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Predicting and Managing the Difficult Airway

You are about to perform orotracheal intubation. Do you expect it to proceed smoothly, or do you anticipate a challenge? If you encounter difficulty, what will be your next move? In a case-based format, the lecturer will discuss techniques to predict difficulties in standard orotracheal intubation. An algorithmic approach to the potentially difficult airway will be presented.

- Discuss the anatomic variants that may predict a difficult intubation.
- Explain common and alternative techniques that may maximize intubation success when faced with a difficult airway.
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- Discuss a stepwise approach to the difficult airway.

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FACULTY

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Introduction:

Airway management is one of the most critical interventions in Emergency Medicine. The very nature of our field; a myriad of different patient characteristics, disease processes and happenstance, all conspire to make emergency airway management one of the most anxious and challenging procedures we perform. It is critical that the EM physician have a fluid and intimate understanding of how to anticipate, recognize and secure the difficult airway. One can not overstate the importance of the physician having an airway 'strategy' that takes into account a number of essential elements: patient and disease characteristics, available equipment, personal experience/skill level, etc. This strategy should also be flexible; anticipating that clinical situations are prone to sudden change, and that difficult airway problems may require alternative approaches and techniques. This discussion will focus primarily on the general approach to definitive airway management with a special focus on airway strategy and the difficult airway algorithm. .

Preparation:

Airway emergencies may arise with little or no warning. Assure that all your equipment is available and organized in a way that is familiar to you and your staff. It may be useful to go through a check list at the beginning of each shift. We are also strong proponents of the dedicated airway tray - present on the right-hand side, at or near the head of each resuscitation bay - which includes all the essential equipment for routine intubation. This avoids the last second need to assemble critical items located in distinct drawers, cupboards and carts. The tray should include at least the following:

[] Bag-Valve-Mask: Standard BVM securely attached to a high-flow oxygen source via flex tubing. The flow of oxygen can be initiated when the patient arrives. Occasionally, the standard BVM mask may prove too large for the smaller female or adolescent patient. Verify the availability of at least one smaller size BVM in addition to the standard assortment of pediatric and neonatal BVMs.

[] Oral and nasal airways: a selection of oral airways and nasal trumpets should be available to facilitate ventilation prior to intubation or after a failed attempt. Lubricant and lidocaine jelly should be present on the tray as well as lidocaine spray. If cricothyrotomy is a possibility, lidocaine for local anesthesia should be readily available.

[] Yankauer suction catheter: Important to assure that the suction tubing is securely connected and that the negative pressure gauge is preset to high (max). Placing a piece of tape over the sump hole of the suction catheter avoids the need to occlude it with one's thumb

during the intubation procedure.

[] Laryngoscope handle: At a minimum, there should be two laryngoscope handles on each airway tray. Check battery strength by attaching a blade to each handle and verifying that the light source in bright and sustained. Since there are several manufacturers of laryngoscopes, not all blades and handles are compatible. Check that they fit and work together. Lastly, keep spare batteries stocked in a familiar location in the ED.

[] Laryngoscope blades: There are two main types of laryngoscope blades: Macintosh and Miller (see below). Each comes in several sizes and lengths appropriate for neonatal - large adult patients. The choice of which blade to use is almost exclusively a matter of personal preference. However, when confronted with a difficult airway, the ability to switch blade size or type may offer an easy solution to the problem. Therefore, each airway tray should offer a full complement of both Miller and Macintosh blades, compatible with the laryngoscope handles used.

[] Endotracheal tubes: Modern ET tubes are made of polyvinyl chloride and have a high volume, low pressure cuff. Tubes are sized in millimeters based upon their internal diameter. Most adults will accommodate either a 7.0, 7.5 or 8.0 ET tube. Each tray should offer two of each of these sizes, plus ET tubes ½ size larger and smaller. Check the integrity of the balloon cuff by inflating with a 10 cc syringe. Leave a syringe attached and loaded to the two ET tubes most likely to be used.

[] Stylets: 'Pre-load' at least one of the ET tubes with a stylet, adjusting its length so as not to extend beyond the tip of the ET tube. Consider applying a small amount of lubricant to the stylet so it may be removed more easily.

Anticipation

Anticipating the difficult airway is as much a matter of one's 'mind-set' as it is the practical process of evaluating a patient's airway for any tell-tale indications of potential problems. It is safest to assume that even the most routine of intubations in the ED may be difficult, and proceed accordingly. Anesthesia studies on preoperative patients have described difficulty with intubations in 6-18% of cases. It is reasonable to assume that in the uncontrolled setting of a busy ED, difficult airways are even more common.

Nevertheless, there are several general categories of patients that are more likely to pose a challenge for airway management: baseline anatomic characteristics, acute and/or chronic disease processes, and behavioral problems. In reality, patients who appear to be difficult may be easy to intubate and vice-versa; making the need for a consistent and comprehensive strategy all the more important.

Anatomic Characteristics:

Subjective: In general, the longer the neck, and the more prominent the mandible, the easier the intubation will be .....

- Short (receding) mandible
- Short, thick "bull" neck

- narrow mouth opening
- large tongue
- dental abnormalities (buck teeth)

Objective:

- Thyro-mental distance <
- Thyro-hyoid distance <
- Mallampati Classification

Chronic disease processes

- Limited cervical mobility: DJD, pain etc
- Limited ROM of the jaw: TMJ arthritis, etc

Acute disease processes

- upper airway conditions: oropharyngeal infections leading to swelling, trismus; angioedema, epiglottitis
- facial trauma, cervical trauma, laryngeal trauma - airway blood and secretions, limited ROM of neck, distorted anatomy

Behavioral problems:

- drug intoxication, psychiatric illness - poor patient cooperation

Technique: Normal Oro-tracheal intubation

The above mentioned clinical and anatomic obstacles notwithstanding, the most common reason for experiencing a difficult airway is substandard technique. Meticulous patient preparation and excellent technique go far in negating the root causes of a difficult airway problem.

- Patient preparation: In our haste to secure the airway, standard pre-intubation procedures are often over looked. The well prepared patient will better tolerate prolonged/multiple intubations attempts common in difficult cases. Similarly, standard non-invasive monitoring offers immediate feed-back on how the patient is responding to the procedure.
  - IV access (preferably two secure lines)
  - Pulse oximetry, ECG monitor, removal of dentures/foreign bodies
  - Pre-oxygenation: 100% O2 given to spontaneously breathing patient or gently ventilated via BVM will provide an O2 reserve to bridge the apneic period during intubation.
  - Patient positioning
    1) Elevate the patient's bed to at least the level of your mid waist (or higher)
    2) Patient's head at the top of the bed, near intubator - permits a mechanical advantage when bagging the patient as well.
    3) Place patient in 'sniffing position' (assuming no C-spine concerns). Sometimes facilitated by placing a sheet behind the patient's head
       - Flexion of neck at shoulders ~30 ^{o}
       - Extension of neck at Atlanto-occipital joint

    3) Open mouth as widely as possible - 'scissors' technique
- Oro-tracheal Intubation:

  Macintosh blade: This blade is equipped with a large scoop designed to secure the tongue out of the line of sight. The number 3# blade is the most popular. Occasionally the number 4# will be required for larger patients, those with a deep glottis or excess

tissue.

1) The blade is inserted into the mouth from the right-hand side, from an angle nearly perpendicular to the frontal plane of the patient.
2) The blade is gently moved toward the left, sweeping the tongue out of the line of sight.
3) Advance the blade, following the natural curvature of the base of the tongue until the epiglottis is visualized. Seat the blade into the vallecula
4) The laryngoscope handle is then lifted at a 45^0 angle to the patient until the epiglottis rises up, exposing the vocal cords.
5) The ET tube (with stylet and a slight anterior bend to the distal 5 cms) is inserted in the mouth from the right side, following an oblique path until it meets the midline at the level of the cords.
6) The tube is gently passed through the cords under direct vision, approximately 3 cms or until the cuff disappears.

Miller Blade: The Miller blade lacks the scoop shape of the Macintosh and is less effective in sweeping the tongue to the side. More typically, the tongue and soft tissues of the floor of the month are compressed in the midline. The tip of the Miller blade is advanced past the epiglottis towards the vocal cords (not placed in the vallecula). The long axis of the blade provides a line of sight. It is very important not to obscure this visual axis with the ET tube which should inserted laterally and advanced obliquely toward the glottis.

- Post-intubation care:
    1) Inflate the cuff with the 10 c syringe already attached
    2) Verify tube placement by one or more of the following methods:
        - auscultation over both sides of chest, stomach
        - colorimetric and End-tidal CO2 devices, together with a stable or rising pulse-oximetry
        - esophageal intubation detector vs Tumi syringe
    3) Place a NG tube to compress the stomach - Obtain a post-intubation chest x-ray to verify the location of the tip of the tube

Common causes of unsuccessful intubations:

Inadequate Oral Access

- Not opening the mouth adequately : using the scissors technique or an assistant, maximally distract the jaw.
- Tongue obscures viewing : preference for Macintosh blade - concentrate on sweeping the tongue away and to the left
- Large over-bite limits blade insertion and manoeuverability: maximally distract the jaw with above technique - use a smaller Miller blade (blade and handle may be entirely placed inside the mouth, bypassing the teeth

- Small oral opening - use an assistant to distract the side of the mouth lateral

Inadequate visualization of the cords

- Obscuration of the glottis by the ET tube (most common cause of inadvertent esophageal intubation in a patient whose cords are well visualized): ET tube must be inserted obliquely, joining the midline at the glottis (not before) .
- Rocking the laryngoscope handle posteriorly: may allow the epiglottis to fall into the field of view and/or reduces the oral aperture making tube passage more difficult.
- Improper patient positioning (poor alignment of the axes makes the glottis appear too anterior) - flexion at the shoulders and extension at the neck - "sniffing position"

Anterior Cords:

The problem of anterior cords is a common one and deserves special discussion. Fewer than 3 finger breaths of distance between the symphysis of the mandible and the hyoid bone predicts an anterior glottis.

Adjuncts:

1) Patient positioning
2) Cricoid pressure - the Sellick maneuver is part of every rapid sequence intubation procedure. In addition to limiting the risk of aspiration, cricoid pressure will posteriorly displace the glottis allowing easier visualization.
3) BURP manoeuver: **B**ackwards, **U**pwards, **R**ightwards **P**ressure
3)Blind Oral Endotracheal intubation: The concept of blind oral intubation refers to the situation where the cords are incompletely visualized and intubation proceeds using airway landmarks such as the esophagus, epiglottis and arytenoids. There are several techniques and devices which may facilitate success in these situations.

- Hockey Stick Stylet: creating a sharp bend to the distal tube using the stylet may help direct the tube through the cords anteriorly.
- Magill Forceps: The Magill forceps was designed initially to assist with nasotracheal intubation under direct visualization. It may also be used with oral intubation techniques. The distal ET tube is directed anteriorly toward to the glottis. An assistant may be needed to advance the tube while the intubator concentrates on directing it in to the airway.
- Endotracheal tube with directional control tip (Endotrol) : These endotracheal tubes allow the intubator to alter the distal curve of the tube as necessary during intubation. These tubes are slight softer and more flexible than standard ET tubes and as such are

popular for blind nasotracheal intubation. The stylet should either omitted completely or alternatively, inserted only partially in order to allow flexing of the distal ET tube.

Special laryngoscopes : There are several commercially available laryngoscopes specifically designed to assist in the visualization of patients with anterior cords or with limited cervical mobility of any variety. These adaptations range from simple prisms attached to the laryngoscope to more complex devices involving rigid fiberoptic scopes integrated into a laryngoscope blade. In the case of the latter, the intubator places the blade in the usual fashion, then advances the tube under direct visualization through the fiberoptic scope.

- Bullard Laryngoscope: rigid fiberoptic laryngoscope allowing direct visualization of distal blade/ETT
- Visualized Endotracheal Tube(VETT): fiberoptic ETT with optional head set or video capabilities

Visualization of the cords but unable to pass the tube. In some instances, the glottic opening can be seen adequately but insertion of the tube is difficult. This is most commonly the result of the tube being either too large or too flexible. The addition of a rigid stylet or alternatively using a smaller sized ET tube can remedy the situation. Occasionally, abnormal anatomy (airway edema, scarring or mass effect) may force the intubator to use very small tubes - on the order of a 5.5 -6.0. Another technique is to use a guiding stylet. These stylets can be passed through the glottis and serve as a guiding trocar for subsequent passage of the ET tube, analogous to the Seldinger technique for IV access. Several devices have been used for this purpose: suction catheters, tracheal tube exchangers, as well as special guides with directional controlled tips.

Difficult Airway Scenario - A non -algorithmic approach

The core elements of the airway strategy - Preparation, Anticipation and Technique - lay the foundation for a smooth transition to one's back-up plan should the initial airway approach prove unsuccessful. A variety of factors: patient anatomy, disease processes, available equipment and the physician's experience all come to bear in deciding the best course of action.

Course of action post Failed Intubation

Patient preparation: Begin by re-oxygenating and ventilating the patient

- 100% O2 via NRB or BVM (if patient not adequately ventilating)
- oral airway and /or nasal trumpet
- monitor pulse oximetry

Physician preparation:

- orient yourself and your staff to the needed equipment and procedure for the next step.

Decision tree:

- The decision to pursue definitive airway control with intubation vs a rescue airway is complex one. The likelihood of a successful intubation using the alternative method is weighed against the patient's ability to tolerate yet another failed intubation attempt. Since this remains largely a clinical decision, it will vary enormously from case to case.

Case Studies:

1) 43 year-old presents in status asthmaticus. The patient has a prior history intubation for respiratory failure. He has received SQ terbutaline, IV salumedrol and 20 minutes of continuous inhaled bronchodilators but appears to be fatiguing. Sitting bolt upright - VS: 170/110, 125, 20, pulse oximetry 95% on 100% NRB. You decide to intubate the patient.....

2) 22 year-old male presents post assault with an obvious unstable mandible fracture. Although the patient has limited jaw opening due to pain, you still are able to notice a large ecchymotic swelling to the floor of the mouth. The patient has a throaty sounding voice but appears comfortable. Over the next hour, he develops more labored respirations. Reexamination confirms a dramatic worsening of the sublingual hematoma. You decide to intubate prophylactically to stave off complete airway collapse.....

3) 45 year-old male with end stage liver disease due to alcoholic cirrhosis presents with altered level of consciousness, increasing jaundice and asterixis. VS: 100/50, 110, 24, 92.7 F, pulse oximetry = 93% RA. You make a presumptive diagnosis of sepsis with hepatic encephalopathy. While in the ED, the patient develops bright red hematemesis. He becomes unresponsive, blood pressure is 70/P and the pulse oximetry fails to register. You begin your resuscitation.....

ADDENDUM

Alternative Techniques (in more detail)

N**asotracheal intubation** :

Advantages:

- reduced movement of cervical spine (although not significantly better than in-line stabilization).
- maybe performed quickly and reliably by the experienced operator
- requires less equipment and medication (no paralysis)
- most appropriate for low acuity patients, with non-trauma related

problems, and/or limited access to oral pharynx

Disadvantages:

- requires somewhat cooperative, breathing patient
- more patient preparation time, delays in intubation, higher complication rate
- no protection against aspiration unless Sellick is used - Sellick is relatively contraindicated in awake patients due to its irritation of the airway and stimulation of coughing
- epistaxis common
- contraindicated in maxillofacial trauma, basilar skull fractures, head injuries or any patient with distorted anatomy.

Technique for Nasotracheal intubation:

1) Patient preparation: O2, suction, pulse oximetry, ECG monitoring
2) Identify and prepare the nares.
   - inspect for septal deviation, prominent turbinates
   - 2-3 drops of neosynephrine solution in the chosen nostril,
   - Spray the oral pharynx with lidocaine
   - lubricate the nostril with 2% viscus lidocaine
3) Place the patient in the 'sniffing' position (unless cervical injury) and gently insert a 6.5-7.0 (size appropriate for nostril) ET tube with bevel away from the septum.
4) Once at the posterior pharynx, rotate the bevel to the superior position and advance the tube.
5) Position the distal tube immediately above the cords. Advance the tube quickly, preferably during inspiration.

Adjuncts to blind nasotracheal intubation

- Endotrol ET tube: directional control may aid in positioning the tube anteriorly into the glottis.
- Lighted Stylet: a fiberoptic light source located at the tip of the stylet inside the ET tube will transilluminate the airway during blind nasal (and oral) intubation. As the tube is advanced, a characteristic glow of light from the anterior neck indicates its position. A bright glow in the midline indicates proper positioning of the tube. If the red glow is off to one side, the tube is likely in the piriform sinus. A dull, diffuse light indicates esophageal intubation. The Pittsburgh group reported a success rate of 88-100% with an average time to intubation of 20-37 seconds.

Translaryngeal guided stylet: This technique involves intubation over a guide wire which has been passed retrograde through the cricothyroid membrane, larynx and oral cavity. A 16-18 gauge needle in placed through the cricothyroid membrane at a 30 degree angle cephalad. A through-the-needle wire is then advances retrograde out the mouth. The guide wire is threaded into the distal side port of the ET tube and out the proximal end. The tube is then passed into the larynx while the guide wire is held taut. The physician then cuts the distal end of the wire at the skin while applying a little downward pressure on the tube to ensure that it passes into the glottis.

Advantages:

- minimal movement of the head and neck in cases of suspected cervical spine injury
- ability to intubate despite the presence of blood or emesis in the airway since direct visualization is not required
- represents a viable alternative to oral intubation with no specific contraindications

Disadvantages

- failures rates relate to inability to cannulate the cricothyroid membrane or inability to recover distal wire in oropharynx
- may be impossible in cases of distorted anterior neck anatomy

Transtracheal Jet Ventilation (PTV) : When orotracheal intubation is unsuccessful or appears impossible, PTV may offer a temporizing solution until a more definitive airway can be established.

Technique: 12-16 gauge over-the-needle catheter is passed through the cricothyroid membrane and angle caudad at 30 degrees. Aspirate with a syringe to verify that the needle is in the airway. Advance the catheter to the hub and attach to pressurized oxygen source (50 psi). Using an on-off valve, provide one second insufflations at a rate of 12 per minute.

- If a high pressure source is not available: The 15 l/min oxygen regulator system may be used. One method is to attach nasal cannula to the hub of the catheter. The opposite cannula can be used as an on-off valve. In the case of soft silex nasal cannulas, a 3.0 pediatric ETT can be used to couple the cannula wit the catheter hub. Lastly, BVM can also be attached via the proximal connector of a 3.0 ETT. Alternatively, the proximal connector of a 8.0 ETT will fit inside a 3.0 cc syringe which can then be attached to the catheter hub.

Advantages:

- provides a bridging airway in the setting of failed traditional airway. Alternative to cricothyrotomy
- may be used in any age group including children
- may be easily convertible to a cricothyrotomy using currently available cricotome kits

Disadvantages

- contraindicated in complete upper airway obstruction - inspired air must have a free avenue of egress through the proximal airway. If a 8.5 french catheter is used, evidence suggests that adequate exhalation maybe possible
- Provides oxygenation, but inadequate ventilation - hypercapnia will ensue
- provides no protection of the airway against aspiration

) **Cricothyrotomy**

Cricothyrotomy is the surgical airway of choice for Emergency Medicine. . Proficiency in this technique is an essential skill for the ED physician caring for the critically injured trauma patient. In the past, this airway method was used routinely in the setting of an unsuccessful nasotracheal intubation, particularly when cervical injury was suspected. Today, with the advent of RSI technique for oral intubation and in-line stabilization for cervical

injuries, the role of cricothyrotomy has become more narrowly defined.

Indications: common settings where cricothyrotomy may be an alternative to oral endotracheal intubation include:
- severe maxillofacial trauma preventing oral intubation
- known, unstable cervical spine fracture (consider also RSI with in-line stabilization or fiberoptic intubation).
- laryngotracheal trauma (except for tracheal transection)
- complete upper airway obstruction
- inability to secure an airway by other intubation techniques

Contraindications:
- pediatric patients less than 8-12 years old
- laryngotracheal separation or tracheal transection
- severe swelling or hematoma to the anterior neck distorting landmarks

Technique: Cricothyrotomy is a procedure entirely dependent upon the confident . identification of anatomic landmarks. When indicated, it must be performed rapidly and can usually be completed in less than thirty seconds. It is a procedure of 'feel', not 'sight'. A common misconception is that the cricothyroid membrane or other landmarks can be reliably visualized during the procedure. This is rarely the case and the time required to do so likely would cause unreasonable delays in establishing the airway. As such, a bloody field with unrecognizable tissue planes is the rule rather than the exception.

1) Locate the cricothyroid membrane
   - stabilize the larynx - this can be done by bracing the laryngeal cartilage from above with the thumb and middle finger while maintaining identification and position of the cricothyroid membrane with the index finger
   - If the patient is awake and sensate, consider either local or systemic anesthesia prior to proceeding
2) Initial skin incision
   - preferred method is to perform a vertical, midline incision ~ 1-2 cms above and below the cricothyroid membrane. Alternatively, one may make a horizontal incision directly over the membrane.
3) Transverse incision through the lower portion of the cricothyroid membrane, just above the cricoid cartilage. This incision is made guided by palpation of the membrane with the index finger, not visualization.
4) A tracheal hook should be placed through the incision and seated underneath the lower thyroid cartilage in order to gain anterior control of the glottis. A Trousseau dilator may then be place to enlarge to the opening.
5) Insert a tracheostomy tube (#4 for most adults or a 6.0 ETT)
6) secure the airway

Percutaneous Cricothyrotomy (Cricotomes) : There are currently several commercially available kits for establishing a cricothyrotomy using a percutaneous needle technique. While subtle variations exist between the

various kits, the common strategy involves cannulation of the cricothyroid membrane with a needle which is then used to guide the passage of the formal tracheostomy tube. There is some evidence to suggest that these devices may offer a higher success rate with fewer complications. In addition, they appear to enjoy a greater acceptance among physicians uncomfortable with the purely surgical approach.

Fiberoptic Intubation: Although well established in anesthesiology, the use of fiberoptic instruments for intubation in Emergency Medicine remains somewhat limited. Nevertheless, with adequate training, fiberoptics offer a powerful technique for dealing with a wide range of difficult airways. ED studies of fiberoptic intubation found success rates ranging from 76-95% , with average times to intubation of 1-3 minutes. The most common causes listed for failure were inadequate experience and blood/secretions obscuring the scope.

Indications:

- Laryngotracheal trauma: relatively atraumatic intubation while allowing for assessment of extent of injury
- Distorted airway anatomy: as above
- Thermal injuries: allows simultaneous assessment of extent of injury
- Cervical spine injury - limits neck movement
- Airway foreign body

Contraindications:

- apnea/agonal respirations: due to time need for procedure
- heavy bleeding or secretions - impaired view
- severe agitation: patient compliance is needed
- complete upper airway obstruction

Technique: The technique involves passing an ETT through the nose (or mouth if a bite block is in place) into the posterior pharynx. The fiberoptic scope is then passed through the lumen of the tube, beyond its tip and directed past the cords to the carina under direct visualization. The tube is then advanced over the scope similar to the Seldinger technique.

Laryngeal Mask Airway (LMA) - The LMA was introduced into the USA in 1991 and has steadily gained popularity as a general purpose airway in elective anesthesia as well as a rescue airway for cases of difficult or failed intubation. In emergency medicine, the LMA primarily serves as a bridging airway until more definitive control can be established. The Fast -Trach adaptation of the LMA provides for a shorter and larger gauge tracheal tube allowing for the convenient conversion of the LMA to a traditional endotracheal intuabtion.

Indications:

- rescue airway in the setting of a failed or difficult intubation attempt
- temporary or bridging airway, pending extubation or more definitive technique

Contraindications:

- not ideal in high inspiratory pressure patients (asthmatics) due to potential air leak
- may not protect airway for aspiration

Technique: The LMA is placed into the oral cavity and advanced blindly into the posterior pharynx/glottis (while maintaining the Ant-Post orientation) until resistence is felt. The device will find its natural seating immediately *posterior* to the glottis and *anterior* to the posterior wall of the glottis. The bladder is then inflated creating the seal.

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