Bronchospasm (due to Asthma and Obstructive Lung Disease)

(Adapted from an evidence-based guideline created using the National Prehospital Evidence-Based Guideline Model Process)

Aliases

Asthma, respiratory distress, wheezing, respiratory failure, bronchospasm, obstructive lung disease, albuterol, levalbuterol, duoneb, nebulizer, inhaler

Patient Care Goals

1. Assure adequate oxygenation and ventilation.
2. Recognize impending respiratory failure.
3. Promptly identify and intervene for patients who require escalation of therapy.
4. Deliver appropriate therapy by differentiating likely cause of respiratory distress.
5. Alleviate respiratory distress.

Patient Presentation

Inclusion Criteria

1. Respiratory distress with wheezing or decreased air entry in patients 2 y/o or older, presumed to be due to bronchospasm from reactive airway disease, asthma, or obstructive lung disease. These patients may have a history of recurrent wheezing that improves with beta-agonist inhalers or nebulizers such as albuterol or levalbuterol.
    a. Symptoms and signs may include:
        i. Wheezing: will have expiratory wheezing unless they are unable to move adequate air to generate wheezes
        ii. Signs of respiratory infection (e.g. fever, nasal congestion, cough, sore throat)
        iii. Acute onset after inhaling irritant
    b. This includes:
        i. Asthma exacerbation
        ii. Chronic obstructive pulmonary disease (COPD) exacerbation
        iii. Wheezing from suspected pulmonary infection (e.g. pneumonia, acute bronchitis)

Exclusion Criteria

1. Respiratory distress due to a presumed underlying cause that includes one of the following:
    a. Anaphylaxis
    b. Bronchiolitis (wheezing less than 2 yo)
    c. Croup
    d. Epiglottitis
    e. Foreign body aspiration
    f. Submersion or drowning
    g. Congestive heart failure
    h. Trauma

Patient Management

Assessment

1. History
    a. Onset of symptoms
    b. Concurrent symptoms (fever, cough, rhinorrhea, tongue and/or lip swelling, rash, labored breathing, foreign body aspiration)
    c. Usual triggers of symptoms (cigarette smoke, change in weather, upper respiratory infections)
    d. Sick contacts
    e. Treatments given EMS: Oxygen, inhaler, nebulizer, other treatments, chronic or recent

steroids

f. Hospitalizations: Number of emergency department visits in the past year, number of hospital admissions in the past year, number of ICU admissions (ever), previously intubated (ever)
g. Family history of asthma, eczema, or allergies

2. Exam
    a. Full set of vital signs (T, BP, RR, P, O_2 sat) - waveform capnography is a useful adjunct and will show a "sharkfin" waveform in the setting of obstructive physiology
    b. Air entry (normal vs. diminished, prolonged expiratory phase)
    c. Breath sounds (wheezes, crackles, rales, rhonchi, diminished, clear)
    d. Signs of distress (grunting, nasal flaring, retracting, stridor)
    e. Inability to speak full sentences (sign of shortness of breath)
    f. Color (pallor, cyanosis, normal)
    g. Mental status (alert, tired, lethargic, unresponsive)
    h. Signs of distress include:
        a. Apprehension, anxiety, combativeness
        b. Hypoxia (***less than*** 90% oxygen saturation)
        c. Intercostal, subcostal, or supraclavicular retractions
        d. Nasal flaring
        e. Cyanosis

Treatment and Interventions

1. Monitoring
    a. Use pulse oximetry and end-tidal CO_2 ($ETCO_2$) routinely as an adjunct to other forms of respiratory monitoring.
    b. Check an 12-Lead ECG *only* if there are no signs of clinical improvement after treating respiratory distress.
2. Airway
    a. Administer oxygen ***[EMR]*** as appropriate for dyspnea or distress with a target of achieving greater than 93% saturation for most acutely ill patients.
    b. Suction the nose and/or mouth (via bulb, Yankauer, suction catheter) if excessive secretions are present.
3. Inhaled Medications
    a. **Albuterol *[EMR]***: Administer to all patients in respiratory distress with signs of bronchospasm (e.g. known asthmatics, quiet wheezers).
        - **2.5mg (1 ampule) Nebulized every 5 minutes as needed**
            - if concern for severe respiratory distress consider starting with **5mg (2 ampules)**
        - Repeat this medication at this dose with unlimited frequency for ongoing distress
        - Alternative 6 puffs of metered dose inhaler equalize approximately 5mg albuterol
    b. **Ipratropium nebulized: [EMT]**
        - **Typical Dose: 0.5mg (1 ampule) every 4 hours**
        - May administer up to 3 doses, in conjunction with albutero
4. Non-invasive airway adjuncts for improvement of oxygenation and/or respiratory distress
    a. Administer non-invasive positive pressure ventilation ***[EMT]*** via continuous positive airway pressure (CPAP) or bi-level positive airway pressure (BiPAP) for severe respiratory distress.
    b. Utilize bag-valve-mask ventilation in children with respiratory failure.
5. Utility of IV Placement and Fluids: Place IVs when there are clinical concerns of dehydration in order to administer fluids, or when administering IV medications ***[AEMT]***.
6. **Steroids *[PARA]:* Methylprednisolone 2mg/kg (max 125mg) IV/IO**
7. **Magnesium sulfate *[PARA]:*** Administer for severe bronchoconstriction and concern for impending respiratory failure.
    a. **Adult/Pediatrics 40mg/kg (max 2g) IV/IO over 10 minutes**
8. **Epinephrine*:*** Administer *only* for impending respiratory failure as adjunctive therapy when there

are no clinical signs of improvement. Primarily an ALS **[PARA]** level consideration but may be administered at BLS level **[EMR-O/EMT-R]** if ALS is not readily available
    a. **Adult: 0.3mg IM or 0.3mg auto-injector**
    b. **Pediatric: 0.01mg/kg IM or 0.15mg auto-injector**
9. **Non-visualized airways** ***[EMR]*** and **intubation** ***[PARA]:*** Utilize *only* if bag-valve-mask ventilation fails. The airway should be managed in the least invasive way possible.

Patient Safety Considerations

1. Normal EtCO2 (35–45 mmHg) with tachypnea and respiratory distress is an indicator of impending respiratory failure.
2. Invasive airway placement does not improve bronchospasm. The airway should be managed in the least invasive way possible. Supraglottic devices and endotracheal intubation should be considered only if BVM ventilation fails.
3. Positive pressure ventilation in the setting of bronchoconstriction, either via a supraglottic airway or intubation, increases the risk of air trapping which can lead to pneumothorax and cardiovascular collapse. These

Notes and Educational Pearls

- The combination of ipratropium with albuterol may decrease the need for hospital admission in certain patients.
- Magnesium sulfate may cause hypotension that will usually respond to a fluid bolus.
- When assessing for cause of respiratory distress, CHF tends to be associated with lower levels of EtCO2 compared to COPD. EtCO2 values that are extremely low and high are markers of poor outcomes and need for intubation or ICU admission.

Key considerations

1. Nebulizer droplets can carry viral particles and other airborne pathogens, so additional PPE should be considered, including placement of a surgical mask over the nebulizer (if feasible) to limit droplet spread.
2. Factors that have been shown to be associated with increased mortality from asthma include:
    1. Severe asthma as evidenced by at least one of the following:
        a. Prior near-fatal asthma (e.g., ICU admission or intubation/mechanical ventilation)
        b. Prior admissions for asthma or repeated ED visits, particularly if in the last year
        c. Heavy use of beta-agonist medications, or requiring three or more classes of asthma medication
    2. Together with one or more behavioral or psychosocial contributors:
        a. Medication noncompliance
        b. Alcohol or drug abuse
        c. Obesity
        d. Psychosis, depression, other psychiatric illness, or major tranquilizer use
        e. Employment or income difficulties
        f. Severe domestic, marital, or legal stressors

Pertinent Assessment Findings

1. Severe respiratory distress may manifest with hypoxia, altered mentation, diaphoresis, or inability to speak more than 2–3 words.
2. In the setting of severe bronchoconstriction, wheezing may not be heard. Patients with known asthma with severe dyspnea should be empirically treated, even if wheezing is absent.
3. A "shark fin" on waveform capnography suggests significant bronchospasm and obstructive physiology.
4. Etiology of respiratory distress:
    1. Bronchospastic etiology (e.g., asthma, COPD) is suggested by:
        a. Wheezing on auscultation.
        b. "Shark fin" waveform capnograph or prolonged expiratory phase.

c. History of asthma/COPD.

Quality Improvement

- **Associated NEMSIS Protocol(s) (eProtocol.01)**
  9914139—Respiratory Distress/Asthma/COPD/Croup/Reactive Airway

Key Documentation Elements

Document key aspects of the exam to assess for a change after each intervention:

- Respiratory rate
- Oxygen saturation
- Use of accessory muscles
- Breath sounds
- Air entry
- Mental status
- Color

Performance Measures

- CPAP/BiPAP utilization
- Time to administration of specified interventions in the protocol
- Rate of administration of accepted therapy (whether or not certain medications/interventions were given)
- Change in vital signs (heart rate, blood pressure, temperature, respiratory rate, pulse oximeter, capnography values)
- Time to administration of specified interventions in the protocol
- Number of advanced airway attempts
- Mortality

References

1. Abroug F, Nouira S, Bchir A, Boujdaria R, Elatrous S, Bouchoucha S. A controlled trial of nebulized salbutamol and adrenaline in acute severe asthma. *Intensive Care Med.* 1995;21(1):18-23.
2. Abramo TJ, Wiebe RA, Scott SM, Primm PA, McIntyre D, Mydlyer T. Noninvasive capnometry in a pediatric population with respiratory emergencies. *Pediatr Emerg Care.* 1996;12(4):252- 4.
3. Alter HJ, Koepsell TD, Hilty WM. Intravenous magnesium as an adjuvant in acute bronchospasm: a meta-analysis. *Ann Emerg Med.* 2000;36(3):191-7.
4. Barnett PLJ, Caputo GL, Baskin M, Kuppermann N. Intravenous versus oral corticosteroids in the management of acute asthma in children. *Ann Emerg Med.* 1997;29(2):212-7.
5. Becker AB, Nelson NA, Simons FER. Inhaled salbutamol (albuterol) vs injected epinephrine in the treatment of acute asthma in children. *J Pediatr.* 1983;102(3):465-9.
6. Beers SL, Abramo TJ, Bracken A, Wiebe RA. Bilevel positive airway pressure in the treatment of status asthmaticus in pediatrics. *Am J Emerg Med.* 2007;25(1):6-9.
7. Birken CS, Parkin PC, Macarthur C. Asthma severity scores for preschoolers displayed weaknesses in reliability, validity, and responsiveness. *J Clin Epidemiol.* 2004;57(11):1177- 81.
8. Blitz M, Blitz S, Beasely R, Diner B, Hughes R, Knopp JA, Rowe BH. Inhaled magnesium sulfate in the treatment of acute asthma. *Cochrane Database Syst Rev.* 2005;(4):CD003898.
9. Bryant DH, Rogers P. Effects of ipratropium bromide nebulizer solution with and without preservatives in the treatment of acute and stable asthma. *Chest.* 1992;102:742-7.
10. Camargo CA, Rachelefsky G, Schatz M. Managing asthma exacerbations in the emergency department: summary of the National Asthma Education and Prevention Expert Panel Report 3 guidelines for the management of asthma exacerbations. *J Emerg Med.* 2009;37(Suppl 2):S6-17.
11. Carroll CL, Schramm CM. Noninvasive positive pressure ventilation for the treatment of status asthmaticus in children. *Ann Allergy Asthma Immunol.* 2006;96(3):454-59.

12. Chalut DS, Ducharme FM, Davis GM. The preschool respiratory assessment measure (PRAM): a responsive index of acute asthma severity. *J Pediatr.* 2000;137(6):762-8.
13. Davis DP, Wiesner C, Chan TC, Vilke GM. The efficacy of nebulized albuterol/ipratropium bromide versus albuterol alone in the prehospital treatment of suspected reactive airways disease. *Prehosp Emerg Care.* 2005;9(4):386-90.
14. Denver Metro Airway Study Group. A prospective multicenter evaluation of prehospital airway management performance in a large metropolitan region. *Prehosp Emerg Care.* 2009;13(3):304-10.
15. Ducharme FM, Chalut D, Plotnick L, Savdie C, Kudirka D, Zhang X et al. The pediatric respiratory assessment measure: A valid clinical score for assessing acute asthma severity from toddlers to teenagers. *J Pediatr.* 2008;152(4):476-80 408.e1.
16. Ducharme FM, NiChroinin M, Greenstone I, Lasserson TJ. Addition of long-acting beta2-agonists to inhaled corticosteroids versus same dose inhaled corticosteroids for chronic asthma in adults and children. *Cochrane Database Syst Rev.* 2010;(5):CD005535.
17. Edmonds M, Camargo CA, Pollack CV, Rowe BH. Early use of inhaled corticosteroids in the emergency department treatment of acute asthma. *Cochrane Database Syst Rev.* 2003;(3):CD002308.
18. Ehrlich PF, Seidman PS, Atallah O, Haque A, Helmkamp J. Endotracheal intubations in rural pediatric trauma patients. *J Pediatr Surg.* 2004;39(9):1376-80.
19. Everard M, Bara A, Kurian M, N'Diaye T, Ducharme F, Mayowe V. Anticholinergic drugs for wheeze in children under the age of two years. *Cochrane Database Syst Rev.* 2005;(3):CD001279.
20. Fergusson RJ, Stewart CM, Wathen CG, et al. Effectiveness of nebulized salbutamol administered in ambulances to patients with severe acute asthma. *Thorax.* 1995;50:80- 2.
21. Freedman SB, Haladyn JK, Floh A, Kirsh JA, Taylor G, Thull-Freedman J. Pediatric myocarditis: emergency department clinical findings and diagnostic evaluation. *Pediatr.* 2007;120(6):1278-85.
22. Gausche M, Lewis RJ, Stratton SJ, et al. Effect of out-of-hospital pediatric endotracheal intubation on survival and neurological outcome. *JAMA.* 2000;283(6):783-90.
23. Gordon S, Tompkins T, Dayan PS. Randomized trial of single-dose intramuscular dexamethasone compared with prednisolone for children with acute asthma. *Pediatr Emerg Care.* 2007;23(8):521-7.
24. Gorelick MH, Stevens MW, Schultz TR, Scribano PV. Performance of a novel clinical score, the Pediatric Asthma Severity Score (PASS), in the evaluation of acute asthma. *Acad Emerg Med.* 2004;11(1):10-8.
25. Guthrie BD, Adler MD, Powell EC. End-tidal carbon dioxide measurements in children with acute asthma. *Acad Emerg Med.* 2007;14(12):1135-40.
26. Hunt RC, Brown LH, Cabinum ES, et al. Is ambulance transport time with lights and siren faster than that without? *Ann Emerg Med.* 1995;25(4):507-11.
27. Ho J, Casey B. Time saved with use of emergency warning lights and sirens during response to requests for emergency medical aid in an urban environment. *Ann Emerg Med.* 1998;32(5):585-8.
28. Keahey L, Bulloch B, Becker AB, Pollack CV, Clark S, Camargo CA. Initial oxygen saturation as a predictor of admission in children presenting to the emergency department with acute asthma. *Ann Emerg Med.* 2002;40(3):300-7.
29. Keenan SP, Sinuff T, Cook DJ, Hill NS. Does noninvasive positive pressure ventilation improve outcome in acute hypoxemic respiratory failure? a systematic review. *Crit Care Med.* 2004;32(12):2516-23.
30. Kornberg AE, Zuckerman S, Welliver JR, Mezzadri F, Aquino N. Effect of injected long-acting epinephrine in addition to aerosolized albuterol in the treatment of acute asthma in children. *Pediatr Emerg Care.* 1991;7(1):1-3.
31. Kunkov S, Pinedo V, Johnson Silver E, Crain EF. Predicting the need for hospitalization in acute childhood asthma using end-tidal capnography. *Pediatr Emerg Care.* 2005;21(9):574-7.
32. Kuzma K, Sporer KA, Michael GE, Youngblood GM. When are prehospital intravenous catheters used for treatment? *J Emerg Med.* 2009;36(4):357-62.

33. Lacher ME, Bausher JC. Lights and siren in pediatric 911 ambulance transports: are they being misused? *Ann Emerg Med.* 1997;29(2):223-7.
34. Lanes SF, Garrett JE, Wentworth CE, et al: The effect of adding ipratropium bromide to salbutamol in the treatment of acute asthma. *Chest.* 1998;114(2):365-72.
35. Mallory MD, Shay DK, Garrett J, Bordley WC. Bronchiolitis management preferences and the influence of pulse oximetry and respiratory rate on the decision to admit. *Pediatr.* 2003;111(1):e45-51.
36. Manser R, Reid D, Abramson MJ. Corticosteroids for acute severe asthma in hospitalized patients. *Cochrane Database Syst Rev.* 2001;(1):CD001740.
37. Markenson D, Foltin G, Tunik M, Cooper A, Treiber M, Caravaglia K. Albuterol sulfate administration by EMT-basics: results of a demonstration project. *Prehosp Emerg Care.* 2004;8(1):34-40.
38. Mehta SV, Parkin PC, Stephens D, Schuh S. Oxygen saturation as a predictor of prolonged, frequent bronchodilator therapy in children with acute asthma. *J Pediatr.* 2004;145(5):641- 5.
39. Moses JM, Alexander JL, Agus MSD. The correlation and level of agreement between end-tidal and blood gas PCO_2 in children with respiratory distress: A retrospective analysis. *BMC Pediatr.* 2009;9:20.
40. Panickar J, Lakhanpaul M, Lambert PC, et al. Oral prednisolone for preschool children with acute virus-induced wheezing. *N Engl J Med.* 2009;360(4):329-38.
41. Plotnick LH, Ducharme FM. Should inhaled anticholinergics be added to beta2 agonists for treating acute childhood and adolescent asthma? A systematic review. *BMJ.* 1998;317(7164):971-7.
42. Quadrel M, Lavery RF, Jaker M, Atkin S, Tortella BJ, Cody RP. Prospective, randomized trial of epinephrine, metaproterenol, and both in the prehospital treatment of asthma in the adult patient. *Ann Emerg Med.* 1995;26(4):469-73.
43. Ram FSF, Wellington SR, Rowe B, Wedzicha A. Non-invasive positive pressure ventilation for treatment of respiratory failure due to severe exacerbations of asthma. *Cochrane Database Syst Rev.* 2012 Dec 12;12:CD004360.
44. Richmond NJ, Silverman R, Kusick M, Matallana L, Winokur J. Out-of-hospital administration of albuterol for asthma by basic life support providers. *Acad Emerg Med.* 2005;12(5):396- 403.
45. Rodenberg H. Effect of levalbuterol on prehospital patient parameters. *Am J Emerg Med.* 2002;20(5):481-3.
46. Rodrigo GJ, Pollack CV, Rodrigo C, Rowe BH. Heliox for non-intubated acute asthma patients.
Cochrane Database Syst Rev. 2006;(4):CD002884.
47. Rowe BH, Bretzlaff J, Bourdon C, Bota G, Blitz S, Camargo CA. Magnesium sulfate for treating
exacerbations of acute asthma in the emergency department. *Cochrane Database Syst Rev.* 2000;(1):CD001490.
48. Rowe BH, Keller JL, Oxman AD. Effectiveness of steroid therapy in acute exacerbations of asthma: a meta-analysis. *Am J Emerg Med.* 1992;10(4):301-1
49. Rowe BH, Spooner C, Ducharme F, Bretzlaff J, Bota G. Early emergency department treatment of acute asthma with systemic corticosteroids. *Cochrane Database Syst Rev.* 2001;(1):CD002178.
50. Scarfone RJ, Loiselle JM, Wiley Li JF, Decker JM, Henretig FM, Joffe MD. Nebulized dexamethasone versus oral prednisone in the emergency treatment of asthmatic children. *Ann Emerg Med.* 1995;26(4):480-6.
51. Silverman R, Osborn H, Runge J, et al. IV magnesium sulfate in the treatment of acute severe asthma; a multicenter randomized controlled trial. *Chest.* 2002;122(2):489-97.
52. Smith D, Riel J, Tiles I, Kino R, Lis J, Hoffman JR. Intravenous epinephrine in life-threatening asthma. *Ann Emerg Med.* 2003;41(5):706-11.
53. Smith M, Rowe BH, N'Diaye T. Corticosteroids for hospitalized children with acute asthma. *Cochrane Database Syst Rev.* 2003;(1):CD002886.
54. Spaite DW, Valenzuela TD, Criss EA, Meislin HW, Hinsberg, P. A prospective in- field comparison of intravenous line placement by urban and nonurban emergency medical services

personnel. *Ann Emerg Med.* 1994;24(2):209-14.
55. Stiell IG, Spaite DW, Field B, et al. Advanced life support for out-of-hospital respiratory distress. *N Engl J Med.* 200; 356(21):2156-64.
56. Thompson J, Petrie DA, Ackroyd-Stolarz S, Bardua DJ. Out-of-hospital continuous positive pressure ventilation vs usual care in acute respiratory failure: a RCT. *Ann Emer Med.* 2008;52(3):232-41.
57. Thompson M, Wise S, Rodenberg H. A preliminary comparison of levalbuterol and albuterol in prehospital care. *J Emerg Med.* 2004;26(3):271-7.
58. Uden DL, Goetz DR, Kohen DP, Fifield GC. Comparison of nebulized terbutaline and subcutaneous epinephrine in the treatment of acute asthma. *Ann Emerg Med.* 1985;14(3):229-32.
59. Warner GS. Evaluation of the effect of prehospital application of continuous positive airway pressure therapy in acute respiratory distress. *Prehosp Dis Med.* 2010;25(1):87-91.