**Inclusion Criteria**
- 1-18 y.o with asthma exacerbation admitted to general medicine service

**Exclusion Criteria**
- Acute Illnesses
  - Patients with pneumonia, bronchiolitis, or croup as their primary diagnosis
- Chronic Conditions:
  - Chronic lung disease: (e.g. cystic fibrosis, restrictive lung disease, bronchopulmonary dysplasia)
  - Cardiac disease requiring baseline medication
  - Airway Issues: (e.g. vocal cord paralysis, tracheomalacia, tracheostomy dependent)
  - Medically complex children
  - Immune disorders
  - Sickle cell anemia

---

### RESPIRATORY SCORE (RS)

<table>
<thead>
<tr>
<th>Variable</th>
<th>0 points</th>
<th>1 points</th>
<th>2 points</th>
<th>3 points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2 mo</td>
<td>≤60</td>
<td></td>
<td>61-69</td>
<td>≥70</td>
</tr>
<tr>
<td>2-12 mo</td>
<td>≤50</td>
<td></td>
<td>51-59</td>
<td>≥60</td>
</tr>
<tr>
<td>1-2 yr</td>
<td>≤40</td>
<td></td>
<td>41-44</td>
<td>≥45</td>
</tr>
<tr>
<td>2-3 yr</td>
<td>≤34</td>
<td></td>
<td>35-39</td>
<td>≥40</td>
</tr>
<tr>
<td>4-5 yr</td>
<td>≤30</td>
<td></td>
<td>31-35</td>
<td>≥36</td>
</tr>
<tr>
<td>6-12 yr</td>
<td>≤26</td>
<td></td>
<td>27-30</td>
<td>≥31</td>
</tr>
<tr>
<td>&gt;12 yr</td>
<td>≤23</td>
<td></td>
<td>24-27</td>
<td>≥28</td>
</tr>
<tr>
<td><strong>Retractions</strong></td>
<td>None</td>
<td>Subcostal or intercostal</td>
<td>2 of the following: subcostal, intercostal, substernal, OR nasal flaring (infant)</td>
<td>3 of the following: subcostal, intercostal, substernal, suprasternal, supraclavicular OR nasal flaring / head bobbing (infant)</td>
</tr>
<tr>
<td><strong>Dyspnea</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-2 years</td>
<td>Normal feeding, vocalizations and activity</td>
<td>1 of the following: difficulty feeding, decreased vocalization or agitated</td>
<td>2 of the following: difficulty feeding, decreased vocalization or agitated</td>
<td>Stops feeding, no vocalization, drowsy or confused</td>
</tr>
<tr>
<td>2-4 years</td>
<td>Normal feeding, vocalizations and play</td>
<td>1 of the following: decreased appetite, increased coughing after play, hyperactivity</td>
<td>2 of the following: decreased appetite, increased coughing after play, hyperactivity</td>
<td>Stops eating or drinking, stops playing, OR drowsy and confused</td>
</tr>
<tr>
<td>&gt;4 years</td>
<td>Counts to ≥10 in one breath</td>
<td>Counts to 7-9 in one breath</td>
<td>Counts to 4-6 in one breath</td>
<td>Counts to ≤3 in one breath</td>
</tr>
<tr>
<td><strong>Auscultation</strong></td>
<td>Normal breathing, no wheezing present</td>
<td>End-expiratory wheeze only</td>
<td>Expiratory wheeze only (greater than end-expiratory wheeze)</td>
<td>Inspiratory and expiratory wheeze OR diminished breath sounds OR both</td>
</tr>
</tbody>
</table>
Supplemental O2 should be administered to keep O2 saturation > 90%

1st HOUR (ED)

- RS 1-5
  - **Albuterol** MDI 8 puffs
  - **Dexamethasone** 0.6 mg/kg x 1 (16 mg max)

2nd HOUR (ED)

- RS 1-4
  - If first hour RS 1-5, discharge
  - Albuterol MDI 8 puffs

3rd HOUR (ED)

- RS 1-4
  - **Albuterol** MDI 8 puffs
  - Give **Ipratropium** neb 1.5 mg (0.75 mg for <2 yo) if not given
  - Determine disposition

4th HOUR (ED)

- RS 1-8
  - **Albuterol** continuous neb 20 mg/hr x 1 hr

Assess and Score at end of 1st hour

Assess and Score at end of 1st hour

Assess and Score at end of 2nd hour

Assess and Score at end of 3rd hour

Assess and Score at end of 4th hour

**Urgent Care Transfer Criteria**
- Score >8 following first hour of nebulized albuterol- send by ALS
- Score 5-8 following 8 puffs of albuterol in second hour- send by ALS
- Signs of clinical deterioration or poor clinical response to therapy

**ED Discharge Criteria**
- RS 1-4 for minimum of 1 hour
- (Patients with an initial RS of 10-12 should be observed for 2 hours prior to discharge)
- Shared decision making in hour 3 for RS 5-8
- Tolerating oral intake
- Adequate family teaching
- Follow-up established

**Discharge Instructions**
- Continue to use albuterol MDI every 4 hours until seen by provider
- Follow up with provider within 24-48 hours (when possible)
Asthma v9.0: Inpatient Management

**PHASE II: INPATIENT**
- **Albuterol** continuous neb 20 mg/hr (maximum on floors)
- Assessment q 1 hour
- Advance after 1 hr of treatment for score 1-8

**PHASE III: INPATIENT**
- **Albuterol** MDI 8 puffs q 2 hours
- Assessment q 2 hours
- Begin discharge teaching and planning

**PHASE IV: INPATIENT**
- **Albuterol** MDI 8 puffs q 4 hours
- Assessment q 4 hours

**PHASE V: INPATIENT**
- **Albuterol** MDI 4 puffs q 4 hours
- Assessment q 4 hours

**Discharge Instructions**
- **Discharge With Asthma Management Plan**
  - “Living with Asthma” book
  - Follow-up with PCP in 24-48 hours (when possible)

**Discharge Criteria**
- In Phase V with RS 1-4
- Observe for minimum of 2 hours after initial treatment in Phase V
- Tolerating oral intake
- No supplemental oxygen
- Completion of asthma education and asthma management plan
- Follow-up established

**Inpatient Steroid Treatment**
- Transition to prednisone or prednisolone (2 mg/kg/day) for a total course of 5-10 days depending on severity of exacerbation

**Supplemental O2** should be administered to keep O2 saturation > 90%

**Call RRT for:**
- Signs of clinical deterioration
- RS 9-10 on Continuous albuterol for 12 hours in phase II
- RS 11-12

**RISK Watch on Inpatient**
- Dashboard until RS <9

**ICU Transfer**
- RS 11-12 with 3 hours continuous
- Signs of clinical deterioration

Phase Change by Respiratory Score is the standard of care for patients on the asthma pathway
- Scoring is performed by RN & RT

Patients with unique clinical conditions that complicate their asthma treatment: **Phase Change by Physician Assessment & Order Only**
- Scoring by RN, RT & MD
- Provider to assess pt every 2-3 hrs

Conditions in which this is appropriate:
- Patient transferred from ICU
- Complex asthma history (e.g. hx intubation for asthma)
- Medical comorbidity (e.g. morbid obesity)

If Physician Assessment needed for phase changes, go to Inpt Asthma phase to discontinue “Phase Change by Respiratory Score” subplan and order “Phase Change by Physician Assessment & Order Only” subplan. If appropriate, “Phase Change by Respiratory Score” may also be re-ordered as patient improves.
Asthma v9.0: Appropriate Use of the Pathway

Does patient meet inclusion/exclusion criteria?

YES

Asthma Pathway
For use with all patients with an asthma exacerbation who are expected to benefit from standardized care.

NO

Asthma Orderset
For use with any patients with an asthma exacerbation.

Phase Change by Respiratory Score
- This is the standard.
- Your patient will be scored by the RN and RT and advanced by protocol.

Phase Change by Physician Assessment and Order Only
- The MD is expected to assess the patient every 2-3 hours while in phase 2 & 3.
- Please discuss the use of this order with RN and RT prior to use as it represents a deviation from the standard of care.

Please select “Exclude from Pathway” and indicate the reason.

Note: Patients not on the asthma pathway are not considered safe to receive continuous albuterol on the floors. Contact the charge nurse or the CNS to discuss alternatives.

Inclusion Criteria
- 1-18 y.o with asthma exacerbation admitted to general medicine service

Exclusion Criteria
- Acute Illnesses
  - Patients with pneumonia, bronchiolitis, or croup as their primary diagnosis
- Chronic Conditions:
  - Chronic lung disease: (e.g. cystic fibrosis, restrictive lung disease, bronchopulmonary dysplasia)
  - Cardiac disease requiring baseline medication
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- Immune disorders
- Sickle cell anemia

Phase Change by Respiratory Score is the standard of care for patients on the asthma pathway.
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Patients with unique clinical conditions that complicate their asthma treatment: Phase Change by Physician Assessment & Order Only
- Scoring by RN, RT & MD
- Provider to assess pt every 2-3 hrs

Conditions in which this is appropriate:
- Patient transferred from ICU
- Complex asthma history (e.g. hx intubation for asthma)
- Medical comorbidity (e.g. morbid obesity)

If Physician Assessment needed for phase changes, go to Inpt Asthma phase to discontinue “Phase Change by Respiratory Score” subplan and order “Phase Change by Physician Assessment & Order Only” subplan. If appropriate, “Phase Change by Respiratory Score” may also be re-ordered as patient improves.

For questions concerning this pathway, contact: Asthma@seattlechildrens.org
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Last Updated: October 2019
Next Expected Review: October 2020
## Asthma v9.0: Examples for Appropriate Use of the Pathway

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Issue</th>
<th>Pathway Inclusion</th>
<th>Phase Advancement</th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient also has a viral illness</td>
<td>Viral illnesses that result in pneumonia, bronchiolitis or croup may not score predictably.</td>
<td>Yes</td>
<td>Standard (RN &amp; RT)</td>
<td>Virus alone does not preclude use of pathway or scoring tool.</td>
</tr>
</tbody>
</table>
| Patient also has pneumonia           | Patients with pneumonia may have hypoxia that does not respond to asthma treatment.    | Yes               | Standard (RN & RT)                     | Assess the patient for evidence that pneumonia might be the predominant problem:  
  * infiltrate on CXR  
  * minimal or no response to albuterol treatment  
  * fever |
| Patient also has bronchiolitis       | Some patients with bronchiolitis respond to albuterol treatment.          | Yes               | Standard (RN & RT)                     | Assess the patient for evidence that bronchiolitis might be the predominant problem:  
  * responsive to nasal suctioning  
  * minimal or no response to albuterol treatment  
  * less than 2 year old (children < 1 yr should not be on the asthma pathway) |
| Patient also has croup                | Some patients with croup wheeze as well.                                   | Yes               | Standard (RN & RT)                     | Assess the patient for evidence that croup might be the predominant problem:  
  * moderate stridor  
  * wheeze not improved with albuterol |
| Patient transferred from ICU          | Patient’s exacerbation may be more severe than a typical floor patient.   | Yes               | Most patients: Standard (RN & RT)      | The decision to order advancement by MD should be discussed with RN and RT prior to use.  
  Consider using MD assessment orderable |
| Complex asthma history                | Intubation for asthma, previous ICU stay for asthma, 2+ admits for asthma in past year, or chronic steroid use for asthma. | Yes               | Most patients: Standard (RN & RT)      | The decision to order advancement by MD should be discussed with RN and RT prior to use.  
  Consider using MD assessment orderable |
| Medical comorbidity                   | Obstructive sleep apnea, morbid obesity, or another condition that might impair assessment. | Yes               | Most patients: Standard (RN & RT)      | The decision to order advancement by MD should be discussed with RN and RT prior to use.  
  Consider using MD assessment orderable |
| Patient requires continuous albuterol but does not meet inclusion criteria. | Patients < 1 year or with significant comorbidities are not considered safe to receive continuous albuterol on the floors. | No                 | N/A                                      | Contact ICU and discuss case with medical CNS or charge. This patient population likely requires a higher level of nursing care while on continuous albuterol. |
| The medical team disagrees with the content of the Asthma CSW. | Some providers bring experience or knowledge to patient care that differ from these standards. | Yes               | Standard (RN & RT)                     | Please discuss any concerns that you have with the CNS or charge nurse.  
  To contact the Asthma CSW Team, Email: asthma@seattlechildrens.org |

For questions concerning this pathway, contact: Asthma@seattlechildrens.org

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Last Updated: October 2019
Next Expected Review: October 2020
Respiratory Scoring Tool

How are patients scored using the tool?

The respiratory scoring tool consists of four elements that make up the respiratory assessment of the patient in distress. You assess each component distinctly and add them to make a total between 1-12.

- A patient’s RR is 1-3 whereas all other categories are scored 0-3
- The SCH respiratory scoring tool has been validated for interobserver reliability. (15)

<table>
<thead>
<tr>
<th>RR</th>
<th>Four Elements of Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1-3)</td>
<td>Respiratory rate (RR): assessed over 60 seconds</td>
</tr>
<tr>
<td>(0-3)</td>
<td>Retractions: work of breathing</td>
</tr>
<tr>
<td>(0-3)</td>
<td>Dyspnea: shortness of breath</td>
</tr>
<tr>
<td>(0-3)</td>
<td>Auscultation: wheezing on lung exam</td>
</tr>
<tr>
<td>(1-12)</td>
<td>Total</td>
</tr>
</tbody>
</table>

- There are other scoring tools that have been validated such as the pulmonary score (PS), pediatric asthma severity score (PASS) and pediatric respiratory assessment measure (PRAM) but no single tool that has been adopted universally. (1,2,20,23,26)

*The respiratory scoring tool is displayed on the next page and is always included with the pathway for convenience.*
Patients >2 yrs old will now get 1.5 mg Ipratropium bromide

Patients >2 yrs old scoring 10-12 in the first hour should receive one dose of Magnesium sulfate

Patients can be admitted to the floors or the ICU after 2 hours of therapy

Patients in urgent care who score >8 following the first hour should transfer to the SCH ED
Inpatient Overview

RISK nurse and RRT available to assure that patients who do not respond appropriately to therapy can be more closely monitored or transferred to the ICU.

After their ED dose of dexamethasone, transition to prednisone or prednisolone to complete a total of 5-10 days of steroids based on clinical severity.

Patients no longer need to receive 2 treatments in phase V for discharge. They should be observed for at least 2 hours prior to leaving though.
Phase Ia: Treatment in the First Hour in the ED

Supplemental O2 should be administered to keep O2 saturation > 90%

**1st HOUR (ED) PHASE Ia**

**RS 1-5**
- **Albuterol** MDI 8 puffs
- **Dexamethasone** 0.5 mg/kg x1 (16 mg max)

**RS 6-9**
- **Albuterol** continuous nebulizing 20 mg x 1 hr
- **Ipratropium** 1.5 mg (0.75 mg for <2 yrs)
- **Dexamethasone** 0.6 mg/kg x1 (16 mg max)
- **Magnesium Sulfate** V 50 mg/kg x1
(max 2 grams) for age > 2 yrs

**RS 10-12**
- **Albuterol** continuous nebulizing 20 mg x 1 hr
- **Ipratropium** neb 1.5 mg (0.75 mg for <2 yrs)
- **Dexamethasone** 0.6 mg/kg x1 (16 mg max)
- **Magnesium Sulfate** V 50 mg/kg x1
(max 2 grams) for age > 2 yrs

Assess and Score at end of 1st hour

Lower acuity patients receive albuterol MDI.
- It is just as effective as nebulized delivery.

The dose of ipratropium has been doubled to 1.5 mg in patients greater than 2 years old.
- Evidence suggests that this might reduce admission rates.
Phase Ib: Second Hour in the ED

All patients who continue to have a RS of 9-12 after one hour of therapy should be given Magnesium Sulfate IV one time.

- Patients scoring 9-12 should not be admitted prior to receiving Magnesium as this is not available on the floors.

Place a bed request at this point to facilitate patient flow.
Determine Disposition

- There is no evidence to guide decisions on disposition in this group
- Take into account factors such as:
  - severity at presentation and previous exacerbation severity
  - use of albuterol or steroids prior to presentation
  - age of the patient
  - ability of the patient and system to provide next day follow-up
  - ability of the patient to return to ED if needed
  - PCP comfort
  - family preferences

All patients scoring 10-12 should get a PICU consult at this point.

If uncertain about disposition, have a follow-up huddle after another hour of treatment with the ICU and floor team.

Admission should be facilitated at this point to the inpatient unit or the ICU.
Phase 4: Fourth Hour in the ED

RS 1-8: Determine Disposition
RS 9-10: Albuterol continuous neb 20 mg/hr x 1 hr
RS 11-12: Admit to ICU

Assess and Score at end of 4th hour:
- Huddle with Floor Charge Nurse, Floor Team and consider ICU consult (if not already done)
- Admit to Inpatient or ICU

Patients scoring 9-10 can receive a fourth neb in the ED in order to determine disposition at the second huddle.

Follow up huddle should include medical unit charge nurse and floor team to assure that there is agreement about suitability for the inpatient unit.

Return to Criteria & Respiratory Score
Return to ED Management
Return to Inpatient Management
Transfer / Discharge in Urgent Care and the ED

**Urgent Care Transfer Criteria**
- Score >5 following first hour of nebulized albuterol - send by ALS
- Score 5-8 following 8 puffs of albuterol in second hour - send by ALS
- Signs of clinical deterioration or poor clinical response to therapy

**ED Discharge Criteria**
- RS 1-4 for minimum of 1 hour
- (Patients with an initial RS of 16-12 should be observed for 2 hours prior to discharge)
- Shared decision making in hour 3 for RS 5-8
- Tolerating oral intake
- Adequate family teaching
- Follow-up established

**Discharge Instructions**
- Continue to use albuterol MDI every 4 hours until seen by provider
- Follow up with provider within 24-48 hours when possible

Patients who are likely to be admitted have criteria to be transferred to the ED.

Patients receiving continuous albuterol should be observed for 2 hours off therapy prior to discharge.

All asthma discharges should have follow up arranged within 24-48 hours.
Phase II: Continuous Nebulized Albuterol 20 mg/hr

**PHASE II: INPATIENT**
- Albuterol continuous neb 20 mg/hr (maximum on floors)
- Assessment q 1 hour
- Advance after 1 hr of treatment for score 1-8

**RISK Watch on Inpatient**
- Dashboard until R3 <3

**ICU Transfer**
- RS 11-12 with 3 hours continuous
- Signs of clinical deterioration

**Call RRT for:**
- Signs of clinical deterioration
- RS 9-10 on Continuous albuterol for 12 hours in phase II
- RS 11-12

**Patients who are worsening or not improving should have an RRT to assess for need for ICU transfer.**

**Patients requiring escalation of care should be transferred to the ICU.**

Maximum dose for continuous albuterol in the inpatient unit is now 20 mg/hr.

Patients who remain on the floors on continuous should be monitored by the RISK nurse with regular check-ins with the medical team.

Return to Criteria & Respiratory Score  
Return to ED Management  
Return to Inpatient Management
Signs of Clinical Deterioration

The following are red flags that a patient may have impending respiratory failure:

<table>
<thead>
<tr>
<th>Inadequate response to therapy:</th>
<th>Characterized by a patient who receives optimal therapy and does not improve clinically.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure to progress along the pathway:</td>
<td>This is defined as 12 hours in any phase.</td>
</tr>
<tr>
<td>Drowsiness:</td>
<td>Drowsiness is highly associated with acute respiratory acidosis (100)</td>
</tr>
<tr>
<td>Silent chest exam:</td>
<td>The absence of breath sounds in a patient with respiratory distress.</td>
</tr>
<tr>
<td>Hypercapnea:</td>
<td>Values cited for hypercapnea in an asthmatic range from a pCO2 of &gt;40-45. (1,4,5,100-104)</td>
</tr>
<tr>
<td>Confusion:</td>
<td>Altered mental status</td>
</tr>
</tbody>
</table>

Return to ED Management

Return to Inpatient Management
Phase III-V: Weaning Albuterol MDI treatment

Nurses and RTs score the patient in order to wean them off albuterol until the patient reaches an appropriate regimen for home.

Once a patient is on MDI, the respiratory therapist begins asthma teaching using the Living with Asthma book.
Inadequate treatment with oral steroids is a risk factor for readmission. As a guideline, patients should receive 3-5 days of steroid past discharge day.

Patients should be observed for a minimum of 2 hours after their first treatment with 4 puffs.

Inpatient Steroid Treatment
- Transition to prednisone or prednisolone (2 mg/kg/day) for a total course of 5-10 days depending on severity of exacerbation.

Discharge Criteria
- In Phase V with RS 1-4
- Observe for minimum of 2 hours after initial treatment in Phase V
- Tolerating oral intake
- No supplemental oxygen
- Completion of asthma education and asthma management plan
- Follow-up established

Discharge Instructions
- Discharge With Asthma Management Plan
- “Living with Asthma” book
- Follow-up with PCP in 24-48 hours

The asthma management plan (“asthma action plan”) is required discharge education for families. It can be found in “ad hoc charting” in CIS.
**Asthma Education and Discharge**

**Discharge Checklist:**

<table>
<thead>
<tr>
<th>Checklist</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Living with Asthma” Asthma Education Booklet</td>
<td>Verify patients received copy of the asthma education booklet in their appropriate language and reviewed this with a respiratory therapist (RT).</td>
</tr>
</tbody>
</table>
| Asthma Discharge Summary and Management Plan. | • RN is responsible for completing the Discharge Summary (page 1) and reviewing with the family.  
• MD is responsible for completing the Asthma Management Plan (page 2) and reviewing with the family. |
| Inhaled corticosteroids (ICS) | • Patients with clinically significant asthma exacerbations should be started on an ICS at discharge unless there is a question about whether or not the patient will benefit from it.  
• The decision to start the patient on inhaled corticosteroids should be made with the primary care doctor when possible. |
| GetWell Network Asthma Videos | Check for documentation that patient and family have watched the following 4 videos:  
• Preventing Asthma Flare-ups  
• Handling Asthma Flare-ups  
• Using an Inhaler with a Spacer  
• What is Asthma? |

**Patients should be offered refills on all medications.**
Asthma Exacerbation Management Options

- Oxygen
- Albuterol
- Ipratropium
- Magnesium Sulfate
- Systemic Corticosteroid
- Terbutaline
- Heliox
Supplemental Oxygen Use in Asthma Exacerbations

When does a patient require oxygen?

- **Patients with acute asthma should receive supplemental oxygen to maintain oxygen saturation greater than 90%.** [LOE: Guideline] (1,2,3)
  - Supplemental oxygen is administered with all continuous nebulization therapy.

- **Monitoring oxygen saturation is recommended for patients with acute asthma exacerbations.** [LOE: Guideline, C] (1,2,12)
  - Once a patient has reached phase IV, oxygen saturation monitoring is no longer necessary unless the patient has persistent hypoxia.

**Oxygen saturation as a diagnostic tool:**

- Oxygen saturation is correlated with severity of illness in asthma. (8,9)
- However, it is not useful as the sole indicator for need for admission. (11,13)
- An oxygen saturation of < 92% after 1 hour of treatment is a better predictor of need for hospitalization than initial oxygen saturation. (7,14).
- Persistent hypoxia in the presence of an adequate response to therapy can be indicative of another contributing condition such as pneumonia.
Albuterol Treatment for Asthma Exacerbations

Albuterol

- An inhaled short-acting beta2-agonist (SABA) that is the drug of choice in the US for rapid reversal of airflow obstruction.
  - The onset of action for albuterol is less than 5 minutes.
  - Repetitive administration produces incremental bronchodilation.
- Methods of administration:
  - Continuous versus intermittent delivery
    - Continuous delivery is the preferred method for severe acute asthma. [LOE: M] (24, 25, 34, 35, 36, 38)
    - Intermittent delivery is appropriate for relief of mild and moderate exacerbations. [LOE: M] (24, 25, 34, 35, 36, 38)

Albuterol Treatment for Asthma Exacerbations (Cont'd)

- Methods of administration (Cont'd):
  - Metered dose inhaler (MDI) versus nebulized medication

Recommendations (2015):

- Give albuterol in the form of MDI as the standard method of delivery. (Ditcham 2014, Sabato 2011, Titus 2012)
- Give nebulized albuterol as the standard for method of delivery for continuous. (Ditcham 2014, Sabato 2011, Titus 2012)
- Breath actuated nebulizers should be explored as an alternative delivery method.
Albuterol Treatment for Asthma Exacerbations (Cont'd)

- Facts about MDI use
  - MDI is the preferred method of delivering albuterol at our institution.
    - MDIs deliver a discreet dose, are portable, and do not require a power source. (23)
    - MDI use in acute asthma is associated with shorter length of stay in the ED and lower pulse rates. (1,4,5,23,27,39,43)
    - MDIs should always be administered with a valved-holding chamber (VHC). (1,4,5,42,43,44)
  - It is at times necessary to substitute nebulized albuterol for MDI in an uncooperative patient.
    - The dose equivalency is as follows:
      - 2.5 mg = 4 puffs MDI, and
      - 5 mg = 8 puffs MDI

Albuterol Treatment for Asthma Exacerbations (Cont'd)

- Levalbuterol
  - An alternative short-acting beta2-agonists (SABA) formulated with the intention of creating a drug with fewer adverse side effects than albuterol.
    - Levalbuterol is an adequate substitute but it provides no additional benefit in efficacy or side effects over albuterol and is more costly. (1,4,28,29,31,32,33,37)
  - It is therefore not recommended for use.
Ipratropium Treatment for Asthma Exacerbations

Ipratropium bromide (Atrovent)

- An acetylcholine receptor antagonist that is used as an **adjunctive** therapy for asthma exacerbations by administering in combination with albuterol.
  - Ipratropium produces additional bronchodilation particularly in patients noted to have severe airflow obstruction. (1,4,5,49)

**Recommendations (2015):**

*Use ipratropium dosing of 750 mcg for patients less than 2 years of age and 1500 mcg in patients older than 2 years of age the ED for treatment of status asthmaticus. All admitted patients should receive ipratropium in the ED.*


---

Ipratropium Treatment for Asthma Exacerbations (Cont’d)

Ipratropium bromide (Atrovent) (Cont’d)

- In the ED setting when given as multiple doses, ipratropium has been shown to improve lung function and reduce admission rate. (49)
  - The number of children needed to treat in this systematic review was 12 to prevent one admission.
- There is no evidence that treatment with ipratropium is of benefit to children beyond their initial dosing in the ED. (52,53)

**We do not recommend routine use of ipratropium in the inpatient unit.**
Magnesium Sulfate IV as an Adjunctive Therapy for Asthma Exacerbations

Magnesium sulfate IV (MgSO₄)

- Mechanism: This drug produces bronchodilation, smooth muscle relaxation and may also have an anti-inflammatory effect.

Recommendations (2015):
Give IV Magnesium sulfate to all patients 2 years of age and older who are being admitted on continuous albuterol prior to leaving the ED (Low quality- Shan 2013, Powel 2014, Egelund 2013)

- We recommend use in the first 6 hours of presentation in moderate to severe exacerbations whose respiratory score remains 9-12 after the first hour of continuous nebulized albuterol.
- Magnesium sulfate can be administered IV at 50 mg/kg/dose 1 time over 30 minutes in the emergency department prior to admission. (Max dose: 2 grams)

Magnesium Sulfate IV as an Adjunctive Therapy for Asthma Exacerbations (Cont'd)

Magnesium sulfate IV (MgSO₄) (Cont'd)

- We recommend administration of 20 mL/kg NS bolus prior to infusion to avoid hypotension. This is an expected side effect that is self-limited and not harmful in the trials noted.
- Checking Mg or Ca levels routinely for patients receiving this therapy is not recommended.
- IV Magnesium sulfate is currently not approved for use in asthma in the inpatient unit.
- Nebulized magnesium has been demonstrated to be efficacious in children but is currently not the recommended therapy at SCH.
**Corticosteroids in the ED for Asthma Exacerbations**

**ED Treatment: Dexamethasone**

- All patients with asthma exacerbations should receive a single dose of dexamethasone at 0.6 mg/kg within the first hour of presentation. (max: 16 mg)
  - Initial effects of systemic steroids are noted at 2 hours with maximal effects seen at 6 hours. (58)
  - Use of corticosteroids within 1 hour of presentation to an ED significantly reduces the need for hospital admission in patients with acute asthma. (1,4,5,58)
- If the patient can be discharged from the ED, they should complete a second dose of 0.6 mg/kg on the following day for a total of 2 days of therapy.
  - For outpatients, this is as effective as 5 days of prednisone or prednisolone. (56,61,66)
  - Additional regimens such as single dose dexamethasone PO and IM have been studied but are not recommended at this time. (60,62,65,66)

**Corticosteroids in the ED for Asthma Exacerbations (Cont'd)**

**ED Treatment: Dexamethasone (Cont'd)**

- IV methylprednisolone is not recommended for routine use but is dosed as follows:
  - Loading dose 2 mg/kg/dose x1 then 1 mg/kg q6-12 hrs until patient can be transitioned to orals.
    - IV steroid is only needed when orals are not tolerated or GI absorption is in question. (1,4,5,70)
    - Extra doses of inhaled corticosteroids have not been shown to be of any benefit in an asthma exacerbation. (69)


- There is less emesis associated with the administration of dexamethasone versus alternative oral steroids.
Inpatient Corticosteroids

Inpatient Treatment: Prednisone or Prednisolone

- We recommend transitioning inpatients to prednisone or prednisolone to complete a 5-10 day total course.
  - The standard therapy for an acute asthma exacerbation is a 5-10 day course of systemic steroid. (1,4,5)
- Prednisone and prednisolone are dosed QD at 2 mg/kg/day (60 mg max)
  - QD dosing is recommended to improve adherence.
  - Prednisone should only be used for the oral tablet form.
  - Prednisolone should be used for the liquid preparation.
- Why not just continue the dexamethasone?
  - There are no studies on using extended courses of dexamethasone for asthma.
    - Steroids reduce length of stay in the hospital and reduce relapse rate. (57)
- Only 3 patients need to be treated to prevent a relapse in this systematic review.
<table>
<thead>
<tr>
<th>Medication</th>
<th>Dosage</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inhaled Short Acting Beta₂-Agonists (SABA)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albuterol Nebulizer Solution 0.5% 5 mg/mL</td>
<td>20 mg/hr continuous nebulization</td>
<td>Doses up to 20 mg/hr allowed in the inpatient unit. Doses beyond this require ICU.</td>
</tr>
<tr>
<td>Albuterol MDI 90 mcg/puff</td>
<td>4-8 puffs q 2-4 hours</td>
<td>Always use with a valved holding chamber (VHC), aka spacer.</td>
</tr>
<tr>
<td>Levalbuterol (R-albuterol) 45 mcg/puff</td>
<td>4-8 puffs q 2-4 hours</td>
<td>Not recommended over albuterol but is safe and effective.</td>
</tr>
<tr>
<td>Ipratropium bromide Nebulizer Solution 500 mcg/2.5 mL</td>
<td>0.75-1.5 mg (750-1500 mcg)</td>
<td>1500 mcg is the recommended dose for 2 years and older. 750 mcg should be used for less than 2 years old. Not recommended for use in inpatients.</td>
</tr>
<tr>
<td><strong>Systemic corticosteroids</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dexamethasone PO (tablet or liquid)</td>
<td>0.6 mg/kg/day PO QD (16 mg max dose)</td>
<td>Should be given within 1 hour of entering the ED.</td>
</tr>
<tr>
<td>Prednisone PO (tablet)</td>
<td>2 mg/kg/day PO QD (60 mg daily max dose)</td>
<td>For inpatient use. Recommended duration of therapy 5-10 days total of steroids.</td>
</tr>
<tr>
<td>Prednisolone PO (liquid)</td>
<td>2 mg/kg/day PO QD (60 mg daily max dose)</td>
<td>For inpatient use. Recommended duration of therapy 5-10 days total of steroids.</td>
</tr>
<tr>
<td>Methylprednisolone IV</td>
<td>1 mg/kg IV q6 (60 mg max per dose)</td>
<td>Only indicated in patients who cannot tolerate orals or have concerns about GI absorption.</td>
</tr>
<tr>
<td><strong>Adjunctive medications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium Sulfate IV</td>
<td>50 mg/kg IV over 30 minutes x1 dose (max dose 2g)</td>
<td>Limits: age 2-18 yo only and only one dose in the ED.</td>
</tr>
</tbody>
</table>

**Additional Adjunctive Therapy for Severe Asthma Exacerbations**

**Terbutaline IV**

- This drug is a nonselective beta-agonist that produces bronchodilation with risk for additional side effects associated with beta1 stimulation.
- This drug is currently reserved for use with ED and/or ICU consultation.
- Given concerns about cardiac effects evidenced by diastolic hypotension and elevated cardiac enzymes in other studies (see albuterol data), its use should be carefully considered.

*Restrict terbutaline usage to ICU consult only. (Travers 2012, Carroll 2006)*

Terbutaline’s efficacy is not demonstrated by medical literature at this point but it remains widely used for patients who do not respond to conventional therapy. (82, 83)

**Heliox**

- Heliox-driven albuterol nebulization has been studied as a method for more effectively delivering medication in asthma exacerbations.
- This treatment is currently reserved for use with ED and/or ICU consultation.
- There is insufficient evidence regarding the effectiveness of heliox in asthma exacerbations to recommend its routine use. (96-99)
Approved by the CSW Asthma Team for the July 2015 go live.

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Executive Approval:

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Surgeon-in-Chief Bob Sawin, MD

Retrieval Website: http://www.seattlechildrens.org/pdf/asthma-pathway.pdf

Please cite as:

This pathway was developed through local consensus based on published evidence and expert opinion as part of Clinical Standard Work at Seattle Children’s. Pathway teams include representatives from Medical, Subspecialty, and/or Surgical Services, Nursing, Pharmacy, Clinical Effectiveness, and other services as appropriate.

When possible, we used the GRADE method of rating evidence quality. Evidence is first assessed as to whether it is from randomized trial or cohort studies. The rating is then adjusted in the following manner (from: Guyatt G et al. J Clin Epidemiol. 2011;4:383-94.):

Quality ratings are downgraded if studies:
- Have serious limitations
- Have inconsistent results
- If evidence does not directly address clinical questions
- If estimates are imprecise OR
- If it is felt that there is substantial publication bias

Quality ratings are upgraded if it is felt that:
- The effect size is large
- If studies are designed in a way that confounding would likely underreport the magnitude of the effect OR
- If a dose-response gradient is evident

Guideline – Recommendation is from a published guideline that used methodology deemed acceptable by the team.

Expert Opinion – Our expert opinion is based on available evidence that does not meet GRADE criteria (for example, case-control studies).

Quality of Evidence:
- High quality
- Moderate quality
- Low quality
- Very low quality

Guideline
Expert Opinion
Summary of Version Changes

- **Version 1 (9/14/2011):** Go live
- **Version 2 (9/15/2011):** Patients progressing from Phase II to Phase III are now advanced for a respiratory score of 1-8
- **Version 2.1 (10/19/2011):** Added reminder to algorithm that IV Magnesium Sulfate is restricted to patients ≥ 6 years of age.
- **Version 3 (12/4/2012):** Added information regarding appropriate use of pathway; Magnesium Sulfate should be given to all qualified patients in the Emergency Department.
- **Version 4.0 (10/13/2014):** “Poor Clinical Response” added. Clinical deterioration altered to promote RRT or code blue as response. Peak flow suggestion removed.
- **Version 5.0 (1/29/2015):** Poor clinical response page changed: specific medication recommendations removed and re-huddle time changed to 4 hours.
- **Version 6.0 (7/15/2015):** Scheduled review update (see executive summary for significant changes)
- **Version 6.1 (7/22/2015):** Methylprednisolone IV and Magnesium Sulfate IV updated on medication slide/tab.
- **Version 7.0 (4/12/2018):** Exclusion criteria changed to “Cardiac disease requiring baseline medication”
- **Version 8.0 (11/19/2018):** Magnesium given to patients with RS 10-12 in first hour; shared decision making for disposition in hour 3 for patients with RS 5-8
- **Version 9.0 (10/2/2019):** Revised pathway and algorithm, specifically page 18, to align with redesigning of organizational asthma educational material.
Medical Disclaimer

Medicine is an ever-changing science. As new research and clinical experience broaden our knowledge, changes in treatment and drug therapy are required.

The authors have checked with sources believed to be reliable in their efforts to provide information that is complete and generally in accord with the standards accepted at the time of publication.

However, in view of the possibility of human error or changes in medical sciences, neither the authors nor SCHS nor any other party who has been involved in the preparation or publication of this work warrants that the information contained herein is in every respect accurate or complete, and they are not responsible for any errors or omissions or for the results obtained from the use of such information.

Readers should confirm the information contained herein with other sources and are encouraged to consult with their health care provider before making any health care decision.
Search Methods, Asthma Pathway, Clinical Standard Work

Studies were identified by searching electronic databases using search strategies developed and executed by a medical librarian, Jackie Morton. Searches were performed in December, 2014. The following databases were searched – on the Ovid platform: Medline, Cochrane Database of Systematic Reviews; elsewhere – Embase, Clinical Evidence, National Guideline Clearinghouse, TRIP and Cincinnati Children’s Evidence-Based Care Guidelines. Clinical questions regarding albuterol and ipratropium were searched from 1990 to date or the closest date range available in the respective databases. Clinical questions regarding magnesium sulphate, levalbuterol, and corticosteroids were searched from 2011 to date and clinical questions regarding terbutaline and subcutaneous epinephrine were searched from 2004 to date. Retrieval was limited to humans ages 0 – 18 and English language. In Medline and Embase, appropriate Medical Subject Headings (MeSH) and Emtree headings were used respectively, along with text words, and the search strategy was adapted for other databases using their controlled vocabularies, where available, along with text words. Concepts searched were asthma or status asthmaticus, therapeutics, dosing and drug delivery systems. All retrieval was further limited to certain evidence categories, such as relevant publication types, Clinical Queries filters for diagnosis and therapy, index terms for study types and other similar limits.

Jackie Morton, MLS
June 18, 2015

Identification

530 records identified through database searching

2 additional records identified through other sources

Screening

526 records after duplicates removed

526 records screened

404 records excluded

Eligibility

122 records assessed for eligibility

99 full-text articles excluded, 25 did not answer clinical question, 74 did not meet quality threshold, 0 outdated relative to other included study

Included

23 studies included in pathway

Flow diagram adapted from Moher D et al. BMJ 2009;339:bmj.b2535
Guidelines and Reviews


Admission Criteria


Admission Criteria (Cont'd)

Scoring Tools

Albuterol / Beta-agonists
Albuterol / Beta-agonists (Cont'd)


Albuterol / Beta-agonists (Cont’d)

Ipratropium / Anticholinergics


Corticosteroids


Bibliography

Corticosteroids (Cont'd)


Magnesium Sulfate

Magnesium Sulfate (Cont’d)


Terbutaline / IV Beta-agonists


Quality Improvement


Risk Factors


Asthma Management Plan


Heliox


Criteria for ICU evaluation

Additional articles from 2015 Literature Search

Albuterol and Ipratropium


All Other Drugs


