AIRWAY MANAGEMENT/PEDIATRIC SEDATION

Airway Management

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Clinical assessment: first examine and assess airway; previous intubation history useful; routine preoperative tests help prepare for possible difficult airway; examination — assessment of patient size, facial hair, overall appearance, and mouth opening (finger breadths); decreased mouth opening associated with temporomandibular joint disease, scarring, or congenital anomalies; check for dentures, loose teeth, or braces; Mallampati (MP) class 1 — view of entire uvula, tonsillar pillars, and palate; MP class 2 — uvula and upper portion of tonsillar pillars; MP class 3 — base of uvula and palate; MP class 4 — palate only; MP classes 3 and 4 associated with difficult laryngoscopy; decreased neck extension and thyromental distance ≤2 finger breadths associated with difficult airway; difficult mask ventilation associated with obesity, obstructive sleep apnea (OSA), presence of beard, MP class 3 or 4, and airway masses; obesity, high MP class, and airway pathology associated with difficult laryngoscopy; airway affected by congenital syndromes, including Pierre Robin, Treacher Collins, Goldenhar, mucopolysaccharidoses, achoondroplasia, micrognathia, and Down; acquired conditions include obesity, acromegaly, airway infection, rheumatoid arthritis, OSA, ankylosing spondylitis, tumors, or trauma of airway or cervical spine

Obese patients: obesity associated with OSA, increased risk for aspiration, and oxygen desaturation; using ramp position aids mask ventilation and direct laryngoscopy (align sternal notch with external auditory meatus); increased risk for failed extubation, airway obstruction, and oxygen desaturation postoperatively; airway management — establish mask ventilation; if difficulty encountered, reposition head or insert oral airway; if efforts fail, attempt 2-person mask ventilation; if unsuccessful, insert supraglottic airway; select intubation technique based on patient assessment, available equipment, and expertise of provider; direct laryngoscopy with Macintosh or Miller blade most common; video laryngoscopy increasingly common; tube delivery sometimes difficult despite clear view of larynx; improved view of glottis in patients with restricted neck movement

Airway management plan: choose awake or asleep intubation; indications for awake intubation include history of difficult intubation, difficult or impossible mask ventilation, or cervical spine pathology requiring neurologic assessment after intubation; advantages include maintenance of airway reflexes, preservation of spontaneous ventilation, reduced risk for aspiration and desaturation, and ability to perform neurologic assessment; disadvantages include need for patient cooperation, adequate topicalization, patient recall, and need for provider expertise; fiberoptic intubation — most common awake technique (oral or nasal); advantages include ability to suction, maneuver in small mouth or around pathology, and to inspect airway; avoid nasal route if risk of bleeding, nasal fractures present, or infection of concern; topicalization of airway — aids awake intubation; administer antiallgogue and titrate sedation to maintain airway reflexes and spontaneous ventilation; anesthetizes sensory nerves of airway with aerosolized medication or nerve blocks; transtracheal injection of local anesthetic blocks recurrent laryngeal nerve; block superior laryngeal nerve with bilateral injections at greater cornu of hyoid bone or topical anesthesia in piniform recess; block glossopharyngeal nerve with injections to base of tonsillar pillar or posterior to styloid process bilaterally; selection of airway device based on availability and provider skill; consider patient and prepare back-up; alternative intubation techniques include bougie, rigid intubating styles, lighted stylets, or intubation through supraglottic airway; if all fail, awake patient and consider awake intubation or postpone surgery; if unable to awake patient, invasive intubation techniques include retrograde intubation, transtracheal jet ventilation, and surgical airway

Cormack–Lehane scale: scoring system for laryngoscopy views; grade 1 — all laryngeal structures visible; grade 2 — posterior portion of glottis; grade 3 — epiglottis only; grade 4 — neither glottis nor epiglottis visualized; for grade 3 or 4 view, reposition head, change blades, or apply external laryngeal pressure

Rapid sequence technique: recommended for patients with high risk for aspiration; administer short-acting induction agent and muscle relaxant without mask ventilation; succinylcholine drug of choice but contraindicated in presence of hyperkalemia, history of malignant hyperthermia, or muscular dystrophy; little evidence supports use of cricoid pressure (Sellick maneuver) and may interfere with intubation

Supraglottic airway: laryngeal mask airway (LMA) placed blindly and inflated, displacing soft tissue and epiglottis, allowing ventilation; added to American Society of Anesthesiologists (ASA) difficult airway algorithm (2003) as rescue device and conduit for intubation; newer designs allow placement of orogastric tube to decompress stomach; intubating LMA also available; for elective surgery, supraglottic device used as alternative to endotracheal intubation for fasted patients at low risk for aspiration; also used as rescue device in cannot intubate/cannot ventilate scenario; useful as bridge to extubation (place before removal of endotracheal tube [ETT]); contraindicated

Educational Objectives
The goals of this program are to improve management of adult and pediatric airways and anesthetic management of pediatric patients during magnetic resonance imaging (MRI). After hearing and assimilating this program, the clinician will be better able to:

1. Perform an airway examination and develop a complete management plan with attention to potential complications.
2. Use the American Society of Anesthesiologists 2003 practice guidelines to manage a difficult airway.
3. List potential airway complications in pediatric patients and appropriate management techniques.
4. Promptly recognize and treat laryngospasm.
5. Improve the safety profile for pediatric patients undergoing MRI.

Faculty Disclosure
In adherence to ACCME Standards of Commercial Support, Audio-Digest requires all faculty and members of the planning committee to disclose relevant financial relationships within the past 12 months that might create any personal conflicts of interest. Any identified conflicts were resolved to ensure that this educational activity promotes quality in health care and not a proprietary business or commercial interest. For this program, the following has been disclosed: Dr. Berkow is a consultant for Teleflex. Dr. Roy and the planning committee reported nothing to disclose.
with airway edema or masses and use caution in prone patients or for laparoscopic procedures; complications — sore throat (≤30%), aspiration, laryngeal edema, inability to ventilate or oxygenate, or dislocation of device; replace with ETT if laryngospasm or airway obstruction occurs

**Management of difficult airway:** 2003 ASA practice guidelines recommend assessment of every patient to include difficulty with ventilation, intubation, tracheostomy, and patient cooperation; creation of multiple airway plans recommended (step 1 of algorithm); step 2 — supplemental oxygen for all patients; step 3 — management choices of awake vs asleep intubation, non-invasive vs invasive, and preservation vs abolition of spontaneous ventilation; remainder consists of pathways for awake or asleep intubation, with emergent and nonemergent paths (based on adequacy of mask ventilation); emphasis on back-up plans and importance of calling for help

**Complications of intubation:** include hypoxia, brain damage, cardiovascular collapse, and death; increased during emergent airway management and outside operating room setting; unrecognized esophageal intubation reduced with end tidal CO2 monitoring; confirm endotracheal intubation with bilateral chest auscultation, continuous CO2 monitoring, and condensation in ETT; absence of any of these signs suggestive of esophageal intubation; endobronchial intubation — can be caused by changes in patient positioning during procedure; indicated by unilateral breath sounds, increased airway pressure, or intraoperative oxygen desaturation; causes hypoxia, atelectasis, and pulmonary edema; other complications include ET tube obstruction or disconnection of breathing circuit, trauma (eg, dislodgement of teeth, soft tissue damage), laryngeal or tracheal injury, or edema of glottis or larynx; vocal cord edema or injury presents as hoarseness; unilateral injury temporary, but bilateral requires immediate reintubation; laryngospasm — protective reflex resulting in closure of vocal cords; triggered by secretions, inadequate depth of anesthesia, or removal of ETT; remove stimulus, deepen anesthesia, and provide positive-pressure mask ventilation; inspiratory efforts against closed glottis may cause negative pressure pulmonary edema; bronchospasm — treat with bronchodilators or volatile anesthetic; late or prolonged complications include vocal cord paralysis, ulceration of vocal cord mucosa, vocal cord granuloma, and tracheal scarring or stenosis

**Exubtation:** concerns include airway edema, hemodynamic instability, and small environment for airway management; 12% incidence of complications; risks from reduced airway reflexes, airway edema, and human factors; extubation criteria — patient fully awake and alert, following commands (unless deep extubation planned); all anesthetics off, with muscle relaxants reversed, regular respiratory rate, and stable vital signs with tidal volume of 5 to 10 mL/kg; consider nasal airway; plan for extubation before induction; high risk — patients with preexisting airway difficulty, restricted access, or perioperative deterioration of airway; extubate awake, use supraglottic airway or exchange catheter as bridge, or delay extubation; monitor patient postoperatively until airway exchange catheter removed; patients with airway edema (eg, prolonged prone position, procedures involving airway or cervical spine), morbid obesity, and OSA at high risk for failed extubation

**Airway management outside of operating room:** more challenging with poor resources, lack of planning, and unknown, unstable patients and results in higher complication rate; airway guidelines and checklists, standardized equipment, use of capnography, improved communication and training recommended

**Trauma patients:** cervical spine injury present in 2% to 5% of trauma patients; Glasgow coma score <8 often requires emergent airway management; remove cervical collar but maintain manual in-line stabilization of cervical spine during rapid sequence intubation

**Cardiopulmonary resuscitation (CPR):** American Heart Association (AHA) 2010 guidelines changed “A-B-C” (airway, breathing, circulation) to “C-A-B” (compressions, airway, breathing), delaying rescue breathing until full round of compressions performed; continuous capnography and titration of oxygen to saturation >94% also recommended

**Pediatric Airway Issues and Sedation for Magnetic Resonance Imaging**

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**Pediatric airway:** difficult mask ventilation — includes very premature infants when mask does not fit architecture of face, macroglossia, naso encephalocoele; indication of need for intubation before anesthesia and paralysis; difficult laryngoscopy — incidence 1% in children (9% in adults); increased if child <1 yr of age, underweight, ASA class 3 or 4, or has craniofacial anomalies; rethink induction technique if bag mask ventilation unavailable; analgesia absolute contraindicated; potential awake intubation (rare), especially in very premature infants; preparation essential in advance of anesthesia, including acquisition of fiberoptic bronchoscope, GlideScope, appropriate airways, ETT, and styles; video laryngoscopy improves ease of securing airway; manage with gas induction, IV access, all equipment, suction, and assistance available; if required, otolaryngologist standing by with bronchoscope; insertion of LMA followed by intubation with fiberoptic bronchoscope most reliable method for securing airway; vocal cords often visualized with video laryngoscopy but difficult to maneuver styletted ETT through cords; difficult ventilation — airway secured but unable to ventilate; etiology includes laryngotracheobronchitis, tracheomalacia, kinked or blocked ETT, endobronchial intubation, severe bronchospasm, extrinsic airway compression (eg, mediastinal mass), or subglottic stenosis; often requires rigid bronchoscope to bypass pathology; manage with combination of IV anesthesia (propofol 100 μg/kg per minute) and sevoflurane, oxygen, and spontaneous ventilation; “can’t intubate, can’t ventilate” — rare event; following attempted intubation, attempt airway with bag and mask, insert LMA, and finally, obtain surgical airway; cricothyroidotomy — based on age of child and expertise available; may not be lifesaving (65% failure rate) and literature suggests tracheostomy most appropriate procedure in children <6 yr of age; use 14-gauge angiocatheter for children and 18-gauge for infants (or cricothyroidotomy kit); good for oxygenation, not ventilation; cricothyroidotomy buys small amount of time to obtain surgical airway

**Viral laryngotracheobronchitis:** seen less often due to improved therapy; most common cause of life-threatening airway obstruction; patients present with stridor, hoarse cough, and difficulty breathing; most often children aged 6 to 26 mo; rule out laryngomalacia, tracheomalacia, epiglottitis, foreign body in airway, external compression, vascular and mediastinal malformation, and retropharyngeal abscess; Nebulized adrenaline brings prompt relief lasting 3 to 4 hr; incidence of intubation <2%

**Laryngospasm:** glottic closure from reflex constriction of laryngeal muscles; partial obstruction — chest movement, stridor, and some ventilation; complete obstruction — inadequate chest movement, no breathing, absence of stridor; incidence 3 times greater than in adults (17 episodes/1000 anesthetics in children ≤9 yr of age); incidence 96 episodes/1000 anesthetics in children with upper respiratory infections (URI); most common cause inadequate depth of anesthesia associated with increased stimulation (eg, secretions, laryngoscopy, oropharyngeal airway); management of laryngospasm — treat incomplete obstruction with pressure on styloid process, advance mandible anteriorly (elongsates larynx), and apply continuous positive airway pressure with 100% oxygen; if spasm not broken, proceed with IV medication (propofol and/or succinylcholine with..."
atropine) or administer intramuscular succinylcholine (deltoide or sublingual, 4 mg/kg) and secure airway; risk factors — URI, airway anomaly, and insertion of LMA; LMA often used preferentially in presence of URI, but may aggravate laryngospasm. **Anesthesia for magnetic resonance imaging (MRI):** review all equipment for safety in MRI suite and verify patient free from implantable devices (eg, pacemaker, implantable cardiac defibrillator, cochlear implant, vagal nerve stimulator); anesthesia choices include 1) nasal prongs with end-tidal attachment, shoulder roll for full extension of neck, and propofol infusion (150-200 μg/kg per minute); 2) insertion of LMA with propofol infusion or inhalational anesthetic, or 3) general endotracheal anesthesia (recommended for small infants); dexmedetomidine sometimes used; for code blue in MRI suite, move patient out of magnetic field (to prevent injury caused by objects on code responders); controversy over which providers should administer sedation (eg, intensivists, certified registered nurse anesthetists, anesthesiologists); recent study indicates intubation in MRI suite increases atelectasis vs spontaneous breathing with nasal prongs and propofol infusion.

**Suggested Reading**


**Acknowledgements**

These lectures by Drs. Berkow and Roy are from our recently published Audio-Digest Anesthesiology Board Review Course. The course is designed to match the defined learning objectives of the American Board of Anesthesiology, and is intended to provide a source of review material for those who are preparing for the ABA’s Maintenance of Competence Assessment or the initial examinations of the Board. For more information, please visit audioldigest.org/anbr. The Audio-Digest Foundation thanks Drs. Berkow and Roy for their cooperation in the production of this program.

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**Estimated time to complete the educational process:**

| Review Educational Objectives on page 1 | 5 minutes |
| Take pretest | 10 minutes |
| Listen to audio program | 60 minutes |
| Review written summary and suggested readings | 35 minutes |
| Take posttest | 10 minutes |
1. What is the positioning goal of the ramp position during induction of anesthesia?
   (A) Extend the atlanto-occipital joint
   (B) Align thyroid cartilage with temporomandibular joint
   (C) Move C1 anterior to the sternal notch
   (D) Align sternal notch with external auditory meatus**

2. A transtracheal injection of local anesthetic blocks which of the following nerves?
   (A) Recurrent laryngeal
   (B) Hypoglossal
   (C) Glossopharyngeal
   (D) Superior laryngeal

3. A grade 3 view on the Cormack-Lehane scale refers to visualization of which of the following structures?
   (A) Posterior portion of glottis
   (B) Epiglottis only
   (C) All laryngeal structures
   (D) No structures beyond the tongue

4. The American Society of Anesthesiologists (ASA) difficult airway algorithm (2003) added the laryngeal mask airway (LMA) as:
   (A) Treatment for laryngospasm
   (B) Protection from aspiration
   (C) A rescue device**
   (D) A primary tool when airway edema is present

5. The American Heart Association (AHA) 2010 guidelines for cardiopulmonary resuscitation recommend all the following, except:
   (A) Delaying rescue breathing until full round of compressions performed
   (B) Continuous support with 100% oxygen
   (C) Continuous capnography
   (D) “C-A-B” (compressions, airway, breathing)

6. Mask ventilation is often difficult or impossible with very premature infants.
   (A) True**
   (B) False

7. When presented with a “can’t intubate, can’t ventilate” situation, cricothyroidotomy:
   (A) Is lifesaving in the majority of cases
   (B) Is the best choice of surgical airway in children <6 yr of age
   (C) Provides good ventilation
   (D) Buys a small amount of time to obtain surgical airway**

8. Choose the true statement about viral laryngotracheobronchitis.
   (A) Increasing in frequency
   (B) Most common in children between the ages of 3 and 5 yr
   (C) Most common cause of life-threatening airway obstruction
   (D) Intubation required in 14% of cases

9. Which of the following is the most common cause of laryngospasm?
   (A) Improperly secured endotracheal tube
   (B) Inadequate depth of anesthesia
   (C) Patient crying before induction
   (D) Upper respiratory infection

10. When a code blue occurs in the MRI suite, the patient should be immediately moved out of the magnetic field.
    (A) True**
    (B) False

Answers to Audio-Digest Anesthesiology Volume 55, Issue 24: 1-A, 2-D, 3-C, 4-D, 5-A, 6-C, 7-A, 8-C, 9-B, 10-B