The As and Bs (no Cs) of Intubation and Airway Management

Michael R. Panger, M.D.

General Anesthesia Services Inc.

3508 Staunton Ave SE, PO Box 4005
Charleston, WV 25304
(304) 552-1592
panger.michael@gmail.com

Lisanne N. Leasure

Faraci Leasure LLC

4500 Cherry Creek Dr South Ste 625
Glendale, CO 80246
(303) 630-0502
lleasure@faracileasure.com
Michael R. Panger, M.D., was born and educated in West Virginia, attending West Virginia University for undergraduate studies, medical school and residency. He has been in practice for 23 years in Charleston, WV with General Anesthesia Services Inc., specializing currently in pediatric and obstetric anesthesia. Having a background in anesthesia for adult cardiovascular and general surgical anesthesia as well as adult and pediatric trauma services, he has an extensive background in intubation techniques for the elective and emergent surgical patient. 

Lisanne N. Leasure has been a medical malpractice defense attorney since 1999. In addition to medical malpractice cases, she handles cases involving premises liability, employment and intellectual property matters and personal injury claims for a national restaurant entity. She has extensive trial experience. Lisanne graduated from CU Boulder, attended University of Maine where she served on the Maine Law Review and graduated with honors. She attended the IADC Trial Academy (2003), CU Mini Med School (2006), and CU Mini Med School II (2015). She was selected a Rising Star in Super Lawyers in 2009 and 2010 and a Super Lawyer yearly from 2011 through 2016.
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Table of Contents

I. Introduction ...................................................................................................................................................5
II. The Medicine ..................................................................................................................................................5
   A. Background ............................................................................................................................................. 5
   B. Anatomy .................................................................................................................................................. 6
   C. Equipment ...............................................................................................................................................7
   D. Indications for Intubation ......................................................................................................................8
   E. Confirmation of Placement ................................................................................................................... 9
   F. Monitoring the Intubated Patient ........................................................................................................ 9
   G. Potential Pitfalls in Intubation and Monitoring ............................................................................... 10
III. Medico Legal Issues in Airway Cases .........................................................................................................11
IV. Who Can Intubate? ......................................................................................................................................13
V. Tips for Evaluating and Defending Intubation Cases ................................................................................14
VI. Conclusion ....................................................................................................................................................15
Endnotes .....................................................................................................................................................................15
The As and Bs (no Cs) of Intubation and Airway Management

I. Introduction

Most attorneys who handle medical malpractice matters have learned the A, B, Cs – Airway, Breathing, and Circulation – because at least some of those physiologic concepts exist in many cases. In this presentation, Dr. Panger and Lisa Leasure will focus on airways and breathing in intubated patients. Intubation and management of an intubated patient is implicated in many malpractice cases. The medicine and physiology involved can be fairly complex to not only understand (equipment used, medications involved, technical aspects, confirmation of placement, and ongoing monitoring) but also to explain to a jury of lay people. Dr. Panger will explain the medicine involved and Lisa Leasure will discuss how these issues arise in medical malpractice cases and strategies for defense.

II. The Medicine

A. Background

Insertion of an endotracheal tube is a routine part of the administration of a general anesthetic. Intubation is not a risk free procedure, however, and not all patients receiving a general anesthetic require an endotracheal tube. Controlling the airway with a mask or laryngeal mask airway (LMA) is usually satisfactory for peripheral procedures, such as bladder surgery or extremity operations, but an endotracheal tube is placed for more extensive operations or thoraco-abdominal procedures.

Endotracheal tubes are also used outside of surgery when a patient needs an airway for breathing due to pathology of the lungs, trauma, or other serious medical conditions in which the patient cannot maintain breathing on their own without assistance.

Tracheotomy was first described around 3600 BC. The first endotracheal intubation occurred in the 1540's and was successfully used to manage diptheria in the 1800's. The first cuffed endotracheal tube was developed by Dr. Arthur Geudel, an American anesthesiologist, in the 1920’s. In the “dunked dog” experiment, he anesthetized the family dog, appropriately named “Airway”, then intubated and placed it in a water tank for over an hour. The dog was successfully revived and ran off without incident, demonstrating the safety of a cuffed ET tube.
B. Anatomy

The pertinent anatomy is divided into the nasal cavity, oral cavity, pharynx, larynx, trachea, and lungs.

The pharynx is separated into the nasopharynx, oropharynx, and hypopharynx (or laryngopharynx), corresponding to the anatomic area in the throat.

The larynx is comprised of the glottis and subglottic area. The glottis includes the epiglottis (a cartilaginous structure that protects the trachea from aspiration), the vocal cords (used for phonation) and the space between the cords. The subglottic area includes the cricoid ring (the only completely circumferential cartilage in the airway) which is frequently the narrowest part of the airway and when stenotic, can be a significant cause of respiratory distress.

The trachea extends from the larynx to the bronchial tree, first separating into the right and left mainstem bronchi to each side of the lung, then branching greatly until the alveolus is reached, the smallest sac in the lung where gas exchange occurs.
C. Equipment

In addition to standard endotracheal tubes, RAE tubes are available to keep the tube away from the surgical field. There are many different types of laryngoscope blades available but the two most common are the Macintosh and Miller. They come in pediatric and adult sizes.

![Standard ET tubes](image1)

![Oral Airway](image2)

![Nasal Airway](image3)

![Standard laryngoscope blades](image4)
In addition, many other pieces of equipment are essential for routine laryngoscopy and intubation. Airways, both nasal and oral, a mask and circuit for hand ventilation, and suction for clearing the airway of blood, emesis or secretions. When standard direct laryngoscopy is unsuccessful, supraglottic airways, video laryngoscopes, or fiberoptic laryngoscopes are available for management of the difficult airway.

Supraglottic airway (Laryngeal Mask Airway)

Fiberoptic intubating bronchoscope

Tube introducers or changers have an angled tip which is designed to assist with tube placement during difficult intubations. It is most commonly known as a Bougie. There is also a guide with a straight tip that is designed to assist in tracheal tube exchange so that a tube can be removed and replaced over the guide to ensure the placement stays the same.

D. Indications for Intubation

Endotracheal tubes are placed for protection of the airway, to control ventilation, and for airway access in a wide variety of settings. In general anesthesia, intubation is indicated for patients at risk for aspiration (unable to protect their airway) and for those undergoing surgical procedures involving the chest and abdomen or head and neck. Intubation is also indicated in respiratory distress situations, including asthma exacerbations that cannot be managed with medications and more conservative measures, injury from trauma, neurologic injury, birth depression, and any clinical scenario when a patient is unable to protect or maintain his or her own airway and breathing. This includes patients with decreased oxygen content and oxy-
gen saturation of the blood caused when their breathing is inadequate (hypoventilation), suspended (apnea), or when the lungs are unable to sufficiently transfer gas to the blood.

E. Confirmation of Placement

Waveform capnography is currently the gold standard for confirmation of endotracheal tube position. A positive tracing merely implies CO2 exchange and does not guarantee appropriate position. Mainstem bronchus, supraglottic, or segmental bronchus intubation can all occur. While ventilation can still occur with malposition, effective ventilation of the entire lung may not. In addition, capnography also implies adequate pulmonary blood flow so in a cardiac arrest situation, further confirmation is needed.

Other forms of confirmation include: direct visualization of the tube passing the glottis; auscultation of lung fields; ultrasound or other imaging of the chest cavity; nonwaveform capnography (monitor simply produces a number); and colorimetric devices where a color change occurs due to presence of CO2, again requiring pulmonary blood flow.

F. Monitoring the Intubated Patient

Monitoring the patient in an intensive care setting (ICU) currently lacks capnography. The patients are typically sedated and sometimes restrained. Pulse oximetry, blood pressure, and heart rate are monitored in addition to the occasional more invasive measures of arterial blood pressure, central venous pressure, or pulmonary artery pressure through a Swan Ganz (pulmonary artery) catheter. Alterations in these variables are inefficient for respiratory monitoring as they can be sustained for some time without adequate ventilation and oxygenation. Ventilators monitor respiratory pressure and, in the case of unintended extubation, are the first monitors to alarm and indicate an aberration in ventilation.
G. Potential Pitfalls in Intubation and Monitoring

The goal of endotracheal intubation is to place a tube in the patient’s trachea that provides an unobstructed pathway for ventilation. However, although ETI is a routine procedure, it comes with a number of risks and challenges. For example, it can be difficult in some patients to locate the correct landmarks allowing placement of the tube in the trachea. If the tube is mistakenly placed in the esophagus or is too high or too low to provide optimal ventilation and the error is not recognized, serious brain damage or death can occur. The complications of laryngoscopy and intubation include hypoxia, hypercarbia, dental and airway trauma, tube malpositioning, physiological responses to instrumentation, and tube malfunction. These complications can occur during laryngoscopy and intubation, while the tube is in place, or following extubation.

Airway Trauma – Instrumentation with a metal blade and stiff ET often traumatize delicate airway tissue. Although dental trauma is the most common cause of malpractice claims against anesthesiologists, laryngoscopy and intubation can lead to a range of complications from sore throat to tracheal stenosis. Inflation of the ET cuff to the minimum pressure that creates a seal during routine positive pressure ventilation (usually 20 mm Hg) reduces tracheal blood flow by 75% at the cuff site. Further cuff inflation or hypotension can totally eliminate mucosal blood flow.

Vocal cord paralysis from cuff compression or other trauma to the recurrent laryngeal nerve results in hoarseness and increases the risk of aspiration. The incidence of postoperative hoarseness appears to increase with obesity, difficult intubation, and anesthetics of long duration. Smaller tubes appear to be beneficial as does fewer attempts at laryngoscopy.

Errors in Positioning – Esophageal intubation can be catastrophic. Therefore multiple means are utilized to ensure proper endotracheal positioning. Direct visualization, auscultation, and capnography are standard. Auscultation over the stomach may help in determining if esophageal intubation has occurred. Capnography is transiently positive even with gastric insufflation but gradually disappears. Mainstem intubation may be detected by unilateral breath sounds, high inflation pressure or decreasing oxygen saturation. Typically true esophageal intubations are readily recognized because they lead to a rapid decline in the patient’s clinical picture. In some instances, even if the tube is placed properly initially, it can move and become displaced despite being taped at the lip or otherwise secured.
Physiologic response to intubation – This is a stimulating event and predictably can cause hypertension and tachycardia, the sympathetic “fight or flight” response. General anesthetics, narcotics or vasoactive drugs all attenuate the response to laryngoscopy and intubation. Cardiac dysrhythmias frequently occur and indicate a light level of anesthesia.

Laryngospasm is a forceful involuntary spasm of the laryngeal musculature and can occur from pharyngeal stimuli (secretions) prior to intubation or after extubation when the tube is pulled back through the vocal cords during a light plane of anesthesia. Large negative intrathoracic pressures may develop and can cause a type of pulmonary edema called negative pressure pulmonary edema.

Bronchospasm can develop in patients with asthma or reactive airway disease (recent URI). Increased intracranial or intraocular pressure can occur. Depression of laryngeal reflexes from prolonged intubation may increase the risk of aspiration.

ET malfunction – Airway fire if ignited, cuff or valve malfunction, kinking if bent, and obstruction from thickened secretions are all examples for malfunction of the ET tubes.

III. Medico Legal Issues in Airway Cases

Because failing to intubate a patient when necessary or making errors in intubation or monitoring can lead to hypoxia/anoxia and serious brain injury or death, this is an area ripe for litigation. These cases often are large damage cases due to the severity of the claimed damages. The claim typically made is for medical negligence against the care providers involved with the patient’s care. Entity claims are seen not just relating to vicarious liability for alleged employee negligence by nurses or respiratory therapists but also based on claims of: insufficient training; improper staffing or unavailable staff; and failure to have appropriate equipment available. Failed intubation cases rarely lend themselves to novel theories of liability such as consumer protection, fraud, false advertising, or breach of contract theories that sometimes are attempted in other medical malpractice scenarios.

The medicine involved in intubation cases can be difficult to explain to a jury of lay people. Therefore having good anatomic illustrations, anatomic models, and using the actual equipment in demonstrations by experts and the defendant are invaluable. Charts of O2 saturations and vital signs can also be helpful to paint the clinical picture and rebut a contention of an esophageal or misplaced endotracheal tube (ETT).

Some intubation cases involve relatively less serious injuries such as broken teeth or injury to the tissues of the upper airway. However, claims of esophageal intubation, failure to intubate timely, and failure to establish an airway causing serious and sometimes catastrophic patient outcomes such as brain injury and death are not uncommon.

For discussion purposes, some of the case vignettes below may be used. The following are issues are taken from actual cases:

Case Vignette #1 – “You Placed The Tube In the Wrong Place”
Alleged Damages – Death

A young woman was in a motor vehicle accident and sustained serious but not life threatening injuries. At the scene, the paramedics inserted a nasopharyngeal airway. The patient was confused and agitated and pulled it out. Because the nature and extent of her internal injuries was unknown and due to her agitation and movement, for transport they decided to paralyze and intubate her. Unknowingly, the intubation was esophageal. Her condition on air transport deteriorated. The patient was not on a cardiac monitor and no pulse oximetry or capnography was used during transport although it was available. She continued to deterio-
rate and died in the helicopter on the way to the hospital. It did not occur to the care providers that the tube was in the esophagus and was causing the patient’s deterioration.

Esophageal intubation occurs but it usually rapidly identified due to the decline in the patient’s condition. However, there are several cases reported in medical literature where there was an esophageal intubation but, because the tube was thought to be confirmed as being endotracheal and the patient was able to remain relatively stable, it was not identified promptly. Although unrecognized esophageal intubation cases may seem indefensible at first blush, there are scenarios when it is reasonable for a clinician to not identify the esophageal intubation right away because the patient’s clinical condition does not deteriorate and the clinician reasonably relies on confirmatory (although in retrospect false) data. For example, patients can breathe around the tube leading to O2 saturations that remain reasonable despite that the tube is not in the trachea. Also, confirmatory methods including CO2 detectors that change color can mislead the provider into thinking the tube is properly positioned when it is not. These are among the most difficult airway cases to defend, however, and it is important to marshal every piece of information available to show why the care provider’s judgment was not unreasonable given the entire clinical scenario.

**Case Vignette #2 – “The Tube Moved And No One Figured it Out”**

**Alleged Damages – Death**

Asthmatic young woman presents to ED, 30-32 weeks pregnant, with an exacerbation of her severe asthma, bilateral pneumonia, and an H1N1 exposure. Her O2 sats upon presentation were 89% on room air. She was treated in the ED for 5 hours with nebulizer treatments but her condition worsened. The defendant critical care physician was consulted. It was determined that endotracheal intubation was indicated. Defendant sedated the patient but could not intubate after two attempts. The ED physician was able to intubate. Defendant physician took the patient to ICU for monitoring of her condition as well as monitoring by L&D of the fetus. Defendant performed a bronchoscopy to try to clear secretions, further evaluate the lung pathology, and to obtain further sample for H1N1 testing. Throughout the time in the ICU including during the bedside bronchoscopy procedures, the patient’s O2 sats were 95-100%. Later that evening, the RT reported that she thought there was a blown cuff on the ETT due to breath sounds and decreased O2 sats to the 80s. The tube was changed over a tube changer without improvement in the patient’s condition. As the RT and defendant were trouble shooting (O2 sats stayed in the low 80s and vital signs were stable), there was a fetal bradycardia and a crash c-section in the ICU room. During the c-section, gas was noted to be coming from the rectum and the abdomen was distended. An hour after the initiation of the c-section in the context of a follow up procedure to try to determine the source of the abdominal distention, the anesthesiologist, who was co-managing the patient from the start of the c-section on, looked and saw the ETT straddling the vocal cords. She tried to advance it but could not so she pulled and replaced it. The patient’s O2 sats increased but she then suffered cardiac arrest. She was resuscitated but also had a major hemorrhage requiring more surgery the next day. The patient died 9 days later. The claim against the RT and the defendant doctor alleged that they improperly managed the patient including failing to recognize the displaced ETT resulting in death to the mother and an hypoxic brain injury to the child.

In this case, it was very difficult to determine when and how the tube moved from the optimal position in which it was initially placed to a malposition high in the pharynx. Although it was still feeding O2 to the lungs, the abdominal distension occurred because the tube became high and was likely feeding air to the stomach as well. Plaintiff alleged that the tube was esophageal but the patient’s clinical picture as well as the position when the anesthesiologist looked at the tube (cuff straddling the vocal cords) shows that the tube was high but not esophageal. Tubes can move after placement even if the RT secures it. For example, neck flexion has been associated with 3–5 cm of endotracheal tube movement, which can result in tube dislodgement. It is
important to document all methods used to confirm placement and the securing of the tube. It is also important to closely document the patient's clinical picture to show that her O2 sats remained reasonable and did not cause the patient's death.

**Case Vignette #3** – “I Needed to Be Intubated But You Didn't Do It”

Alleged Damages – Brain Injury

Patient presented to the emergency department with severe respiratory distress. The non-party emergency room resident summoned the defendant pulmonary resident for consultation. The pulmonology resident administered anti-asthmatic medication. The plaintiff contended that her condition significantly deteriorated over the ensuing two hour period, that her pulse oximetry readings worsened instead of improved, and that she became unresponsive. She claimed that the pulmonary resident failed to timely intubate her when she allegedly became unresponsive and stuporous because of a severe asthma attack. She claimed that she sustained brain damage manifesting in severe and permanent loss of motor functioning and a severe speech deficit which improved following extensive speech therapy.

**Case Vignette #4** – “Inexperienced Person Intubated Me”

Alleged Damages – Injury to Upper Airway

The Patient presented to the ED with respiratory distress. A newly-trained resident attempted intubation three times prior to requesting assistance from another provider. Plaintiff claimed resident, who had only intubated patients in that clinical setting on a few occasions, was too inexperienced to be intubating patients and that his inexperience and multiple attempts caused her injury.

In cases where there was some complication with intubation, the skill, experience, and clinical judgment of the intubator will always come into question. How many times has the provider intubated patients in the past? How many attempts did he/she use? Did the provider ask for help when the difficulties intubating the patient occurred? Has the provider had failed intubation attempts in the past?

Most if not all medical students in the United States will learn ETI (endotracheal intubation) in medical school. An interesting study by Tarasi et al. found that most medical students performing ETI under the guidance of an anesthesiologist were initially approximately 75% successful. However, with additional encounters, their success rate improved. It took the students (178 students – 1,646 patients) on average at least 17 ETI encounters to achieve a 90% success rate. Med Educ Online. 2011; 16: 10.3402/meo.v16i0.7309. Published online 2011 Aug 23. PMCID: PMC3164220.

“Endotracheal intubation skill acquisition by medical students” Paul G. Tarasi, M.D. The way to learn is to do and these types of cases require educating the jury, not only about the medicine involved, but also the process of medical education.

**IV. Who Can Intubate?**

There are many types of physicians and healthcare providers who can intubate as long as they have trained to obtain that skill. Respiratory therapists at many institutions are allowed to intubate. Paramedics and EMTs can intubate in the field if it falls under the scope of their skills. Anesthesiologists, pulmonologists, emergency physicians, and critical care providers are all typically expert in intubation because it is prevalent in their work. In newborn settings, often the newborn needing resuscitation and intubation will be attended to by a pediatrician, family practice physician, neonatal nurse practitioner, neonatologist, or labor and delivery nurses. Most providers who attend deliveries will have completed the Neonatal Resuscitation Program (NRP) which gives very specific guidelines about resuscitation of neonates. Neonatal Resuscitation Program™ at http://www2.aap.org/NRP (now in its 7th edition) is a must read for anyone handling cases involving resus-
citation including intubation of a neonate. It is important to know about your client’s experience and training in intubation and to paint it in the best light.

V. Tips for Evaluating and Defending Intubation Cases

1. Watch and learn from your client how to intubate. The more you know about the process and equipment, the better job you can do explaining it to the jury.

2. Use demonstratives including actual equipment to demonstrate to the jury your client’s skill (have them practice because anatomic models will feel different than real patients) in intubating. Having them and your experts teach the jury will establish their expertise.

3. Make a list of everything your client did to confirm placement.² For example:
   - Directly visualized tube passing the cords;
   - Used a CO2 confirmation device, which showed color change confirming placement;
   - Auscultation of bilateral breath sounds;
   - Observed chest rise and fall;
   - Absence of epigastric sounds with expiration;
   - Monitored 02 sats, which stayed in a range showing proper positioning;
   - Absence of air escape;
   - Presence of an exhaled tidal volume;
   - Ordered imaging if necessary to confirm position of tube above carina;³
   - Observed condensation in the tube;
   - Monitored vital signs;
   - Absence of gastric contents in the tube.

4. Charting the patient’s clinical picture from the multiple sources of information – nursing notes, including vital signs; RT notes; physician progress notes; labs; and imaging – will help rebut a contention that the tube was esophageal or malpositioned or that the patient’s condition was declining relating to the ETT or respiratory issues.

5. Explain all aspects of the patient’s lung pathology or other critical issues to show that there were other reasons causing the patient’s decline, not airway mismanagement (e.g. H1N1, pneumonia).

6. Be aggressive in defending on causation. In cases where the patient is critically ill, it will be difficult for plaintiff to prove that negligent malpositioning of the tube (which is itself sometimes difficult for plaintiff to prove) as opposed to the underlying illness of the patient caused the brain injury or death. Get the right experts to help you debunk their causation theory. Plaintiffs often fail to carefully work up their causation case, instead assuming a connection between alleged airway mismanagement and outcomes. It is important to get experts who can explain and debunk causation where appropriate. For example, in Vignette #2 above, Plaintiff assumed that O2 saturations in the low 80s for an hour were sufficient to cause the patient’s hypoxic/anoxic brain injury. In reality, people at base camp at Everest live for weeks with O2 sats in the low 80s. They neglected to identify that the hemorrhage issues caused the death and not a transiently malpositioned ETT.

7. Get admissions from opposing experts about their own experiences with failed intubation. Any healthcare provider who has intubated patients will have had experiences where they failed in...
their attempts and needed to get help or change the plan. Failure to intubate does not mean a care provider is negligent. Many factors can impact whether an intubation attempt is successful, for example, difficult patient anatomy, airway secretions, airway pathology such as tracheobronchomalacia.4

8. The goal is to help the jury understand that intubation can be very complex, that intubation was indicated (or was not), the care provider took reasonable measures to confirm proper placement, and that the monitoring was reasonable and did not indicate that the tube was malpositioned or that there were other airway issues occurring that they should have known about.

9. Explain the medicine, the clinical context, and the reasons behind your client's thought process and management and the jury will likely make the right choice.

VI. Conclusion
Airway management cases can be among the most challenging to defend, because it is a surprisingly complex area of medicine in which discrete errors can lead to serious brain injury or death. Armed with the medical understanding and practical advice set forth above, defense counsel will be better prepared to handle these difficult cases.

Endnotes
1 “Evidence-Based EMS: Endotracheal Intubation”, authors Moy, M.D. and Andino, M.D., published online on EMS-World.com on JAN 7, 2015, gives an interesting breakdown of success of prehospital intubation in the field and compares ETI and bag mask ventilation in the field.


3 Although plain chest films will not show whether the tube is in the esophagus versus the trachea because those structures are on top of each other, it can show the level of the tip of the tube in relation to the carina and can be correlated with other clinical information such as O2 sats, vital signs, to confirm placement.

4 Tracheomalacia is characterized by flaccidity of the supporting tracheal cartilage and reduced anterior-posterior airway caliber. These factors can cause tracheal collapse. http://emedicine.medscape.com/article/426003 Bronchomalacia means ‘floppiness’ of some part of the bronchi. These conditions can complicate intubation and bronchoscopy.