ASTHMA CLINICAL PATHWAY

EXECUTIVE SUMMARY

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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

- **Respiratory Score (RS):** An RS provides guidance for advancing clinical care. We have selected a validated scoring system from another institution that will be implemented in all patient care areas. This tool has age-based thresholds for respiratory rate and does not factor oxygen saturation into the score. All patients will be scored before and after albuterol treatments to gauge illness severity, progression on the pathway, and bronchodilator responsiveness.
- **Medications:**
  - Dexamethasone is the preferred systemic steroid in the ED.
  - A metered-dose inhaler with an AeroChamber (Spacer) is the preferred method for albuterol administration, regardless of age.
  - Intravenous magnesium sulfate is to be administered at a larger dose (compared to replacement therapy) and standardized infusion rate.
  - Terbutaline indications and dosing are provided for ED patients who remain in severe respiratory distress after an initial combination therapy of albuterol, ipratropium bromide, and steroids.
    - Use is restricted to ED and ICU secondary to cardiotoxicity risks.
- **Assessment for need for controller therapy:** ED patients will be assessed with an Asthma Control Test to determine need for ICS therapy prior to discharge. EPR-4 guidelines will be used by inpatient teams to determine need for controller therapy or specialist follow-up. (http://www.asthma.com/additional-resources/asthma-control-test.html)

Inclusion Criteria:

- Child with an asthma diagnosis, or presenting with cough, wheeze, or respiratory distress consistent with bronchospasm.

Exclusion Criteria:

- Chronic lung disease, other than asthma:
  - Bronchopulmonary dysplasia
  - Cystic fibrosis
  - Restrictive lung disease, etc.
- Obstructive sleep apnea
- Tracheostomy/airway anomalies
- Unrepaired or residual Congenital heart defect or previous ECMO
- Neuromuscular disorder
- Medically complex children
- Immune disorders
- Sickle cell disease

- Patients on HHF pathway or croup protocol

MEDICATION REVIEW

Short-Acting Beta-Agonists (SABAs): The committee reviewed dosing recommendations and side effects of nebulized albuterol. There is no clear evidence on optimal dosing, though many recommend between 0.5-1mg/kg/hr. Higher doses cause greater bronchodilation until receptor saturation but also result in increased side effects of tachycardia, hypokalemia, and diastolic hypotension (especially within first six hours of administration).[8, 13, 14] **The lowest dose to achieve bronchodilator effect should be used (typically 0.5mg/kg/hr)**. Fluid administration prior to albuterol initiation decreased the risk of hypotension development.[14] Other notable side effects related to prolonged use of continuous albuterol include elevated troponins and/or ST segment changes, though these improved within the study period. [13] In comparison to levalbuterol, albuterol results in greater improvement in FEV at one hour, and there is no significant difference in vital signs (heart rate, respiratory rate, or oxygen saturation) or admission rate; therefore, levalbuterol is not indicated for use in asthma exacerbations. [11, 12]

Ipratropium Bromide (IB): The committee reviewed indications for ipratropium bromide in acute asthma exacerbations and status asthmaticus. **Combination therapy of albuterol and IB in the ED setting in patients with severe exacerbations has been shown to reduce hospitalization rates.**[17] It has also proven to improve RS and oxygen saturations while reducing escalation in bronchodilator during the initial treatment phase in patients with moderate exacerbations.[22] There is insufficient evidence to support or refute the use of continuous albuterol and IB in hospitalized patients; once patients transition from continuous to intermittent scheduled albuterol, evidence suggests IB is not indicated. [18, 19, 23] The literature reports no signification difference in RS, length of stay, progression through asthma pathways, or escalation of therapies with the use of IB, although additional research may be warranted.

Systemic Steroids:

- ED Studies: It has long been accepted that initiation of systemic steroids within the first hour of presentation to the ED significantly reduces the need for hospital admission in pediatric patients with acute asthma exacerbations.[29] **We recommend a single dose of dexamethasone at 0.6 mg/kg within the first hour with a max of 16 mg**. The initial effects of systemic steroids are noted at 2 hours with maximal effects closer to 6 hours.[30] Dexamethasone has grown in favor of oral prednisone/prednisolone over the years due to many reasons.[31] Dexamethasone is 5-6 times more potent than prednisone and has a half-life of 36-72 hours, thus requiring fewer doses to achieve similar results.[28] Benefits of dexamethasone are found when comparing cost savings of a shorter course, palatability, improved compliance, and fewer side effects such as vomiting. [28, 32, 33] Multiple authors have concluded the benefits of using single or 2-dose regimens of dexamethasone as a viable alternative to a 5-day course of prednisone.[31, 32, 34, 35, 36] A meta-analysis published in 2021 in Pediatric Emergency Care combined results of 10 studies to again conclude there were no differences between the groups receiving dexamethasone vs prednisone/prednisolone in hospitalization rate, ED revisit rate, and hospital admission rate after relapse.[37] Historically, many of the retrospective studies have compared a single IM injection of dexamethasone, a single dose of oral dexamethasone vs a 2-dose oral regimen. By definition, a single dose dexamethasone option ensures 100% patient compliance. A recent 2022 prospective, randomized study published in Pediatric Emergency Care showed there was no difference in the rate of return visits for continued or worsening symptoms between patients randomized to one or

two doses of oral dexamethasone.[38] *This further supports the option of a single dose of 0.6 mg/kg (max 16 mg) oral dexamethasone for treatment of acute asthma exacerbations.*

- Inpatient Studies: There is limited evidence regarding dexamethasone and prednisolone in the inpatient setting. One multicenter retrospective cohort study found no difference in readmission rates but did report decreased length of stay (LOS) and cost with dexamethasone; however, the dosing was not standardized.[27] Another multi-institutional retrospective study found no difference in LOS if steroids were initiated before admission, while a shorter LOS was noted if steroids were initiated at the time of admission. They found no difference in PICU transfer rates, ED revisits and hospital readmissions among the groups.[39] Our own data at CHMC demonstrates similar findings with no difference in LOS, RS scores, or escalation of asthma care between those that received DEX only, PRED only, or a DEX-PRED combo, though patients receiving a DEX-PRED combo are more likely to receive ipratropium.[26] *As such* ***a two-day course of dexamethasone, or an initial dose of dexamethasone followed by prednisolone for the remaining 4 days, could be considered reasonable alternatives****,* with further prospective non-inferiority studies needed to determine the optimal course, including recommendations regarding dosing and duration guidelines.

Magnesium Sulfate: This committee reviewed the dosing guidelines and side effects of intravenous magnesium sulfate in acute asthma exacerbation and status asthmaticus. **If there is insufficient response to SABAs or a combination nebulization of albuterol and IB, intravenous magnesium sulfate may be administered at 50mg/kg (maximum 2g) over 20 minutes following a 20ml/kg normal saline fluid bolus** (pre-hydration to increase preload and minimize risk of developing hypotension). There is a dose-dependent effect with improved clinical outcomes when serum concentration rises above 4mg/dL, and a dose of 20mg/kg has not shown to reliably achieve this supraphysiologic concentration.[40, 41, 46] In addition, a dose above 50mg/kg has not been shown to provide clinical benefit.[43, 44] The most common side effects of flushing and vomiting are not associated with a serum magnesium level and therefore should not drive clinical decision making on dosing. [43] The recommended administration time is 20 minutes; faster rates have shown to increase the risk of hypotension.[38, 41, 47] Repeat doses can be administered every six hours, based on the half-life (2.7 hours) and return-to-baseline concentrations (4-6 hours).[42] Magnesium sulfate should not be used in patients with creatinine clearance <30mL/min, neuromuscular diagnoses (such as myasthenia gravis), AV block, or a myocardial conditions.[52]

Radiology Criteria:
We do not recommend routine ordering of chest x-rays (CXR) in patients presenting with an acute asthma exacerbation. There have been numerous studies that have shown overall low yield in this situation.[54, 55, 56, 57, 58, 59, 60, 61] Often, diagnostic testing adds little to the management of these patients and results in unnecessary costs and radiation exposure. A 2005 study by Buckmaster and Boon showed that nearly 45% of children receiving treatment for acute asthma exacerbation had an unnecessary CXR performed.[61] The National Heart, Lung, and Blood Institute's asthma guidelines recommend reserving CXRs for children with severe disease or presentations suggestive of conditions such as pneumonia, pneumothorax, or pneumomediastinum.[53, 62] *The guidelines for obtaining a CXR in asthmatic patients are often referred to as the 4 Fs:* ***F****ever,* ***F****ocal lung findings, concern for* ***F****oreign body, and* ***F****ailure to improve*. [62, 63] These guidelines, however, pose some challenges to clinicians. For example, children experiencing an asthma exacerbation often have concomitant viral infections resulting in fever. In addition, focal lung examination findings are often due to atelectasis caused by mucous plugging and not

lower airway infection.[66, 65] Bacterial superinfection is rare in asthma, and apparent infiltrates on CXRs are often atelectasis.[62, 63] When imaging is obtained, it is not uncommon to see areas of consolidation, either lobar or segmental. These consolidations are usually due to obstruction of airways by secretions but may be misinterpreted as pneumonia resulting in unnecessary antibiotic administration.[65] In light of this, *do not routinely order chest x-rays in asthma patients*.

EMERGENCY DEPARTMENT MANAGEMENT

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 the patient meets the inclusion criteria (without having any exclusion criteria) before initiating the pathway.
3) The RN 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) The RT will provide respiratory treatments; nursing will be trained in how to give these treatments if RT is delayed or unavailable.
5) **The 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 ensure 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 IB 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.[18] **The combination of 15 mg of albuterol with two vials of 0.02% ipratropium bromide (500 mcg/2.5 mL) may be referred to as a High-Dose Combination Neb (aka "combo neb")**. Patients under 10 kg receive 7.5 mg albuterol with 1 vial of 0.02% IB (500 mcg).
8) All patients who receive a combo neb will be reassessed within 60 minutes of their treatment's completion. 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, clinical improvement and RS, and admission requirements. An initial spot pulse oximetry is useful for assessing exacerbation severity but not for predicting need for hospitalization.[91, 99, 100, 101, 102] A repeat pulse oximetry of <92% 60 minutes after initial therapy is a better predictor (NHLBI Guidelines p.379).[99, 100, 101] Oxygen will be provided for patients to keep saturations equal to or above 90% while in the ED.
10) We will attempt to make disposition decisions within four hours based on the patient's reassessment and need for repeat albuterol after the 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.[30, 76] 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

1) Upon arrival on the floor, the patient will be assessed by a provider and a respiratory therapist (RT). The RT will assign a RS and the provider will select where the patient falls on the pathway: “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 per the ED pathway.
3) The provider will use the EPIC order set to place where a patient begins on the pathway and the care will be advanced as the patient improves based on an RT-driven weaning protocol for albuterol. If the team does not want to use the dosing or schedule built into the pathway, the order set can still be used without the RT weaning protocol. 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, .asthmahistorytool**. Based on the history, all patients will be evaluated as to whether they are on proper controller medications.
5) The nurse 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 their state Quitline when amendable.
6) **For the RT-driven protocol the RT may advance the patient per the protocol based on their RS and clinical assessments with an Voalte FYI message to the primary team.** For patients not on the protocol, the RT will notify the provider when the RS is improving, and the provider will be expected to assess the patient and advance their orders promptly.
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 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 (AAP) will be created for all patients by the primary team and taught to the family by RT.

IMPLEMENTATION ITEMS

- CP Smart Sets

- ED and Inpatient Algorithms
- ED and Inpatient Order Sets
- Asthma Pathway Training Module for ED Nurses
- Asthma Pathway Training Session for RTs
- Asthma History Tool for Admission
- Asthma Action Plan Tip Sheet
- Abbreviated EPR-4 and Pulmonology Referral Guidelines
- At-A-Glance Guidelines

Rationale

- Safety and Quality will be enhanced by utilizing consistent terminology, dosing, and treatment plans between ED, inpatient, and subspecialty/outpatient providers along with their nursing, respiratory therapy, and case management staff. A pathway will also reinforce that all Children's providers deliver evidence-based care in line with the NHLBI Guidelines.
- 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 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].
- Engagement is created and supported by the involvement of a multi-disciplinary team in the development and maintenance of the pathway, which includes MDs, RNs, RTs, 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 deliver a consistent message to patient families.

Metrics

Children's Physicians & Urgent Care Management – in progress

Emergency Department

Outcome Metrics

1. Decrease the median time from triage to steroid administration to less than 60 minutes by September 2023.
2. Maintain rate of chest x-ray utilization (goal ≤15%) by September 2023.

Process Metrics

3. Maintain utilization of ED asthma order set ≥ 80% by September 2023.

Balancing Metrics

4. Monitor number of patients that return within 72 hours and if they received steroids on revisit.

Inpatient

Outcome Metric

1. Maintain LOS ≤ 33 hours (10% decrease from baseline) by September 2023.
2. Increase the proportion of patients being screened for smoke exposure to 80% by September 2023.

3. Increase the proportion of patients with smoke exposure documented that were counseled on quitting in notes to 50% by September 2023.

Process Metric:

1. Increase utilization of RT wean order set ≥75% by September 2023.
2. Increase Asthma order set utilization at ≥80% by September 2023.

Balancing Metric

1. Monitor number or return visits for asthma within 7-days to ED and readmissions within 30 days.
2. Monitor number of PICU transfers during hospitalization.

Team Members

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- Abby Vipond MSN, APRN, FNP-C (Clinical Effectiveness)
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Evidence

General

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Role of Clinical Care Pathways

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