Pediatric Asthma

Section 1: Case Summary

Scenario Title:	Pediatric Asthma
Keywords:	Peds status asthmaticus
Brief Description of Case:	8 year old with known asthma comes in with 4 days of cough and runny nose, itchy eyes. Parents have been giving him Ventolin 4 puffs Q3h via spacer but are finding this is not working anymore. He is on Flovent BID. They are in the middle of home renovations. He has intermittent vomiting. The child comes in with tachypnea, borderline low sats (~93%), looks pale, audibly wheezing with indrawing. Treatment is initiated and should follow the BCCH asthma pathway. Child will become worse and will ultimately need to be admitted on ketamine infusion and NIPPV

Goals and Objectives	
Educational Goal:	Recognition of status asthmaticus, avoid intubation
Objectives: (Medical and CRM)	**Medical:** 1) Understand and use the PRAM scoring to guide use of BCCH emergent asthma management protocol 2) Recognize the severe asthmatic who is refractory to usual therapies and know when to institute NIPPV **CRM:** Bedside approach to the pediatric patient is different than the adult patient Locate resources to help with pediatric emergent conditions management Know who else to call for help if local support unavailable Understand locally available resp supports for pediatrics
EPAs Assessed:	

Learners, Setting and Personnel				
Target Learners:	☐ Junior Learners	☒ Senior Learners	☐ Staff	
	☒ Physicians	☐ Nurses	☐ RTs	☐ Inter-professional
	☐ Other Learners:			
Location:	☒ Sim Lab	☐ In Situ	☐ Other:	
Recommended Number of Facilitators:	Instructors:			
	Confederates:			
	Sim Techs:			

Scenario Development	
Date of Development:	Sept 14, 2023
Scenario Developer(s):	JMacleod/MPaquette
Affiliations/Institutions(s):	RTVS
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Pediatric Asthma

Section 2A: Initial Patient Information

A. Patient Chart					
Patient Name: Johnny Wheezer			Age: 8	Gender: M	Weight: 30kg
Presenting complaint: Sob/asthma exacerbation					
Temp: 36.7	HR: 190	BP: 99/48	RR: 32	O_2Sat: 93%	FiO_2: R/A
Cap glucose: 6.3			GCS: (E V M)		
Triage note: Hx of asthma SOB x 4 days, parents giving Ventolin q3H Intermittent vomiting – emesis at triage Triage PRAM 6 Direct to Room 8					
Allergies: seasonal, eggs					
Past Medical History: Asthma			Current Medications: Flovent 50mcg 1 puff BID via spacer Ventolin 2-4 puffs q4h via spacer Aerius prn		

Section 2B: Extra Patient Information

A. Further History
Include any relevant history not included in triage note above. What information will only be given to learners if they ask? Who will provide this information (mannequin's voice, confederate, SP, etc.)? All of the following info will only be given if asked of parent: Asthma since age 4, triggers are dust, seasonal (pollen) 1 prior admission for asthma exacerbation, no hx of ICU admissions Both parents smoke

B. Physical Exam	
List any pertinent positive and negative findings	
Cardio: tachycardia, no murmurs	Neuro: Awake but appears tired
Resp: Decreased throughout with exp wheezes	Head & Neck: no adenopathy
Abdo: mildly distended, nontender	MSK/skin: cap refill ~3 seconds
Other:	

Section 3: Technical Requirements/Room Vision

A. Patient
☒ Mannequin *(specify type and whether infant/child/adult)* ***CHILD***
☐ Standardized Patient
☐ Task Trainer
☐ Hybrid
B. Special Equipment Required
C. Required Medications
Ventolin and Atrovent MDIs, aerochamber, IV epinephrine, ketamine, phenylephrine, IV methylprednisolone, IV zofran
D. Moulage
E. Monitors at Case Onset
☒ Patient on monitor with vitals displayed ☐ Patient not yet on monitor
F. Patient Reactions and Exam
Include any relevant physical exam findings that require mannequin programming or cues from patient (e.g. – abnormal breath sounds, moaning when RUQ palpated, etc.) May be helpful to frame in ABCDE format. A – no stridor B – spontaneous resps, tachypnea, decreased A/E throughout with wheezing C – pale, cap refill ~3 seconds D – nil E – clothes covered in vomit

Section 5: Scenario Progression

Scenario States, Modifiers and Triggers				
Patient State/Vitals	Patient Status	Learner Actions, Modifiers & Triggers to Move to Next State		Facilitator Notes
1. Baseline State Rhythm: NSR HR: 190 BP: 99/48 RR: 30 O_2SAT: 93% R/A T: 36.7°C GCS: 15	*Alert, tachypneic, audibly wheezing, PRAM 6*	Expected Learner Actions ☐ O2/monitor/cap glucose ☐ Administer O2 via nasal prongs (1-2L/minute) ☐ Zofran, po dexamethasone ☐ Ask for the PRAM and BCCH asthma protocol printouts **-NO NEBULIZER** **-Dexamethasone PO 16mg** **-Initiate MDI puffs** **-Call RTVS/Charlie** Do **NOT** need Chest x ray at this point	Modifiers -RNs at bedside can't agree on initial PRAM>>MD to provide input -PRAM decreases from 6 to 4 after initial treatment, observation for 1 hour -If no IV inserted, RN asks if they can try ORT -Mom asks if she can feed child lunch >> child will vomit if you say yes Triggers Repeat PRAM after 1 hour (5 minutes in Sim) >>, PRAM worsens to 9 and O2 sats start dropping >>Stage 2	**PRAM moderate score 4-7** O 2 sat'n 93%=1 NOT Using suprasternal muscles=0 Decreased air entry to base and apex=2 Wheeze audible=3 **Total= 6=Moderate** **Provide salbutamol 10 puffs via SPACER/MDI q 20 min x 3 doses**. (equivalent of 5mg via spacer) Atrovent via **SPACER/MDI** 6 puffs up to 3 doses q 20 min in first 60 min. (equivalent 500mcg via neb)
2. Deterioration HR: 200 BP: 95/48 RR: 38 O_2SAT: 87% R/A T: 36.7°C GCS: 13	Getting more tired, still audibly wheezy, poorer air entry. Child vomits twice. Pulsus paradoxus	Expected Learner Actions ☐If available consider Hi Flo O2 Initiate transfer/PTN if not already done ☐Insert IV if not already done IV NS bolus 20cc NS/kg and maintenance infusion, labs with IV ☐ Repeat or ask for ABG/VBG/iSTAT ☐ CXR and ECG ☐ **Continuous nebulized Ventolin 15-20mg/hr with O2** ☐ IV methylpred 1mg/kg/dose q6h ☐Start IV MgSO4 (40-50mg/kg/dose over 20 minutes)	Modifiers -If no ECG ordered, RN to point out musical pattern on pulse ox waveform -if PTN/Charlie **NOT** called, child becomes more agitated and screams, refuses bloodwork and IV -If IV MGSO4 started, hypotension develops (BP 70/40) >> RN to prompt for treatment	**Pram Score** 0 2 sat'n <92%= 2 Using suprasternal retractions= 2 Decreased a/e to base and apex= 2 Audible wheeze= 3 **Total=9=severe** **Hi-flow nasal canula**: 1 L/kg/min to 2 L/kg/min upper limit is 50 L/min on 100% fi O2 to achieve o2 sat'n 94-98% **Hi-flow adult cannula use ONLY if obvious fit to child nostrils and ONLY as a temporary bridge to transfer**. (no studies performed) **Only in severe asthma PRAM> 8 use nebulizers**

		☐consider sc or IM Epinephrine (0.01mg/kg sc q20min x 3)		
3. Improved HR: 195 BP: 100/80 RR: 20 O_2SAT: 95% on hi flow Fi o2 0.5 T: 36.7°C GCS: 14	Less drowsy and less work of breathing with improved air entry	<u>Expected Learner Actions</u> ☐Charlie has organized through PTN to transfer to PICU @ ☐Continue with intermittent nebulized Ventolin as needed ☐Have tools for intubation ready at bedside (VL or DL, blade, tube size) in case of deterioration.		Repeat PRAM after 40 minutes PRAM improves to 6
4. Intubation (optional for complexity)		<u>Expected Learner Actions</u> ☐ Choose appropriate vent settings (either rpressure or volume control, lower resp rate, tidal volume 6-8mL/kg), start with FiO2 100% then titrate down to maintain O2>92%, I:E ratio of 1:4-1:8, very low to NO PEEP such as 0-3, just enough to overcome resistance of ETT.) Best to try bagging first and count the seconds for full expiration, then set RR ☐ Monitor for air-trapping: expiratory flow should be 0 at end of expiration before next breath begins ☐Manage hypoxia and hypotension (disconnect from vent and allow full recoil, then go through DOPE pneumonic) ☐ Check response via ABG (initial hypercapnia is ok until airway	<u>Modifiers</u> post-intubation>> hypoxia and hypotension>>recognize and treat pneumothorax >> 5 minutes passes or pneumo treated >> end of scenario	Discuss pathophysiology changes in asthma that dictate ventilator settings

		obstruction can be reversed) ☐ Ensure appropriate level of sedation to avoid ventilator asynchrony; try to avoid prolonged paralysis to prevent excessive hypercarbia and myopathy		

Appendix A: Laboratory Results

WBC		12.2
RBC		4.50
Hgb		123 g/L
MCV:	76	
RDW:	13.4	
PLT:		348
Na+		138 mmol/L
K+		2.8 mmol/L
Cl		108 mmol/L
CO2		22
BUN		7.2
Creatinine	56 mmol/L	
Glucose		16.4 mmol/L

VBG for Stage 2

pH 7.35
pCO_2 42
pO_2 92mmHg
HCO_3 22

ABG for Stage 3:

pH: 7.20
pCO2: 51 mmHg
pO2: 77 mmHg
HCO3: 19 mmol/L

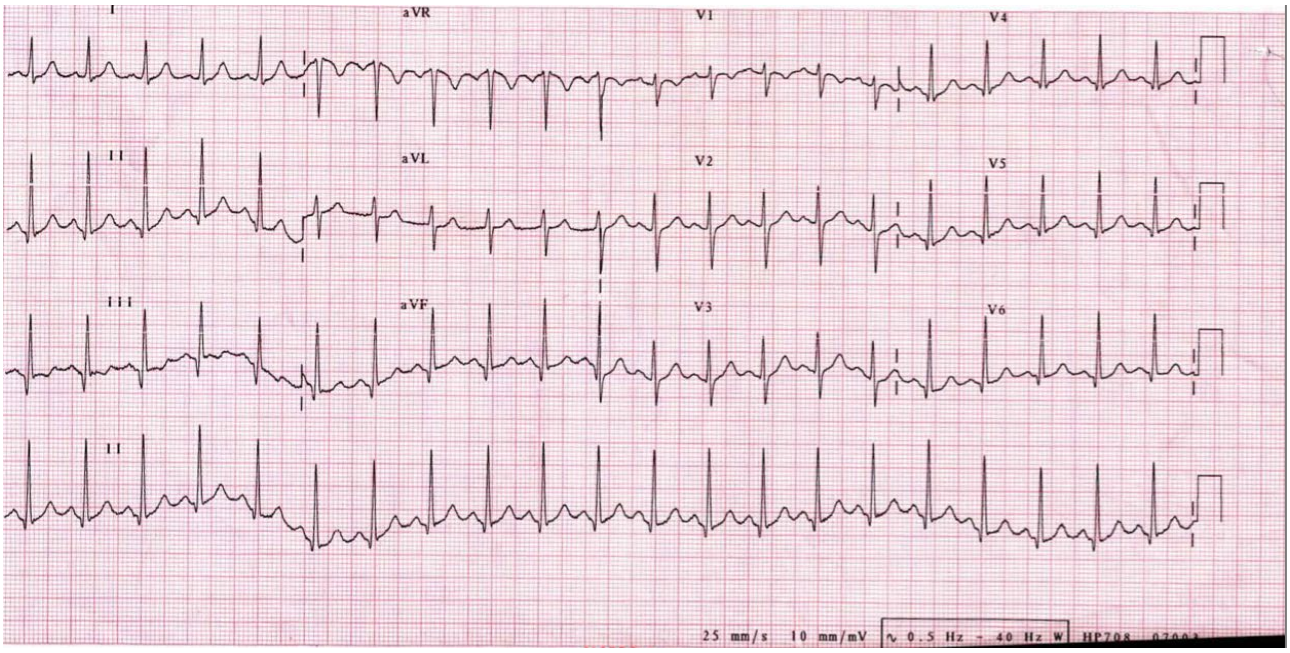
ABG Stage 4:

pH 7.40
pCO2 40
pO2 93mmHg
HCO3 19mmol/L

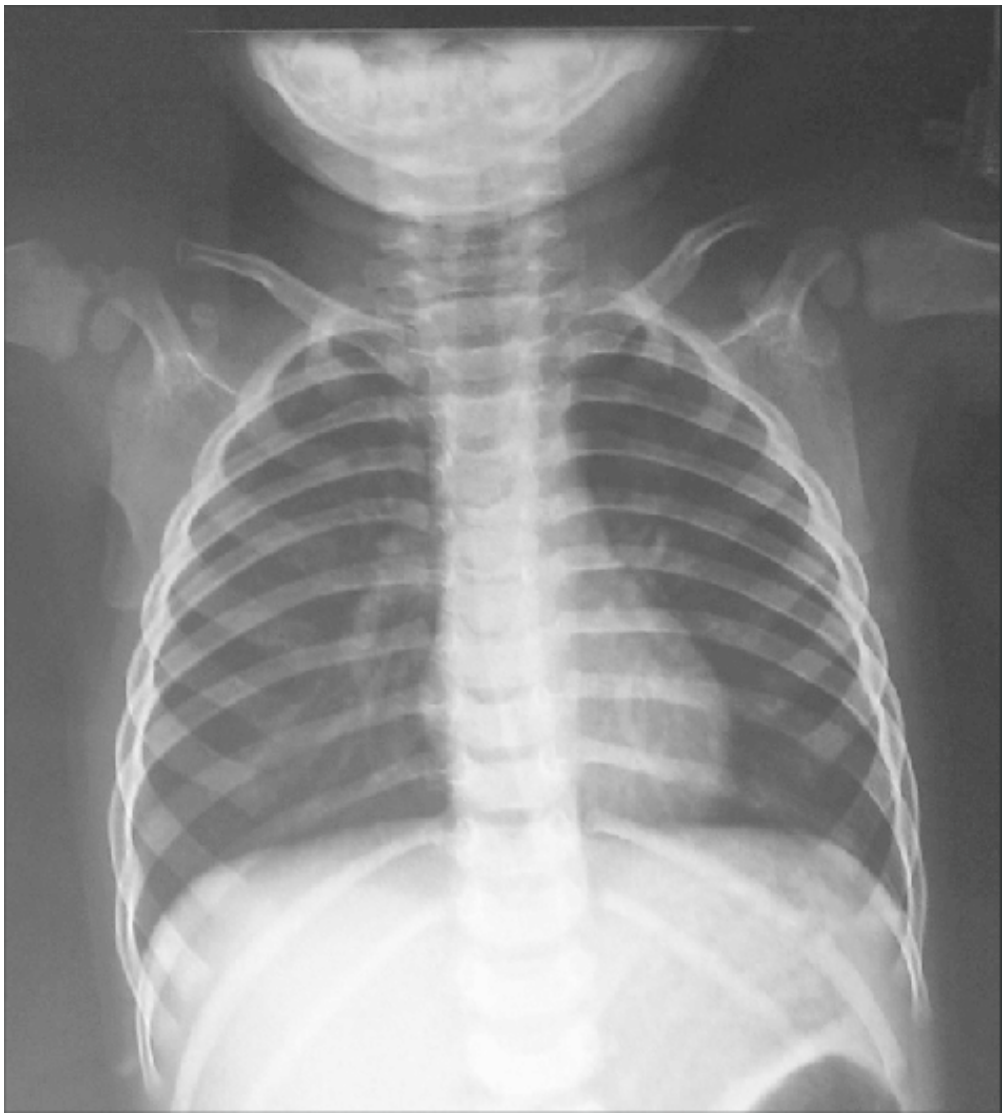
Appendix B: ECGs, X-rays, Ultrasounds and Pictures

Paste in any auxiliary files required for running the session. Don't forget to include their source so you can find them later!

ECG – pulsus paradoxus:



CXR – hyperinflation, flattened diaphragm:



https://www.researchgate.net/figure/X-ray-chest-shows-hyperinflation_fig1_310475382

Appendix C: Facilitator Cheat Sheet & Debriefing Tips

Include key errors to watch for and common challenges with the case. List issues expected to be part of the debriefing discussion. Supplemental information regarding any relevant pathophysiology, guidelines, or management information that may be reviewed during debriefing should be provided for facilitators to have as a reference.

Please print out or give link to:

http://www.bcchildrens.ca/Asthma-site/Documents/PRAM-Initial-Management-Pathway.pdf

-know how to use the PRAM so that you are confident in your clinical management (RNs are trained but do you agree?)
-DON'T REASSESS AND DISCHARGE TOO EARLY! Minimum 2 hours of ED stay if very mild asthma, longer if hx of prior admissions
Discharge criteria from the ED include:

- Needing beta-agonists less often than q4 h after 4 to 8 h of conventional treatment
- A reading of SpO2 94% on room air

-there are no clinical trials supporting ipratropium use beyond the first hour or first 3 doses in children.
-Single dose Dexamethasone is the preferred oral corticosteroid for Pediatric Asthma
-do they all need a CXR?
-avoid intubation in asthmatic kids –
-if you do intubate – avoid high vent pressures (25% will have pneumothorax, cardiac arrest)
Asthma-specific ventilator settings include:

- Low RR (4 to 8 per minute)
- Low I:E ratio (1:4 or 1:5)
- Tidal volumes not to exceed 8-10 ml/Kg
- Peak pressures not exceeding 40 cm H2O

-HFNC is gaining popularity and is being used more in kids to provide a little bit of CPAP (nasal CPAP is a good choice in younger kids who won't tolerate the BiPAP mask, but has been used mostly in bronchiolitics)
-ketamine may be as good as aminophylline in a study from 2016; aminophylline has fallen out of favour due to narrow toxicity, range of side effects, frequent serum testing, and no evidence that it shorts ICU stay (it may in fact prolong it). Only start this with intensivist input.
-causes of agitation >> hypoxia and hypercapnia, but also being a scary and mean doctor! (discuss bedside approach such as getting down to their level, using kid-friendly language, using toys/props/child-life specialist)
-MgSO4 can be given IO or nebulize if no IV access

- pulsus paradoxus - Marked variation in baseline of an asthmatic patient's pulse oximeter tracing is observed in the presence of pulsus paradoxus.
- Thought to be due to high negative intrapleural pressures during inspiration, which decrease stroke volume, which is reflected in the altered baseline tracing.
- This pattern is seen in severe asthma indicating impending respiratory failure and the need for assisted ventilation.
- RWV reflects pulsus paradoxus where a drop in systolic blood pressure is seen with decreased venous return during inspiration.

- Correction of this pattern is seen with improving lower airway obstruction.

Pediatric vent settings in asthma:
Physiologic considerations:

- Heterogenous and reversible increased airway resistance
- Severe limitation of expiratory flow
- Premature airway closure
- Lung hyperinflation
  - Decreased elastic recoil and increased FRC of up to 2 times normal and decreased
- Chest wall dynamic changes
- High intrinsic PEEP

These produce clinically apparent:

- Respiratory fatigue
- Increased utilization of accessory muscles of respiration
- Ventilation/Perfusion Mismatch
- Very heterogenous areas of lung parenchyma with varying degrees of aeration
- Barotrauma
- High pulmonary pressures
- Hemodynamic instability
- Increased intrathoracic pressures negatively influencing the cardiac venous return/Preload and, hence, cardiac output.

Complications of mechanical ventilation:

- Hemodynamic instability following intubation.
- Hypotension occurs as a result of worsening hyperinflation leading to decreased cardiac preload.
- Cardiac Arrest can occur due to this progression as well.
- Barotrauma
- Pneumothorax
- Ventilator Associated Pneumonia
- Most common – accounting for ~10% of the complications

PEARLS:
-used a CUFFED ETT (pediatric-specific ETTs now mean less risk of mucosal injury) >> allows for better ventilator control by reducing air leak
Mode: there is no evidence to support one mode over another. Many start with Volume-Control.

- Tidal Volume: 6-10 ml/kg ideal body weight
- Enough to move the chest.
- Expiratory Time: 4-5 seconds
- Inspiratory: Expiratory ratio may be 1:4, but can be as high as 1:8
  - Goal is to allow exhalation and avoid stacking breaths with barotrauma.
  - Expiratory flow rate should be 0 at the end of exhalation and before next breath is initiated
- Resp Rate: Below physiologic rate for age.
  - Controlled Hypoventilation has been shown to be safe

- PEEP: 0-3 (in acute phase. PEEP used once improving and weaning starts).
- FiO2: can start at 100%, but titrate to keep sats >90%.
- Keep the child adequately sedated!
- Avoid patient-ventilator asynchrony.
- Also helps decrease CO2 production.
- Ketamine is a useful med to
- consider!
- It is best to avoid prolonged neuromuscular paralysis if you are able to.
- Keep Plateau Pressures <30 cmH20
- Increased risk of barotrauma above this level.
- Measured by an end-inspiratory pause of several seconds in a system without leaks (hence, the cuffed ETT).

Appendix D: References

1. Child Health BC provincial asthma guideline (https://www.childhealthbc.ca/initiatives/asthma-care-across-community-settings)

2. Annals of Thoracic Medicine – Vol 11, Issue 4, October-December 2016.

3. https://emergencymedicinecases.com/pediatric-asthma/

4. Jones BP, Paul A, . Management Of Acute Asthma In The Pediatric Patient: An Evidence-Based Review. *Pediatric Emergency Medicine Practice* (ISSN Print: 1549-9650) 2013 May; 10(5).

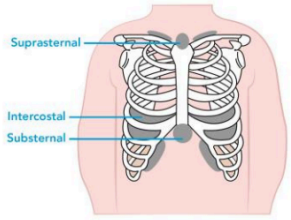
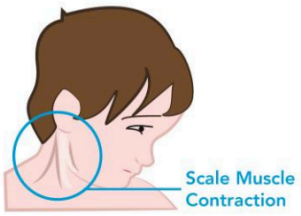
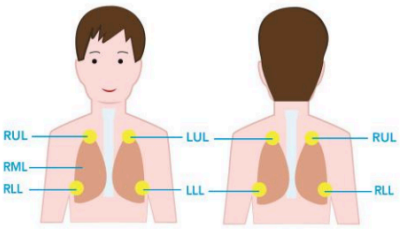
5. Mechanical Ventilation for Severe Asthma. BY SEAN M. FOX · PUBLISHED NOVEMBER 7, 2014 · UPDATED NOVEMBER 6, 2014. PEDIATRIC EM MORSE

CHILD HEALTH BC
LEAD BENEFACTOR save on foods
TIERS OF SERVICE

Child Health BC Provincial Asthma Guideline

Initial Management of Pediatric Asthma
In Emergent/Urgent Care Settings

Table 1: PRAM Scoring Table

Criterions	Description	Score	Notes
O2 saturation	Greater than or equal to 95% 92-94% Less than 92%	0 1 2	O2 saturation must be measured with the patient breathing ambient air until stabilization of the oximetry value for at least 1 minute **Turn Off Supplementary Oxygen** when measuring PRAM. If SpO2 falls to less than 92% you can turn oxygen back on immediately as they have automatically scored maximum (2) points.
Suprasternal Retraction 	Absent Present	0 2	The suprasternal retraction is visible indrawing of the skin above the sternum and between the sterno-cleido-mastoid muscle with every intake of breath. **This is a visual assessment**
Scalene Muscle Contraction 	Absent Present	0 2	The scalenes are deep cervical muscles located in the floor of the lateral aspect of the neck Scalene contraction cannot be seen. **This is a palpable assessment**. Land mark for locating scalene muscles in the triangle bordered by the clavicle (in the front), the trapezius (in the back) and neck (medially) in the line with the ear lobe.
Air Entry 	Normal ↓ at the base ↓ at the apex and the base Minimal or absent	0 1 2 3	****In cases of asymmetry, the most severely affected lung field determines the rating.** Use lung fields to grade air entry. **Lung field=two contiguous VERTICAL auscultation zones of the major lobes:** Right anterior lung field: RUL & RML Right posterior lung field: RUL & RLL Left anterior lung field: LUL & LLL Left posterior lung field: LUL & LLL
Wheezing	Absent Expiratory only Inspiratory (± expiratory) Audible without stethoscope or silent chest (minimal or no air entry)	0 1 2 3	Use auscultation zones to grade wheeze **At least two auscultation zones must be affected to influence the rating.** **In case of asymmetry, the two most severely affected auscultation zones, irrespectively of their location (RUL, RML, RLL, LUL, LLL), will determine the rating criterion.
PRAM Score Total	**0 – 3 Mild**	**4 – 7 Moderate**	**8 – 12 Severe**

PRAM Initial Management Pathway

Pediatric Asthma References

MILD
PRAM Score 0-3

- Salbutamol every 20 minutes, 1-2 doses in the first hour delivered via metered dose inhaler (MDI) and spacer rather than nebulization[2]
- RN/RT to reassess PRAM Score 20 minutes after each dose of salbutamol
- **Note:** There is no clear evidence of the benefit of giving corticosteroids in those with mild respiratory distress

REASSESS

PRAM Score 0-3 | PRAM Score 4-7 | PRAM Score 8-12

- Observe for a minimum of 1 hour after last inhaled salbutamol
- If the PRAM score remains in the 0-3 range during this time proceed to discharge instructions

REASSESS

PRAM Score 0-3 | PRAM Score 4-7 | PRAM Score 8-12

Discharge Medications and Follow up

- Provide asthma teaching/device information using a discharge checklist
- Provide written discharge instructions/action plan (short-term management plan)
- Inhaled salbutamol PRN and inhaled steroids
- Recommend follow-up with community physician/ health care practitioner within 2 weeks
- Refer to asthma education (if available)

MODERATE
PRAM Score 4-7

- Salbutamol every 20 minutes, X 3 doses delivered via MDI and spacer rather than nebulization[2]
- Ipratropium every 20 minutes, X 3 doses delivered in the first hour only, 3 delivered via MDI and spacer
  - This has been shown to yield greater improvement and lower hospital rates[4]
- Give oral corticosteroid before or immediately after the first dose of salbutamol
  - This has been shown to decrease time to improvement, emergency department length of stay, and hospitalization rates[5-6]
  - Either oral dexamethasone or prednisone/ prednisolone is likely to have comparable efficacy, with lower rates of vomiting with dexamethasone[7]
- RN/RT to reassess PRAM Score 20 minutes after each dose

REASSESS

PRAM Score 0-3 | PRAM Score 4-7 | PRAM Score 8-12

- Notify MRP of the score
- Salbutamol every 30-60 minutes for PRAM greater than or equal to 4
- Reassess PRAM 20 minutes after each dose of Salbutamol

REASSESS

PRAM Score 0-3 | PRAM Score 4-7 | PRAM Score 8-12

- If the PRAM Score remains in this range for 4 hours after oral corticosteroid consult a pediatrician and consider admission or transfer to a higher level of care

SEVERE
PRAM Score 8-12

1. Call MRP Immediately
2. Salbutamol continuous nebulization with oxygen
   - Bronchodilators delivered continuously for 60-180 minutes via aerosol result in more rapid improvement compared to intermittent delivery
3. Ipratropium nebulized every 20 minutes for 3 doses if not already given
4. Establish IV access, run maintenance fluids
5. Methylprednisolone IV 1 mg/kg/dose every 6 hours even if a previous steroid has been given
6. Continuous cardio/respiratory/SaO2 monitoring
7. Consider chest x-ray

PRAM Score 4-7 | **REASSESS** | PRAM Score 8-12

- Magnesium Sulfate IV[8]
  - In addition to continuous bronchodilator therapy
  - Consider 0.9% sodium chloride bolus IV of 20mL/kg over 20 minutes to vent hypotension
- Consult Pediatrician
  - Consider calling BC Patient Transfer Network (PTN) to arrange consultation or transfer: 1-866-233-2337
  - Consider Tele PICU consult (if available)
- If the patient is deteriorating consider:
- RT consult if not already involved
- Blood gases (venous, capillary or arterial)
- High-flow oxygen therapy or BIPAP
- Anesthesia consult if considering airway management
- Assisted ventilations or intubation
- At the direction of intensivist, aminophylline or ketamine IV

PRAM Score 4-7 | **REASSESS** | PRAM Score 8-12

- Continue to give Salbutamol every 30-60 minutes
- Consider admission to hospital

Go to the moderate pathway

- Continue to give Salbutamol continuous nebulization with oxygen
- Consult and prepare for transfer to a higher level of care
- BC Patient Transfer Network (PTN): 1-866-233-2337

See Page 2 for dose references to accompany the initial management pathway[1]

UBC CPD
UBC CONTINUING PROFESSIONAL DEVELOPMENT FACULTY OF MEDICINE

Course Material for:
Pediatric Asthma Management
ubccpd.ca/course/pediatric-asthma-management

Updated: March 26, 2019

PRAM Initial Management Pathway Dose References[1]

Salbutamol	**Less than 20 kg:** 5 puffs by MDI and spacer or 2.5 mg by nebulizer **20 kg or greater:** 10 puffs by MDI and spacer or 5mg by nebulizer
Ipratropium	**Less than 20 kg:** 3 puffs by MDI and spacer or 250 mcg by nebulizer **20 kg or greater:** 6 puffs by MDI and spacer or 500 mcg by nebulizer
Dexamethasone	0.3-0.6 mg/kg/dose (max dose 16 mg per dose) PO daily x 1-2 days
Prednisone/ Prednisolone	1-2 mg/kg/dose (max dose 60 mg per dose) PO daily x 5 days
Methylprednisolone	1 mg/kg/dose (max dose 60 mg per dose) IV q 6 hours
Magnesium Sulfate	40-50 mg/kg/dose (max dose 2 g per dose) IV x 1 dose over 20 minutes **Avoid** *in children with neuromuscular disease*
Sodium Chloride	0.9% 20 mL/kg bolus IV over 15-30 minutes

For a complete interactive experience with the PRAM Initial Management Pathway and PRAM Score
Take UBC CPD's Pediatric Asthma Management Course
ubccpd.ca/course/pediatric-asthma-management

References

1. Child Health BC. Provincial Asthma Guideline: Initial Management of Pediatric Asthma in Emergent/Urgent Care Settings. www.childhealthbc.ca/initiatives/asthma. Published May 31, 2018. Accessed November 20, 2018.
2. Cates CJ, Welsh EJ, Rowe BH. Holding chambers (spacers) versus nebulisers for beta-agonist treatment of acute asthma. *Cochrane Database Syst Rev.* 2013;(9):CD000052. DOI: 10.1002/14651858.CD000052.pub3.
3. Vézina K, Chauhan BF, Ducharme FM. Inhaled anticholinergics and short-acting beta(2)-agonists versus short-acting beta2-agonists alone for children with acute asthma in hospital. *Cochrane Database Syst Rev.* 2014;(7):CD010283. DOI: 10.1002/14651858.CD010283.pub2.
4. Griffiths B, Ducharme FM. Combined inhaled anticholinergics and short-acting beta2-agonists for initial treatment of acute asthma in children. *Cochrane Database Syst Rev.* 2013;(8):CD000060. DOI: 10.1002/14651858.CD000060.pub2.
5. Bhogal SK, McGillivray D, Bourbeau J, Benedetti A, Bartlett S, Ducharme FM. Early administration of systemic corticosteroids reduces hospital admission rates for children with moderate and severe asthma exacerbation. *Ann Emerg Med.* 2012; 60(1):84-91. DOI: 10.1016/j.annemergmed.2011.12.027
6. Zemek R, Plint A, Osmond MH, et al. Triage nurse initiation of corticosteroids in pediatric asthma is associated with improved emergency department efficiency. *Pediatrics.* 2012;129(4):671-680. DOI: 10.1542/peds.2011-2347.
7. Keeney GE, Gray MP, Morrison AK, et al. Dexamethasone for acute asthma exacerbations in children: a meta-analysis. *Pediatrics.* 2014;133(3):493-499. DOI: 10.1542/pesd.2013-2273.\
8. Griffiths B, Kew KM. Intravenous magnesium sulfate for treating children with acute asthma in the emergency department. *Cochrane Database Syst Rev.* 2016 Apr 29;4:CD011050. DOI: 10.1002/14651858.CD011050.pub2.