

Managing Pediatric Asthma Exacerbations in the ED

Incorporating evidence-based guidelines will help clinicians reduce repeat visits.

Jonah Preston, a five-year-old boy with a history of asthma, was brought to triage by his mother early one morning with a chief complaint of “difficulty breathing.” (This case is a composite based on our experience.) Ms. Preston reported that her son had recently been sneezing and had a runny nose. Overnight, he’d begun to cough, finally waking her at 5 AM complaining that he couldn’t breathe. He’d had a fever of 101.8°F (38.8°C) and needed albuterol nebulizer treatment every two hours that morning. Ms. Preston called her child’s pediatrician for advice. The pediatrician referred her to our ED for a chest X-ray and evaluation.

Children who have a history of asthma often present to the ED with exacerbations because of poor control at home.

Jonah presented to triage alert and tachypneic, with mild nasal flaring and no retractions. He was speaking in full phrases, his skin color was normal, and he had tight inspiratory and expiratory wheezing throughout. His vital signs were as follows: temperature, 38.6°C; apical pulse, 130 beats per minute; respiratory rate, 32 to 36 breaths per minute; blood pressure, 136/58 mmHg; and oxygen saturation (SpO₂) level, 94% on room air. His last nebulizer treatment had been given two hours prior to his arrival.

Jonah had been born prematurely, at 28 weeks’ gestation, requiring a 40-day stay in the neonatal intensive care unit (NICU). He’d had multiple episodes of bronchiolitis as an infant and was formally

diagnosed with asthma. His pediatrician had prescribed an asthma action plan that directed Ms. Preston to initiate his rescue medication, albuterol (Ventolin HFA and others), every four hours in the event of a flare-up. Although Jonah hadn’t needed any medication all summer, he’d had two prior hospitalizations for acute exacerbations, both at the age of four, neither of which required intubation or admission to the ICU. He lived at home with his mother, father, and one sibling; his dad smoked “outside,” and Jonah had a pet hamster.

BACKGROUND AND EVIDENCE

Asthma—a chronic inflammatory disorder of the airways characterized by reduced function of bronchi and bronchioles and caused by smooth muscle spasm, mucosal edema, and excessive mucus in airway lumen—creates lung hypersensitivity, airflow limitations, respiratory symptoms, and disease chronicity. Asthma is one of the most common chronic diseases in childhood and affects over 6 million children in the United States.¹ These children have significantly higher hospitalization and ED visit rates than their peers. In addition, ED and hospitalization rates are significantly higher for Latino and black children with asthma than for white children, particularly for those living in cities.^{2,3} This discrepancy has been found to be true even among patients with the same asthma severity score. Many patients—especially those under five years of age⁴—return to the ED in less than one week with continued symptoms.

Children with asthma present to the ED with an array of chief complaints, including wheezing, cough, and respiratory distress. Many underlying conditions, such as respiratory viruses, foreign body aspiration, and undiagnosed laryngomalacia or cystic fibrosis, can also cause respiratory distress. For this reason, infants and children under four years of age are diagnosed with asthma only after careful consideration of these factors.¹

Inconsistent home care . . . repeat ED visits.

Children who have a history of asthma often present to the ED with exacerbations because of poor control at home. A variety of factors contribute to this high frequency of ED visits. Some children don't have a primary care provider to oversee their asthma management. Some patients who do have primary care providers may not follow up with them as advised by the ED clinicians.^{5,6} Sometimes families with a primary care provider make an appointment but miss it. Further, if primary care providers aren't informed that their patient has been seen in the ED, they can't provide outreach to that patient.⁵

Expensive medications. Many patients are uninsured or underinsured and can't afford their asthma medications or their insurance copayments. A recent regulatory change related to inhalers occurred in December 2008: the propellant in inhalers was replaced with an environmentally safer propellant.⁷ An unintended consequence of this change was that inhalers were classified as "nongeneric" medications in many health insurance prescription plans, which meant that to fill their prescriptions families had to pay higher copayments of as much as \$50 or \$60. For many families, this has become a financial hardship. Children's Hospital Boston, where we work, has seen the repercussions from this change; many children who were brought to the ED with asthma have returned the next day because they couldn't afford the inhaler needed to control their wheezing. Ironically, the copayments for two ED visits can be higher—and the interruption in treatment potentially far more dangerous—than purchasing a rescue inhaler.

Follow the guidelines. Several practice guidelines and educational resources have been developed to guide clinicians in the emergency management of asthma. Evidence-based guidelines cover the entire spectrum of emergency care, including the taking of a focused history, targeted assessment criteria, treatment, and discharge teaching. The most recent guidelines, published in 2007 by the National Asthma Education and Prevention Program (NAEPP) of the National Heart, Lung, and Blood Institute, serve as the gold standard for emergency practitioners.¹ Also useful are studies that attempt to ascertain a predictive model for successful discharge from the ED without a return within seven days, such as the one by Gorelick and colleagues.⁸ The key components of the model are the use of a validated four-item clinical score (the Pediatric Asthma Severity Score) and the number of albuterol treatments. A study conducted by Norton and colleagues in the ED of a 178-bed Canadian hospital showed that, once integrated into practice, evidence-based clinical pathways can decrease the hospital admission



rate and the return ED visit rate for asthma patients.⁹ A cause for concern, however, is that at least one study has found that EDs may not be fully complying with certain key elements of asthma treatment guidelines.¹⁰

An essential area currently being promoted in asthma management is patient and family education. A Cochrane review by Boyd and colleagues found that patients and families who receive focused education on asthma management had reduced ED visits and hospital admissions.¹¹ And it's our experience that obtaining an in-depth medication history can help clarify issues affecting adherence, such as a lack of access to medications.

The asthma clinical practice guidelines developed in 1994 for the ED at Children's Hospital Boston were the hospital's first clinical practice guidelines based on the initial NAEPP guidelines, originally published in 1991 and updated in 1997, 2002, and, most recently, 2007.¹ The original NAEPP Expert Panel Report was intended to bridge the gap between research and practice, and its goal was to standardize assessment and care of asthma patients in the ED. Our hospital guidelines were recently updated to reflect the 2007 changes and continue to support those goals.

TRIAGE ASSESSMENT

It's essential for the triage nurse to classify asthma severity, assess the potential for rapid deterioration, and obtain a brief history. At Children's Hospital Boston, the nurse uses the Triage Respiratory Severity Score Reference (Table 1)—developed by the hospital's Asthma Clinical Practice Guideline Subject Matter Expert Group, consisting of attending physicians from pulmonary, allergy, emergency, and primary care specialties—to classify a patient's signs and symptoms into one of three categories: nonurgent (mild), urgent (moderate), or emergent (severe). The objective measures used to aid this classification include respiratory rate, oxygen saturation level on room air, breath sounds, retractions, and mental status. Although no single assessment tool appears to be the best for assessing severity of the exacerbation or for monitoring response to treatment and predicting hospital admissions in children, limited evidence and our clinical experience suggest that using a standardized

approach to respiratory assessment is beneficial.^{8, 12}

Peak expiratory flow rate (PEFR) is an objective measure that more reliably indicates the severity of an exacerbation than does the severity of symptoms. It represents the maximum flow of air during exhalation and is recommended to guide therapeutic decision making in patients with moderate-to-severe asthma.¹ PEFR measurement should be attempted in children six years of age and older and is particularly useful in adolescents over 12 years of age, who are effectively managed like adults.

However, we've found that obtaining this measurement in our pediatric setting during an exacerbation is difficult, and therefore peak flow monitoring isn't often performed. Gorelick and colleagues found that only 65% of children five to 18 years of age could actually perform this maneuver during an acute flare-up.⁸ Although peak flow monitoring in the ED may prove helpful for ongoing assessment of lung function and response to treatment, it's usually

Table 1. Triage Respiratory Severity Score Reference (circle criteria^a)

Indicator	Nonurgent (Mild)	Urgent (Moderate)	Emergent (Severe)
RR, 12–24 months	< 50	50–60	> 60 or apnea
25 months–5 years	< 40	40–50	> 50 or apnea
6–8 years	< 30	30–40	> 40 or apnea
> 8 years	< 22	22–40	> 40 or apnea
SpO ₂ (RA)	≥ 95%	92%–94%	< 92%
PEFR	> 70%	50%–70%	< 50%
Dyspnea	None/mild	Moderate	Severe
Auscultation	None or end expiratory wheeze	Inspiratory and/or expiratory wheeze	Marked ↓'ed aeration/inaudible breath sounds
Retractions	None/mild	Moderate	Severe
Mental Status	Normal	Normal	Altered
Emergent medical history: Asthma admits	None	Any within past year	ICU within past 3 years
Visit to PCP/ED	None	24–72 hours	< 24 hours
Patients with emergent history should be categorized as "Severe"			

↓'ed = decreased; ED = emergency department; ICU = intensive care unit; PCP = primary care physician; PEFR = peak expiratory flow rate; RA = room air; RR = respiratory rate; SpO₂ = oxygen saturation.

^a Score patient in most severe category in which signs or symptoms are present.

possible only if patients are familiar with the technique because they already use it at home.

Patients with a history of either an ICU admission for asthma or an ED or physician's office visit within the past 24 hours are at increased risk for morbidity and mortality and should be categorized as "emergent." Children in this category require immediate treatment and intensive monitoring and care.

TREATMENT

Treatment should be started as soon as an asthma exacerbation is recognized and an assessment of lung function has been completed. The intensity of treatment and monitoring are tailored to the severity of the exacerbation.

Determining Jonah's underlying etiology wasn't the first priority. Using the respiratory severity score reference, clinicians categorized his acute episode as "urgent." The principal goals for treating Jonah at this point were to correct his hypoxemia and reverse-airflow obstruction—with short-acting β_2 -adrenergic agonists (such as albuterol) and systemic corticosteroids (such as prednisolone) the widely accepted drugs of choice. Jonah received supplemental oxygen and albuterol nebulizer treatment within 10 minutes of his arrival in triage. This met the goals set by the hospital's asthma clinical practice guidelines, which are to ensure that all children in the moderate-to-severe category receive treatment within 30 minutes of initial contact.

Although Jonah's oxygen saturation level improved, he had an incomplete response to the medication and continued to wheeze. Inhaled albuterol's onset of action is less than five minutes, and repetitive administration is the most effective means of reversing airflow obstruction. In about 60% to 70% of patients, response to the initial three doses in the ED will be sufficient to allow for their discharge, and most patients will have a significant response after the first dose.¹³⁻¹⁵

Children who fail to respond promptly and completely to the first albuterol nebulizer treatment during a moderate-to-severe exacerbation require systemic corticosteroids to reverse the inflammation. It's important to give systemic corticosteroids early in the course of treatment in the ED to reduce the need for hospitalization and the rate of relapse on discharge.^{16, 17} Before administering steroids, the nurse must screen the pediatric patient for possible chickenpox exposure or varicella immunization within the preceding two weeks to avoid placing the patient at high risk for infection. There are a few case reports, including fatalities, of disseminated disease from varicella infection occurring while an otherwise healthy child

was on pulse steroids, which is similar to the therapy we use to treat reactive airway disease exacerbations.^{18, 19}

A dose of prednisolone was administered within 30 minutes of Jonah's arrival in triage, meeting the Children's Hospital Boston standard of less than 80 minutes to treatment. This was followed by three consecutive nebulizer treatments of albuterol

It's essential for the triage nurse to classify asthma severity, assess the potential for rapid deterioration, and obtain a brief history.

mixed with the anticholinergic agent ipratropium (Atrovent), each spaced 20 minutes apart. Adding ipratropium to short-acting β_2 -agonists, in conjunction with the early introduction of corticosteroids, has also been reported to decrease the need for hospital admission, particularly in children with severe airflow obstruction, because of the combination's "enhanced and prolonged" bronchodilation properties.²⁰

After stabilization. At this point, Jonah's respiratory status had stabilized and it was time to determine the underlying etiology of his wheezing. The decision to obtain a chest X-ray was based on his fever of 38.6°C and on concerns for a complicating condition such as pneumonia. (Had Jonah been a patient with a first-time episode of wheezing, many senior clinicians at Children's Hospital Boston might still have recommended a chest X-ray, since foreign body aspiration is always a possibility in young children.)

To discharge or not to discharge. The decision to release a child from the ED is based on response to treatment, as well as on regular assessment and close monitoring. Factors that should be considered include

- duration and severity of symptoms.
- severity and course of prior exacerbations.
- medication use at the time of exacerbation.
- access to medical care and home support.

After each nebulizer treatment, Jonah was reassessed using the respiratory severity score reference. Following his three back-to-back nebulizer treatments, Jonah was sent for a chest X-ray, which was read as normal. When an hour had passed since the

completion of his treatment, he was reassessed, with the following findings: respiratory rate, 20 breaths per minute; SpO₂ level, 97%; and breath sounds clear. His status was now categorized as “nonurgent” (mild) rather than “urgent” (moderate).

Further considerations affecting discharge. A patient’s response to the first dose of albuterol in the ED is thought to be a better predictor of the need for hospitalization than the severity of an exacerbation on presentation.¹⁴ Children who have a rapid

Response to the first dose of albuterol in the ED is thought to be a better predictor of the need for hospitalization than the severity of an exacerbation on presentation.

response after treatment should be observed for 30 to 60 minutes to ensure they remain stable before they’re discharged home. An SpO₂ level of 92% to 94% by pulse oximetry 30 minutes after treatment has been initiated in young children and infants is also cited as a useful predictor of the likelihood of severity and the need for further treatment.²¹ Four hours after Jonah’s last bronchodilator, he was no longer wheezing and had no shortness of breath. Also, his SpO₂ level was greater than 94% on room air, making him eligible for discharge.

Optimal dosing of albuterol in children prior to a decision about whether or not to discharge them remains unclear. According to our ED asthma clinical practice guidelines working group, based on group consensus and limited evidence, clinicians can decide whether or not to discharge children under six years of age after three nebulizer treatments. For children six years of age and over, a decision can be made after three or six treatments. The number of treatments includes those received at any site, including within four hours before presentation to the ED (for example, at a primary care provider’s office, a clinic, or at home). In general, before discharge the patient’s PEFr should return to greater than 70% of predicted or personal best, and symptoms of respiratory distress should be minimal or absent. Children should also be able to space their albuterol treatments four hours apart, have no oxygen requirement, and eat and drink without respiratory distress.

DISCHARGE PLANNING

The NAEPP Expert Panel Report recommends that clinicians create an ED asthma discharge plan as a bridge to safe discharge home.¹ This plan manages the acute exacerbation phase until an asthma action plan can be developed at a future visit with a primary care provider. Jonah’s ED discharge plan addressed the following:

- medications and education on how to use them
- access to medication and devices
- communication of details of the ED visit to a primary care provider
- follow-up visit with a primary care provider within 48 hours
- case-management referral

Prescribed ICS? In almost all cases, children with an asthma exacerbation are sent home with an albuterol prescription. The asthma clinical practice guidelines at Children’s Hospital Boston stipulate that all children treated with corticosteroids in the ED receive a short course of oral corticosteroids at discharge (three to 10 days, with no tapering). The NAEPP guidelines recommend that children with persistent asthma receive a one-to-two-month prescription for inhaled corticosteroids (ICS).¹ A retrospective review published in 2002 by Sin and Man showed a significant reduction in subsequent ED visits in patients receiving ICS.²² A literature review published in 2004 by Rowe and colleagues examined the pooled effect of the few clinical trials comparing ED patients discharged with and without ICS and found “emerging evidence” in support of adding ICS to oral systemic corticosteroids to prevent relapse.¹⁷

While the asthma experts at Children’s Hospital Boston strongly support initiation and continuation of ICS at discharge on a case-by-case basis in order to bridge the gap between emergency and primary care, the responsibility for prescribing ICS normally lies with the child’s pediatrician. The practice of prescribing ICS upon discharge hasn’t been fully adopted by ED physicians at Children’s Hospital Boston because of ongoing concerns about possible systemic adverse effects and long-term effects on growth in children they won’t be able to monitor over time.^{23, 24} All asthma patients without a pediatrician are referred to case management for assistance in obtaining a primary care provider.

Parental education. Before Jonah was discharged, the staff nurse made sure that his mother understood how to administer his medications and was familiar with their possible adverse effects by having her explain back what she had heard, in her own words. The nurse also had her demonstrate how to use the home nebulizer machine. She was

asked if she could afford insurance copayments for the medications. In cases where patients are underinsured and can't afford to pay, free medication can be dispensed from our pharmacy and a referral made to case management and financial counseling for follow-up. The nurse reviewed the asthma discharge plan and taught Jonah's mother about the two primary responses in the disease process—inflammation of the airways and bronchospasm—and the signs and symptoms requiring a return to the ED. A report of Jonah's visit was faxed to Jonah's primary care provider, and his mother was instructed to follow up within 48 hours.

A follow-up visit with a primary care provider is essential to reinforce adherence to the written asthma action plan, address control of exposure to possible asthma triggers in the patient's environment, and determine whether to "step up" the therapy. At Children's Hospital Boston, nurses attempt to call back the caregivers of all moderate-to-severe asthmatics within 24 hours after discharge to encourage follow-through on asthma discharge plans.

The day after Jonah's visit, a staff nurse made a follow-up call to his mother to make sure that she'd filled the prescriptions and had scheduled a follow-up appointment. The nurse was delighted to hear that Jonah was much improved and hadn't relapsed. Our ED case managers also contacted Jonah's health insurer's asthma disease management education program, an added resource with which they could address any other barriers.

EDs play an important role in the care of children with asthma. ED clinicians often treat families who don't have a consistent relationship with a primary care provider. Given this opportunity, it's essential that all members of the pediatric ED health care team be informed, educated, and updated on the latest asthma treatment guidelines to ensure best practice and high quality outcomes. ▼

Diana I. Volpe is a staff nurse III and nurse patient safety leader in the ED at Children's Hospital Boston, where Mary Fallon Smith is a nurse case manager and Kathleen Sultan is a staff nurse. Contact author: Mary Fallon Smith, mary.fallonsmith@childrens.harvard.edu. Emergency is coordinated by Polly Gerber Zimmermann, MS, MBA, RN, CEN: pollyzimmermann@msn.com.

REFERENCES

1. National Heart Lung and Blood Institute. *Expert panel report 3 (EPR3): guidelines for the diagnosis and management of asthma*. National Institutes of Health. 2007. <http://www.nhlbi.nih.gov/guidelines/asthma/asthgdln.htm>.
2. Boudreaux ED, et al. Race/ethnicity and asthma among children presenting to the emergency department: differences in disease severity and management. *Pediatrics* 2003;111(5 Pt 1):e615-e621.
3. Stingone JA, Claudio L. Disparities in the use of urgent health care services among asthmatic children. *Ann Allergy Asthma Immunol* 2006;97(2):244-50.
4. Walsh-Kelly CM, et al. Emergency department revisits for pediatric acute asthma exacerbations: association of factors identified in an emergency department asthma tracking system. *Pediatr Emerg Care* 2008;24(8):505-10.
5. Hsiao AL, Shiffman RN. Dropping the baton during the handoff from emergency department to primary care: pediatric asthma continuity errors. *Jt Comm J Qual Patient Saf* 2009;35(9):467-74.
6. Zorc JJ, et al. Scheduled follow-up after a pediatric emergency department visit for asthma: a randomized trial. *Pediatrics* 2003;111(3):495-502.
7. U.S. Food and Drug Administration. *Transition from CFC propelled albuterol inhalers to HFA propelled albuterol inhalers: questions and answers*. 2008. <http://www.fda.gov/Drugs/ResourcesForYou/Consumers/QuestionsAnswers/ucm077808.htm>.
8. Gorelick M, et al. Predicting need for hospitalization in acute pediatric asthma. *Pediatr Emerg Care* 2008;24(11):735-44.
9. Norton SP, et al. Effect of a clinical pathway on the hospitalisation rates of children with asthma: a prospective study. *Arch Dis Child* 2007;92(1):60-6.
10. Ly CD, Dennehy CE. Emergency department management of pediatric asthma at a university teaching hospital. *Ann Pharmacother* 2007;41(10):1625-31.
11. Boyd M, et al. Interventions for educating children who are at risk of asthma-related emergency department attendance. *Cochrane Database Syst Rev* 2009(2):CD001290.
12. Chey T, et al. Validation of a predictive model for asthma admission in children: how accurate is it for predicting admissions? *J Clin Epidemiol* 1999;52(12):1157-63.
13. Karpel JP, et al. Emergency treatment of acute asthma with albuterol metered-dose inhaler plus holding chamber: how often should treatments be administered? *Chest* 1997;112(2):348-56.
14. Rodrigo C, Rodrigo G. Therapeutic response patterns to high and cumulative doses of salbutamol in acute severe asthma. *Chest* 1998;113(3):593-8.
15. Strauss L, et al. Observations on the effects of aerosolized albuterol in acute asthma. *Am J Respir Crit Care Med* 1997;155(2):454-8.
16. McFadden ER, Jr. Acute severe asthma. *Am J Respir Crit Care Med* 2003;168(7):740-59.
17. Rowe BH, et al. Corticosteroid therapy for acute asthma. *Respir Med* 2004;98(4):275-84.
18. Kasper WJ, Howe PM. Fatal varicella after a single course of corticosteroids. *Pediatr Infect Dis J* 1990;9(10):729-32.
19. Silk HJ, et al. Fatal varicella in steroid-dependent asthma. *J Allergy Clin Immunol* 1988;81(1):47-51.
20. Plotnick LH, Ducharme FM. Combined inhaled anticholinergics and beta2-agonists for initial treatment of acute asthma in children. *Cochrane Database Syst Rev* 2000(4):CD000060.
21. Sole D, et al. Pulse oximetry in the evaluation of the severity of acute asthma and/or wheezing in children. *J Asthma* 1999;36(4):327-33.
22. Sin DD, Man SF. Low-dose inhaled corticosteroid therapy and risk of emergency department visits for asthma. *Arch Intern Med* 2002;162(14):1591-5.
23. Irwin RS, Richardson ND. Patient-focused care: using the right tools. *Chest* 2006;130(1 Suppl):73S-82S.
24. Orrell-Valente JK, et al. Parents' specific concerns about daily asthma medications for children. *J Asthma* 2007;44(5):385-90.