Figure 1. Clinical pathways for asthma exacerbation

Evaluation: Including vital signs, PRAM score ± FEV_1

INITIAL TREATMENT: FIRST HOUR

For all: OXYGEN to keep saturation ≥92%

Mild **PRAM 0 to 3** **FEV_1 >70%**	**Moderate** **PRAM 4 to 7** **FEV_1 50% to 70%**	**Severe** **PRAM 8 to 12** **FEV_1 <50%**	**Impending respiratory failure – Confused, drowsy, lethargic, cyanotic, decreasing respiratory effort**
• Salbutamol every 30 to 60 minutes for 1 to 2 treatments • Consider oral steroids (particularly for children with risk factors for severe asthma)	• Keep patient calm, seated • Salbutamol every 30 minutes for 2 to 3 treatments • For PRAM 6 to 7: Consider adding ipratropium with the first 3 salbutamol treatments • For all: Oral steroids before or immediately after first treatment	• Keep patient calm, seated • Salbutamol with ipratropium, every 20 minutes for 3 treatments • Oral steroids before or immediately after first treatment **When PRAM is 11 to 12 or if response is poor:** • Cardiopulmonary monitor, 1 to 2 IV lines • Patient NPO • Continuous nebulized salbutamol and ipratropium for 60 minutes (equivalent to 3 treatments in 60 minutes) • IV steroids (if vomiting or not improving) • IV magnesium sulfate • CXR, blood gas • **CALL FOR HELP**: PICU • Consider IV salbutamol • Consider heliox-driven beta2-agonist nebulization • Consider noninvasive ventilation until HELP arrives	• **CALL FOR HELP**: PICU, anesthesia • **Keep patient NPO and calm, seated** • O2 100% via non-rebreather mask • Support ventilation when required • Consider tension pneumothorax • Cardiopulmonary monitor, 2 IV lines or intraosseous if no IV line available • Blood gas + electrolytes • Support hemodynamics • Continuous nebulized salbutamol and ipratropium for 60 minutes • IV/IM steroids • IV magnesium sulfate • CXR when possible • Consider IV salbutamol • Consider heliox-driven beta2-agonist nebulization, ketamine, anesthesic gases • Consider noninvasive ventilation until HELP arrives • **At any point, if patient is not responding to treatment and has impending respiratory failure, consider rapid sequence intubation by the most experienced person available, with IV ketamine**

Re-evaluation: Including vital signs, PRAM score			
SECOND HOUR OF TREATMENT			
Mild PRAM 0 to 3	**Moderate PRAM 4 to 7**	**Severe PRAM 8 to 12**	**Impending respiratory failure – Confused, drowsy, lethargic, cyanotic, decreasing respiratory effort**
• Consider discharge if PRAM 0 to 3 for at least 1 to 2 h after last treatment • Treatment plan • Follow-up • Discharge instructions • Consider oral steroids at home	• Salbutamol every 30 minutes for another 2 to 3 treatments • For PRAM 6 to 7: Consider ipratropium every 30 minutes for 3 treatments with salbutamol, if not already given in the first hour	• Patient NPO • Salbutamol every 20 minutes for another 3 treatments • Ipratropium every 20 minutes for 3 treatments, if not already given • Plan an admission to hospital • Consider calling for help if not responding: PICU, and treat as outlined above (continuous nebulized treatment salbutamol and ipratropium, IV steroids, and IV magnesium)	• CALL FOR HELP, patient NPO • ADMIT/TRANSFER TO PICU • Treat as outlined above
Re-evaluation: Including vital signs, PRAM score			
4 HOURS POST STEROIDS ADMINISTRATION			
Mild PRAM 0 to 3	**Moderate PRAM 4 to 7**	**Severe PRAM 8 to 12**	**Impending respiratory failure – Confused, drowsy, lethargic, cyanotic, decreasing respiratory effort**
• Consider discharge if symptoms improved and PRAM 0 to 3 for at least 1 h after last treatment • Treatment plan • Follow-up • Discharge instructions • Consider oral steroids at home	• CONTINUE treatment as above • CONSIDER ADMISSION to hospital if not improving	• CALL FOR HELP, patient NPO • ADMIT/TRANSFER TO PICU • Treat as outlined above	• CALL FOR HELP, patient NPO • ADMIT/TRANSFER TO PICU • Treat as outlined above

Table 2. Medications and dosages for acute asthma treatments by health care providers in children older than 1 year

Drug and route	Dose (maximum)	Risks	Comments
Salbutamol*, MDI with spacer	<20 kg: 500 mcg/dose (5 puffs of 100 mcg/puff) ≥20 kg: 1000 mcg/dose (10 puffs of 100 mcg/puff)	Tachycardia, hypokalemia, hyperglycemia	Preferable route
Salbutamol, intermittent nebulization	<20 kg: 2.5 mg (0.5 mL of 5 mg/mL) ≥20 kg: 5 mg (1 mL of 5 mg/mL) Dilute in NaCl 0.9% to obtain a total volume of 3 mL	Tachycardia, hypokalemia, hyperglycemia	If severe desaturation between treatments with spacer. Monitor potassium serum levels in patients requiring frequent doses
Salbutamol, continuous nebulization	0.5 mg/kg/h (max 15 mg/h) OR <20 kg: 7.5 mg nebulized, to be given over 1 h ≥20 kg: 15 mg nebulized, to be given over 1 h Dilute in NaCl 0.9% In the first hour, salbutamol can be given with nebulized ipratropium		If severe desaturation between treatments with spacer or poor response to first treatment Monitor heart rhythm and rate, glucose and electrolytes
Ipratropium bromide*, MDI with spacer	4 puffs (20 mcg/puff) x 3 doses ≥30 kg: can increase to 8 puffs/dose		
Ipratropium, bromide nebulized	With the salbutamol nebulization over the firsthour: 3 x 250 mcg of nebulized ipratropium for a 1-hour continuous nebulization ≥30 kg: Can increase to 3 x 500 mcg for a 1-hour continuous nebulization		Can be mixed with salbutamol nebulization
Oral corticosteroids **PO dexamethasone**	0.3 mg/kg to 0.6 mg/kg (max 10 to 16 mg)	Adrenal suppression has been associated with prolonged course or frequent repeat treatments	Start treatment early Less vomiting than with prednisone/prednisolone
PO prednisolone or prednisone	1 mg/kg to 2 mg/kg (max 50 mg)		Do not use commercial dexamethasone elixir because of high alcohol content Dexamethasone is also available IM/IV
IV corticosteroids **Methylprednisolone**	1 to 2 mg/kg (max 80 to 125 mg)		If not responding to treatment or if vomiting PO steroid, IV drug of choice
Hydrocortisone	5 to 8 mg/kg (max 400 mg)		If not responding to treatment or if vomiting PO steroid and IV methylprednisolone not available
IV magnesium sulfate	40 mg/kg to 75 mg/kg over 20 to 30 minutes (max 2.5 g) Need to dilute Mg 50% (500 mg/mL) to obtain a solution of Mg 2% (20 mg/mL)	Hypotension, nausea, bradycardia	Consider if patient is not improving Cardiorespiratory monitoring required
IV salbutamol	Perfusion beginning at 1 mcg/kg/minute (some guidelines propose max 80 mcg/min) Administer in PICU Titrate progressively (max generally 5 mcg/kg/minute) Need to dilute salbutamol 1mg/mL to obtain salbutamol 0.5mg/mL	Tremor, tachycardia, arrhythmia (SVT), HBP, cardiac ischemia, hypokalemia, hyperglycemia, increased lactate	Cardiorespiratory monitoring required Monitor glucose, electrolytes

HBP: High blood pressure, IV: Intravenous, MDI: Metered dose inhaler, PO: By mouth, SVT: Supraventricular tachycardia

***A variety of weight- and age-based recommendations for dosing exist in references 2, 17, 41**

TABLE 3: Inhaled daily dose of corticosteroids (ICS) for asthma therapy in children *†

Medication (trade name) Inhaler device - Formulation	Low corticosteroids dose for age	Medium corticosteroids dose for age
Beclomethasone (QVAR) φ MDI/spacer - 50 mcg or 100 mcg/puff	1 to 5 years: 50 mcg twice daily 6 to 11 years: 50 to 100 mcg twice daily ≥12 years: 100 mcg twice daily	1 to 5 years: 100 mcg twice daily 6 to 11 years: 200 twice daily ≥12 years: 200 mcg twice daily
Budesonide (Pulmicort) φ Dry powder inhaler ‡ -100 or 200 mcg/puff	≥6 years: 100 to 200 mcg twice daily	≥6 years: 400 mcg twice daily
Budesonide/LABA for ≥12 years : Budesonide/Formoterol (Symbicort) Dry powder Inhaler ‡ -100/6, 200/6 mcg/puff or 400/12	≥12 years: 100 to 200 mcg twice daily	≥12 years: 400 mcg twice daily
Ciclesonide (Alvesco) φ§ MDI/spacer - 100 or 200 mcg/puff	1 to 5 years: 100 mcg once daily ≥6 years: 100 to 200 mcg once daily	1 to 5 years: 200 mcg once daily ≥6 years: 400 mcg once daily
Fluticasone propionate (Flovent) φ MDI/spacer - 50, 125, 250 mcg/puff or Dry powder inhaler‡ - 100 or 250 mcg/puff	1 to 5 years: 50 mcg twice daily or 125 mcg once daily ¤ 6 to 11 years: 50 to 100 mcg twice daily or 125 mcg once daily ¤ ≥12 years: 125 mcg once or twice daily	1 to 5 years: 100 to 125 mcg twice daily 6 to 11 years: 200 mcg twice daily ≥12 years: 250 mcg twice daily
Fluticasone propionate/LABA for ≥4 years: Fluticasone propionate/salmeterol (Advair) MDI/spacer – 125/25, 250/25 mcg/puff or Dry powder inhaler ‡ - 100/50 or 250/50 mcg/puff Ж	≥12 years: 100 to 25 mcg twice daily	4 to 11 years: 100 to 125 mcg twice daily ≥12 years: 250 mcg twice daily
Fluticasone Fuorate (Arnuity Ellipta) § Dry power inhaler 100 or 200 mcg/puff	≥12 years: 100 mcg once daily	
Fluticasone fuorate/LABA for ≥12 years: Fluticasone furoate/vilanterol (Breo Ellipta)§ 100/25 or 200/25 mcg/inh	≥12 years: 100 mcg once daily	
Mometasone (Asmanex) φ Twisthaler- 100 or 200 mcg/inh	6 to 11 years: 100 mcg once daily ≥12 years: 100 mcg twice daily	6 to 11 years: 100 mcg twice daily ≥12 years: 200 mcg twice daily
Mometasone/LABA for ≥12 years: Mometasone/formoterol (Zenhale) MDI- 50/5, 100/5 or 200/5 mcg/puff	≥12 years: 100 mcg twice daily	≥12 years: 200 mcg twice daily

* Adapted from https://www.cps.ca/en/documents/position/asthma-in-preschoolers and https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4527232/ and https://www.tandfonline.com/doi/full/10.1080/24745332.2017.1395250

† High-dose inhaled corticosteroids should be administered in consultation with an asthma expert, if asthma not controlled under a medium dose of ICS.

φ ICS are currently approved by Health Canada for the following ages: QVAR ≥5 yo, Pulmicort (dry powder) ≥6 yo, , Alvesco ≥6 yo, Flovent ≥ 1 yo, Asmanex ≥4 yo.

‡ The youngest children able to use a dry powder inhaler are generally 6 yo.
While some dry powder inhalers may be approved by Health Canada for <6 y.o, use of a metered dose inhaler with an age-appropriate valved-spacer is preferred in this age group.

§ Ciclesonide and Fluticasone Fuorate are approved for use once daily.

Ж The maximale dose of salmétérol (LABA) is of 50 mcg/dose. Then, if dry powder is use (fluticasone propionate/salmeterol 100/50 or 250/50 mcg/inh) , 1 puff only /dose can be used.

¤ Fluticasone Propionate is not licensed for once-daily dosing in Canada but 125 µg once daily is sometimes used to improve adherence over twice-daily use of 50 µg

MDI: Metered-dose inhaler

Source: Managing an acute asthma exacerbation in children, Acute Care Committee, Paediatric Emergency Medicine Section, October, 2021. Available at www.cps.ca