Section 1

Critical incidents

Chapter 1

Crisis management

General principles

Mary A. Felberg

1. Presentation
   a) Critical incident definition: An event which puts the patient in imminent danger and cannot be resolved without active intervention
   b) Two broad categories of critical incidents
      i) Sudden, brief and intense event (e.g., uncontrolled surgical hemorrhage, allergic reaction)
      ii) The culmination of a series of problems evolving into imminent danger (e.g., faulty anesthesia machine → incomplete machine check-out → alarms turned off → distraction during airway management → unrecognized esophageal intubation).
   c) Anesthesiologists assume the responsibility of detecting and correcting problems that occur in the perioperative period and thus help avoid critical incidents or minimize the extent of harm
   d) Crisis management involves early detection of a problem and instituting measures to minimize or eliminate harm
   e) Crisis management is based on the effective use of all available resources and effective team communication
   f) Resources, in addition to your abilities, include operating room personnel, equipment, cognitive aids, external resources, and plans of care
   g) Prevention is the most effective strategy for crisis management. Adequate preoperative patient assessment, room set-up, and communication with the surgeon and operating room staff increases identification of potential problems and also allows for the formulation of contingency plans prior to induction of anesthesia.
2. Risk factors
   Failure to recognize a problem before it evolves into a critical incident may be due to:
   a) Loss of vigilance (e.g., turning alarm monitors off, multitasking beyond clinical care, loud auditory stimulus, external distractions)
   b) Increased production pressure (e.g., incomplete machine check or preoperative evaluation)
   c) Failure of action
   d) Error of fixation: the persistent failure to revise a diagnosis or plan despite available evidence to the contrary

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e) Fatigue
f) Hazardous attitudes
    i) Antiauthority – resists rules/policies; feels the rules don't apply
    ii) Impulsivity – urge to act now, before appropriately evaluating the situation
    iii) Invulnerability – "It can't happen to me" thinking
    iv) Macho – need to prove you can handle the situation alone
    v) Resignation – feel hopeless in the situation.

3. Management
    a) Recognition of critical incident
    b) Mobilize all available resources
    c) Call for help early
    d) Assume a leadership role
    e) Initiate treatment using repeating loops of Observation, Decision, Action and Re-evaluation for response to treatment
    f) Leader should assign clear roles and tasks; leader should only do specific tasks if no other expertise is available
    g) Distribute the workload as evenly as possible among available resources (based on known skill sets of team members)
    h) Maintain awareness of the big picture (situational awareness)
    i) Maintain clear communication with all team members (closed loop communication)
    j) Listen to input from other team members
    k) Focus on what is right for the patient, not who is right
    l) Use all available information (e.g., electronic medical record)
    m) Utilize cognitive aids as appropriate (e.g., pediatric advanced life support algorithm)
    n) Avoid errors of fixation
    o) Avoid hazardous attitudes
    p) Utilize team debriefing after the critical incident to highlight strengths and areas for improvement.

4. Prevention
    a) Identification of individual risk for every anesthetic based on the patient's comorbidities, the planned procedure, and available resources
    b) Surgical time-outs or briefings are opportunities to verbalize contingency plans for probable events
    c) Develop effective communication skills with all members of the perioperative team
    d) Identify cognitive resources in advance of at-risk procedures (e.g., location of malignant hyperthermia treatment algorithm).

Further reading

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Part A

Airway/Pulmonary

Chapter 2

Airway fire

Tae W. Kim

1. Presentation
   Airway fires occur more frequently in patients undergoing airway surgical procedures. Adverse outcomes include inhalation injuries, spread of fire to nearby flammable materials, secondary infection, disfigurement and death.
2. Risk factors
   a) Presence of three components is required to generate fire: oxidizer, ignition source, and fuel
   b) Oxidizer: oxygen concentration above room air or any concentration of nitrous oxide
   c) Ignition source: use of electrocautery or any device emitting intense heat (e.g., laser, light source)
   d) Fuel
      i) Solids: tracheal tubes, sponges, drapes
      ii) Liquids: alcohol-containing prep solutions
      iii) Gases: methane (GI tract).
3. Differential diagnosis
   a) Surgical fire occurring but not within the airway
   b) Near miss that does not actually result in airway fire (e.g., spark).
4. Pathophysiology
   a) The interaction of all three elements – oxidizer, ignition source, and fuel – leads to combustion
   b) Intense heat and burning of tissue may lead to airway swelling and obstruction, scarring, severe disfigurement.
5. Management
   a) Treatment of an airway fire
      i) Immediately remove tracheal tube
      ii) Stop flow of all airway gases
      iii) Remove all flammable materials from airway
      iv) Pour saline into mouth and airway to extinguish fire
      v) Remove all burning and flammable materials from patient

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vi) Use fire extinguisher (carbon dioxide variety) in operating room and on patient if fire not extinguished with saline
vii) If fire persists and does not involve patient: evacuate patient, close doors, turn off gas supply to room.

b) After fire is extinguished

i) Re-establish ventilation
ii) Avoid oxidizer-enriched atmosphere if clinically acceptable
iii) Examine tracheal tube for damage and airway for any residual fragments
iv) Assess airway for inhalation injury.

6. Prevention

a) Determine the risk of fire prior to starting procedure
b) Discuss strategy with team for prevention and management of fire prior to starting procedure
c) Verify essential equipment immediately available prior to initiating case (e.g., sterile water, fire extinguisher)
d) Place surgical drapes in a configuration to minimize the accumulation of oxidizers
e) Moisten sponges and gauze when placed in proximity to any ignition source
f) Minimize or avoid an oxidizer-enriched atmosphere when any ignition source is being utilized
g) Communication is essential during the planned use of at-risk devices (e.g., 100% oxygen, laser)
h) Reduce potential for oxygen-enriched environments, allow flammable skin-preparation solution to dry, use laser-resistant tracheal tubes and cuffed tracheal tubes
i) Education

i) Acquire knowledge of institutional fire safety protocols
ii) Participate in institutional fire safety education including operating room fire drills that include the entire operating room team
iii) Identify high-risk patients and procedures.

Further reading

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Part A

Airway/Pulmonary

Chapter 3

Airway foreign body

John E. Fiadjoe

1. Presentation
   a) Stridor
   b) Wheezing
   c) Cough
   d) Witnessed choking episode (most sensitive finding)
   e) Acute respiratory distress
   f) Atelectasis
   g) Bronchiectasis
   h) Pneumonia, empyema
   i) Pneumothorax.
2. Risk factors
   a) Age less than 3 years
   b) Lack of molars before age 4
   c) Developmental delay
   d) Child neglect/abuse.
3. Differential diagnosis
   a) Asthma
   b) Chronic cough
   c) Pneumonia
   d) Bronchitis
   e) Atelectasis.
4. Pathophysiology
   a) Tracheal aspiration is associated with a mortality as high as 45%
   b) Most common item aspirated is food (peanuts, popcorn, grapes, hotdogs comprise > 60% of all choking episodes)
   c) Coins, toys, needles, pins, balloons, balls, and batteries are also common
   d) Batteries lead to corrosive damage and should be removed emergently
   e) Right main bronchus is a common location for the item to become lodged due to the larger diameter of the right bronchus and shallower angle from trachea.

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5. Management
   a) Radiologic findings: most objects are radiopaque except food items
   b) Lateral decubitus radiographs confirm presence of obstruction as obstructed lung will not deflate in the dependent position
   c) Inspiratory and expiratory films may identify air trapping, hyperinflation, obstructive emphysema, atelectasis, and mediastinal shift
   d) Communication between care providers is essential, teamwork is mandatory, and the endoscopist should be familiar with equipment prior to induction of anesthesia
   e) Anticholinergic administration should be considered to minimize secretions and can easily be achieved if preoperative intravenous access is present
   f) General inhalation anesthesia with supplemental intravenous anesthesia while maintaining spontaneous ventilation is the preferred technique by most providers
   g) Topical aerosolization of the airway with local anesthetic by surgeon attenuates airway reflexes prior to foreign body extraction
   h) Rigid bronchoscopy is performed with administration of anesthetic gases through the side port
   i) Intraoperative intravenous steroid administration is commonly administered to decrease airway mucosal swelling
   j) Laryngeal/airway edema may occur after surgery, requiring racemic epinephrine.
6. Prevention
   a) Close supervision of children at risk
   b) Labeling of toys that may present a choking hazard.

Further reading

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Part A

Airway/Pulmonary

Chapter 4

Bronchospasm

Luigi Viola and Senthilkumar Sadhasivam

1. Presentation
   a) Intraoperative bronchospasm may present as hypoxemia, hypercarbia, and expiratory wheezing
   b) If using pressure-controlled ventilation, expired tidal volumes will decrease; with volume-controlled ventilation, peak inspiratory pressures will increase
   c) The display of the capnograph tracing changes from the appearance of a square wave to an upsloping pattern.
2. Risk factors
   a) Recent history of upper or lower respiratory tract infection
   b) History of reactive airway disease including asthma
   c) Passive or active exposure to parental smoking
   d) Anesthesia-related: endobronchial intubation, endotracheal intubation, airway instrumentation with inadequate levels of general anesthesia, carina irritation by the endotracheal tube, volatile agents (e.g., desflurane, isoflurane), medications (e.g., morphine, neostigmine)
   e) Airway foreign body, aspiration of gastric contents, mucous plug.
3. Differential diagnosis

   Wheezing is not always secondary to bronchospasm.
   a) Preoperative wheezing may be due to many causes including:
      i) Bronchiolitis, aspiration, asthma, bronchiectasis, chronic lung disease, vascular malformations, airway foreign bodies.
   b) Intraoperative wheezing:
      i) Bronchial stimulation due to a relatively inadequate level of general anesthesia
      ii) Bronchial reactivity from medications (e.g., desflurane) or gastric contents (i.e., aspiration after rapid sequence induction)
      iii) Mechanical airway obstruction (kinking or plugging of tracheal tube, inhaled airway foreign body, obstructive airway mass, pneumothorax, pulmonary edema).
4. Pathophysiology

   Bronchospasm results from the smooth muscle contraction and obstruction of intrathoracic small airways or main bronchi; this leads to forced expiration and generates turbulent airflow appreciated clinically as wheezing.

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5. Intraoperative management
   a) Rapid identification of the cause:
      i) Inspect circuit, auscultate both lungs, exclude main stem bronchus intubation
      ii) Increase oxygen concentration to 100%
      iii) Suction tracheal tube, exclude tracheal tube obstruction
      iv) Deepen anesthesia (i.e., with a nonirritating volatile agent such as sevoflurane, or intravenous medications such as propofol and ketamine)
      iv) Review administered drugs particularly for histamine release and allergic reaction potential; discontinue all suspected medications.
   b) Administer a beta-2 agonist with a spacer device through the breathing circuit (e.g., albuterol 4–8 puffs)
   c) Consider administration of anticholinergic agents with a spacer device through the breathing circuit (e.g., ipratropium: 1–2 puffs)
   d) Administer an intravenous corticosteroid such as methylprednisolone (1 mg/kg) or hydrocortisone (2 mg/kg)
   e) Consider administration of lidocaine (1 mg/kg) to reduce airway reactivity
   f) Modify ventilation settings to avoid gas trapping (i.e., increase the expiratory time) and barotrauma (i.e., decrease tidal volume along with increasing respiratory rate)
   g) For severe or refractory bronchospasm:
      i) Administer epinephrine (1 μg/kg)
      ii) Magnesium sulfate (25–50 mg/kg over 10 minutes)
      iii) Consider high-dose volatile agents for status asthmaticus (i.e., 2–3 MAC).
   h) Consider obtaining an arterial blood gas and chest x-ray.
6. Prevention
   a) Avoid elective procedures within 2–6 weeks of a significant respiratory infection
   b) Consider preoperative administration (48–72 hours before anesthesia) of corticosteroids in poorly controlled asthmatic patients
   c) Strongly consider premedication with beta-2 agonists (e.g., albuterol) in high-risk patients
   d) Ensure adequate levels of general anesthesia, especially during airway management.
   e) Avoid histamine-releasing drugs (e.g., morphine)
   f) Consider anesthetic techniques that avoid tracheal intubation if appropriate
   g) Consider using a deep extubation technique if acceptable (i.e., not with a full stomach or suspected difficult airway)
   h) Consider empiric administration of intra-tracheal lidocaine (1–2 mg/kg).

Further reading

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