Asthma Pathway v12.0: **Table of Contents**

Stop and **Review**

Inclusion Criteria

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

Exclusion Criteria

- Patients with pneumonia, bronchiolitis, or croup as their primary diagnosis
- 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

Asthma Care

Appendix

Last Updated: January 2024
Next Expected Review: April 2028

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

If you are a patient with questions contact your medical provider, Medical Disclaimer

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Asthma Pathway v12.0: **Respiratory Score**

Stop and **Review**

Inclusion Criteria

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Variable	0 points	1 point	2 points	3 points
RR				
0-8 weeks		≤60	61-69	≥70
2-11 months		≤50	51-59	≥60
12-23 months		≤40	41-44	≥45
2-3 years		≤34	35-39	≥40
4-5 years		≤30	31-35	≥36
6-12 years		≤26	27-30	≥31
≥13 years		≤23	24-27	≥28
Retractions	None	Subcostal or intercostal	2 of the following: subcostal, intercostal, substernal OR nasal flaring (infant)	3 of the following: subscostal, intercostal, substernal, suprasternal, supraclavicular OR nasal flaring / head bobbing (infant)
Dyspnea				
<2 years	Normal feeding, vocalizations and activity	1 of the following: difficulty feeding, decreased vocalization or agitated	2 of the following: difficulty feeding, decreased vocalization or agitated	Stops feeding, no vocalization, drowsy or confused
2 to 4 years	Normal feeding, vocalizations and play	1 of the following: decreased appetite, increased coughing after play, hyperactivity	2 of the following: decreased appetite, increased coughing after play, hyperactivity	Stops eating or drinking, stops playing OR drowsy and confused
>4 years	Counts to ≥10 in one breath	Counts to 7-9 in one breath	Counts to 4-6 in one breath	Counts to ≤3 in one breath
Auscultation	Normal breathing, no wheezing present	End-expiratory wheeze only	Expiratory wheeze only (greater than end-expiratory wheeze)	Inspiratory and expiratory wheeze OR diminished breath sounds OR both

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

Asthma Pathway v12.0: **ED Management**

Stop and **Review**

Inclusion Criteria

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

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Assess and Score at Initial Assessment

- If patient has received pathway concordant care prior to ED arrival, continue pathway at the appropriate phase and hour

↓

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

↓

1st Hour (ED) – Phase 1a

RS 1-6

- Albuterol MDI 8 puffs
- Dexamethasone 0.6 mg/kg x1 (16 mg max)

RS 7-9

- Albuterol/ipratropium continuous neb over 1hr (see note below)
- Dexamethasone 0.6 mg/kg x1 (16 mg max)

RS 10-12

- Albuterol/ipratropium continuous neb over 1hr (see note below)
- Dexamethasone 0.6 mg/kg x1 (16 mg max)
- Magnesium sulfate IV 50 mg/kg x1 (2,000 mg max) for age ≥2 y.o.

↓

Assess and Score at end of 1st hour

Continuous Nebulizer Dosing

- Large volume nebulizer
  - Albuterol 20 mg
  - Ipratropium 1 mg
- Vibrating mesh nebulizer
  - Albuterol 7.5 mg
  - Ipratropium 0.5 mg

↓

2nd Hour (ED) – Phase 1b

RS 1-4

- If first hour RS 1-5, discharge
- If first hour RS 6-9, observe for 1 hour
- If first hour RS 10-12, observe for 2 hours
- Dexamethasone 0.6 mg/kg x1 (16 mg max) -- if not already given

RS 5-8

- Albuterol MDI 8 puffs at beginning of hour
- Dexamethasone 0.6 mg/kg x1 (16 mg max) -- if not already given

RS 9-12

- Albuterol continuous neb
- Dexamethasone 0.6 mg/kg x1 (16 mg max) -- if not already given
- Ipratropium neb -- if not already given
- Magnesium sulfate IV 50 mg/kg x1 (2,000 mg max) for age ≥2 y.o. -- if not already given
- Place bed request

↓

Assess and Score at end of 2nd hour

↓

Go to

- 3rd Hour (ED) – Phase 1c
- 4th Hour (ED) – Phase 1d
- Urgent Care Transfer Criteria
- Discharge Criteria
- Discharge Instructions

Risk for Inequity

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Asthma Pathway v12.0: **ED Management**

Stop and **Review**

Inclusion Criteria

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Risk for Inequity

3rd Hour (ED) – Phase 1c

RS 1-4

- Discharge

RS 5-8

- Albuterol MDI 8 puffs at beginning of hour
- Determine disposition

RS 9-12

- Albuterol continuous neb
- Magnesium sulfate IV 50 mg/kg x1 (2,000 mg max) for age ≥2 y.o. -- if not already given
- Admit to Inpatient / ICU
- If undecided on Inpatient or ICU, move on to 4th hour

↓

Assess and Score at end of 3rd hour

↓

4th Hour (ED) – Phase 1d

RS 1-8

- Determine disposition

RS 9-10

- Albuterol continuous neb

RS 11-12

- Consider acute care vs ICU
- If unclear disposition, huddle by contacting FlowDoc

↓

Assess and Score at end of 4th hour

Urgent Care Transfer Criteria

- After first hour of nebulized albuterol, if score >8, send by ALS
- At end of second hour:
  - If score >8, send by ALS
  - If score 5-8, shared decision making about discharge versus transfer by ALS
- If signs of clinical deterioration or poor clinical response to therapy, send by ALS

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
- For patients who have received dexamethasone, discharge with second dose to be given 24 hours after
- Consider patient's disease severity and possible initiation or discussion of inhaled corticosteroids
- Consider creating Asthma Action Plan
- Follow up with provider within 24-48 hours (when possible)

Last Updated: January 2024
Next Expected Review: April 2028

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

Asthma Pathway v12.0: **Inpatient Management**

Stop and **Review**

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

Exclusion Criteria
- Patients with pneumonia, bronchiolitis, or croup as their primary diagnosis
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Signs of Clinical Deterioration: drowsiness, confusion, silent chest exam, hypercapnia

PHASE Progression (Phases III-V)

- Phase Progression (i.e. “spacing a patient”) is based on the patient’s RS ***pre***-albuterol
- **RS 1-4**: Advance after one treatment at this phase
- **RS 5-8**: Continue therapy at this phase
- **RS 9-12**: Step back to previous phase

RN to notify MD
- For all phase transitions
- Failure to advance on pathway after 3 hours on continuous albuterol or after 12 hours in all other phases
- Persistent O2 requirement in Phase IV

Inpatient Steroid Treatment
- Transition to prednisone or prednisolone 2 mg/kg/day (60 mg/day max) for a total course of 5-7 days depending on severity of exacerbation
- Alternatively, may consider second dose of dexamethasone instead of prednisone or prednisolone for mild exacerbations or for patients under 5 years old without previously established diagnosis of asthma

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

PHASE II: INPATIENT
- Albuterol continuous nebulization
  - Large volume nebulizer, albuterol 20 mg
  - Vibrating mesh nebulizer, albuterol 5 mg
- Assessment q 1 hr
- Advance after 1 hr of treatment for RS 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 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
- Consider patient's disease severity and possible initiation or discussion of inhaled corticosteroids
- Follow-up with PCP in 24-48 hours (when possible)

Call RRT for
- Signs of clinical deterioration
- RS 11-12
- 4+ hours of q 1 hr nebulizer treatments after arrival to floor

RISK Watch on Inpatient
- Dashboard until RS <9
- History of ICU admission

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 by RN & RT

Consider Phase Change by Physician Assessment and Order

Patients with unique clinical conditions that complicate their asthma treatment
- Scoring by RN, RT & MD
- Provider to assess pt every 2-3 hours

Conditions in which this may be 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
- Uncheck “RN/RT wean” albuterol protocol (phase change by respiratory score)
- Check “Provider wean” albuterol protocol (phase change by physician)
- If appropriate, “RN/RT albuterol protocol” may be ordered as patient improves

Providing Equitable Care

Pause to examine bias:

- Patients with Asthma are at risk for inequitable care.
- In an analysis of our own SCH data, we found disparities in the admission rate. Patients identified as Black/African American or Hispanic are less likely to be admitted. Those who identified as Asian had a higher admit rate (see figure).
- There may be multiple factors that contribute to the disparity in the admission rates.
- When using a pulse oximeter, be aware that skin pigmentation is one of multiple factors that can affect the accuracy of a reading (Shi 2022; FDA).
- Dark skin pigment has been shown to correlate with falsely higher pulse oximetry values. (Shi 2022; FDA).
- Given this, we hope you will pause to consider the clinical features and decision making for each patient and reflect on the possibility of implicit bias or structural racism affecting their care.

What is Implicit Bias?

The National Institutes of Health defines implicit bias "as a form of bias that occurs automatically and unintentionally, that nevertheless affects judgments, decisions, and behaviors." This bias impacts our interpersonal relationships with patients, families/caregivers, and colleagues and care decisions. Please keep this in mind when utilizing CSW pathways and consciously challenge your assumptions and biases.

Return to ED

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%
  - Supplemental oxygen is administered with all continuous nebulization therapy
- Monitoring oxygen saturation is recommended for patients with acute asthma exacerbations
  - 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
- However, it is not useful as the sole indicator for need for admission
- An oxygen saturation of <92% after 1 hour of treatment is a better predictor of need for hospitalization than initial oxygen saturation
- Persistent hypoxia in the presence of an adequate response to therapy can be indicative of another contributing condition such as pneumonia

Return to ED **Return to Inpatient**

Signs of Clinical Deterioration

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

- **Inadequate response to therapy**: Characterized by a patient who receives optimal therapy and does not improve clinically
- **Failure to progress along the pathway**: Defined as 12 hours in any phase
- **Drowsiness**: Highly associated with acute respiratory acidosis
- **Silent chest exam**: Absence of breath sounds in a patient with respiratory distress
- **Hypercapnia**: Values cited for hypercapnia in an asthmatic range from a pCO2 of >40-45
- **Confusion**: Altered mental status

Return to Inpatient

Disease Severity Table

Level of severity (Columns 2–5) is determined by events listed in Column 1 for both impairment (frequency and intensity of symptoms and functional limitations) and risk (of exacerbations). Assess impairment by patient's or caregiver's recall of events during the previous 2–4 weeks; assess risk over the last year.

Components of Severity		Intermittent			Persistent								
					Mild			Moderate			Severe		
		Ages 0–4 years	Ages 5–11 years	Ages ≥12 years	Ages 0–4 years	Ages 5–11 years	Ages ≥12 years	Ages 0–4 years	Ages 5–11 years	Ages ≥12 years	Ages 0–4 years	Ages 5–11 years	Ages ≥12 years
Impairment	Symptoms	≤2 days/week			>2 days/week but not daily			Daily			Throughout the day		
	Nighttime awakenings	0	≤2x/month		1–2x/month	3–4x/month		3–4x/month	>1x/week but not nightly		>1x/week	Often 7x/week	
	SABA* use for symptom control (not to prevent EIB*)	≤2 days/week			>2 days/week but not daily	>2 days/week but not daily and not more than once on any day		Daily			Several times per day		
	Interference with normal activity	None			Minor limitation			Some limitation			Extremely limited		
	Lung function		Normal FEV_1 between exacerbations	Normal FEV_1 between exacerbations									
	→ FEV_1* (% predicted)	Not applicable	>80%	>80%	Not applicable	>80%	>80%	Not applicable	60–80%	60–80%	Not applicable	<60%	<60%
	→ FEV_1/FVC*		>85%	Normal†		>80%	Normal†		75–80%	Reduced 5%†		<75%	Reduced >5%†
Risk	Asthma exacerbations requiring oral systemic corticosteroids‡	0–1/year			≥2 exacerb. in 6 months, or wheezing ≥4x per year lasting >1 day AND risk factors for persistent asthma	≥2/year		*Generally, more frequent and intense events indicate greater severity.*			*Generally, more frequent and intense events indicate greater severity.*		
		*Consider severity and interval since last asthma exacerbation. Frequency and severity may fluctuate over time for patients in any severity category. Relative annual risk of exacerbations may be related to FEV_1.**											

* **Abbreviations:** EIB, exercise-induced bronchospam; FEV_1, forced expiratory volume in 1 second; FVC, forced vital capacity; ICS, inhaled corticosteroid; SABA, short-acting $beta_2$-agonist.

† Normal FEV_1/FVC by age: 8–19 years, 85%; 20–39 years, 80%; 40–59 years, 75%; 60–80 years, 70%.

‡ Data are insufficient to link frequencies of exacerbations with different levels of asthma severity. Generally, more frequent and intense exacerbations (e.g., requiring urgent care, hospital or intensive care admission, and/or oral corticosteroids) indicate greater underlying disease severity. For treatment purposes, patients with ≥2 exacerbations may be considered to have persistent asthma, even in the absence of impairment levels consistent with persistent asthma.

Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma Quick Reference Guide
https://www.nhlbi.nih.gov/files/docs/guidelines/asthma_qrg.pdf

This guide summarizes recommendations developed by the National Asthma Education and Prevention Program's expert panel after conducting a systematic review of the scientific literature on asthma care. See www.nhlbi.nih.gov/guidelines/asthma for the full report and references.

Inhaled Corticosteroids

NHLBI PUBLICATIONS AND RESOURCES
https://www.nhlbi.nih.gov/health-topics/all-publications-and-resources/clinician-guide-2020-focused-updates-asthma-management-guidelines

2020 Focused Updates to the Asthma Management Guidelines: Clinician's Guide
https://www.nhlbi.nih.gov/sites/default/files/publications/Asthma Clinicians Guide 508_02-03-21.pdf

Stepwise Approach for Management of Asthma
Pages 11-12: ages 0 to 4 years
Pages 13-14: ages 5 to 11 years
Pages 15-16: ages 12+ years

This Clinician's Guide summarizes the 2020 Focused Updates to the Asthma Management Guidelines: A Report from the National Asthma Education and Prevention Program Coordinating Committee Expert Panel Working Group to help clinicians integrate the new recommendations into clinical care. *Note: The ages 0-4 stepwise approach table was updated in February 2021.

Return to ED **Return to Inpatient**

Corticosteroids

Evidence Synthesis: Guidelines

Inhaled corticosteroids probably prevent hospitalizations (Guideline: NHLBI 2007, +3 Keans 2020). No advantages were found for IV or IM administration (LOE: Guieline NHLBI 2007, +2 Kirkland 2018). Dexamethasone is as effective as prednisone/prednisolone but better tolerated; studies were not able to establish the best dosage, formulation, or route of administration; a majority of patients preferred 1-2 dosese of oral or IM dexamethasone (LOE: Guideline, Cincinnati Childrens 2018).

Evidence Synthesis: Systematic Reviews

Table: Effect of systemic or inhaled corticosteroids for acute asthma exacerbations

			Outcome					
Intervention	Comparison	Population	Length of hospital stay	Hospital admission	Escalation of care	Readmission	Adverse events	Magnitude of Effect, Number needed to treat (NNT) (95% CI)
Corticosteroids								
Inhaled corticosteroids and systemic corticosteroids	Systemic corticosteroids alone	Children and adults		Favors intervention +2			Nausea and vomiting (N/V): No difference +2	Adding inhaled corticosteroids to systemic corticosteroids may decrease hospital admission, NNTB 16 (10 to 78) for a 30% control group rate, and may have little to no difference in N/V (Kearns 2020).
Inhaled corticosteroids alone	Systemic corticosteroids alone	Children and adults		Favors intervention +2			N/V: No difference +2 Tremor: No difference +2	Inhaled corticosteroids may decrease hospital admission compared to systemic corticosteroids, NNTB 13 (8 to 132) for a control group rate of 25%, and may make little to no difference in N/V and tremor (Kearns 2020).

Evidence Synthesis Statements

Inhaled corticosteroids alone	Placebo	Children and adults		Favors intervention +3			N/V: No difference +2	Using inhaled corticosteroids alone instead of placebo probably decreases hospital admission, NNTB 10 (8 to 20) and may make little to no difference in N/V (Kearns 2020).
Prednisolone	Dexamethasone	Children		No difference +2		No difference +2	Vomiting: No difference +2	Using prednisolone instead of dexamethasone may make little to no difference in hospital admission or readmission. Dexamethasone is an effective antiemetic in other settings; the lack of a significant reduction in vomiting compared to prednisolone (OR 3.05, 0.88 to 10.55) may be due to small sample size (Normansell 2016).
Prednisolone 5 day course	Prednisolone 3 day course	Children				No difference +2	All: No difference +3	Extending prednisolone therapy from 3 to 5 days may make little to no difference in readmission rates and probably does not impact adverse events (Normansell 2016).
Dexamethasone dose in ED followed by repeat dose in 2 days	Dexamethasone single dose of in ED	Children				(To hospital, 7 days) No difference +1		We are uncertain whether repeating dexamethasone for 2 days after the single dose in ED decreases hospital readmissions (Normansell 2016).
Prednisolone Higher dose (2 mg/kg)	Prednisolone Lower dose (0.5 mg/kg or 1 mg/kg)	Children				(to hospital, 14 days) No difference +2		We are uncertain whether a higher dose of prednisolone reduces admissions compared with a low dose (Normansell 2016).

Single IM dose of corticosteroid	Short course oral corticosteroid	Children and/or adults				(relapse to additional care 5-28 days) No difference +2	All: No difference +2	Administering corticosteroids IM instead of oral may make little to no difference in readmissions or adverse effects (Kirkland 2018).

The preferred study arm is highlighted in green. If both study arms are white, there is no difference. If a cell in an outcome column is blank then there is no outcome reported for that intervention and control comparison.

The CSW Asthma Pathway team (nursing, pharmacy, ED, inpatient, and pulmonary) reviewed the results of the literature review of systematic reviews which suggested that inhaled corticosteroids (ICS) or ICS plus systemic corticosteroids (SCS) were equivalent or superior to SCS alone. The team investigated the possibility of replacing SCS for low score patients and adding ICS to SCS for more severe exacerbations. The team reviewed the primary literature that formed the basis of the meta-analysis and investigated the logistics of adding ICS to the pathway. After these reviews, expert consensus to add ICS to the pathway could not be reached and a decision was made to leave the pathway as it currently stands.

Magnesium

Evidence Synthesis: Guidelines

Effect of IV or inhaled magnesium sulphate ($MgSO_4$) for acute asthma exacerbations.

Nebulized MgSO4 results in little to no effect on control of acute mild to moderate asthma in children (+2 Knightly).
For children with severe asthma symptoms (SpO2 <92%) not responding to nebulized beta2-agonist within the first hour, adding 150 mg MgSO4 to each nebulized short acting beta2-agonist likely reduces asthma symptoms (+2 Powell 2013) (LOE: Guideline, SIGN158 British 2019)
Intravenous MgSO4 (40 mg/kg/day) likely reduces symptoms and is a safe treatment for acute asthma in children not responding to first-line treatment. Side effect of hypotension with a single dose of IV MgSO4 is rare (+2 Singhi 2014) (LOE: Guideline, SIGN158 British 2019)

Evidence Synthesis: Systematic Reviews

			Outcome and Certainty					
Intervention	Comparison	Population	Length of hospital stay	Hospital admission	Escalation of care	Readmission	Adverse events (all)	Magnitude of Effect, Number needed to treat (NNT) (95% CI)
IV Magnesium Sulfate ($MgSO_4$)	Placebo	Children	Favors intervention +2	Favors intervention +2		(Return to ED 48h) No difference +2		Assuming a control group event rate of 50%, administering IV MgSO4 may decrease hospital admission NNTB 4 (3 to 13) for a control group rate of 77%. MgSO4 may make little to no difference in returns to ED within 48 hours and may slightly decrease LOS, MD -5.3 hrs (-9 to -1) hours (Griffths 2016).

Inhaled $MgSO_4$	Short acting beta agonist	Adults and Children		No difference +1			Serious and mild: No difference +3	We are very uncertain whether inhaled MgSO4 increases or decreases hospital admission when compared to short acting beta agonists; there is little to no difference in serious and mild adverse events (Knightly 2017).
Inhaled $MgSO_4$ and short acting beta agonist and ipatroprium	Short acting beta agonist and ipratropium	Adults and children		No difference +4	No difference +3	(Hospital 30 days) No difference +2	All and serious: No difference +3, +3	Adding inhaled MgSO4 to short-acting beta agonists and ipratropium results in little to no difference in hospital admission, probably causes no difference in escalation of care or adverse events, and may make little to no difference in readmission. (Knightly 2017).
Inhaled $MgSO_4$ and short acting beta agonist	Short acting beta agonist	Adults and children		No difference +3			All and serious: No difference +3, +4	Adding inhaled MgSO4 to a short acting beta agonists probably results in little to no difference in hospital admission and all adverse events and little to no difference in serious events (Knightly 2017).

The preferred study arm is highlighted in green. If both study arms are white, there is no difference. If a cell in an outcome column is blank then there is no outcome reported for that intervention and control comparison.

Antibiotics

Evidence Synthesis: Guidelines

Insufficient evidence to support or refute the role of antibiotics in acute asthma. The majority of asthma attacks are triggered by viral infection (LOE: Guideline, SIGN 2019),

Evidence Synthesis: Systematic Reviews

Effect of antibiotics for acute asthma exacerbations			Outcome and Certainty					
Intervention	Comparison	Population	Length of hospital stay	Hospital admission	Escalation of care	Readmission	Adverse events	Magnitude of Effect, Number needed to treat (NNT) (95% CI)
Antibiotics								
Azithromycin, telithromycin or ampicillin	Placebo	Children and/or adults	No difference +1				All: no difference +2	We are uncertain whether azithromycin, telithromycin or ampicillin increases or decreases length of hospital stay when compared to placebo. There may be little to no difference in adverse events (Normansell 2018).

The preferred study arm is highlighted in green. If both study arms are white, there is no difference. If a cell in an outcome column is blank then there is no outcome reported for that intervention and control comparison.

Theophylline

Evidence Synthesis: Systematic Reviews

Effect of theophylline for acute asthma exacerbations

			Outcome and Certainty					
Intervention	Comparison	Population	Length of hospital stay	Hospital admission	Escalation of care	Readmission	Adverse events (all)	Magnitude of Effect (95% CI)
Other								
Theophylline with or without ethylene diamine	Placebo	Children and adults	Favors intervention +2	No difference +1			All: Favors control	Compared to placebo, theophylline may make little to no difference in hospital LOS [MD -0.23 days (95% CI: -0.37 to -0.08)], have uncertain effect on hospital admission, and may increase all adverse events, NNTH 7 (5 to 11) for a control group rate of 13% (Mahemuti 2018).
Bipap for 2 hours	Standard of care	Children					All: not estimable, no deaths	

The preferred study arm is highlighted in green. If both study arms are white, there is no difference. If a cell in an outcome column is blank then there is no outcome reported for that intervention and control comparison.

Summary of Version Changes

- **Version 1.0 (9/14/2011):** Go live.
- **Version 2.0 (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 3.0 (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):** Periodic review go live. See executive summary for significant changes.
- **Version 6.1 (7/22/2015):** Methylprednisolone IV and Magnesium Sulfate IV updated on medication slide/tab.
- **Version 6.2 (12/11/2015):** Generic language clarification for ED phase.
- **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.
- **Version 10.0 (4/24/2023):** Periodic review go-live with new formatting style. Clarified age ranges for respiratory score table, ED initial assessment, ED timing for albuterol MDI and dexamethasone, urgent care transfer criteria, and inpatient phase progression. Updated ED 1st hour RS groups, nebulizer dosing for albuterol and ipratropium, discharge instructions, inpatient steroid treatment, and criteria for RRT and RISK watch. Removed ED 3rd hour ICU consult, ED 4th hour floor team huddle, and most educational pages. Aligned verbiage to correspond with Epic. Medication dosages reviewed and approved by Pharmacy and Therapeutics Committee on 4/18/2023.
- **Version 10.1 (7/10/2023):** Added max dose for prednisone and prednisolone.
- **Version 11.0 (11/3/2023):** Equity pauses were incorporated into the ED Management Phase with supporting content. Additional references added to bibliography.
- **Version 12.0 (1/18/2024):** Updated to include albuterol viral mesh nebulizer on inpatient; amended rationale for calling RRT.

Approval & Citation

Approved by the CSW Asthma Pathway team for April 24, 2023, go-live

CSW Asthma Pathway Team:

Hospital Medicine, Owner	Lynda Ken, MD
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Retrieval Website: https://www.seattlechildrens.org/pdf/asthma-pathway.pdf

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Evidence Ratings

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, Hultcrantz M et al. J Clin Epidemiol. 2017;87:4-13.):

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

Certainty of Evidence

✪✪✪✪ High: The authors have a lot of confidence that the true effect is similar to the estimated effect
✪✪✪○ Moderate: The authors believe that the true effect is probably close to the estimated effect
✪✪○○ Low: The true effect might be markedly different from the estimated effect
✪○○○ Very low: The true effect is probably markedly different from the estimated effect
Guideline: Recommendation is from a published guideline that used methodology deemed acceptable by the team
Expert Opinion: Based on available evidence that does not meet GRADE criteria (for example, case-control studies)

Bibliography

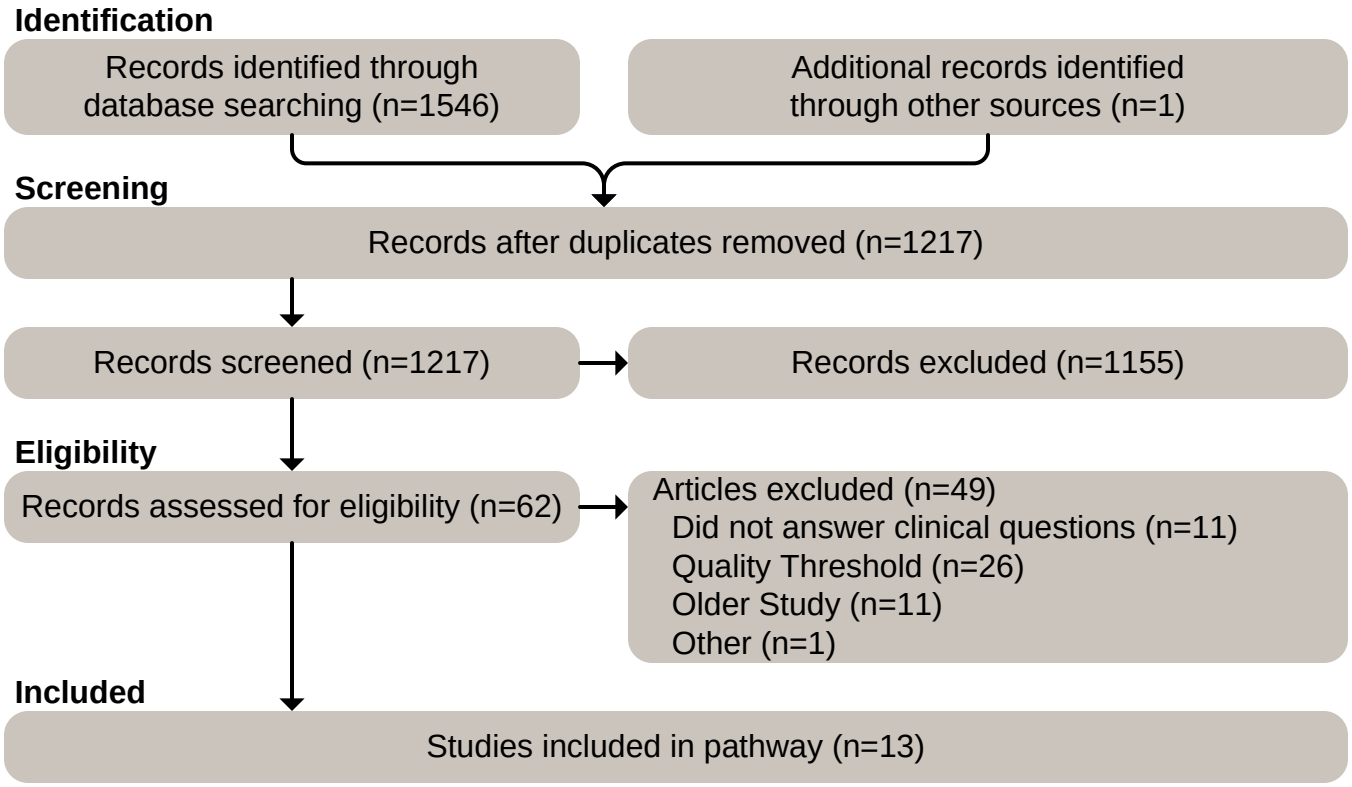
Literature Search Methods

For this update, we revised the search strategies in line with current Library practices. Literature searches were conducted in June 2020 to target synthesized literature on acute asthma exacerbations for 2015 to current and limited to English and humans. The search was executed in Ovid Medline, Embase, Cochrane Database of Systematic Reviews (CDSR) and Turning Research into Practice (TRIP) databases.

Screening and data extraction were completed using DistillerSR (Evidence Partners, Ottawa, Canada). Two reviewers independently screened abstracts and included guidelines and systematic reviews that addressed optimal treatment in an acute inpatient or emergency department setting. One reviewer screened full text and extracted data and a second reviewer quality checked the results. Differences were resolved by consensus.

Literature Search Results

The searches of the four abovementioned databases retrieved 1546 records. Our searches of other resources identified 1 additional record that appeared to meet the inclusion criteria. Once duplicates had been removed, we had a total of 1217 records. We excluded 1155 records based on titles and abstracts. We obtained the full text of the remaining 62 records and excluded 49. We combined these studies with those previously identified for prior versions of this pathway, and for this update we have included a total of 13 studies. The flow diagram summarizes the study selection process. Citations obtained outside the structured search parameters are listed under Additional References.



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

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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.

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