Updates on Asthma and Asthma Medication

Randall C. Wetzel, MBBS, MRCP, Professor of Clinical Pediatrics and Anesthesiology, Keck School of Medicine of the University of Southern California, Los Angeles, and Chair, Department of Anesthesiology Critical Care Medicine, Children’s Hospital Los Angeles

Definition of asthma: recurrent chronic inflammatory disease; obstructive disease of lower airways; reversible bronchoconstriction of hyperreactive airways; may be precipitated by myriad of stimuli (eg, allergens, food products, infections), which can cause acute attack and may contribute to actual pathogenesis of disease

Pathophysiology: type 1 hypersensitivity — antigen stimulates release of immunoglobulin E from B cells, which results in mast cell degranulation; release of proinflammatory cytokines and interleukin-4 (IL-4) stimulates helper T cells, production of additional IL-4, and further stimulation of B cells; histamine, leukotrienes, and chemokines lead to bronchospasm; degranulation of neutrophils and stimulation of eosinophils occur; inflammation either acute, subacute, or chronic; other contributors to acute asthmatic response — include neural afferents, epithelium, and endothelium; vascular endothelial growth factor implicated in causing new vascularization, which contributes some types of pediatric asthma; respiratory viruses (eg, respiratory syncytial virus) can exacerbate asthma and play etiologic role in development of chronic condition that reflects asthma

Clinical history: assess duration of asthma symptoms vs degree to which lung function has been affected; cluster 1 defined as short duration of disease, lung function well maintained, well controlled by inhaled corticosteroids, and not highly allergic; clusters 1 and 2 usually do not require β2-adrenergic agonists; cluster 4 defined as severe deterioration of lung function and resting hyperinflation

Pulmonary function: asthma obstructive lung disease; patients experience decreased expiratory flow, decreased vital capacity, delayed expiratory phase, and decreased tidal volumes for same amount of work; asthma affects inspiration and expiration, and ultimately leads to increase in end expiratory lung volume above functional residual capacity (ie, increased total lung capacity and decreased tidal volumes with hyperinflation); because of increased dead space, increased minute ventilation required to normalize CO2; patients experience increased resting respiratory rate and decreased lung compliance

Associated conditions: allergies; in utero influences (eg, prenatal infections); respiratory syncytial virus in mother associated with 30% increased incidence of asthma in offspring; smoking in prenatal period, maternal obesity, childhood obesity, and gastroesophageal reflux disease (GERD) increase risk; differential diagnosis — foreign body of airway, tracheomalacia, congenital disorders, primary ciliary dyskinesia (rare), tracheoesophageal fistula, bronchiolitis, immunodeficiency states, and cardiogenic pulmonary edema

GERD and asthma: 20% to 80% of children with chronic respiratory disease have GERD (depending on criteria used for GERD); exact relationship unclear; results of treatment for GERD often disappointing in children; however, after usual asthma medications have been used, treatment for GERD worth considering

Obesity: asthma phenotype in obese patients different than that in nonobese patients (can be reversed with weight loss, with subsequent improvements in pulmonary function); rate of asthma in children of obese mothers increased by 30%; risk for hospitalization for exacerbation of asthma doubled in obese patients; odds ratio 2.5 for nonatopic asthma in obese patients; asthma more difficult to control in obese children than in nonobese children; pathophysiology — mechanical changes lead to decreased functional residual capacity; increased peribronchial pressure and decreased tidal volume cause airflow smooth muscle to become stiff, which leads ultimately to airway hyperresponsiveness and decreased airway caliber; hypoxia of adipose tissue causes systemic inflammation; comorbidities — include dyslipidemia, GERD, sleep-disordered breathing, diabetes, and hypertension, all of which play role in exacerbating asthma

Pharmacologic management: β2-adrenergic agonists — administered intravenously, inhaled, or taken orally; act on β2-adrenergic receptors; final common pathway is increased intracellular cyclic adenosine monophosphate (cAMP), which leads to changes in intracellular calcium and muscle relaxation; phosphodiesterase inhibitors — stop breakdown of cAMP, which affects potassium and calcium channels and leads to smooth-muscle relaxation

Treatment of asthma: short-acting β2-adrenergic agonists and inhaled corticosteroids cornerstone of therapy; long-acting β2-adrenergic agonists (eg, salmeterol, formoterol, bambuterol) provide chronic stimulation of β2-adrenergic receptors; use of inhaled steroids limited by systemic absorption (via lungs, mouth, and gastrointestinal tract)

Anesthesia evaluation of child presenting with asthma: obtain thorough history of drugs and allergies; ask about smoker in house (likelihood of intraoperative wheezing increases nearly 10-fold if child resides with 1 person who smokes); track peak expiratory flow rate in older children; chest radiography not
Anesthesia management:

Risk factors: include previous history of mechanical ventilation, >2 hospitalizations in past year, >3 emergency department (ED) visits in past year, current and recent chronic steroid use, any history of severe or loss of consciousness with asthma, or hospital visit with asthma symptoms within past month; therapy should be optimized prior to elective surgery in patients with any of these risk factors; Health Effectiveness Data and Information Set — general high-risk category; patient may be at increased risk for intraoperative bronchospasm if history in past year includes ≥1 visit to ED for asthma, ≥1 hospitalization for asthma, ≥4 ambulatory visits for asthma with ≥2 prescription medications, or ≥4 prescription medications for asthma

Signs of unstable asthma: shortness of breath or wheezing ≥2 days/wk; awakening with shortness of breath ≥1 night/wk; some for asthma, intracellular cAMP; recommended); ketamine for IV induction; propofol may be used; apy should be optimized prior to elective surgery in patients with asthma symptoms within past month; therapy should be evaluated; any history of seizure or loss of consciousness with asthma, or ≥1 visit to ED for asthma, ≥4 prescription medications for asthma, ≥4 prescription medications for asthma

Intubation:

Optimizing therapy: administer oral corticosteroids (prednisone 1-2 mg/kg/day) at least 24 hr prior to anesthetic if asthma uncontrolled or if FEV1 <80%; start or increase short-acting bronchodilators, treat active bronchospasm, and consider leukotriene-receptor antagonists; consider ipratropium or disodium cromoglycate; theophylline in this setting probably does not decrease intraoperative risk; look for and eradicate infections (eg, otitis, sinusitis, chronic respiratory illness)

Lauer et al (2012): children with uncontrolled asthma requiring emergency surgery should receive short-term bronchodilators and corticosteroids; however, patients still at high risk and providers should prepare for perioperative bronchospasm (which can be profound)

Algorithm: step 1 — patients with controlled asthma but no symptoms and not receiving therapy (no additional therapy required, but bronchodilators should be made available); step 2 — patients with controlled asthma but receiving inhaled corticosteroids and long-acting β2-adrenergic agonists (consider additional therapy); step 3 — patients with recent changes in symptoms and receiving short-acting β2-adrenergic agonists; step 4 — patients receiving oral corticosteroids and experiencing symptoms daily; step 5 — patients receiving long-acting β2-adrenergic agonists, inhaled corticosteroids, and oral corticosteroids and experiencing severe symptoms daily (aggressive therapy required)

Anesthesia management: midazolam or atropine for premedication; sevoflurane for inhalation induction (desflurane not recommended); ketamine for IV induction; propofol may be used; morphine not recommended; deep anesthesia should be induced before intubation (eg, after inhalation induction, ketamine may be added to deepen anesthesia); inhalation anesthetics probably work through β2-adrenergic mechanism to increase release of intracellular cAMP; endotracheal intubation — considered alternatives (eg, regional anesthetics); intubation of airway causes increased in airway reactivity and resistance; laryngeal mask airway probably has some advantages over endotracheal intubation, but any stimulation of airway can lead to reflex bronchospasm; short-acting bronchodilator agents recommended just before induction (possibly in operating room) because they attenuate increase in airway resistance; lidocaine — blocks intubation-induced bronchospasm in patients with asthma; recommended dose 1 to 2 mg/kg; repeat administration at emergence may be useful in controlling asthma and may obviate need for deep extubation

Exacerbation of asthma during anesthesia: laryngospasm and aspiration exacerbate asthma; use gentle anesthesia technique; short-acting bronchodilator agents may be introduced into endotracheal tube; administer continuous β2-adrenergic agonist in aerosol form by adding nebulizer to inspiratory circuit; corticosteroids can be administered either orally or intravenously; anticholinergic agents worth considering even during acute episode; leukotriene receptor antagonists acceptable; use of theophylline debated, but probably not beneficial; magnesium — shown to reduce membrane excitability, decrease release of acetylcholine, and inhibit mast cell degranulation; may increase release of nitrous oxide and prostacyclin (smooth-muscle relaxants); however, multiple studies in pediat-ric literature have shown mixed results; Cochrane review of 4 trials found benefit for use of magnesium sulfate given intra-venously for acute exacerbation; randomized controlled trial concluded that nebulized isotonic magnesium sulfate (150 mg given 3 times in first hour) beneficial as adjuvant therapy in acute asthma; refractory asthma — patients require mechanical ventilation and admission to intensive care unit; use permissive hypercapnia, IV β2-adrenergic agonist, and prolonged inhalation anesthesia (latter ultimate treatment for asthma); sevoflu-rane acceptable

Suggested Reading


Obesity and Outcomes

Patrick A. Ross, MD, Assistant Professor of Clinical Pedi-atrics and Anesthesiology, Keck School of Medicine of the University of Southern California, Los Angeles, and Children’s Hospital Los Angeles

Defining obesity: in adults, obesity based on body mass index (BMI >30 considered obese); in children, percentages of normal weight and age used (85th percentile considered overweight, and 95th percentile considered obese); Centers for Disease Control (CDC) uses weight for length in children <2 yr of age and weight for height or BMI in children ≥2 yr of age; Children’s Hospital Los Angeles study — looked at data from ≈136,000 patients and calculated Z-scores and percent-ages using CDC growth curve; based on percentiles, increased number of children with failure to thrive and large percent-age of children with obesity; however, when classified based on Z-score appeared as standard distribution; other stud-ies — most surgical studies define obesity based on weight for height, whereas intensive care unit studies use weight for age; when using weight for age, curves shift to left, resulting in misclassi-fication of patients into lighter categories

Comorbidities associated with obesity: increased bronchial hyperreactivity, asthma, upper airway infections, obstructive sleep apnea, volume overload, hypertension, left ventricular hypertrophy, diabetes, elevated lipid levels, hepatic steatosis, and GERD; obesity associated with decreased functional residu-al capacity; high closing volume can cause atelectasis

Preoperative evaluation: consider increased sensitivity to opio-oids; know location of postoperative recovery when choosing anesthetic; airway should be evaluated; IV access may be difficult

Intubation: Naftu et al (2007) — studied >6000 patients and found that difficult laryngoscopy occurred in 0.4% of
normal-weight children, 0.2% of overweight children, and 1.3% of obese children (statistically significant); Naflu et al (2009) — studied 2000 patients retrospectively and found that 12% of normal-weight children required multiple laryngoscopies compared with 27.4% of overweight children; Tait et al (2008) — prospectively studied success of tracheal intubation and found no difference between normal-weight children and overweight children; Heinrich et al (2012) — retrospectively studied 11,000 patients and demonstrated significantly increased difficulty of laryngoscopy in younger children, children with elevated American Society of Anesthesiology classification score, children with elevated Mallampati score, and children with low BMI (eg, failure to thrive); no correlation with obesity found, which may be due to anesthesiologists instituting alterations in care to ensure ease of laryngoscopy in obese patients, which may mitigate effects of obesity; Collins et al (2004) — randomized controlled trial found that ramped position resulted in increased likelihood of grade 1 view compared with sniff position.

**Respiratory events:** more common in obese children; 3- to 7-fold increase in mask ventilation difficulty; increased incidence of desaturation, bronchospasm, obstructed airway, coughing during mask ventilation, and unplanned admission, but no evidence of increased risk for pulmonary aspiration; rapid sequence induction may not be beneficial.

**Recommendations for managing airway:** goal to prevent atelectasis and improve functional residual capacity; positioning patient head-up serves to unload diaphragm; preoxygenate for extended period with positive pressure ventilation (may need to deflate stomach); should have all equipment available; perform tracheal intubation or laryngeal mask airway as appropriate for procedure; once airway secured, applying positive end-expiratory pressure probably warranted.

**Suggested Reading**


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1. Which of the following antibodies is involved in type 1 hypersensitivity?
   (A) Immunoglobulin A
   (B) Immunoglobulin E **
   (C) Immunoglobulin G
   (D) Immunoglobulin M

2. Which of the following is typically demonstrated on pulmonary function testing in patients with asthma?
   (A) Increased tidal volume
   (B) Increased vital capacity
   (C) Decreased functional residual capacity **
   (D) Decreased respiratory rate

3. Which of the following statements about childhood obesity and asthma is true?
   (A) Asthma is no more difficult to control in obese children than in nonobese children
   (B) The asthma phenotype in obese patients cannot be reversed by weight loss
   (C) The risk for hospitalization for exacerbation of asthma is no higher in obese patients than in nonobese patients
   (D) The rate of asthma in children of obese mothers is higher than that in children of nonobese mothers **

4. The likelihood of a child to experience intraoperative wheezing increases nearly _______ if he or she resides with 1 person who smokes.
   (A) 2-fold
   (B) 5-fold
   (C) 10-fold **
   (D) 20-fold

5. Which of the following is LEAST useful when performing an anesthesia evaluation of an older child with asthma?
   (A) Physical examination
   (B) Chest radiography **
   (C) Measurement of peak expiratory flow
   (D) Measurement of exhaled nitrous oxide

6. All the following are signs of unstable asthma, EXCEPT:
   (A) Forced expiratory volume 85% of predicted
   (B) Awakening with shortness of breath >1 night/wk
   (C) Use of quick-acting agents >2 days/wk
   (D) Shortness of breath or wheezing >2 days/wk

7. Which of the following is LEAST likely to decrease intraoperative risk in children with uncontrolled asthma?
   (A) Prednisone
   (B) Ipratropium
   (C) Leukotriene-receptor antagonist
   (D) Theophylline **

8. All the following are acceptable for the anesthetic care of a patient with asthma, EXCEPT:
   (A) Midazolam
   (B) Morphine **
   (C) Propofol
   (D) Sevoflurane

9. A randomized controlled trial of laryngoscopy in obese patients found that the likelihood of grade 1 view was greater with the _______ than with the _______.
   (A) Sniff position; ramped position
   (B) Ramped position; sniff position **

10. Obesity does not increase the risk for _______ in an intubated child.
    (A) Difficult mask ventilation
    (B) Bronchospasm
    (C) Pulmonary aspiration
    (D) Obstructed airway

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