscope blade is probably in the esophagus and you will need to carefully withdraw the blade into the mouth. As you slowly withdraw, the epiglottis should come into view.

If you are using a curved (MACINTOSH) blade (Fig. 6), the tip of the blade is positioned behind the epiglottis in the vallecula, and the floor of the mouth is raised by lifting the handle of the laryngoscope. This raises the epiglottis too and it (and the vocal cords) will come into view.

If you are using a straight (MILLER) blade (Fig. 7), the tip of the blade is inserted just beyond the epiglottis which is then raised by the tip of the blade under the epiglottis, and the vocal cords will come into view.

When the vocal cords are under direct visualization, the endotracheal tube is inserted between the cords, into the trachea.
Chapter 3  Basic Intubation

Classification of glottic visualization obtained during direct laryngoscopy (Fig. 8) according to Cormack-Lehane.4

- **Grade I** – full view of glottic opening
- **Grade II** – posterior portion of glottic opening visible
- **Grade III** – only tip of epiglottis visible
- **Grade IV** – only soft palate visible

Insert the tube through the cords until the cuff goes out of view. Check the depth of insertion – typically the 19–21 cm marks should be at the level of the teeth.

Remove the laryngoscope carefully to prevent damage to the teeth.

Firmly grasp the newly inserted endotracheal tube and carefully remove the stylet. Inflate the cuff on the endotracheal tube noting the pressure in the pilot balloon by palpation. Remove the stylet. Connect the endotracheal tube to a ventilation circuit or an Ambu bag.

**Confirmation of Endotracheal Tube Placement**

- Squeeze the ventilation bag several times to confirm placement of the endotracheal tube in the trachea.
- Confirm the presence of CO₂ with a chemical detector. Alternatively, use a suction device to confirm placement in a large gas containing space.
- Watch for the chest rising symmetrically with each delivered breath.
- Listen for bilateral and equal breath sounds over the chest.
- If you hear breath sounds only over the right side, but not over the left, then the endotracheal tube is probably located in the right mainstem bronchus and needs to be pulled back a little until breath sounds are heard over the left side as well.
- Listen over the stomach for evidence of unintentional esophageal intubation.

**Confirmation of Endotracheal Tube Placement by Auscultation (Fig. 10)**

- Auscultate both lungs and stomach – sounds may be referred from stomach
- Bilaterally equal breath sounds
- Rule out endobronchial intubation
- CO₂ detector (chemical or preferably as a wave form – capnography)
- Pulse oximetry is a late indicator of incorrect placement of the tube
Further Steps After Intubation

If you do not hear breath sounds over the chest, or if the patient is difficult to ventilate, or if you hear bubbling over the stomach with each delivered breath, then the endotracheal tube is in the esophagus and must be removed immediately.

Replace the mask and ventilate the patient by mask for 3 to 4 breaths before maneuvers such as changing to a more optimal blade or repositioning the patient are accomplished and a second attempt at endotracheal intubation is done.

If the second attempt fails, try to have a more experienced laryngoscopist attempt the intubation. This should be done because even though you may be able to ventilate the patient by mask, continued intubation attempts may cause you to lose the ability to mask ventilate due to airway trauma causing edema and/or bleeding. This concept will be reviewed in detail under our advanced airway management section.

A CO₂ monitor attached to the airway circuit will demonstrate a waveform to confirm successful intubation. It is necessary to check.

**Note:** It is possible to insufflate CO₂ into the stomach and get a CO₂ waveform with esophageal intubation, but this waveform will rapidly dissipate (decrease in size over 2–3 breaths) and incorrect placement should be detected by auscultation over the stomach and chest.

If correct placement of the endotracheal tube is confirmed by auscultation and CO₂ measurement, secure the endotracheal tube to the patient with tape, noting the position of the tube in the patient’s mouth (typically 19–21 cm markings at the teeth.)

Conclusion

Anesthesia providers maintain patent airways, provide mask ventilation or intubate patients as a part of their normal practice. But for most medical providers, intubation is a procedure that is rarely performed. This lack of practice makes it very challenging for a non-anesthesia provider to accomplish successful intubations during emergency situations.

Intubation practice performed in a simulation laboratory combined with practicing this task in the operating room in concert with the anesthesia staff may increase the success and safety of out-of-operating-room intubations.

Novel airway management devices, such as the video laryngoscope, may enhance the success and safety of intubations by non-anesthesia providers. Future developments may include telementoring capabilities from intubation equipment which could broaden the reach, virtually, by consultants in anesthesia to remote locations.
References


Intubation Using the Videolaryngoscope

Ben H. Boedeker, DVM, MD, PhD, MBA* and W. Bosseau Murray, MD**

Overview

Inadequate airway management is a major contributor to morbidity and mortality in the prehospital and out-of-operating room hospital settings. Difficulties that occur during airway management are usually related to the intubator not being able to achieve an adequate view of the glottic opening to allow insertion of an endotracheal tube. In previous studies, the videolaryngoscope has been shown to improve the view of the glottic opening by at least one Cormack-Lehane grade\(^5\) (Fig. 1) as compared with standard direct laryngoscopy.\(^3-5, 7, 10-12, 17, 18\) Video laryngoscopy offers a solution for managing airways especially when performed by personnel who infrequently intubate patients. It is likely that video laryngoscopy will become the standard of care for airway management in the future.

The Problem

Inadequate airway management is a major contributor to morbidity and mortality in the prehospital and out-of-operating room hospital settings.\(^6\) Helm et al.\(^6\) reported that several studies examining prehospital deaths from trauma in the United Kingdom have shown that airway obstruction was thought to have contributed to death from major trauma in up to 85% of patients who died.\(^6, 8, 16\) Mort\(^15\) reported that in patients requiring reintubation outside the operating room after an unplanned tracheal extubation, there was an incidence of difficult laryngoscopy in 16%, difficult intubation in 14%, and esophageal intubation in 14%. Less than one third of the patients he studied underwent a mishap-free reintubation.

An analysis by the Medical Advisory Secretariat of Canada found that rates of difficult intubation in the operating room are slightly lower (1.5%–3%) than in the emergency room (3%–5%) or out in the field (3%–10%). They speculated that the lower rate of difficult intubation in the operating room was because the operating room is a relatively controlled environment, the patient is often unconscious during intubation attempts, and the intubation is performed by anesthetists who perform this procedure routinely.\(^13\)

The American Society of Anesthesiologists’ Closed Claims Project tracks airway management problems that lead to anesthesia malpractice claims.\(^14\) This database demonstrates that difficult intubation is the second most frequent primary damaging event leading to anesthesia malpractice claims. It is responsible for 6.4% of 4,459 claims in the closed claims database.\(^14\)
Chapter 4  Intubation Using the Videolaryngoscope

Not only does difficult intubation lead to a significant proportion of claims, the severity of outcome can be devastating. Brain damage or death was the outcome in 57% of the 283 claims involving difficult intubation.14

Why is Airway Management and Intubation so Difficult?

Difficulties that occur during airway management are usually related to the intubator not being able to achieve an adequate view of the glottic opening to allow insertion of an endotracheal tube. Review of the anatomy related to intubation shows why obtaining an adequate view of the glottic opening is often difficult. In order to attain a view of the glottic opening from the patient’s mouth, the oral, pharyngeal, and laryngeal axes must be aligned (Fig. 2). This is anatomically very difficult in many patients, such as those with limited cervical spine mobility, large tongues, short necks of large circumference, protruding incisors, small mandibles, cervical trauma, or other abnormalities of the neck (such as high, anterior or immobile / fixed larynx), or mouth. In the out-of-operating room cases, the victim’s neck is often in a cervical collar, and the present advice and management is to avoid extension of the neck. This creates a problem for visualizing the glottic opening of the patient, as the axes cannot be readily aligned.

A Possible Solution

Numerous intubation devices have been developed that incorporate an optical fiber image transmitter integrated with a modified laryngoscope blade to facilitate visualization of the glottic opening. These rigid fiberoptic laryngoscopes offer the advantage of providing a non–line-of-sight view of the airway and visual control of endotracheal tube advancement through the vocal cords.1 Examples include the Bullard laryngoscope (Gyrus ACMI, Inc., Southborough, MA), the WuScope (Achi Corporation, San Jose, CA), and the UpsherScope Ultra (Mercury Medical, Clearwater, FL).1, 4, 11, 19–21 These devices have been shown to be effective in providing visualization of difficult airways, but they have a long and difficult learning curve, which results in abandonment by many prospective operators before they acquire competence.4, 9 More recent additions to the field of fiberoptic laryngoscopy include laryngoscopes that have similar shapes as traditional laryngoscopic blades but with cameras or a lens to transmit images through a fiberoptic bundle located on their distal tips. This image is projected through a conduit system (wired or wireless) to a monitor seen by the operator. With the addition of these devices, which have a short, more beneficial learning curve, video laryngoscopy has emerged as a leading method of obtaining an improved view of the glottic opening during intubation.

The KARL STORZ TELE PACK video laryngoscope intubation system (KARL STORZ Endoscopy-America, Culver City, CA) was a pioneer advancement for the field of video laryngoscopy. This device includes a detachable camera which can be placed inside the laryngoscope handle. The camera interfaces with a fiberoptic bundle, which runs to the distal tip of the blade, thereby allowing the laryngoscopist to ‘see around the corner’ by using this indirect view. As shown in Fig. 3, the glottic view by classic direct visualization offers a 10° view as compared to a much wider 60° view projected by the lens on the video laryngoscope. The camera head is detachable and can be used to interface with several other compatible devices such as rigid stylets, straight or curved laryngoscope blades, and fiberoptic bronchoscopes.
Second-generation KARL STORZ videolaryngoscopes have much better resolution, more mega-pixels and less over saturation. These include the KARL STORZ C-MAC® (KARL STORZ Endoscopy, Tuttlingen, Germany (Fig. 4) which is more portable than the TELE PACK and the C-MAC® PM (KARL STORZ Endoscopy, Tuttlingen, Germany) (Fig. 5), which provides a small viewing screen attached directly to the laryngoscope handle. These devices incorporate a CMOS video camera in the distal end of the video laryngoscope in contrast to fiberoptic technology. The technology change from CCD to CMOS means the device is also suited to prehospital airway management, as it is robust against changing environmental conditions such as temperature, dust, moisture and day light.

Advantages of Video Laryngoscopy

Video laryngoscopy offers several advantages for airway management.

1. This technique offers an expanded and enlarged view of the glottic opening. The displayed anatomy is magnified, making recognition of normal anatomy easier, as shown in Fig. 6a. If laryngeal manipulations must be performed to improve the glottic view, the assistant performing these maneuvers can see on the monitor what impact this effort is having on the view. This greatly coordinates efforts between the laryngoscopist and the assistant performing laryngeal manipulations, as shown in Fig. 6b.

2. When a trainee intubator is attempting to intubate a patient, the video laryngoscope allows the instructor to directly observe the view the trainee has attained and assess his or her actions in manipulating the airway. This enables improved mentoring of the trainee and decreases the chances of the trainees damaging the airway during intubation attempts, which might make the patient unable to be ventilated or intubated.12

3. If the airway exceeds the intubation skills of the student, the more experienced laryngoscopist can recognize the difficulty early in the intubation process and intervene.

4. Projection of the image of the airway to the video monitor facilitates teaching of multiple students who may be observing this procedure.

5. Pictures and/or videos of the image can be taken with KARL STORZ videolaryngoscopes for documentation of proper intubation or recording of pathologic findings during intubation (for instance, burns to the vocal cords after an explosion).

6. The MEDI PACK (KARL STORZ, Tuttlingen, Germany) can allow video with sound input and output, which enables it to serve as a telemedicine platform if interfaced via a videoconferencing communication advantage of telementoring (in the future). The C-MAC® also allows video output and can be connected via the C-HUB® to a computer as shown in Fig. 7.

7. The newer videolaryngoscopes provide color graphics.

8. The newer videolaryngoscopes provide higher resolution (more megapixels) for better viewing.

9. The relative size of objects: the C-MAC® shows the tip of the C-MAC® blade in view at all stages – this provides an immediate reference to the size of objects (which can be distorted due to the camera).

10. The relationship of tip to anatomical structures: The user always know where the tip of the C-MAC® blade is, as it is visible in the picture. This helps to know exactly in which direction to move the tip of the blade to obtain a better view. This is in contrast to many other video-devices where the tip of the blade is not in view – more difficult to know if the tip of the blade is exactly in the vallecula, or in the mid-line, of determine (“follow”) the effect of any movement of the tip of the device.
11 The newer videolaryngoscopes have less over-saturation (less white-out).

12 The videolaryngoscope can be used with an intubation stylet (gum elastic bougie). After the intubation stylet, one can watch the endotracheal tube go in, avoiding trauma to the vocal cords.

13 With the videolaryngoscope, there is minimized levering on the upper teeth, as the view is better (direct line of sight is not needed).

14 With the videolaryngoscope, Yankauer suction is the correct shape for suction using the C-MAC® blade.

15 With videolaryngoscopy, pictures and/or videos are ideal for post-event debriefing and discussion. Can demonstrate:
   - too shallow (in terms of vallecula – cannot flip the epiglottis up),
   - too deep in terms of vallecula – cannot flip epiglottis up (actually pushing it down),
   - can see if not midline,
   - can see if endotracheal tube is advanced incorrectly, and goes off the right vocal cord into the para-vocal space.

16 With the videolaryngoscope, the intubator does not have to be at the head of the bed with the patient at a very specific height (or in the flexion position); the intubator can be in an unusual position, and still have a good chance of intubating successfully. This is useful for patients in entrapped positions, lying on the ground, etc.

17 Consider the trainee learning classical direct MACINTOSH type intubation: while the instructor has the screen turned away from the trainee: As the camera on the videolaryngoscope is near the tip of the blade, and also slightly to the left of the view the trainee is seeing, the instructor sees more than the trainee (as the trainee is looking into the mouth, and the tube typically obscures the right vocal cord just as the trainee is trying to advance the tube through the vocal cords. As the bevel of the typical tube is pointing left (with the sharp tip on the right), there is a tendency for the trainee to ‘let the tip/bevel slide off’ the right vocal cord into the lateral space. Many times, the trainee perceives this as ‘The tube is too big.’ And requests a smaller tube. However, the view from the videolaryngoscope clearly indicates that the tip of the tube is not through the vocal cords, but is impinging on the tissues lateral to the right vocal cord.

18 With videolaryngoscopy, the direction of endotracheal tube insertion is a ‘straight shot’. This is due to the shapes of the MACINTOSH blade and the endotracheal tube being similar. The tube passes straight through the vocal cords (does not impinge on the anteriror wall of the trachea; does not need a specially shaped stylet, with a special two-handed / two-person technique to slide (‘railroad’) the tube off the stylet. Also there is less possibility of trauma to the anterior wall of the trachea with rough ‘pushing off’ the stylet. There is no wasted time while railroading the tube off the stylet with the tip barely through the vocal cords.

19 In normal patients, the C-MAC® can be used as an assessment of correct MACINTOSH use. When the C-MAC® blade is used correctly, due to the similar shapes of the standard endotracheal tube and the MACINTOSH blade, there is a straight shot right through the vocal cords without any need for a stylet.

In difficult intubation patients, a stylet is often needed to enable the tip of the tube to be maneuvered through the vocal cords.
Tips on the Use of the Video Laryngoscopy

a. **Insert in Midline over Tongue** – The video laryngoscope functions similarly to a ‘bronchoscope on a stick’. Midline insertion (just as you would use a bronchoscope) provides a better view and also provides more room to maneuver the endotracheal tube while threading it through the glottic opening. Also it is easier if one stays in the midline – there is not so much of a tendency to ‘get lost’.

b. **Use Prebent Stylet for Difficult Intubations** – The video laryngoscope allows the intubator to ‘see around the corner’, so the view is indirect. The endotracheal tube can be styletted and bent to accommodate placement when working outside of the direct field of vision. Fig. 8 shows prebending a stylet in the shape of the video laryngoscope blade to facilitate use with an indirect view of a difficult intubation.

c. **Do Not Sweep Tongue** – It is not necessary to sweep the tongue when using a video laryngoscope. Sweeping the tongue with a standard laryngoscope is done to create a ‘keyhole’ direct view of the glottis. This smaller working environment makes it more difficult to maneuver the tube through the glottic opening. This is not necessary with a video laryngoscope because the video laryngoscope has a camera on its distal end permitting an expanded, indirect view of the glottic opening. So there is no need to try to achieve a direct line of site.

d. **‘Drive’ Slowly** – Insert the video laryngoscope slowly; keep structures in view and maintain awareness of airway anatomy as it is advanced. This slow insertion prevents the intubator from losing anatomical landmarks or inserting the blade too deep as is a common problem with inexperienced users of video laryngoscopes. Lift the video laryngoscope slightly anteriorly and drive forward like a bronchoscope recognizing structures as you advance. For instance, the uvula is easy to find, and it clearly indicated exactly where the midline is. By staying in the midline, it is easy to move the short distance from the uvula to the tip of the epiglottis. Advancing anterior to the epiglottis (between the epiglottis and the tongue base) is the most common next step/maneuver (i.e., the MACINTOSH mode.) With the tip of the blade in the vallecula, an attempt is made to ‘flip up’ the epiglottis. If the epiglottis is too long, and/or floppy, the MILLER mode is tried next. The blade is extracted/withdrawn past the tip of the epiglottis, and then advanced posterior to the epiglottis. The epiglottis is then lifted up in a typical ‘MILLER’ mode to expose the vocal cords.

e. **Use in MACINTOSH or MILLER Fashion** – A curved (MACINTOSH) blade (Fig. 9) is commonly inserted in the vallecula when performing direct laryngoscopy. Most video laryngoscopes have a curved blade. However, the videolaryngoscope blade can be used in either the MACINTOSH fashion (inserting into the vallecula) or in the fashion of a MILLER blade (Fig. 10) (by lifting or picking up the epiglottis with the blade tip).

f. **Visually Coordinate Laryngeal Manipulations** – The video laryngoscope offers the advantage of projecting the airway view to a monitor when the operating room team can see the view in addition to the intubator seeing it. This presents an opportunity to train assistants to perform airway manipulation maneuvers (such as cricoid pressure (Fig. 6), adding or removing pillows under the head or shoulders) to improve the airway view. Assistants must be trained to recognize the desired airway view and become more active participants in performing laryngeal manipulations (Fig. 6).
Summary of Tips for Video Laryngoscopy

- Optimize first attempt
- Suction available – helps improve view from fogging
- Do not sweep tongue
- May use MACINTOSH like MILLER blade and pick up epiglottis
- Need stylet – bend in shape of blade

Use of Video Laryngoscopy for Teaching

The video laryngoscope offers advantages for teaching in real-time because both the student and instructor can see the airway view on the monitor screen as shown below. This allows the instructor to point out anatomical landmarks to the students, mentor them as they insert the laryngoscope and perform the intubation. Safety is greater because the instructor can constantly see what the student is seeing and observe all portions of the intubation process. If the student is making a mistake, it can be immediately corrected by the mentor. Projection of the airway view onto a video monitor also enables more than one student to participate in learning the anatomy and intubation process. This is useful nowadays when there is competition among students for intubation training.

The video laryngoscope offers advantages for teaching off-line instruction / debriefing using still images and/or video clips (Fig. 11).

Teaching Direct Intubation with a Video Laryngoscope

A standard curved (MACINTOSH) or straight blade can be used with the KARL STORZ video laryngoscope series. This allows a student to use a standard shaped curved or straight blade. If the viewing monitor is turned away from the student's view, it creates a training situation where the student is performing a standard, direct laryngoscopy, while the instructor has a full view of the intubation process. This allows the student to learn and practice direct laryngoscopy with greater safety as the instructor is monitoring the entire process (Fig. 12).

Conclusion

In conclusion, it is clear that videolaryngoscopy has the following advantages:

1. **Easy to Learn** – The KARL STORZ video laryngoscope uses a standard shaped laryngoscope blade which facilitates learning to perform videolaryngoscopy.
2. **Excellent teaching modality**, as instructor sees what student is viewing – both the student and instructor have the same airway view. This facilitates teaching while also improving safety. Immediate modifications in technique can be performed to optimise safety of the patient.
3. Provides an improved view of glottic opening – numerous studies show that there is an improvement of at least one Cormack-Lehane grade (Fig. 1) using video laryngoscopy as compared with standard direct laryngoscopy.3–5, 7, 10–12, 17, 18
4. **Coordinated laryngeal manipulations** – assistants providing laryngeal manipulations or facilitating patient positioning during intubation can see the airway view on the monitor. This view can be used to guide airway manipulations to optimize intubation conditions.
5. Due to ease of use and enhanced safety for airway management, video laryngoscopy is likely to become the **standard of care**.
References


Difficult Airway Management

Ben H. Boedeker, DVM, MD, PhD, MBA* and Thomas A. Nicholas IV, MD*

The videolaryngoscope offers advantages in management of difficult airway by providing a wider angle of view of the airway than can be obtained using direct visualization. Two techniques to manage difficult airways using the video laryngoscope are discussed below.

Use of the Intubating Stylet with a Video Laryngoscope

Sometimes an endotracheal tube cannot be successfully advanced through the glottis opening when only a poor view of the opening can be obtained. In such situations, use of an intubating stylet may be helpful. The BOEDEKER intubating stylet (Fig. 1) has a smaller diameter than an endotracheal tube, making it easier to introduce through the glottis opening as shown below. The endotracheal tube can then be threaded over the intubating stylet using a Sellinger maneuver.

The following series of pictures shows the use of a BOEDEKER intubating stylet during a difficult intubation. This patient is being intubated using a video laryngoscope, but a poor view of the glottic opening is obtained.

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Intubating through a Supraglottic Device

In emergency situations, patient airways are often managed in the field by insertion of a supraglottic device (LMA or LTA). Subsequently, when the patient arrives at a hospital for definitive care, the LMA is often removed followed by intubation of the patient with an endotracheal tube. If the supraglottic device is removed, the airway is lost until an intubation can be successfully performed. The chance of the patient vomiting is high when the LMA is removed.

With the video laryngoscope, it is possible to insert the laryngoscope blade past the cuff of the LMA, which provides a view of the glottic opening (as shown in Figs. 8–10). An endotracheal tube can be threaded, under observation, through the glottic opening. The LMA can then be removed leaving the endotracheal tube in place. If an operation is being performed and it is planned to extubate the patient, the LMA could be left in place, the patient extubated at the conclusion of the operation, and the patient awakened using the LMA.

Intubation with a Video Stylet

The following pictures show intubation using a KARL STORZ video stylet.
The modified BONFILS video intubating stylet.

The video stylet is inserted midline to achieve a view of the glottic opening. The endotracheal tube is then threaded off of the video stylet.

View of the glottic opening through the modified BONFILS.

View of the endotracheal tube being advanced through the modified BONFILS intubating stylet.

View of the endotracheal tube being railroaded over the intubating stylet.

Side view of the endotracheal tube entering the trachea after being advanced over the modified BONFILS stylet.

Conclusion

In summary, the expanded view of the airway when using the video laryngoscope creates advantages for managing the difficult airway. Difficult airway management can be further supported by exploiting ancillary devices such as an intubating bougie, intubating supraglottic device (LMA or LT) or video stylets.
Videolaryngoscopy for Nasal Intubation

Ben H. Boedeker, DVM, MD, PhD, MBA* and Thomas A. Nicholas IV, MD*

Nasal Intubation

The curved BOEDEKER intubating forceps can also be used with the video laryngoscope for nasal intubation.

1. The standard MAGILL forceps (left) and the curved BOEDEKER intubating forceps (right).

2. The straight shaft (MAGILL) forceps operates along a direct line of vision as seen with a tradition direct laryngoscope.

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Use of the Video Laryngoscope for Nasal Intubation with an Intubation Bougie

For difficult nasal intubations, the soft end of a BOEDEKER intubating bougie can be inserted through the nose and guided into the glottis opening. The BOEDEKER bougie has a wire in $\frac{1}{2}$ of the tube to hold a fixed position for oral intubation. The soft end of the bougie, without a wire, can be used for nasal intubation as shown in Figs. 7–9.
Video Laryngoscopy for Foreign Body Removal

Ben H. Boedeker, DVM, MD, PhD, MBA* and Thomas A. Nicholas IV, MD*

Problem

A foreign body lodged in the upper airway and pharynx is a common clinical problem, especially in children.2, 3 The foreign body is usually removed using MAGILL forceps and direct laryngoscopy (DL).3, 4 While standard laryngoscopes provide a direct view along the line of sight (10° field of view), with videolaryngoscopy (VL), a much wider (60°) field of view may be achieved.1

Conventional (straight shaft) MAGILL forceps are designed to operate in direct line of sight. However, when using VL, the working end of this instrument does not pass into the laryngoscopist’s field of view. A curved intubating forceps (BOEDEKER Intubating Forceps; KARL STORZ Tuttlingen, Germany) was developed to allow the operator to reach into the full field of view offered by VL. We performed a comparison between the MAGILL and BOEDEKER Intubating Forceps for removing a foreign body in a manikin.

Solution – Videolaryngoscope with Curved Intubation Forceps

Figs. 2 and 3 show the view of the glottic opening seen with a video laryngoscope. A coin has been inserted between the vocal cords of a manikin. The standard, straight shafted, MAGILL forceps cannot reach around the angled field of view to grasp the coin. The curved BOEDEKER forceps extend around this curve to allow the endoscopist to grasp the coin and remove it.

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The standard MAGILL forceps can not reach into the field of view under videolaryngoscopy. The curved BOEDEKER intubating forceps extend into the field of view when using videolaryngoscopy.

The utility of a curved forceps when doing video laryngoscopy is shown above. The curved forceps reach into the field of view seen by the indirect video laryngoscope. The conventional straight forceps are made to operate along a direct line of sight and cannot be used in the full view offered by videolaryngoscopy.

References


Airway Management in Unusual Environments

Thomas A. Nicholas IV, MD*, Mary Barak Bernhagen, BS*
and Ben H. Boedeker, DVM, MD, PhD, MBA*

Certain conditions may exist which create unusual challenges for airway management such as the patient’s body position, patient’s condition, and environmental conditions. We will discuss the differing challenges and remedies for these unique situations. The discussion will mainly focus on orotracheal intubation since it is the most challenging in these uncontrollable environments.

Attempting to optimize the patient’s position should be a priority during airway management. However, airway control, especially orotracheal intubation, is exponentially more difficult outside of a controlled hospital setting.\(^1\)\(^3\)-\(^6\) This can be the result of the patient simply being in a less than optimal position such as lying on the ground. A patient lying on the ground may be supine and in an accessible position; however, this situation still poses difficulties to the provider for several reasons. Namely, when a patient is positioned on the ground, it is difficult to align and visualize airway the axes (Figs. 1, 2) as compared to a patient lying on a gurney (Fig. 3).\(^1\)

A remedy to this situation may be to simply lie down at the head of the patient while attempting to intubate (Fig. 4).

However, a provider may have difficulties in this position since significant arm strength is required. Another remedy to this situation would be to utilize a video laryngoscopy (VL) such as the KARL STORZ C-MAC\(^\circledR\). With this VL device the provider may be positioned sitting or kneeling thus improving the leverage needed to visualize the airway for intubation.

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\(1\) Provider performing direct laryngoscopy on patient positioned on the ground.

\(2\) Provider attempting direct laryngoscopy on manikin positioned on the ground (note, this position is incorrect).

\(3\) Provider performing intubation on manikin positioned on gurney.

\(4\) Provider lying down at the head of the manikin while performing direct intubation (this is the correct position).

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VL devices may also improve the chances of definitive airway control in a patient who is located in a confined space such as a helicopter or entrapped (Figs. 6, 7).\(^2\)

Prior to the advent of these devices a provider would need to be located directly behind the patients head in order to intubate. However, with these devices a provider may be in any position as long as he or she is able to visualize the indirect monitor and manipulate the endotracheal tube and blade (Figs. 6–8).

Much like patient entrapment, there may exist numerous environmental conditions which can hamper the provider by limiting field of view or manual dexterity. For example, providers who must wear bulky equipment such as biochemical suits or other rescue gear packs (Fig. 9).

In this situation it may be difficult to utilize a direct laryngoscope since a provider must maneuver themselves into a position while wearing bulky equipment and visualize the airway at a less than adequate distance or through a distorting face shield. However, utilizing a VL device will negate the need to crouch or lie next to the patient since the monitor may be placed in any position. As well, the monitor will provide a much larger view which can be easily seen through a face shield.

Much of our discussion has focused on visual, movement, and space confining restrictions. Yet, the actual patient’s condition may dictate the need to utilize specialized equipment. For instance, many times in out-of-hospital setting, a bloody or secretion filled airway may be experienced; which will certainly obscure an airway view. This condition may be the result of trauma, aspiration, or chemical agent exposure (Fig. 10).
Regardless of the cause, adequate suction may be paramount in visualizing the airway. However, traditional suction with YANKAUER and direct laryngoscopy may be inadequate with copious secretions. A remedy to this dilemma would be the use of the BOEDEKER-DOERGES suction tip blade (Figs. 11–13).

As well, a patient may be placed in a position such as a lateral decubitus or recovery position facilitating postural drainage yet still being intubatable. Maintaining cervical spine precautions ie rigid collar or in-line traction should always be a concern for a patient subject to trauma. Unfortunately, cervical spine precautions limit airway visualization if one is using direct laryngoscopy. Once again, a simple solution to this dilemma would be the use of VL which is able to ‘see around the corner’.

References


Training for Out-of-OR Airway Management

Ben H. Boedeker, DVM, MD, PhD, MBA* and W. Bosseau Murray, MD**

Overview

Airway management is central to medical practice. During the resuscitation of a patient in an airway crisis, the A (Airway), B (Breathing), C’s (Circulation) of resuscitation comprise the critical management paradigm. The first two domains of these universal resuscitation imperatives (airway and breathing) involve airway management. In the prehospital setting or out-of-operating room location, airway management is typically provided by a non-anesthesiologist. Provider scope of practice and currency of experience varies, depending on location and practice patterns. Prehospital personnel do not usually secure an airway with intubation. Airway adjuncts and supraglottic methods are more commonly utilized in this setting. In hospital and clinical settings, procedural sedation for surgical and non-surgical activities is primarily managed by non-anesthesia providers who administer sedation/analgesia and monitor patients in areas distant from the operating room. Airway management by intubation is an infrequently practiced skill by these providers, who may have a limited scope of emergency practice that includes intubation. Over-sedation is responsible for the majority of critical incidents associated with urgent resuscitation in these settings. Respiration may be dangerously depressed and the airway may be lost if unskilled providers or infrequently practiced skills are required for airway rescue in over-sedated patients. Standard training in the use of sedation, analgesia, and airway management is required in many healthcare organizations, and is required by accrediting organizations. Such training is conducted to prevent over-sedation of patients undergoing procedures outside the operating room, and to increase the airway management skills of providers engaged in procedural sedation. This chapter will outline a suggested curriculum for teaching out-of-OR airway management in your hospital system.

Importance of Out-of-Operating Room Airway Management

Airway management is crucial for medical support of the patient with a compromised respiratory status both in and out-of-the OR setting.

In the prehospital setting, Stringer et al. reported that inadequate airway management was the primary cause of preventable mortality. Lack of consensus on which airway skills should be taught to trainees, and how best to teach them, is cited as a contributory reason that airway skills are lacking among prehospital providers. Stringer also comments that very few hospitals have a structured airway training program. Increasingly, sedation and analgesia is performed by non-anesthesiologists, and coincidentally problems with airway management have increased. The American Association of Anesthesiologists (ASA) formed a task force to develop practice guidelines for sedation and analgesia by non-anesthesiologists. The task force concluded that the primary causes of morbidity associated with sedation/analgesia are drug-induced respiratory depression and airway obstruction. Furthermore, they suggested that clinicians practicing sedation should have the skills to manage one level of deeper sedation than intended/envisaged to ensure the ability to provide ‘rescue’ airway management should sedation become more ‘deep’ than planned. Standardization of training for analgesia/

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sedation and out-of-OR airway management would increase the quality of care and improve safety for patients who require respiratory support and airway management by non-anesthesia-trained providers. This chapter will outline a curriculum to support out-of-operating room airway management. An example of user groups would be non-anesthesia personnel performing conscious sedation in-hospital or outpatient settings. This group of providers could include medics, paramedics, mid-level practitioners, physician assistants, advanced practice nurses, nurses and physicians other than anesthesiologists.

**Standardizing Out-of-OR Airway Training**

**Specific Course Structure**

The out-of-operating room airway management course stresses the importance and value of supraglottic airway management devices to include mask ventilation, oral and nasal airways, laryngeal mask devices, and other devices to resuscitate over-sedated patients, and ventilate patients in respiratory failure and arrest until an experienced intubating practitioner is available.

When intubation is being contemplated/envisaged, we suggest that video laryngoscopy (VL) be used as the standard of practice. With VL, a wider view of the airway is attained using this (VL) technology. For training students in out-of-OR airway management, we suggest that the basic laryngeal airway anatomy and intubation skills are initially best taught using a video laryngoscope. Enhanced visualization facilitates enhanced mentoring while the instructor accurately guides students during intubation using proper technique with precise real-time airway anatomy instruction. Using the video recording capability enables post-performance review and debriefing which enables the most powerful learning scenario. Laryngoscopy training with video-enabled devices permits participation of multiple students through group visualization of airway images during intubation training performance by a single operator. This technique thus leverages technology to enhance the teaching efforts, improving education efficiency in addition to learning efficacy. Studies indicate that the use of video laryngoscopy (GlideScope and/or KARL STORZ and/or other video laryngoscope devices) commonly improve the Cormack Lehane view of the glottic opening by an average of 1 to 2 grades, which makes intubation more likely to be successful for a provider who does not routinely perform intubation.1, 3–9, 11, 13–16

Here is the brief overview of course content of an out of operating room airway management course suggested by our team.

The course consists of three phases:

1. **Online web-based flat screen training**
   - Self-directed, modular self-paced program with a pretest and a post-test multiple choice question format evaluation.

2. **Simulation lab training modules (hands-on training)**
   - Mannequin-based training for psychomotor skill development and evaluation. Standard and difficult airway configurations and integration of total patient care including medication management, documentation, and safe monitoring practices.

3. **Clinical training**
   - Accompanying anesthesia personnel into the OR and practicing one and two handed mask ventilation in normal and abnormal (usually obese patients), placement of a nasal airway, placement of an oral airway and performing a video laryngoscopic intubation.
I. Online Web-Based Training

The online training topics include:

- Airway history and physical examination
- Supraglottic airway management planning (as primary or secondary techniques)
- Development of a plan for intubation and extubation techniques
- Emergency alternate airway management planning
- Airway care for select patient populations
- Sedation and analgesia during airway management
- Monitoring
- Documentation standards

II. Simulation Training

Following successful completion of web-based training, hands-on simulation-based curriculum elements are completed. Simulation-based psychomotor training consists of instruction and modeled deliberate practice in medication management, airway anatomy, and basic airway management techniques emphasizing supraglottic airway skills.

Learning and Evaluation Objectives

Standardized scenario-elicited demonstration of critical task performance and sequencing for the following scenarios:

- **Assessment of Airway**
  - Difficult to mask ventilate?
  - Difficult to intubate?

- **Patient Positioning and Airway Opening Maneuvers**

- **Supraglottic Airway Management**
  - Nasopharyngeal Airway Management
  - Oral Airway Selection
  - LMA/LTA

- **Basic and Advanced Mask Ventilation Techniques**
  - One person
  - Two person

- **Basic Intubation Skills**
  - Direct visualization using a MACINTOSH or MILLER blade
  - Indirect visualization techniques (using a video laryngoscope)
  - Plan B techniques: using an intubation stylet, a gum elastic bougie or equivalent device
  - Emergency rescue techniques
III. Clinical Training Curriculum

Following completion of training and demonstration of the simulation-based learning objectives, students participate in an operating room mentored, hands-on airway management course, according to institutional training policies and procedures. Video laryngoscopy is utilized throughout. Student training for direct (standard) laryngoscopy are monitored by an instructor viewing the video screen, which is not visible to the student. This technique permits student performance of standard, direct laryngoscopy, with enhanced instructor monitoring for non-traumatic technique and visual confirmation of endotracheal tube placement through the glottic opening. Immediate instructor intervention in sub-optimal technique or unsafe practice is enabled.

In the operating room, trainees review and perform the following skills and tasks:

<table>
<thead>
<tr>
<th>Task</th>
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<tr>
<td>Review and perform pre-oxygenation technique</td>
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<tr>
<td>Discuss perioperative monitoring</td>
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<tr>
<td>Place nasopharyngeal airway</td>
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<td>Place oral airway</td>
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<tr>
<td>Discuss pharmacology of basic drugs used during intubation</td>
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<tr>
<td>Discuss reversal of basic drugs used during intubation</td>
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<tr>
<td>Intubation using indirect (video) laryngoscopy</td>
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<tr>
<td>Intubation using direct laryngoscopy</td>
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<tr>
<td>Techniques of intubation confirmation</td>
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<td>Securing the endotracheal tube</td>
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References


Telementoring for Airway Training – A Cost Effective Method for Airway Training at RemoteSites

Ben H. Boedeker, DVM, MD, PhD, MBA* and Thomas A. Nicholas IV, MD*

The Need for Virtual Training

- Conducting airway training at distant sites may be required for large health care organizations that must maintain standard training.
- An example would be the Department of Veterans Affairs Out of OR Airway Training program or the Department of Defense whom maintain health care facilities at remote sites around the world.
- This training can be conducted virtually, using video conferencing equipment, preventing the need for trainers to travel long distances.
- This concept can have utility for just in time insertion of novel airway management equipment at remote sites.

Method of Telementoring to Distant Sites

1. The KARL STORZ C-MAC® video laryngoscope can be connected via an USB port to the C-HUB® which interfaces the device to a computer. This allows the image from the video laryngoscope to be projected onto the computer monitor.

2. The KARL STORZ C-MAC® videolaryngoscope connected to the C-HUB® projects the airway image onto the screen.

3. Connecting the computer to a telemedicine link (i.e., the low-cost Adobe Connect [http://www.adobe.com/products/adobeconnect.html] platform shown here) allows the image to be shared to a distant site.

4. The C-CAM® allows image sharing by attaching to optic devices such as the modified BONFILS as in this image. The C-CAM® then can be inserted into the C-HUB®. The C-HUB® allows connection to USB ports on most computer devices. The C-CAM® / C-HUB® combination allows still images or video clips to be shared via communication software programs, such as Adobe Connect, Facetime, or Skype.

Training

When we are conducting airway training, we build a similar training set up at both the primary and distant site. This consists of a video laryngoscope connected to a telemedicine platform and a difficult airway manikin at each site. This allows a trainer to demonstrate techniques, which are then performed by the distant student while the trainer mentors the task.

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The following pictures show a student in Germany being telementored in the removal of a foreign body in a manikin using the C-MAC® video laryngoscope and the curved BOEDEKER forceps.

The provider demonstrates insertion of the C-MAC® blade to the student located at the distant site.

Under the guidance of the distant trainer, the student is able to acquire new learning skills in completing the task at hand.

Both the trainer and trainee share the same view of the videolaryngoscope. The foreign object is identified.

With the proper tools, the trainee is able to locate and grasp the foreign object in the glottic opening of the manikin.

The trainee is successful in completing the task of removing the foreign object in the manikin.

Summary

This concept can support airway training at distant sites preventing the need for expensive travel.

It can be a method of expanding the trainer’s reach worldwide in a cost effective fashion.

Telementoring during patient care could be performed in a similar manner.

References


Airway Management Tips to Support Emergency Airway Management

Ben H. Boedeker, DVM, MD, PhD, MBA* and Thomas A. Nicholas IV, MD*

The following examples demonstrate airway support from the most basic to advanced airway care.

**Rescue Breathing Position**

- If a casualty has trauma to the face with bleeding into mouth or nose, the patient may be better able to maintain his/her airway by sitting up and leaning forward.
- **Do not force the patient to lay down!**
- If the patient is breathing, turn their head to the side so that they will not aspirate if they vomit.

**Jaw Lift**

- When a patient is unconscious, the muscles that hold the airway open may relax and allow the tongue to collapse against the airway closing it as shown in Fig. 3a.
- A simple jaw lift will open the airway allowing the patient to breath (or allowing a rescuer to provide ventilation).

**Nasal Airway**

- Insertion of a nasal airway will provide a ventilation pathway for the patient.
- The nasal airway is inserted at a perpendicular angle to the facial plane into the nasal passage as shown.

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Chapter 11  Airway Management Tips to Support Emergency Airway Management

7 During insertion of an oral airway, care must be taken to ensure the airway is placed over the top of the tongue. This can be easily done with the use of a tongue blade for placement as shown.

8 The tongue blade being used to flatten tongue and facilitate insertion of oral airway.

9 Insertion of the oral airway.

10 The oral airway in place.

11 The oral airway in place.

Oral Airway

12 One-handed masking. Bring the facial structures towards the mask in order to provide adequate seal. Push the mask too hard onto the face may cause extensive head flexion and obstruct the airway.

13 The little finger is positioned between the ear and the angle of the jaw to elevate the jaw forward.

14 Two-handed masking. One rescuer holds the mask with both hands while an assistant provides the ventilation.

15 Note, the index finger is positioned between the ear and the angle of the jaw, thereby elevating the jaw forward.

Masking Techniques
Laryngeal Mask Airway / Laryngeal Tracheal Airway

As shown in Fig. 16, a laryngeal mask airway (LMA) creates a ventilation pathway from the glottic opening through the mouth.

Inflatable cuffs in the LMA form a low-pressure seal around the entrance into larynx.

Intubation through an LMA

When a patient has an LMA in place, an intubation can be performed by inserting a videolaryngoscope blade over the LMA cuff as shown in Fig. 17.

The endotracheal tube is then inserted through the glottic opening under direct visualization.

The videolaryngoscope blade inserted over the deflated cuff of LMA. The tip of the green LMA can be seen resting in the vallecula (a).

The endotracheal tube being advanced into the glottic opening under videolaryngoscopic visualization (b).

The endotracheal tube entering the glottic opening (c).

The endotracheal tube resting in the trachea and the LMA cuff lying within the hypopharynx (d).
Intubation with a Videolaryngoscope

- A definitive airway is achieved by placing a cuffed endotracheal tube through the glottic opening.
- Difficulty in obtaining a clear view of the glottic opening can pose a major challenge to the intubator.
- With the use of a video laryngoscope, the angle of view is greatly magnified.
- This facilitates the intubation process making the provider’s chance of success much higher.

Intubation Using Videolaryngoscopy

If an endotracheal tube cannot be inserted through the glottic opening during intubation, it may be possible to insert an intubating stylet (Figs. 19a–e).

Use of Bougie

Using the videolaryngoscope, the bougie is inserted into the mouth (a). Under videolaryngoscopy, the intubator can visualize the progression of the intubating stylet (b). The intubating stylet (bougie) is inserted into the glottic opening (c). An endotracheal tube is then advanced over the intubating stylet (d). The endotracheal is inserted into the glottic opening. A counter-clockwise rotation of the endotracheal tube may facilitate insertion into the trachea, if impedance is met at the glottic opening (e).
In summary, there are multiple methods to assist the provider with emergency airway management. However, these techniques may not provide control of the airway. Therefore, a provider must be prepared to convert to a surgical airway in order to prevent hypoxic complications. The most rapid method for obtaining a surgical airway is the emergency cricothyrotomy. The technique for this surgical procedure is discussed in further detail in the next chapter.

The Surgical Airway

Thomas A. Nicholas IV, MD*, Joseph Johnson, MD*, and Ben H. Boedeker, DVM, MD, PhD, MBA*

Emergency Surgical Cricothyrotomy

A provider may not be able to secure an airway by non-invasive means such as orotracheal intubation. In this situation, an emergency surgical cricothyrotomy is warranted if there is ongoing or worsening hypoxia. This procedure is not without complications. However, one must weigh the risks and benefits of continued airway loss and its sequelae with the risk of performing a cricothyrotomy. This procedure can be performed in most settings. It requires minimal equipment to perform. This chapter will focus on the open or non-percutaneous method of performing the emergency cricothyrotomy. A variant of the traditional cricothyrotomy was developed by Brofeldt and colleagues.1 This method is based upon a ‘rapid four-step technique’ which includes palpation, incision, traction, and intubation.

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1 Equipment typically needed to perform the procedure. However, in dire circumstances, one can perform this procedure with only a scalpel and endotracheal tube.
Placing the neck in extension will help expose the cricothyroid membrane. However, this procedure can still be performed while maintaining cervical spine precautions.

Quick application of antiseptic such as betadine.

Stabilization of the larynx by the non-dominant hand.

The palpation of the cricothyroid membrane in preparation for incision.
A stabbing horizontal incision is made through the cricothyroid membrane while the non-dominant hand stabilizes larynx. The incision should be approximately 1.5 cm in length. A vertical incision may need to be made through the skin prior to horizontal incision if the patient has extensive anterior neck soft tissue.²

The scalpel is used to stabilize the cricoid cartilage while inserting a tracheal hook to control the lower airway incision.

Picture demonstrates the downward and anterior traction on the cricoid cartilage while inserting endotracheal tube.

The endotracheal tube, which has been shortened to facilitate control and placement, is inserted into trachea.
Gauze packing may be used to control bleeding.

Placement of a horizontal mattress suture in order to control bleeding and secure the endotracheal tube. Most bleeding is caused from superficial vessels; however, significant hemorrhage can result from severing the cricoid arteries located at the anterior superior aspect of the cricothyroid membrane. As well, too broad of a horizontal incision may sever the laterally running superior thyroid arteries.

A horizontal incision may not always allow easy placement of the endotracheal tube; therefore, one may use a bougie or endotracheal tube introducer as a guide. This picture demonstrates placement of the bougie through the cricothyroid membrane incision.

The endotracheal tube is railroaded over the bougie into the trachea.
If a provider does not have access to a tracheal hook, then an 18-Gauge needle may be bent to function as a tracheal hook.

Demonstration of using the modified tracheal hook to control the cricoid cartilage.

Use of tracheal dilator forceps can facilitate placement of the endotracheal tube; however, these may not be available in a field setting.

Demonstration of another substitute to tracheal dilators. Here, a nasal speculum is being utilized to dilate the incision and allow passage of the endotracheal tube.
The ability to place a surgical airway is a vital skill in airway management. The rapid four-step technique can be performed in 30 seconds with infrequent complications by an experienced provider. However, since this is often the last resort in a difficult airway, most practitioners don't have the luxury of repetitive training. A lack of familiarity can lead to serious complications from bleeding, nerve damage, or delayed treatment. It is therefore imperative to frequently review airway anatomy and the surgical technique.

References


Video Systems for Airway Management

KARL STORZ offers a complete armamentarium of instruments and videoendoscopic devices, that is tailored to a wide range of airway management modalities. The broad scope of KARL STORZ products gives you all options – for dealing with a standard or unexpectedly difficult intubation. In addition, all of our fiberscopes are powered by an LED battery light source to make sure that even in an emergency you will never be left in the dark.

It is recommended to check the suitability of the product for the intended procedure prior to use.
C-MAC® Video Laryngoscope
for visual endotracheal intubation

Monitor/Electronic Module

Special Features:
- Resistant ABS plastic housing
- Splash-proof according to IP54
- 7" TFT wide view angle display with resolution of 800 x 480 pixels
- Ready for use within seconds
- Documentation of still images (JPEG) and videos (MPEG4) on SD memory card
- VESA 75 norm for connecting and attaching racks
- Soft keys enable use within seconds
- Cinch video output for connecting external monitor
- System open for further components
- Operating time with lithium-ion batteries of about 2 hours

- World power supply 100 – 240 VAC, 50/60 Hz
- Operation with line voltage and rechargeable lithium-ion batteries
- Processing of the electronic module: Suitable and validated for the following low-temperature reprocessing methods up to bis max. 60 °C: manual/machine cleaning and disinfection, sterilization with Steris® AMSCO VPRO 1, Sterrad® (50S, 100S, 200S, NX, 100NX) and EtO gas; High-Level Disinfection (HLD) acc. to US standards
- Additional standards:
  RTCA/DO-160F, EMI Test Report
  (German air rescue service DRF Luftrettung)

8403 ZX
C-MAC® Monitor für CMOS Endoscopes, screen size 7"
with 1280 x 800 pixel resolution, two camera inputs,
a USB and a HDMI port, optimized user interface,
video and image capturing in real time on SD card,
playback of recorded video clips and still images,
data transfer from SD card to USB flash drive possible,
splash-proof according to IP54, suitable for wipe disinfection,
shock-resistant ABS plastic housing, intelligent power management with rechargeable Li-Ion batteries,
VESA 75 mounting option, power adaptor for EU, UK, USA
and Australia, power supply 110 - 240 VAC, 50/60 Hz

8402 ZX
Monitor for CMOS Endoscopes, screen size 7"
documentation can be stored directly on SD card,
rechargeable Li-Ion batteries, power adaptor for EU, UK,
USA and Australia, power supply 110 – 240 VAC, 50/60 Hz,
additional standards: RTCA/DO-160F, EMI Test Report
(German air rescue service DRF Luftrettung),
suitable for wipe disinfection

8402 X
Electronic Module, for C-MAC® Monitor 8402 ZX,
for use with C-MAC® video laryngoscopes

Accessories included in delivery with 8402 ZX:

8401 YCA
VESA 75 Quick Clip, with 4 fixation screws,
for mounting C-MAC® to tube up to diameter 25 mm
BERCI-KAPLAN C-MAC® Video Laryngoscope
for visual endotracheal intubation

Video Laryngoscope

Special Features:
- European closed laryngoscope blade design
- Angle of view approx. 80°
- Ergonomically designed handle
- CMOS technology with LED illumination
- Proximal slanted blade
- Available with or without suction
- Processing video laryngoscopes: suitable and validated for the following low-temperature reprocessing methods up to bis max. 60 °C: manual/machine cleaning and disinfection, sterilization with Steris® AMSCO V-PRO 1, Sterrad® (50S, 100S, 200S, NX, 100NX) and EtO gas; High-Level Disinfection (HLD) acc. to US standards
- Blade tips of all blade types visible for safe navigation

MACINTOSH
- For direct and indirect laryngoscopy
- Original English MACINTOSH blade shape

D-BLADE
- Special curved blade shape for difficult intubation

MILLER
- For pediatrics and neonatology in the day-to-day clinical routine, teaching and training as well difficult airway management

8401 DXC/GXC
8401 KXC/AXC/BXC

NEW 8401 DXC Miller C-MAC® Video Laryngoscope, CMOS technology, size 0, for use with Electronic Modules 8401 X and 8402 X

NEW 8401 GXC Same, size 1

8401 KXC BERCI-KAPLAN C-MAC® Video Laryngoscope #2, CMOS technology, with MACINTOSH laryngoscope blade, size 2, for use with Electronic Modules 8401 X and 8402 X

8401 AXC Same, size 3

8401 BXC Same, size 4
BOEDEKER-DÖRGES **C-MAC® Video Laryngoscope**

for visual endotracheal intubation

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**8401 AX**  
BOEDEKER-DÖRGES **C-MAC® Video Laryngoscope #3**,  
CMOS technology, with MACINTOSH laryngoscope blade, size 3,  
with catheter introduction sizes 14 – 16 Fr.,  
for use with Electronic Modules 8401 X and 8402 X

**8401 BX**  
**Same**, size 4, with catheter introduction sizes 16 – 18 Fr.

**8401 HX**  
**C-MAC® Video Laryngoscope D-BLADE**, CMOS technology,  
with DÖRGES laryngoscope blade, for difficult intubation,  
with catheter introduction sizes 16 – 18 Fr.,  
for use with Electronic Modules 8401 X and 8402 X
C-MAC® S Video Laryngoscope

Video Laryngoscope for Single Use

**Special Features:**
- Blade and handle form one continuous piece: optimum protection against infections
- D-BLADE with short handle
- Original English MACINTOSH blade shape
- Sturdy plastic material
- Compatible with C-MAC® monitor
- Blade tip always under direct view for safe navigation
- Ergonomically designed handle
- Compact design

**C-MAC® S Imager:**
- Handling oriented towards hygiene
- Reprocessing of the imager: suitable and validated for the following low-temperature reprocessing methods up to bis max. 60 °C: manual/machine cleaning and disinfection, sterilization with EtO gas; High-Level Disinfection (HLD) acc. to US standards
- Compatible with C-MAC® monitor
- Blade can be exchanged within seconds

051113-10  C-MAC® S Video Laryngoscope MAC #3, with MACINTOSH laryngoscope blade, size 3, for single use, sterile, package of 10, for use with C-MAC® Monitor 8402 ZX and C-MAC® S Imager 8402 XS

051114-10  C-MAC® S Video Laryngoscope, size 4, for single use, sterile, package of 10

*mtp medical technical promotion gmbh,
Take-Off GewerbePark 46, 78579 Neuhausen ob Eck, Germany*
C-MAC® S Video Laryngoscope

**NEW**

051116-10

0511610*  C-MAC® S Video Laryngoscope D-BLADE,
with DÖRGES laryngoscope blade, sterile,
package of 10, for use with C-MAC® Monitor
8402 ZX and C-MAC® S Imager 8402 XS

8402 XS

8402 XS  C-MAC® S Imager, for C-MAC® Monitor 8402 ZX-1, suitable for
manual and mechanical disinfection up to 60 °C and High-Level
Disinfection (HLD) acc. to US standards, for use with C-MAC®
S-Video Laryngoscopes 051113-10, 051114-10 and 051116-10

*mtp medical technical promotion gmbh,
Take-Off GewerbePark 46, 78579 Neuhausen ob Eck, Germany
C-MAC® PM – The Pocket Monitor

Special Features:
- Exchange of video laryngoscope within seconds
- Compatible with all C-MAC® video laryngoscopes (D-BLADE, MACINTOSH sizes 2-4, MILLER sizes 0 & 1)
- One hour operating time
- Rechargeable Li-ion battery with capacity control and intelligent power management
- High-resolution 2.4" LED display with 240 x 320 pixels for optimal view
- No additional on/off buttons thanks to the "Open-to-Intubate-Display" (OTI)
- Important for preclinical use: classified for protection class IPX8
- Due to the closed design, the entire pocket monitor unit can be fully immersed in disinfection solution which allows for easy and smooth reprocessing
- Suitable and validated for the following low-temperature reprocessing methods up to max. 60 °C: manual/machine cleaning and disinfection
- Additional standard: RTCA/DO-160F

8401 XDK  C-MAC® Pocket Monitor, Set, unit with LCD monitor and power supply for all C-MAC® laryngoscopes, screen size 2.4", monitor movable via two rotation axis, rechargeable Li-Ion batteries, 1 h operation time, 2 h charging time, power management with capacity indicator: switches off automatically after 10 min, protection class IPX8, additional standard: RTCA/DO-160F, validated for up to a max. of 60 °C, manual/mechanical cleaning and disinfection, for use with C-MAC® video laryngoscopes including:
Protection Cap

8401 XDL  Charging Unit, for C-MAC® Pocket Monitor 8401 XD, with fix integrated power supply and adaptor for EU, UK and USA, power supply 110 – 240 VAC, 50/60 Hz, suitable for wipe disinfection
**FIVE – Flexible Intubation Video Endoscope for C-MAC® NEW**

**Special Features:**
- Compatible with C-MAC® monitor and C-HUB®
- Compact design
- Ergonomically designed handle
- Lightweight at 385 g
- High image resolution
- Video imaging in 4:3 format
- Possible to exchange components within seconds

**Integrated LED light source**
- Suitable and validated for the following low-temperature reprocessing methods up to max. 60 °C: manual/machine cleaning and disinfection, sterilization with Sterrad® (100S, NX, 100NX) and ETO gas; High-Level Disinfection (HLD) acc. to US standards

**Flexible Intubation Video Endoscope 5.5 x 65,**
CMOS technology, with suction valve, for use with C-MAC® Monitor 8402 ZX and C-HUB® 20 2901 01
Deflection up/down: 140°/140°
Direction of view: 0°
Angle of view: 85°
Working length: 65 cm
Total length: 93 cm
Working channel inner diameter: 2.3 mm
Distal tip outer diameter: 5.5 mm
Accessories
Flexible Intubation Video Endoscopes

Accessories included in delivery:

29100 Plug, for Luer-Lock connector for cleaning, black, autoclavable, package of 10

11301 CD1 Irrigation Adaptor, for machine cleaning, reusable, for Flexible Intubation Video Endoscope 11301 BNX

11301 CE1 Suction Valve, for single use, package of 20, for use with Flexible Intubation Video Endoscope 11301 BNX

10309 Bronchoscope Insertion Tube, size 4, with integrated mouthpiece, for single use, sterile, insertion length 85 mm, made from EVA, package of 10

10310 Bronchoscope Insertion Tube, size 2, with integrated mouthpiece, for single use, sterile, insertion length 65 mm, made from EVA, package of 10

11301 CFX Tube Holder, for use with Flexible Intubation Video Endoscope 11301 BNX

27677 FV Case

11025 E Pressure Compensation Cap, for ventilation during gas sterilization

13242 XL Leakage Tester, with bulb and manometer

27651 B Cleaning Brush, flexible, round, outer diameter 3 mm, for working channel diameter 1.8 – 2.6 mm, length 100 cm

8401 YZ Protection Cap, for the C-MAC® video laryngoscope and electronic module, to protect plug contact during reprocessing, cap is reusable
## Accessories
### Flexible Intubation Video Endoscopes

#### Optional Accessories:

- **11001 KL**  
  **Biopsy Forceps**, flexible, spoon-shaped, round, double action jaws, diameter 1.8 mm, working length 120 cm

- **11002 KS**  
  **Grasping Forceps**, flexible, alligator jaws, double action jaws, diameter 1.8 mm, working length 120 cm

- **11301 CA**  
  **Leaflet Valve**, for single use, package of 20

- **11301 CB1**  
  **Suction Valve**, reusable, for use with Flexible Intubation Video Endoscope 11301 BNX

- **39405 AS**  
  **Plastic Container for Flexible Endoscopes**, specially suited for gas and hydrogen peroxide (Sterrad®) sterilization and storage, for use with one flexible endoscope, external dimensions (w x d x h): 550 x 260 x 90 mm

- **11301 BM**  
  **Adaptor**, for leakage test, for Belimed washer-disinfectors

- **11301 FF2**  
  **Adaptor for MIELE Cleaning Machines**, with safety valve, for automatic leakage test of flexible KARL STORZ endoscopes

- **11301 GG2**  
  **Adaptor**, for cleaning and disinfecting the irrigation and working channels of flexible endoscopes, for MIELE-ETD washer-disinfectors

- **11301 HH**  
  **Adaptor for BHT Cleaning Machines**, for automatic leakage test of flexible KARL STORZ endoscopes

- **11301 KK2**  
  **Adaptor**, for working channel of flexible endoscopes, for MIELE-ETD 03 washer/disinfectors  
  Please note: Adaptors 11301 FF2 and 11301 GG2 have to be ordered separately!

- **6927691**  
  **Adaptor for Two-Way Stopcock**, Luer-Lock, with O2 tube connection

- **600007**  
  **LUER-Lock Tube Connector**, male, tube diameter 6 mm
Accessories
C-MAC® Video Laryngoscope

8401 YA  **Stand**, for C-MAC® monitor, height 120 cm, rollable with five feet and antistatic castors, crossbar 25 cm x diameter 25 mm, for positioning the monitor, with tray for laryngoscopes, dimensions (w x d x h): 30 x 20 x 10 cm

8401 YAA  **Crossbar**, for Stand 8401 YA, 50 cm x diameter 25 mm, or positioning C-MAC® Monitors 8401 ZX and 8402 ZX with VESA 75 Quick Clip 8401 YCA

8401 YAB  **Same**, 70 cm x diameter 25 mm

8401 YB  **Clamp**, VESA 75 standard, for fixation of C-MAC® monitor to round profile with diameter 20 – 43 mm and square profile with diameter 16 – 27 mm, for use with Monitors 8401 ZV/8402 ZX
Accessories
C-MAC® Video Laryngoscope

809125, 809120

8402 YD
8402 YD-1
8402 YD-2
8402 YD-3

39501 LC2
8401 YZ

8402 YD*  Protective Bag, blue, for C-MAC® system, made of water-resistant and sturdy material, washable, separate compartments for the monitor and two C-MAC® video laryngoscopes with electronic module
8402 YD-1*  Same, red
8402 YD-2*  Same, orange
8402 YD-3*  Same, NATO-olive
809125  MAGILL Forceps, modified by BOEDEKER, length 25 cm, suitable for endoscopic foreign body removal, for use with video laryngoscopes size 2 – 4
809120  MAGILL Forceps, for children, modified by BOEDEKER, length 20 cm, for use with video laryngoscopes size 1 and 2
39501 LC2  Wire Tray for Cleaning, Sterilization and Storage for two C-MAC® and D-BLADE video laryngoscope blades incl. electronic module, with holder for fixing and sealing electrical connections, external dimensions (w x d x h): 260 x 120 x 170 mm
8401 YZ  Protection Cap, for the C-MAC® video laryngoscope and electronic module, to protect plug contact during reprocessing, cap is reusable

* Crash test carried out by Furtwangen University of Applied Sciences (Germany): C-MAC® system in a protective bag dropped from a height of 5 – 9 meters showed no noteworthy damage.

Please note: The instruments displayed are not included in the sterilization and storage tray.
C-CAM® and C-HUB®

Nothing could be easier!

C-CAM® transforms the C-MAC® video laryngoscope into an all-round system unit for complete airway management. The C-MAC® monitor is at the core of all imaging systems. C-CAM® is a high-grade CMOS camera with VGA resolution which can be connected to all KARL STORZ endoscopes with eyepieces. Illumination is ensured through the Power-LED battery light sources. Consequently, this is the first battery-powered video system to guarantee high-quality documentation. KARL STORZ has once again proven that high quality and mobility are not mutually exclusive.

The C-HUB® is the interface for computer and/or monitor connectivity. The signal from the front end is transmitted directly to a computer or monitor with the aid of the C-HUB®. The enhanced output can be directly linked to any computer via a USB/S-VHS connection. Thanks to the safety offered by galvanic isolation in the C-HUB®, medical products can now be connected to non-medical products (e.g. computer/monitor).

C-HUB® is the perfect signal converter from C-MAC®/C-CAM® to USB or S-Video.
C-CAM® and C-HUB®

202901 32 C-CAM® Camera Head, 8-pin, one-chip CMOS camera head, resolution 640 x 480, focal length f = 20 mm, compatible with C-HUB® 202901 01 and C-MAC® 8402 ZX

202901 31 C-CAM® Camera Head, 6-pin, one-chip CMOS camera head, resolution 640 x 480, focal length f = 20 mm, compatible with C-MAC® 8401 ZX

202901 01 C-HUB® Camera Control Unit, for use with C-CAM® 202901 32, Electronic Module 8402 X or compatible CMOS video endoscopes, Interfaces: USB 2.0, S-Video output (NTSC), power socket including:

- C-HUB® Power Supply
- S-Video (Y/C) Connecting Cable
- USB Connecting Cable
Intubation Fiberscopes
Eyepiece Versions

KARL STORZ provides the instruments you need to meet the special challenges of patients who cannot be intubated with conventional methods. Nasopharyngeal awake intubation is regarded as the gold standard of difficult airway management. We offer solutions for any challenge!

Our versatile intubation fiberscopes can be used in all clinical settings whether in intensive care units or emergency rooms as well as for patients with anticipated difficult airways during induction. The various sheath diameters enable you to select the ideal instrument for your patient and allow a swift reaction thanks to the compact, flexible LED light sources.

Special Features:
- Sheath stiffness adapted to anesthesiological requirements
- Suitable for both fiber optic intubation and bronchoscopy
- Patented sheath surface special treatment requires only minimal lubrication and provides optimal tube insertion
- Developed for use in the OR, ICU, ER
- Even safer tube introduction due to video-assisted control on the monitor
- Tube position of ETT, LMA, DLT can be verified
- Video-assisted monitoring for percutaneous tracheostomy
- Adaptable for foreign body removal or bronchial lavage
- Various outer diameters: 2.8; 3.7; 5.2 mm
- Diameter of working channel ranging from 1.2 to 2.3 mm
- Extremely bright, white light due to the LED light source with rechargeable Li-Ion batteries
- Intubation fiberscope can be directly connected to the C-MAC® monitor with the mobile camera head C-CAM®
- Even safer tube introduction due to video-assisted control on the monitor
- Tube position of ETT, LMA, DLT can be verified
- Video-assisted monitoring for percutaneous tracheostomy
- Adaptable for foreign body removal or bronchial lavage
- Suitable and validated for the following low-temperature reprocessing methods up to a max. of 60 °C: manual/mechanical cleaning and disinfection, sterilization with Steris® AMSCO VPRO 1, Sterrad® (50S, 100S, 200S, NX, 100NX) and EtO gas; High-Level Disinfection (HLD) acc. to US standards

Intubation Fiberscopes – eyepiece version, with optional LED battery light source
Intubation Fiberscopes
Eyepiece Versions

2.8 x 65 Intubation Fiberscope with optimized imaging
Intubation Fiberscope 11301 AA1 is ideal for use in neonatology due to its small outer diameter of 2.8 mm. This fiberscope is the only one of its size that has a working channel with 1.2 mm.

Intubation Fiberscope 11301 AA1 features a connector for suction valves for single or multiple use.

The special sheath surface combined with increased stiffness improves the gliding properties of the ETT over standard intubation fiberscopes.

The use of a mobile LED light source enables independent work under optimal lighting conditions.

Benefits:
- Effective suction possible via the 1.2 mm working channel
- Suitable for use with endotracheal tubes as of 3.5 mm
- Increased stiffness and smoother passage of the ETT
- Ready for immediate use and easy to clean and reprocess
- Optimized for use with mobile light sources
- Intubation fiberscope can be connected to the C-MAC® monitor via the mobile C-CAM® camera head
- Practical tube fixation via special adaptor

11301 AA1

Intubation Fiberscope 2.8 x 65,
Deflection up/down: 140°/140°
Direction of view: 0°
Angle of view: 90°
Working length: 65 cm
Working channel inner diameter: 1.2 mm
Distal tip outer diameter: 2.8 mm
Intubation Fiberscopes
Eyepiece Versions

3.7 x 65 Intubation Fiberscope with optimized imaging
The 3.7 x 65 intubation fiberscope is a universal working instrument as it provides gold standard intubation for both adult and pediatric patients. Due to its small diameter, it is an excellent tool for the placement of double lumen tubes. Using a mobile LED light source and C-CAM®, the intubation fiberscope can be directly connected to the C-MAC® monitor for a monitor-assisted intubation solution that is both mobile and flexible – also suitable for electronic documentation.

Benefits:
- Effective suction possible via 1.5 mm working channel
- Suitable for use with endotracheal tubes as of 4 mm
- Increased stiffness and smoother passage of the ETT
- Practical tube fixation via special adaptor
- Ready for immediate use and easy to clean and reprocess
- Optimized for use with mobile light sources
- Intubation fiberscope can be connected to the C-MAC® monitor via the mobile C-CAM® camera head

11302 BD2
Intubation Fiberscope 3.7 x 65,
Deflection up/down: 140°/140°
Direction of view: 0°
Angle of view: 90°
Working length: 65 cm
Working channel inner diameter: 1.5 mm
Distal tip outer diameter: 3.7 mm
Intubation Fiberscopes
Eyepiece Versions

5.2 x 65 Intubation Fiberscope with optimized imaging
The 5.2 x 65 intubation fiberscope creates an ideal balance between image size, working channel size and fiber optics. Effective suction is possible via the 2.3 mm working channel. The fiberscope is also suitable for removing foreign bodies or for bronchial lavage in the intensive care unit. Using a mobile LED light source and C-CAM®, the intubation fiberscope can be directly connected to the C-MAC® monitor for a monitor-assisted intubation solution that is both mobile and flexible – also for electronic documentation.

Benefits:
- Effective suction possible via the large 2.3 mm working channel
- Suitable for use with endotracheal tubes as of 5.5 mm
- Increased stiffness and smoother passage of the endotracheal tube
- Practical tube fixation via special adaptor
- Ready for immediate use and easy to clean and reprocess
- Optimized for use with mobile light sources
- Intubation fiberscope can be connected to the C-MAC® monitor via the mobile C-CAM® camera head

11301 BN1

<table>
<thead>
<tr>
<th>11301 BN1</th>
<th>Intubation Fiberscope 5.2 x 65,</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deflection up/down: 140°/140°</td>
</tr>
<tr>
<td></td>
<td>Direction of view: 0°</td>
</tr>
<tr>
<td></td>
<td>Angle of view: 110°</td>
</tr>
<tr>
<td></td>
<td>Working length: 65 cm</td>
</tr>
<tr>
<td></td>
<td>Working channel inner diameter: 2.3 mm</td>
</tr>
<tr>
<td></td>
<td>Distal tip outer diameter: 5.2 mm</td>
</tr>
</tbody>
</table>
Intubation Fiberscopes
Eyepiece Versions

<table>
<thead>
<tr>
<th>Intubation Fiberscopes</th>
<th>Eyepiece</th>
<th>Order No.</th>
<th>Deflection up/down</th>
<th>Angle of view</th>
<th>Working length</th>
<th>Total length</th>
<th>Working channel inner diameter</th>
<th>Distal tip outer diameter</th>
<th>Recommended ETT diameter as of*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.8 x 65</td>
<td>11301 AA1</td>
<td></td>
<td>0°</td>
<td>90°</td>
<td>65 cm</td>
<td>98 cm</td>
<td>1.2 mm</td>
<td>2.8 mm</td>
<td>3.5 mm</td>
</tr>
<tr>
<td>3.7 x 65</td>
<td>11302 BD2</td>
<td></td>
<td>0°</td>
<td>90°</td>
<td>65 cm</td>
<td>93 cm</td>
<td>1.5 mm</td>
<td>3.7 mm</td>
<td>4.5 mm</td>
</tr>
<tr>
<td>5.2 x 65</td>
<td>11301 BN1</td>
<td></td>
<td>0°</td>
<td>110°</td>
<td>65 cm</td>
<td>93 cm</td>
<td>2.3 mm</td>
<td>5.2 mm</td>
<td>5.5 mm</td>
</tr>
</tbody>
</table>

Accessories included in delivery:

- **Case**
- **Pressure Compensation Cap**, for ventilation during gas sterilization
- **Leakage Tester**, with bulb and manometer
- **LIPP Tube Holder**, for intubation fiberscopes
- **Cleaning Brush**, flexible, long, for working channel diameter 1.2 mm, working length 150 cm
- **Cleaning Brush**, flexible, round, outer diameter 3 mm, for working channel diameter 1.8 – 2.6 mm, length 100 cm
- **Plug**, for Luer-Lock connector for cleaning, **black, autoclavable**, package of 10
- **Irrigation Adaptor**, for machine cleaning, reusable, for fiberscopes
- **Suction Valve**, for single use, package of 20
- **Bronchoscope Insertion Tube**, size 4, with integrated mouthpiece, for single use, sterile, insertion length 85 mm, made from EVA, package of 10
- **Same**, size 2, insertion length 65 mm
### Intubation Fiberscopes

#### Eyepiece Versions

<table>
<thead>
<tr>
<th>Accessories (included in delivery)</th>
<th>Add. Accessories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case</td>
<td>Pressure Compensation Cap</td>
</tr>
<tr>
<td>27677 A</td>
<td>11025 E</td>
</tr>
<tr>
<td>27677 A</td>
<td>11025 E</td>
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<tr>
<td>27677 A</td>
<td>11025 E</td>
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</table>

**Optional Accessories:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1103 MA</td>
<td><strong>Biopsy Forceps</strong>, flexible, oval, double action jaws, diameter 1 mm, length 110 cm</td>
</tr>
<tr>
<td>1103 MB</td>
<td><strong>Grasping Forceps</strong>, flexible, double action jaws, diameter 1 mm, length 110 cm, for flexible bronchoscopes</td>
</tr>
<tr>
<td>11001 KL</td>
<td><strong>Biopsy Forceps</strong>, flexible, spoon-shaped, round, double action jaws, diameter 1.8 mm, working length 120 cm</td>
</tr>
<tr>
<td>11002 KS</td>
<td><strong>Grasping Forceps</strong>, flexible, alligator jaws, double action jaws, diameter 1.8 mm, working length 120 cm</td>
</tr>
</tbody>
</table>

*Please note that the accuracy of the ETT diameter may vary depending on the manufacturer's quality.*
BONFILS Retromolar Intubation Endoscopes
Eyepiece Versions

The expert instrument for multiple applications in airway management combines technical sophistication with utmost reliability.

Unexpected difficult airways are always a challenge in airway management. With the BONFILS intubation endoscope and its versatile intubation techniques, this situation can be brought back to a controlled status. The endotracheal tube is guided into the trachea under direct vision and the possibility of simultaneous application of oxygen provides more safety. Moreover, KARL STORZ offers a solution to meet the most stringent hygiene requirements – the autoclavable SILVER LINE.
BONFILS Retromolar Intubation Endoscopes
Eyepiece Versions

Special Features:

- SILVER LINE – autoclavable
- Particularly suitable for the unexpected difficult airway
- Use in the case of minimal mouth opening (> 1 cm) possible
- Introduction of the tube under visualization: What you see is what you get!
- Continuous O\textsubscript{2} flow via tube adaptor between tube and instrument
- One-person intubation possible

- Connect and intubate – thanks to the mobile LED "Power of Light" light source
- Quick and easy cleaning
- Suitable and validated for the following low-temperature reprocessing methods up to bis max. 60 °C: manual/machine cleaning and disinfection, sterilization with Steris\textsuperscript{®} AMSCO VPRO 1, Sterrad\textsuperscript{®} (50S, 100S, 200S, NX, 100NX) and EtO gas; High-Level Disinfection (HLD) acc. to US standards
- Recommended for video-assisted intubation with C-CAM\textsuperscript{®} to C-MAC\textsuperscript{®} monitor

10332 B1  BONFILS Retromolar Intubation Endoscope, outer diameter 3.5 mm, for ETT 4 – 5.5 mm, usable sheath length 35 cm, distal bending 40°, with movable eyepiece, including Tube Holder 10332 BA for tube fixation and O\textsubscript{2} application

10331 B2K  NEW  BONFILS Retromolar Intubation Endoscope, outer diameter 5 mm, for ETT > 5.5 mm, usable sheath length 40 cm, distal bending 40°, with movable eyepiece, with Tube Holder 10331 BA for tube fixation and O\textsubscript{2} application

10330 B1  BONFILS Retromolar Intubation Endoscope, outer diameter 5 mm, for ETT > 5.5 mm, usable sheath length 40 cm, distal bending 40°, working channel diameter 1.2 mm, including Tube Holder 10331 BA for tube fixation and O\textsubscript{2} application
## BONFILS Retromolar Intubation Endoscopes

### Eyepiece Versions

<table>
<thead>
<tr>
<th>Intubation Endoscope</th>
<th>Eyepiece</th>
<th>Order No.</th>
<th>Distal bending</th>
</tr>
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<tbody>
<tr>
<td>BONFILS 5 x 35</td>
<td>10332 B1</td>
<td>10332 B1</td>
<td></td>
</tr>
<tr>
<td>BONFILS 5 x 40</td>
<td>10330 B1</td>
<td>10330 B1</td>
<td></td>
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<tr>
<td>BONFILS 5 x 40</td>
<td>10331 B2K</td>
<td>10331 B2K</td>
<td></td>
</tr>
</tbody>
</table>

### Accessories included in delivery:

- **Case**, internal dimensions (w x d x h): 490 x 290 x 85 mm
- **Plastic Case**, without inserts, internal dimensions (w x d x h): 480 x 285 x 80 mm
- **Tube Holder for ETT**, with O₂ application connection, inner diameter 3.5 mm
- **Tube Holder**, inner diameter 5 mm
- **Cleaning Brush**, for Intubation Endoscope 10330 B1
BONFILS Retromolar Intubation Endoscopes
Eyepiece Versions

<table>
<thead>
<tr>
<th>Angle of View</th>
<th>Working length</th>
<th>Total length</th>
<th>Working channel diameter</th>
<th>Distal tip outer diameter</th>
<th>Recommended ETT diameter as of</th>
<th>Case</th>
<th>Tube Holder</th>
<th>Cleaning Brush</th>
</tr>
</thead>
<tbody>
<tr>
<td>90°</td>
<td>35 cm</td>
<td>52 cm</td>
<td>–</td>
<td>3.5 mm</td>
<td>4 mm</td>
<td>27677 BM</td>
<td>10332 BA</td>
<td>–</td>
</tr>
<tr>
<td>110°</td>
<td>40 cm</td>
<td>52 cm</td>
<td>1.2 mm</td>
<td>5 mm</td>
<td>5.5 mm</td>
<td>27677 C</td>
<td>10331 BA</td>
<td>27651 AE</td>
</tr>
<tr>
<td>110°</td>
<td>40 cm</td>
<td>54 cm</td>
<td>–</td>
<td>5 mm</td>
<td>5.5 mm</td>
<td>27677 BM</td>
<td>10331 BA</td>
<td>–</td>
</tr>
</tbody>
</table>

Optional Accessories:

<table>
<thead>
<tr>
<th>Wire Tray for Cleaning, Sterilization and Storage of one rigid BONFILS endoscope, including holder for light post adaptors, silicone telescope holders and lid, external dimensions (w x d x h): 570 x 80 x 52 mm</th>
</tr>
</thead>
</table>

* Please note that the accuracy of the ETT diameter may vary depending on the manufacturer's quality.
LIPP/GOLECKI Airway Management Set

Basic Set

Recommended Set for Difficult and Standard Intubation

11300 B3  LIPP/GOLECKI Airway Management Set, for the difficult airway including:
- Intubation Fiberscope, 3.7 mm x 65 cm
- BONFILS Retromolar Intubation Endoscope, 5 x 40, autoclavable
- Battery Light Source LED for Endoscopes
- Mask Adaption “MAINZ Adaptor”, blue, package of 5
- Laryngeal Tube, size 4
- Laryngeal Tube, size 3
- Spiral Tube, size 6, for single use
- Bronchoscope Insertion Tube, size 4
- Laryngeal Mask, standard, reusable, size 1
- Laryngeal Mask, standard, reusable, size 2
- Laryngeal Mask, standard, reusable, size 4
- Intubation Laryngeal Mask, reusable, size 3
- Intubation Laryngeal Mask, reusable, size 4
- Laryngeal Mask Tube, diameter 7 mm
- Laryngeal Mask Tube, diameter 7.5 mm
- LMA Tube Stabilizer
- MAGILL Forceps, length 25 cm
- Scalpel, for single use, package of 10
- COTTLE Nasal Speculum, blade length 55 mm, length 13 cm
- DÖRGES Emergency Laryngoscope Blade, cold light, universal size
- Handle Sleeve, ISO 7376
- Battery Insert, with 2 Batteries 121306 S and Xenon Lamp 8546 XA
- Case
Intubation Set -C22-, ULM Model

Basic Set

8400 B

Intubation Set -C22-, ULM model
including:
BOEDEKER-DÖRGES C-MAC® Video Laryngoscope, MAC #3
BOEDEKER-DÖRGES C-MAC® Video Laryngoscope, MAC #4
C-MAC® Video Laryngoscope D-BLADE
C-MAC® Pocket Monitor Set
Charging Unit, for C-MAC® pocket monitor
Protective Cap
Handle Sleeve, ISO 7376
DÖRGES Emergency Laryngoscope Blade, cold light
Battery Insert Set LED, with cap
Bag for Intubation Set -C22-, ULM model
MAGILL Forceps, modified by BOEDEKER

8402 YE

Bag for Ulm Intubation Set -C22-, made of water-resistant and sturdy material, washable, including two compartments with several holding facilities for C-MAC® video laryngoscope blades with C-MAC® pocket monitor and conventional laryngoscopes, for use with C-MAC® Pocket Monitor 8401 XD, C-MAC® video laryngoscopes and conventional laryngoscopes
Emergency Tracheobronchoscopy Set
Basic Set

Recommended Set for Difficult and Standard Intubation

10330 F

Emergency Tracheoscope Set
including:
Emergency Bronchoscope, size 6, length 30 cm
Emergency Tracheoscope, size 9, length 25 cm
Emergency Tracheoscope, size 7, length 20 cm
Emergency Tracheoscope, size 5, length 20 cm
FLUVOG Adaptor
Adaptor for Ventilation
DÖRGES Emergency Laryngoscope Blade, cold light, universal size
2x Handle Sleeve, ISO 7376
2x Battery Insert, with 2 Batteries 121306 S and Xenon Lamp 8546 XA
Xenon Lamp, package of 6
Forceps, for peanuts and soft foreign bodies
Forceps, alligator, for hard foreign bodies
MAGILL Forceps, length 20 cm
MAGILL Forceps, length 25 cm
YOUNG Tongue Seizing Forceps
Suction Tube, diameter 3 mm, length 35 cm
Suction Tube, diameter 4 mm, length 35 cm
Suction Tube, diameter 5.5 mm, length 35 cm
Case
Battery Light Source LED BRITE LITE
Accessories for Intubation Fiberscopes and Endoscopes

Special Features:
- Battery light source with extremely high light intensity >100 lm / >150 klx
- Available as battery and rechargeable version
- Absolute white light due to LED technology
- Special light focus allows optimal light adjustment at the endoscope connector
- LED provides up to 50,000 hours lifetime
- Burning time of 120 min
- Waterproof, fully immersible for cleaning and disinfection (11301 D1/D3)

11301 D1/D3/DE/DF

11301 D1 Battery Light Source LED for Endoscopes, with fine screw thread, brightness > 100 lm / > 150 klx, burning time > 120 min, weight approx. 150 g, waterproof and fully immersible for manual cleaning and disinfection, with 2 Photo Batteries 121306 P

11301 D3 Same, with coarse thread

121306 P Photo Battery, lithium, 3 V, CR 123 A

11301 DE Battery Light Source LED for Endoscopes, rechargeable, with click connection, brightness > 110 lm / >150 klx, color temperature 5500 K, lithium-ion batteries, charging time 60 min, burning time at 100% brightness 40 min, weight approx. 150 g ready for use, suitable for wipe disinfection

11301 DF Same, with fast screw thread

11301 DG Charging Unit, for 11301 DE/11301 DF, for two LED battery light sources, with fixed integrated power supply and adaptor for EU, UK, USA and Australia, power supply 110 – 240 VAC, 50/60 Hz, suitable for wipe disinfection

11301 DH Holder, for Charging Units 11301 DG, 8546 LE and 8401 XDL
MACINTOSH Laryngoscope Blades
Cold Light, with Replaceable Fiber Optic Light Carrier

Special Features:
- KARL STORZ blades and handles meet the highest cleaning and hygienic standards
- Chromium-plating gives the laryngoscope blades a compact, smooth surface; edges are rounded, thus preventing the formation of microcracks, fission or sharp edges which can harbour germs
- Handles are not knurled (problematic concerning hygiene), instead have an ergonomic shape and smooth surface.
- Handles can be supplied with LED “BRITE LITE” power system with > 50,000 lux and Li-Ion rechargeable batteries.

- The KARL STORZ laryngoscope blades are the only such products currently commercially available that are autoclavable and show no noticeable reduction in light intensity, even after several hundred cleaning cycles**.
- The Xenon lamps in the fiberoptic light carriers generate a neutral white light which is 30 – 40% brighter than standard halogen light.
- Laryngoscopy blades and handles comply with the ISO 7376 standard.
- On request, additional markings can be etched on the laryngoscope/handle free-of-charge (such as, e.g., “1-83-2/Case” or „Christoph 77/Rucksack”)


MILLER Laryngoscope Blades
Cold Light, Fiber Optic Light Carrier Incorporated

<table>
<thead>
<tr>
<th></th>
<th>MILLER Laryngoscope Blade, size 4</th>
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</thead>
<tbody>
<tr>
<td>8537 A</td>
<td>Same, size 4</td>
</tr>
<tr>
<td>8537 B</td>
<td>Same, size 3</td>
</tr>
<tr>
<td>8537 C</td>
<td>Same, size 2</td>
</tr>
<tr>
<td>8537 D</td>
<td>Same, size 1</td>
</tr>
<tr>
<td>8537 E</td>
<td>Same, size 0</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>MACINTOSH Laryngoscope Blade, size 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>8546</td>
<td>Same, size 4</td>
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<tr>
<td>8546 A</td>
<td>Same, size 3</td>
</tr>
<tr>
<td>8546 LD</td>
<td>Same, size 2</td>
</tr>
<tr>
<td>8546 E</td>
<td>Same, size 1</td>
</tr>
<tr>
<td>8546 LD</td>
<td>Same, size 0</td>
</tr>
</tbody>
</table>
Handles with LED Light Source
for Cold Light Laryngoscope Blades

Special Features:
- Rechargeable lithium-ion batteries
- Extremely bright LED of more than 50 lm/100 klx
- Absolute white light due to LED technology (5500 K)
- Small handle with photo battery
- Special lens system allows optimal light adjustment at the blade connector
- LED provides a lifetime of more than 50,000 hours
- Burning time up to 240 min at 100% brightness
- Charging via inductive technology
- ISO 7376 compatible

**Handle Sleeve**, ISO 7376, autoclavable, length 12 cm, for use with Battery Inserts 8546 A, 8546 LD, 8549 LD and cold light laryngoscopes

**Battery Insert**, rechargeable, length 12 cm, for Handle Sleeve 8546, with high-power LED, 56 lm/100 klx, lithium-ion battery insert, burning time at 100% brightness 240 min, charging via Inductive Charging Unit 8546 LE

**Battery Insert Set**, length 6 cm, autoclavable, for Handle Sleeve 8548, with high-power LED, > 56 lm/100 klx, burning time at 100% brightness > 120 min including:
- **Battery Insert**, high-power LED
- 2x **Battery**, Mignon-Cell, LR 06, 1.5 V Cap

**Battery Insert Set LED**, length 12 cm, for Handle Sleeve 8546 and cold light laryngoscopes, with high-power LED, > 56 lm/100 klx, burning time at 100% brightness > 120 min including:
- **Battery Insert**, high-power LED
- 2x **Battery**, Mignon-Cell, LR 06, 1.5 V Cap
Handles with Xenon Light Source
for Cold Light Laryngoscope Blades

8546

**Handle Sleeve**, ISO 7376, **autoclavable**, length 12 cm, for use with Battery Inserts 8546 A, 8546 LD, 8549 LD and cold light laryngoscopes

8546 A

**Battery Insert**, length 12 cm, with 2 Batteries 121306 S and Xenon Lamp 8546 XA

121306 S

**Batteries**, Baby-Cell, LR 14, for Battery Inserts 8544 A and 8546 A, package of 2

8546 XC

**Xenon Lamp**, 2.5 V, for Battery Inserts 8546 A, 8547 A and 8547 B, package of 6

Especially suitable for use with blades sizes 0 and 1

8547

**Handle Sleeve**, ISO 7376, length 12 cm, **autoclavable**, for use with Battery Inserts 8547 A and 8547 B

8547 A

**Battery Insert**, length 12 cm, including 2 Batteries 121306 KS and Xenon Lamp 8546 XA

121306 KS

**Batteries**, Mignon-Cell, LR 06, 2 Batteries 121306 K, for Battery Inserts 8545 A, 8547 A and Battery Insert Set High-Power LED 8549 LD

8547 B

**Rechargeable Battery Insert**, length 12 cm, for Handle Sleeve 8547, with Xenon Lamp 8546 XA, charging via Inductive Charging Unit 8546 LE

8547 XC

**Xenon Lamp**, 2.5 V, for Battery Inserts 8546 A, 8547 A and 8547 B, package of 6
Inductive Battery Charger
for rechargeable Laryngoscope Handles

Special features:
- No open contacts
- No corrosion and contact problems
- No voltage peaks
- Batteries can be charged with or without handle sleeve, sterile packaging
- For use with LED handles
- Compatible with previous models

8546 LE

8546 LE  Inductive Charging Unit, for two battery inserts (8546 LD, 8544 B, 8545 B, 8547 B), with fully integrated mains adaptor and power adaptor for EU, UK, USA and Australia, power supply 110 – 240 VAC, 50/60 Hz, suitable for wipe disinfection

8546 R  Reduction Sleeve, for Battery Inserts 8545 B and 8547 B, only

11301 DH  Holder, for Charging Units 11301 DG and 8546 LE