

Primary Objective

To provide guidance on the management of acute asthma symptoms for patients across the Children's Hospital & Medical Center continuum (including Children's Physicians clinics, Urgent Care, CHMC Emergency Department and Medical-Surgical Inpatient Units) based on review of current literature and evidence-based practice.

Recommendations

1. An updated respiratory score (RS) will provide more accurate guidance for advancing clinical care. We have chosen a validated scoring system that is utilized at another institution. This tool does not use oxygen saturation as part of its score. It also has tighter, age-based cut-offs for respiratory rate. Use of this tool will be standardized across all areas.
2. Dexamethasone will be the treatment of choice for systemic steroids in the Emergency Department.
3. Metered-dose inhalers with AeroChambers are the preferred method for albuterol delivery.
4. Magnesium sulfate IV will now be given as a larger dose and the rate of infusion will be standardized across areas.
5. Guidance on terbutaline dosing and use has been added as an option for ED patients who remain severe after initial management with a combined albuterol/IB neb and steroids. Use is restricted to ED and ICU secondary to concerns about cardiotoxicity.

Inclusion Criteria:

1. Child with diagnosis of asthma presenting with cough, wheeze, or respiratory distress.

Exclusion Criteria:

1. Chronic lung disease other than asthma (such as Bronchopulmonary Dysplasia, Cystic Fibrosis, restrictive lung disease).
2. Airway anomalies
3. Acquired or congenital heart disease
4. Neuromuscular disorder
5. Medically complex children
6. Immune disorders
7. Sickle cell disease
8. Children with pneumonia, bronchiolitis, or croup as their primary diagnosis.

Rationale (Safety, Quality, Cost, Delivery, Engagement & Satisfaction)

Safety and Quality: Will be enhanced by utilizing consistent terminology, dosing and approach to care between ED, Inpatient, and subspecialty and outpatient providers along with their nursing, respiratory therapy and case management staff. A pathway will also reinforce that all Children's providers deliver care based on the NHLBI guidelines and the latest evidence and sends a consistent message to patients, families, and their outside providers.

Cost: Will be controlled by reducing time spent in the ED prior to admission, encouraging use of MDIs over nebulizers, decreasing LOS, improving use of controller medications, and by improving care coordination across the institution. "Multidisciplinary clinical pathways for asthma appear to be effective in reducing hospital length of stay and inpatient costs"¹.

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Delivery: Will be improved by expediting patient flow through the Emergency Department to the Inpatient floor for providers, RNs and RTs.

Engagement: Is created and supported by the involvement of a multidisciplinary team in the development and maintenance of the pathway, which includes MDs, RTs, RNs, case managers, and pharmacy staff.

Patient/Family Satisfaction: Shall be improved by providing the highest quality care based on established guidelines and having all members of the health care team delivering a consistent message to patient families.

Review of Medications

Short Acting Beta Agonists: This committee reviewed the dosing recommendations and side effects of continuously nebulized albuterol. There is no clear evidence that there is an optimal dose, many recommend between 0.5-1mg/kg/hr. Increasing albuterol dose will cause greater bronchodilation (until receptor saturation), but will also result in worsening tachycardia and hypokalemia⁸. Continuous albuterol can also result in diastolic hypotension within the first 6 hours of administration which can be related to the total dose of albuterol received^{13,14}. Fluid administration prior to initiation of continuous albuterol decreased odds of developing hypotension¹⁴. Patients may also develop elevated troponins and/or ST segment changes, especially with prolonged use of continuous albuterol, though these improved within the study period¹³. There is no role for levalbuterol for management of asthma exacerbations. Albuterol results in greater improvement in FEV₁ at 1 hour and there is no significant difference in changes in HR, RR, oxygen saturation or rate of admission between the two^{11,12}.

Ipratropium bromide: This committee reviewed the literature regarding ipratropium bromide use in acute asthma exacerbations and status asthmaticus. Initial therapy with albuterol plus ipratropium bromide in patients with severe asthma exacerbations is supported by the literature to reduce rates of hospitalization.¹⁷ It is also proven to improve clinical scores, oxygen saturation, and decrease need for additional bronchodilators during the initial phase of treatment for patients with moderate asthma exacerbations.²² For hospitalized patients receiving continuous albuterol the addition of ipratropium bromide is inadequately studied and no data is available to support or refute a clinician's practice. Once hospitalized patients are able to be placed on intermittent scheduled albuterol, the use of ipratropium is not supported by the literature^{18,19,23}. This includes no significant differences in clinical asthma scores, length of stay, progression through asthma pathways, or requirements for additional therapies. While the current literature has not shown that IB impacts these outcomes there are many limitations to these studies and may be a source of future research.

Systemic Steroids:

ED Studies: Dexamethasone has shown to be non-inferior to prednisolone based on lack of difference in number of hospital admissions, mean pediatric respiratory assessment measure on day 4, requirement for additional steroids, vomiting, unscheduled return visits within 14 days, rate of relapse, B-agonist use in ED, days of restricted activity, school days missed or parent work days missed^{25,29,31}. This study

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did not include “severe exacerbations.” However, it is notable that there were higher rates in albuterol use on days 4 and 5 with dexamethasone. A separate study did report a modest reduction in vomiting in both the ED and at home with dexamethasone vs. prednisolone²⁹. A Cochrane review also showed no difference in both adults and children in rates of admission, symptom resolution at 3 days, or new exacerbation during the follow-up period²⁶. While the clinical evidence shows little difference between the two forms, there are cost and convenience savings in using dexamethasone: decreased direct cost to family, total cost of care, and improved compliance^{30,31}.

Inpatient: There is very little literature regarding dexamethasone vs. prednisolone in the inpatient setting. One multicenter retrospective cohort study found no difference in readmission rates, however, did report both shorter length of stay and lower cost with dexamethasone²⁴. However, the dosing regimens were not standardized. A five-day course of prednisolone remains the recommendation for moderate-severe exacerbations, though a two-day course of dexamethasone could be considered a reasonable alternative²⁴. Further studies are needed to further establish dexamethasone’s efficacy. Specifically, regarding dosing, frequency, and duration.

Magnesium Sulfate: This committee reviewed the dosing guidelines and side effects of IV magnesium sulfate in acute asthma exacerbations and status asthmaticus. If there is not sufficient response to SABAs or a combination nebulization of albuterol and ipratropium bromide, IV Magnesium sulfate may be administered at 50mg/kg (maximum 2g) over 20 minutes after administering a 20ml/kg bolus of normal saline. There is a dose-dependent effect with improved clinical outcomes when serum concentration rises above 4mg/dL^{32,39}. A dose of 20mg/kg has been shown to not reliably achieve this supraphysiologic concentration³⁴. The most common side effects of flushing and vomiting are not associated with serum Mg level and therefore should not determine dose used for treatment³⁶. Increasing dose beyond 50mg/kg has yet to show additional clinical benefit^{37,38}. The patient should be monitored for hypotension with this infusion^{33,34,40}. Hypotension is more likely if the bolus is given in under 20 minutes³³. With the relatively short half-life of 2.7 hours and most patients returning to baseline concentrations between 4-6 hours after administration³⁴, repeat doses can be given every 6 hours. This should not be used if the patient has a CrCl <30mL/min, neuromuscular conditions such as myasthenia gravis, AV block or myocardial conditions⁴⁵.

Implementation Items

1. CP Smart sets
2. ED and Inpatient Algorithms
3. ED and Inpatient Order Sets
4. Asthma Pathway Training Module for ED nurses
5. Asthma Pathway Training Session for RTs
6. Asthma History Tool for admission
7. Stepwise Approach to Managing Asthma
8. Asthma, Allergy & Pulmonology Guidelines for Referrals

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Children's Physicians & Urgent Care Management

Metrics:

1. A follow up asthma exacerbation appointment will be set up prior to the child leaving the office. A report will be developed which tracks whether the appointment is made and if the appointment was kept. For those No showing the appointment; the social worker or case manager will follow up to work with the family to set up and keep the next appointment.
2. The first dose of corticosteroid will be given during the asthma exacerbation visit.

Emergency Department

Metrics:

1. Decrease the amount of time to first dose of steroids (goal 60 minutes)
2. Will measure time from triage to steroid administration.
3. Decrease rate of CXR utilization (goal < or equal to 15%)
4. riteria for obtaining a CXR should be suspicion of foreign body, failure to improve with initial treatment, or focal lung findings
5. Metrics report will include RN initiated pathway orders for all patients that have some type of "asthma" listed as a primary diagnosis. Patients must either receive a steroid or a dose of albuterol to be included in the report. Children < 2 are excluded from the report. An ED team member will audit charts from the report monthly.

Overview:

1. Triage nurses will perform a brief history and physical exam and inform respiratory therapy (RT) and the ED provider when there is a patient with a severe exacerbation. The respiratory score (RS) will be documented before and after treatments. The RS will help guide providers through the pathway and demonstrate responsiveness to interventions.
2. The RN will confirm that patients meet the inclusion criteria without having any exclusion criteria before initiating the pathway.
3. RNs will follow the ED Evidence-Based Orders policy for RN-initiated treatment after triage, which includes specific Inclusion Criteria and dosing for RN initiation of treatment.
4. RT will provide respiratory treatments; nursing will be trained on how to give these treatments if RT is delayed or unavailable.
5. Our goal is to have nursing provide the first steroid dose immediately after the patient has been triaged, prior to beginning the first inhaled treatment for all patients that meet criteria for initiation of a steroid.
6. Repetitive administration of SABAs produces incremental bronchodilation. By providing three doses as part of a large nebulized treatment, we will insure that patients receive those doses in a timely manner and make our RTs available to treat more patients. As 60-70% of patients have sufficient response to this type of initial treatment to be discharged, we will make this standard therapy for any patient presenting with a moderate-severe exacerbation and reassess their response one hour after treatment. 1
7. Adding multiple doses (2-3) of ipratropium bromide to a selective SABA produces additional bronchodilation, resulting in fewer hospitalizations, in the ED setting. We have selected a double dose based on Qureshi 1998. The combination of 3 doses of albuterol with 2 doses of ipratropium bromide may be referred to as "Unineb" or weight-based multi-dose nebulizer treatment

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8. All patients who receive a combination nebulizer treatment will be re-assessed within 60 minutes of the completion of their treatment. Response to this initial treatment has been shown to be a better predictor of the need for hospitalization than the initial presentation (Evidence A)1. If patients have had good response and are “mild,” they will be discharged unless they continue to be hypoxic or have a concurrent issue necessitating admission. If the patient remains moderate-severe, they will be continued on scheduled albuterol according to their severity level and be admitted to the appropriate location.
9. Serial pulse oximetry measurements will be assessed to help determine response to therapy and need for admission along with clinical improvement and RS. An initial spot pulse oximetry is useful for assessing exacerbation severity, but not for predicting need for hospitalization.72,80-83 A repeat pulse oximetry of <92% 60 minutes after initial therapy is a better predictor (NHLBI Guidelines p.379).80-82 Oxygen will be provided for patients to keep saturations equal to or above 90% per the Oximetry Protocol.
10. We will attempt to make disposition decisions within 4 hours based on the patient’s reassessment and need for repeat albuterol after their steroid dose and initial SABA (IB) treatment.
11. Studies have shown that initiating inhaled corticosteroids (ICS) at ED discharge can have a significant reduction in the risk of subsequent ED visits or relapse events.57,58 Patients who are not on long-term control therapy will be evaluated for whether it is indicated by utilizing the Asthma Control Test (<http://www.asthma.com/additional-resources/asthma-control-test.html>). Patients who may benefit from an ICS will be requested to follow with their PCP or be referred to either pulmonology or an allergy and asthma group for further evaluation. ED provider may also consider prescribing a 1-2 month supply of an ICS at discharge to bridge the gap to primary care. All patients discharged from the ED will be asked to follow with their PCP within 5-7 days and a pulmonologist or asthma & allergy specialist in 1-4 weeks if indicated.
12. Patient and family education will be performed with RT prior to discharge, which will include how to use a metered dose inhaler (MDI) with spacer and possibly a peak flow meter.

Inpatient Management

Metrics:

1. Decrease LOS
2. Improve advancement of patients when they are medically ready by measuring duration of time in each phase of treatment
3. Maintain the number of transfers to PICU
4. Monitor use and time to administration of magnesium sulfate

Overview:

1. Upon arrival on the floor, the patient will be assessed by a provider and a respiratory therapist. The RT will assign a RS and the provider will select where on the pathway to start the patient on: “Severe,” “Moderate,” or “Mild.” RTs will continue treatments scheduled from the ED until a pathway is selected and then will follow the Inpatient Pathway once ordered.
2. If a patient has not received IB prior to admission, a combination treatment with albuterol may be given as per the ED pathway.
3. The provider will use the EPIC order sets to place where a patient begins on the pathway. If the team does not want to use the dosing or schedule built in to pathway, then the patient

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will not be placed on the pathway and the order set should not be used. The provider will also select whether they want the patient on the RT weaning protocol or not at that time. RS will be performed before and after treatments at intervals as defined by their pathway level.

4. All patients will have a full asthma history obtained on admission using the Asthma History Tool. Based on the patient's history, all patients will be evaluated as to whether they are on proper controller medications.
5. Nursing and physician will screen for smoke exposure upon admission. Positive screens will receive an educational handout at discharge, cessation counseling from the provider, and referral to the NE Quitline when amendable.
6. When a patient is deemed ready to advance on the pathway, for the non-RT driven protocol, the RT will inform the provider who will be expected to assess the patient and advance their orders in a timely fashion. For the RT-driven protocol the RT may advance the patient per the protocol based on their RS and clinical assessments.
7. If a patient is not responding to their treatments, the provider should be notified by RT and/or nursing. Adjunctive therapy should be considered, or the patient should be escalated on the pathway. Patients who are not responsive and are "severe" will be considered for transfer to the PICU if they are have worsening mental status, increasing oxygen requirements, or are not responsive to adjuvant therapy.
8. Throughout the patient's hospital stay, RT will work on asthma teaching with the family, including how to effectively use an MDI with a spacer. At discharge, an Asthma Action Plan will be created for all patients by the primary team and taught to the family by RT.

Team Members

- Dr. Lauren Maskin (Pediatric Hospital Medicine)
- Dr. Nathaniel Goodrich (Pediatric Hospital Medicine)
- Dr. Jason Burrows (Pediatric Hospital Medicine)
- Dr. Aleisha Nabower (Pediatric Hospital Medicine)
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- Dr. Tom Deegan (Emergency Medicine)
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- Lindsay Hattan (Information Technology)
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Evidence

General

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Role of Clinical Care Pathways

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Continuous Albuterol

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Ipratropium Bromide

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Corticosteroids

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Magnesium Sulfate

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Terbutaline

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Controllers

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Other Institutional Pathways

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60. Asthma Clinical Care Guideline for Children’s Hospital/Kaiser/Denver Health, 2009
61. University of Rochester Medical Center Pediatric Asthma Clinical Care Pathway 4/1/13
62. Seattle Children’s Asthma 3.0 Executive Summary 12/7/12

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Asthma Scoring Systems

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