Aspiration pneumonia

Risk factors: low risk for aspiration with general anesthesia (1/2000-1/3000 elective anesthetics); risk increases 3 to 4 times in emergent setting, with aspiration and regurgitation ranked fifth most common adverse event during general anesthesia; 5% mortality from pulmonary aspiration (10%-30% of all anesthesia-related deaths); patient factors—volume of gastric material at time of induction presents largest risk; volume increased in nonfasting patients, emergency situations, and patients with diabetes mellitus, increased intracranial pressure, GI disease, morbid obesity, history of upper abdominal surgery, concurrent opioid therapy, and pregnancy or labor; average gastric volume of fasted patients ≈25 mL; ≥25 mL associated with increased risk for pulmonary aspiration; age—children at 2 to 3 times risk seen in adults, and patients >80 yr-old show 9- to 10-fold risk, compared to patients in twenties; surgical factors—upper abdominal procedures and lithotomy and Trendelenburg positions all push gastric contents toward mouth; risk during tracheostomy 19.1%, and likely related to lack of protection of airway during cannula exchange; increased length of surgery documented independent risk factor; anesthesia factors—if anesthesia too light, airway reflexes and GI motor responses preserved and can trigger gagging, regurgitation, and vomiting during airway manipulation; positive pressure ventilation may insufflate stomach; removal of advanced airway devices (eg, endotracheal tube [ETT], laryngeal mask airway [LMA]) before spontaneous awakening may stimulate airway reflexes and increase risk for aspiration; LMA—may place patient at increased risk for aspiration (reported risk for regurgitation 0%-28%); risk increased if LMA improperly positioned, with resultant gastric insufflation and potential stimulation of airway reflexes; newer devices with improved seals and gastric venting reduce gastric insufflation and isolate patient airway; composition and volume of aspirate—increased risk associated with pH <2.5 and volume >25 mL or >0.4 mL/kg ideal body weight; less risk from gastric acid than from other material (eg, bile); food particles can cause airway obstruction and severe damage to lungs; food particles remain in stomach ≤24 hr after onset of pain, injury, or acute illness, making traditional nPO guidelines insufficient after trauma; severe pulmonary damage results from feculent material

Pharmacologic therapy: drugs affect pH and volume of gastric content; data favor combining prokinetic agent, antacid, and H2 blocker; most agents require dosing ≥60 min before induction of anesthesia for full effect, but administration immediately before or after induction provides coverage for emergence period; antacids—method for quickly increasing gastric pH before induction of anesthesia; short half-life requires dosing every 1 to 2 hr for maintenance of gastric pH >4; avoid particulate antacids preoperatively (pneumonitis if aspirated); typically, patient drinks 15 to 30 mL of nonparticulate antacid (eg, sodium citrate) before induction; H2 blockers—90% to 90% of patients experience increased pH or decreased gastric volume with use of ranitidine; 30 to 60 min required for full efficacy (some patients require continuous infusion); metoclopramide—most common prokinetic drug; decreases gastric volume to <25 mL for 62% to 87% of patients and has antiemetic effect; potential for extrapyramidal side effects and contraindicated in presence of mechanical bowel obstruction; proton pump inhibitors (PPIs)—more potent than H2 blockers and improved protection from aspiration; increased cost and lack of evidence of improved efficacy limit use in perioperative patients

Rapid sequence induction (RSI): used to minimize time between loss of consciousness and intubation of patient; value of cricoid pressure recently questioned; induction agent must provide rapid intubating conditions, avoid awareness, and result in stable hemodynamics; induction mechanics—predetermined dose of hypnotic agent followed immediately by paralytic compared to titration of induction agent until loss of consciousness; study shows titration technique reduces time to intubation over rapid bolus technique; administration of rapid-onset opioids (eg, alfentanil, fentanyl, remifentanil) during induction shows no interference with preoxygenation, allows decreased dose of induction agent, and improved hemodynamic stability; intravenous (IV) lidocaine (1-2 min before induction) blunts hemodynamic response to intubation; succinylcholine—gold standard muscle relaxant for RSI; traditional dose 1 mg/kg IV now challenged, with advocates for both higher and lower doses; nondepolarizing muscle relaxants—slower onset time overcome with larger doses, but these prolong neuromuscular blockade; positive pressure ventilation—classically avoided with RSI, although inspiratory pressures <20 cm H2O show no significant gastric insufflation; some patients (eg, obese, pregnant, critically ill) may experience oxygen desaturation despite preoxygenation, requiring ventilation; cricoid pressure—amount of force and precise location difficult to assess and replicate; lower levels of force associated with incomplete esophageal occlusion, while greater levels of force associated with airway compression (difficult intubation); even when applied correctly, cricoid pressure may induce retching and decrease lower esophageal sphincter (LES) tone

Physiology: LES—antiemetics (eg, metoclopramide), cholinergic drugs, succinylcholine, and antacids increase LES tone.

Educational Objectives

The goal of this program is improve the perioperative management of patients presenting for abdominal and laparoscopic surgery. After hearing and assimilating this program, the clinician will be better able to:

1. Identify patients at risk for aspiration.
2. Employ pharmacologic therapy to reduce the risk for aspiration.
3. Effectively use rapid sequence induction techniques in those patients at risk for aspiration.
4. Explain the physiologic effects of pneumoperitoneum.

5. Recognize postoperative hepatic dysfunction.

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, Dr. Schroeder and the planning committee reported nothing to disclose.
while anticholinergics, tiotinal, opioids, and inhaled drugs decrease tone; inhaled anesthetics also relax upper esophageal sphincter; nasogastric tube cause loss of integrity of upper and lower sphincters, increased frequency of sphincter relaxations, and desensitization of protective pharyngeal reflexes; small bowel obstruction — potential issues include dehydration, acidosis, and electrolyte abnormalities; significant risk for aspiration of feculent or bilious material; perform adequate preoxygenation, suction nasogastric tube (if present) immediately before RSI, apply cricoid pressure, and intubate quickly; LMA appropriate only as rescue for difficult intubation and should be replaced with ETT

Diagnosis and treatment: symptoms include gastric contents visible in oropharynx, hypoxia, increased inspiratory pressures, dyspnea, apnea, or hypoventilation in (in spontaneously ventilating patient), bronchospasm, or laryngospasm (in intubated patient); postoperative patients may have respiratory symptoms (eg, bronchospasm, frothy sputum, respiratory distress) 2 to 5 hr after aspiration event; aspiration pneumonia can progress to acute respiratory distress syndrome (ARDS); immediate therapy — head down or lateral position; aggressive oropharyngeal suctioning; suction ETT if present or secure airway via RSI with cricoid pressure; 100% oxygen with positive end expiratory pressure (PEEP); avoid pulmonary lavage because it risks extending damage; aspiration of particulate material requires bronchoscopic removal and microbiologic analysis of material; treat pulmonary bronchospasm; delay or shorten surgical procedures; obtain baseline chest radiograph (early damage missed in 25% of cases); symptomatic patients (eg, bronchospasm, fever, radiographic changes) require intensive care unit, while patients stable 2 hr after extubation and without radiographic changes consistent with aspiration need no further intervention; empiric treatment — steroid therapy may worsen outcome, and antibiotic therapy not indicated for chemically mediated damage; empiric antibiotic therapy results in increased pathogenic bacteria and lengthens period of mechanical ventilation; consult internal medicine or intensivist colleagues if secondary bacterial infection develops

Laparoscopy: common procedures — cholecystectomy, appendectomy, colectomy, nephrectomy, and bariatric surgery; advantages include decreased blood loss, decreased pain, smaller incisions, less postoperative ileus, better respiratory function, and shorter recovery and hospital stays; disadvantages include increased expense and longer operating times; contraindications — diaphragmatic hernia, acute or recent myocardial infarction, severe pulmonary disease, ventricular septal defect, hypovolemia, congestive heart failure, or valvular disease; abdominal insufflation required for procedures; low solubility of helium and nitrogen increases risk for embolization; carbon dioxide — gas of choice; does not support combustion, rapidly cleared from peritoneum and eliminated by lungs

Complications: carbon dioxide easily absorbed from intra- and extraperitoneal sites, but this carries potential for hypercapnia and resulting stimulation of sympathetic nervous system, hypertension, elevated heart rate and myocardial contractility, and arrhythmias; risks of pneumoperitoneum include hypo- or hypertension, arrhythmias, and cardiac arrest; pressures ≤15 mm Hg increase cardiac output secondary to increased venous return, but high intra-abdominal pressures decrease venous return, cardiac output, and blood pressure; positioning — reverse Trendelenburg position decreases venous return, cardiac output and mean arterial blood pressure; increases peripheral and pulmonary vascular resistance; Trendelenburg position increases venous return and normalizes mean arterial pressure; bradyarrhythmias — result from vagal stimulation related to peritoneal stretch and light anesthesia; also associated with insertion of instruments, manipulation of organs, or carbon dioxide embolization; tachyarrhythmias — caused by hypercarbia-induced sympathetic stimulation or stimulation of adrenal glands; intracranial pressure — increased and cerebral perfusion pressure decreased by hypercapnia, increased systemic vascular resistance, Trendelenburg position, and increased intra-abdominal pressures; patients with baseline elevated intracranial pressure and decreased intracranial compliance, should avoid laparoscopic procedures; Trendelenburg position can also increase intraocular pressures that can result in blindness in patients with glaucoma or other baseline defects in vision; difficulties with ventilation — pneumoperitoneum pressures >15 mm Hg can reduce lung volume and pulmonary compliance, as well as increase peak and mean airway pressures; reduced lung volumes and cephalic diaphragmatic excursion can cause closure of small airways, atelectasis, and decreases in functional residual capacity; upward displacement of diaphragm can lead to endobronchial intubation and ventilation/ perfusion mismatch, and intrapulmonary shunting; pneumothorax and pneumomediastinum possible; if respiratory compromise occurs, lower intra-abdominal pressures, abort, or convert to open procedure

Anesthesia management: routine monitors with arterial line for significant cardiac or pulmonary disease; keep end tidal CO2 ≥35 mm Hg; ProSeal LMA’s have limited use for short procedures in nonobese patients; manage fluid volume to compensate for decreased venous return; short-acting agents speed recovery of ambulatory patients; avoid nitrous oxide due to nausea and bowel distention; naso- or orogastric tubes decompress stomach and aid visualization; utilize spinal or epidural anesthesia only with low insufflation pressures and low risk for aspiration

Complications: hypotension — frequent complication; decrease intra-abdominal pressure, increase IV fluids, and administer vasoactive drugs (watch for reflex bradycardia with phenylephrine); carbon dioxide embolization — incidence 0.002% to 0.02%, with typical presentation of hypotension, cyanosis, pulmonary edema, dysrhythmia, tachycardia, right heart strain pattern, and potential asystole; brief spike in end tidal CO2 falls quickly; immediately deflate abdomen, move patient to left lateral decubitus, head-down position, hyperventilate with 100% oxygen, and consider central venous catheter; chest compressions fragment CO2 emboli, aiding absorption; consider pneumothorax in instances of cardiovascular collapse; hypoxia — ventilate with 100% oxygen; test compliance with hand ventilation; consider addition of PEEP, decrease insufflation, raise head of patient; hypercarbia — results from absorption of CO2 from peritoneum and impaired ventilation; increase minute ventilation or decrease intra-abdominal pressure; surgical complications — risk of perforation of organ or large vessel increased in patients with previous abdominal surgery or low body mass index; establish adequate venous access and blood availability before incision; other effects — oliguria results from intra-abdominal compression and systemic hormonal effects; release of pneumoperitoneum typically results in resumption of normal kidney function; lower extremity venous stasis results in increased incidence of perioperative venous thrombosis (consider preoperative subcutaneous heparin anticoagulation)

Hepatic disease: increases perioperative morbidity and mortality; advanced disease affects glucose homeostasis, protein synthesis (including coagulation factors), bilirubin metabolism, drug metabolism, cardiovascular system, lungs, kidneys, causes coagulopathies, encephalopathy, cerebral edema, and increased intracranial pressure; evaluation of disease — Child-Pugh classification and Model for End-Stage Liver Disease (MELD) score; mortality for Child-Pugh class A patients 10%, 30% for class B, and 82% for class C; emergency surgery associated with 50% mortality risk, increasing to 100% in patients in class C; MELD score ≥9 associated with 29% risk for mortality; preoperative evaluation — cancel all but
emergent surgery for acute hepatic failure; evaluate patient for significant varices or history of variceal bleeding; evaluate and normalize electrolyte values, correct coagulopathy, and evaluate cardiac and pulmonary status; drug responses may be prolonged and unpredictable due to alterations in cytochrome P-450 and drug conjugation systems; consider cisatracurium (Hoffman elimination); RSI if ascites present or acute variceal bleeding (multiple suction sources; prepare for difficult airway); consider risk for esophageal instrumentation if gastric tube or placement of echo probe contemplated; postoperative hepatic dysfunction — immune mediated; primarily caused by halothane, followed by enflurane, isoflurane, then desflurane; fever, jaundice, nausea, and anorexia presenting 3 to 7 days after exposure; obtain full laboratory analysis to isolate cause (eg, acetonaminophen, sepsis, transfusion reaction) and review record for intraoperative events (eg, hypoxia, hypotension); diagnosis of exclusion

**Question and Answer**

**Preoperative gum chewing:** may indicate failure to follow fasting instructions; some studies indicate increased gastric fluid volumes, while others demonstrate improved gastric motility and emptying; likely no increased risk for aspiration in low-risk patients

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**Suggested Reading**


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**Acknowledgements**

Dr. Schroeder’s lecture is 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 audiodigest.org/anbr. The Audio-Digest Foundation thanks Dr. Schroeder for his 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
- Review written summary and suggested readings: 35 minutes
- Take posttest: 10 minutes
ANESTHESIA FOR ABDOMINAL AND GENERAL SURGERY

1. Which of the following poses the highest risk for pulmonary aspiration?
   (A) Patient age >80 yr  (C) Lower abdominal procedures
   (B) Reverse Trendelenburg position  (D) Short surgical duration

2. Aspirates with _______ have the highest risk for pulmonary injury.
   (A) pH >2.5  (C) Particulate matter
   (B) Volume <25 mL  (D) Stomach acid

3. Which of the following drugs decreases gastric volume and has an antiemetic effect?
   (A) Sodium citrate  (B) Metoclopramide  (C) Ranitidine  (D) Omeprazole

4. When performing rapid sequence induction, titration of the induction agent until loss of consciousness delays time to intubation and should be avoided.
   (A) True  (B) False

5. Which of the following increases lower esophageal sphincter tone?
   (A) Succinylcholine  (B) Thiopental  (C) Opioids  (D) Inhaled anesthetic

6. Which technique should be avoided in the patient who has aspirated?
   (A) Suction endotracheal tube  (C) Pulmonary lavage
   (B) Positive end expiratory pressure  (D) Head-down position

7. Empiric steroid therapy is not indicated in cases of pulmonary aspiration.
   (A) True  (B) False

8. Tachyarrhythmias during laparoscopic procedures may be caused by:
   (A) Instrument insertion  (C) Carbon dioxide embolization
   (B) Manipulation of organs  (D) Hypercarbia

9. Which inhalational agent is most likely to cause postoperative hepatic dysfunction?
   (A) Halothane  (B) Isoflurane  (C) Sevoflurane  (D) Desflurane

10. Choose the correct statement about patients who chew gum immediately before surgery.
    (A) The case should immediately be canceled and rescheduled for another day
    (B) There is no effect, and surgery may proceed as scheduled
    (C) Treat the same as clear liquids
    (D) Likely improves gastric motility and emptying and poses no increased risk to a patient at low risk for aspiration

Answers to Audio-Digest Anesthesiology Volume 55, Issue 17: 1-D, 2-A, 3-B, 4-B, 5-D, 6-C, 7-A, 8-B, 9-B, 10-D