Review Article

LIFE-THREATENING ASTHMA IN CHILDREN: A REVIEW

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SUMMARY

We present a case of a child presenting with well-described but poorly recognised symptoms of life-threatening asthma that were initially missed. We present a management protocol for life-threatening asthma, for which evidence in the literature is lacking.

Keywords: life-threatening asthma, acute hysteria, management protocol

INTRODUCTION

It was a Friday afternoon. We received a call from one of our doctors in casualty letting us know that one of our patients was there. She was an 11-year-old, known to us with asthma, who had been in casualty since the night before. According to the doctor, there was nothing wrong with her chest. She had been assessed as having 'acute hysteria' and was being transferred to our step-down facility, Selby Park, for observation. Her parents were refusing to leave until they had seen us, her asthma doctors, hence the call.

We arrived in casualty, took one look at our patient, and called for the resuscitation trolley. The staff were shocked as to which patient was in need of resuscitation at that time. Our patient was very agitated and was groaning and rolling around on the bed. She had been uncooperative the whole night. We ran an urgent arterial blood gas which showed a pH of 6.8 and a PCO_2 of 103 mmHg (13,7 kPa). She was in type 2 respiratory failure and her 'clear' chest was, in fact, a 'silent' chest. The diagnosis of an acute life-threatening asthma exacerbation had been missed.

Our patient was intubated and taken to the paediatric intensive care unit (PICU), where she was ventilated for 11 days. She is well today, still being treated for severe persistent asthma at our paediatric asthma clinic.

ASTHMA PREVALENCE

The Global Initiative for Asthma (GINA)[1] defines asthma as follows:

> Asthma is a heterogeneous disease, characterised by chronic airway inflammation and is defined by the history of respiratory symptoms such as wheeze, shortness of breath, chest tightness and cough that vary over time and intensity together with variable, expiratory airflow limitation.

Asthma affects 339 million people worldwide[2] and is the most common chronic non-communicable disease in children. The International Study of Asthma and Allergies in Childhood (ISAAC) has provided the most reliable data on the prevalence of current asthma symptoms in children across the world. They reported that the prevalence of current asthma symptoms in children in the 13-14-year-old group was 18–20% in South Africa.[3] Not only had the prevalence of symptoms increased over time, so had the degree of severity of symptoms. African children with asthma also have more severe symptoms than those in high-income countries.[4] Poor socio-economic status, environmental triggers, respiratory infection, obesity, genetic susceptibility, less awareness of the symptoms of asthma, missed diagnosis and a lack of access to care and appropriate treatment may be contributing factors in low- to middle-income countries (LMIC) such as South Africa.

ASTHMA MORBIDITY

The Global Burden of Disease collaboration estimated that 420 000 people in the world died from asthma in 2016, equating to more than 1 000 per day.[2] South Africa is ranked 25th worldwide for asthma prevalence and fifth for asthma mortality, with an estimated 18.5 deaths per 100 000 asthma cases.[5] The majority of hospitalised children with a severe asthma exacerbation (SAE) will respond to appropriate first-line therapy, with only 5–16% requiring admission to the PICU.[6]

DEFINITION OF ASTHMA EXACERBATIONS

Asthma exacerbations are episodes of acute or subacute

TABLE I: ASSESSMENT OF SEVERITY OF ASTHMA EXACERBATIONS[10,11,12]

Life-threatening asthma	• Silent chest; poor respiratory effort • Cyanosis; SpO_2 < 90% • Bradycardia, dysrhythmia or hypotension • Exhaustion, confusion or drowsiness • PEFR < 33% predicted
Severe asthma exacerbation	• SpO_2 < 90% • Unable to complete sentences in one breath; too breathless to talk or feed • Agitation • Tachycardia* • Tachypnoea** • Pulsus paradoxus (> 10 mmHg children, > 18 mmHg teenagers) • Accessory muscle use during expiration • Bilateral expiratory wheeze and/or reduced breath sounds • PEFR < 50% predicted or unable to perform PEFR measurements due to fatigue • Previous ICU admission
Moderate asthma exacerbation	• Able to talk in sentences • Pulse rate within normal limits • Respiratory rate within normal limits • Bilateral expiratory wheeze • SpO_2 ≥ 92% • PEFR ≥ 50% predicted

**Tachycardia: Pulse rate > 140/min in children 2–5 years old; > 125/min in children > 5 years old*
***Tachypnoea: Respiratory rate > 40 breaths/min in children 2–5 years old; > 30 breaths/min in children > 5 years old*
PEFR - Peak expiratory Flow Rate
SpO_2 - Oxygen saturation

worsening of asthma symptoms and lung function that require an increase in asthma treatment.[1] A severe asthma exacerbation (SAE) is one that is life-threatening or requires emergency treatment, or both.[7]

PATHOPHYSIOLOGY AND SYMPTOMS

The underlying pathophysiology in asthma is airway inflammation, mucosal oedema, an increase in mucous secretion and variable airflow obstruction resulting in the clinical signs that include wheeze, shortness of breath, chest tightness and cough. Increased airway resistance and dynamic hyperinflation cause a ventilation–perfusion mismatch in the lungs, which leads to increased work of breathing, hypoxia, subsequent respiratory acidosis and cardiovascular compromise.[8] Clinical signs that indicate impending respiratory failure include a decreased level of consciousness, an inability to talk in full sentences (due to shortness of breath), decreased or absent breath sounds and central cyanosis.[9] The clinical signs and assessment of severity of asthma exacerbations are summarised in Table I.[10,11,12]

A recent Lancet commission challenged conventional thinking of asthma as a single disease, stating that a physiology-based classification of airway diseases is outdated as it does not take into account the various pathologically distinct underlying mechanisms that contribute to individual patient morbidity and mortality. They suggested a 'precision medicine' strategy – the need for individualised phenotyping (and endotyping) to guide diagnosis and management rather than the current 'one-size-fits-all' approach.[13]

The risk factors for asthma exacerbations are summarised in Table II.[1,14]

WHEN TO ADMIT TO A PAEDIATRIC INTENSIVE CARE UNIT

The following would require admission to a PICU:[10,11]

- Severe asthma not responding to first-line therapy.
- Severe chest recessions, dyspnoea or work of breathing.
- Minimal chest movement and/or 'silent' chest.
- Respiratory failure – hypoxaemia PaO_2 < 60 mmHg (8 kPa) and/or increased $PaCO_2$ > 45 mmHg (6 kPa).
- Apnoea.
- Decreased level of consciousness, lethargy or agitation.

MANAGEMENT

Asthma management starts at home. All asthmatic patients should have a personalised written action plan detailing the warning symptoms of worsening asthma, when to adjust controller and reliever therapy and when to present to a healthcare facility. A card attached to their hospital card or a Medic-Alert bracelet identifying them as an asthma patient may be useful resources to alert emergency department staff.

While most paediatric guidelines offer evidence-based management of asthma exacerbations,[1,10,12] beyond that, the evidence for PICU-based care is unclear, contradictory or absent. Boeschoten et al surveyed current practices of managing children with severe acute asthma from 37 PICUs across 11 European countries and found a wide variation in the use of adjunctive therapies beyond first-line treatments (oxygen, inhaled short-acting beta-2 agonists (SABAs), and systemic corticosteroids).[6] Another study conducted across eight tertiary-care PICUs in the Collaborative Pediatric Critical Care Research Network (CPCCRN) by Newth et al showed similar results.[15]

Frequent clinical assessment and basic monitoring that includes continuous oximetry (to allow early oxygenation if the child is hypoxic), electrocardiogram (ECG), respiratory rate, heart rate, blood pressure, hydration status and level of consciousness are more important than performing investigations.

INVESTIGATIONS

Chest X-ray (CXR) – this is not necessary to make a diagnosis of asthma. A CXR should be performed only if a localised auscultatory abnormality is found (pneumonia/foreign body), in children who suddenly deteriorate clinically (pneumothorax) and in all patients who have been intubated (to confirm correct placement of the endotracheal tube).[16,17]

Peak expiratory flow rate (PEFR) – this can be reliably performed only in children older than five years of age and is difficult to perform in an acutely distressed patient. A PEFR < 50% predicted together with a poor response to treatment is indicative of an SAE.[1,10]

Arterial blood gas (ABG) – should be considered in patients with a poor response to initial therapy, those whose PEFR is < 50% of the expected flow rate and all children admitted to a

TABLE II: RISK FACTORS FOR ASTHMA EXACERBATIONS[1,14]

History	Uncontrolled asthma symptoms
Severity	Previously intubated/ICU admission ≥ 1 severe exacerbation in the past 12 months requiring hospitalisation or emergency department visit Hypoxia at initial management
Medications	High short-acting beta2-agonists (SABA) use Inadequate inhaled corticosteroids (ICS) or no ICS Currently using or recently stopped oral corticosteroids Incorrect inhaler technique Poor adherence ≥ 3 classes of medication Failure to respond to pharmacological treatment
Comorbidities	Obesity Chronic rhinosinusitis Gastro-oesophageal reflux disease Confirmed food allergy (increased risk of asthma-related death) Obstructive sleep apnoea Pregnancy
Exposures	Smoking (or cigarette smoke exposure) Allergen exposure and polysensitisation Air pollution
Social	Psychosocial problems – depression, anxiety Socio-economic problems – poor access to care, delay in seeking help, lack of education
Lung function	Low forced expiratory volume in 1 second (FEV_1)

PICU. A PaO_2 < 60 mmHg (8 kPa) and $PaCO_2$ > 45 mmHg (6 kPa) indicate respiratory failure.[1,16] In acute asthma, the initial $PaCO_2$ is low as a result of hyperventilation and then slowly rises as the severity progresses. Beware of a 'normal' $PaCO_2$ in a tachypnoeic asthmatic, as this could be a sign of exhaustion.

TREATMENT

First-line treatment for acute asthma includes oxygenation, bronchodilatation and corticosteroid administration. Although discussed separately here, these treatments should be initiated almost simultaneously, starting with adequate oxygen and bronchodilator therapy.

SHORT-ACTING BETA-2 AGONISTS (SABAs)

Inhaled: SABAs should be administered via pressurised metered-dose inhaler (pMDI) and spacer combination.[1] The delivery of inhaled bronchodilators by pMDI with a valved spacer and a tight-fitting mask, together with oxygen administration by nasal cannula, has been shown to be more effective than by a nebuliser in SAE.[18] pMDI use is cheaper, quicker and easier, requiring less personnel time, and it also has less risk of disseminating aerosols and the spread of viral infections, which is of particular concern during the COVID-19 pandemic.[12]

Nebulised: An oxygen-driven nebuliser should be reserved for patients presenting with a life-threatening asthma exacerbation or patients that are intubated (in-line nebulisation unit of the ventilator). SABAs should be administered by continuous rather than intermittent nebulisation within the first hour.[7] Several studies have shown no increase in side-effects, including tachycardia and hypokalaemia, with continuous nebulisation.[19,20]

Intravenous: SABAs should not be administered intravenously first line in patients admitted with SAE, even if they are mechanically ventilated.[1,7,21] However, intravenous SABAs can be considered in life-threatening asthma where minimal airflow occurs and inhaled therapy to the lungs is significantly reduced. A loading dose of salbutamol over one hour followed by a continuous infusion can be considered.[12,14,16] Alternatively, Browne et al reported a quicker recovery time and an earlier discharge from hospital with a single intravenous dose of 15 mcg/kg salbutamol.[22]

ANTICHOLINERGICS

Nebulised: In children admitted to the emergency room with SAE, inhaled anticholinergics should be combined with SABAs.[7] A Cochrane review of combined inhaled anticholinergics and SABAs for the initial treatment of acute asthma in children showed a lower risk of admission to hospital, an improvement in lung function and no overall increase in adverse effects when compared to SABAs alone.[23] In hospitalised children, however, the addition of nebulised anticholinergics to short-acting β2-agonists showed no improvement in hospital length of stay or response to therapy and their use in this setting is discouraged.[1,24]

CORTICOSTEROIDS

Systemic corticosteroids have been shown to improve asthma exacerbations and prevent relapse; they should be administered early on in all children presenting with an asthma exacerbation, preferably within one hour of presentation.[1] Oral administration works within four hours of administration, is as effective as intravenous and is favoured by being quicker to administer, less invasive and cheaper. Intravenous administration should be reserved for patients too distressed to swallow, patients who are vomiting and those requiring non-invasive ventilation or intubation.[1]

MAGNESIUM SULPHATE

Intravenous: Intravenous magnesium sulphate administered as a single dose infused over 20 minutes to paediatric patients with SAE who fail to respond to initial asthma management has been shown to improve respiratory distress and reduce both hospitalisations and the use of mechanical ventilation.[7,25,26,27,28] Evidence for further use is limited. ECG monitoring is required and beware the risk of hypotension.

Nebulised: Nebulised magnesium sulphate has shown no benefit in the treatment of SAE in children.[27,29]

ADRENALINE

A dose of deep intramuscular adrenaline to the anterolateral aspect of the thigh is recommended if the SAE is associated with anaphylaxis and angioedema.[1]

TABLE III. STEPWISE TREATMENT FOR SEVERE ACUTE EXACERBATION OF ASTHMA IN CHILDREN

	OXYGENATION	BRONCHODILATORS	PHARMACOTHERAPY
STEP 1	**Oxygen** via nasal cannula or venturi mask.	**SABAs (pMDI and spacer)** SABAs 4–10 puffs every 20 minutes for the first hour. 6–10 puffs repeated every 1–2 hours or 4–10 puffs every 3–4 hours if there is an improvement[1]	**Corticosteroids** **Oral** Prednisolone 40–50 mg/day PO for 5–7 days (adults), 1–2 mg/kg/day to a maximum of 40 mg/day PO for 3–5 days (children 6–11 years)[1] **OR IV** Methylprednisolone equivalent 2 mg/kg/day IV, maximum of 80 mg/day divided 6–12 hourly.[7,30] Hydrocortisone 4 mg/kg 6 hourly IV.[14,16] Dexamethasone 0.6 mg/kg IV.[12] *A/E: hyperglycaemia, hypertension, acute psychosis, increased risk of myopathy when combined with muscle relaxants.*
STEP 2	**Oxygen** via non-rebreather mask. O_2 flow rate > 6 L/min.	**SABAs (via nebulisation)** Salbutamol 2.5 mg (< 5 years),[1] 5 mg (> 5 years) [12] diluted up to 4 mL sterile normal saline. *A/E: nausea, tremors, tachycardia, hypokalaemia.* **Add anticholinergics (via nebulisation)** Ipratropium bromide 0.25 mg 8 hourly (< 6 years) and 0.5 mg 8 hourly (> 6 years).[7] *A/E: mydriasis, blurred vision.* **Combination therapy** Salbutamol 10 mg (2 mL) OR Fenoterol 2 mg (2 mL) PLUS Ipratropium bromide 0.5 mg/2 mL Total volume of 4 mL. No saline needed.[12] Three times in first hour then continuous.[12]	**If anaphylaxis** Adrenaline IMI 1 mg/ml (1:1000) – 0.01 mg/kg IM (Max – 0,5 ml IM).[1]
STEP 3	**Non-invasive ventilation** Consider HFNC, BiPAP, CPAP. *A/E: pneumothorax, pneumomediastinum.*	**Magnesium Sulphate IVI** $MgSO_4$ ≥ 20 mg/kg/dose up to 50 mg/kg (max 2 g) IV infused over 20 minutes.[7,25] *A/E: nausea, flushing, muscle weakness, hypotension.*	
STEP 4	**Intubation**	**Salbutamol IVI** Load at 5–10 mcg/kg/min IV for 1 hour then reduce to 1–5 mcg/kg/min as a continuous infusion.[12,14,16] OR Single dose 15 mcg/kg over 10 minutes.[22] *A/E: tachycardia, arrhythmias, hypokalaemia, hyperglycaemia, lactic acidosis.* **Then Aminophylline IVI** Loading dose 5 mg/kg IV over 20 minutes (max dose 500 mg) then 0.5–1.0 mg/kg/hr as a continuous infusion.[14,16,30] *A/E: hyperglycaemia, vomiting, arrhythmias, convulsions.*	**Drugs of choice for intubation** Ketamine 1–3 mg/kg IV Suxamethonium 1–2 mg/kg IV or Rocuronium 0.6–1.2 mg/kg IV.[7,16,35,38] Adrenaline 1 mcg/kg IV if haemodynamic collapse. *A/E: increased bronchial secretions (Ketamine).*
STEP 5	**Ventilation**	**Ventilator Settings** PCV/PRVC/PSV/VCV modes. Optimise oxygenation. Permissive hypercapnia pH > 7.2. PIP < 35–40 cmH_2O. Pplat < 30 cmH_20. PEEP 1–5 cmH_20.	**Drugs of choice for sedation** Fentanyl 1–2 mcg/kg IV OR 5–10 mcg/kg/hr (preferred). Midazolam 0.1–0.5 mg/kg IV or 1–4 mcg/kg/min (preferred). Clonidine 2.5 mcg/kg PO (preferred). Ketamine infusion 0.5–2 mg/kg/hr.[17,30] Propofol can be considered in older children up to 4 mg/kg/hr.[16] Avoid morphine (histamine-induced bronchospasm). *A/E: increased airway secretions, hallucinations, hypoventilation, decreased seizure threshold (Ketamine).*
STEP 6			**Paralysis** Lowest dose for shortest duration/ intermittent dosing. Paralyse until FiO_2 < 60%, PIP < 25 cmH_2O.[16] *A/E: Critical illness myopathy.*

HFNC – High flow nasal cannula; BiPAP – Bilevel positive airway pressure; CPAP – Continuous positive airway pressure; PCV – Pressure controlled ventilation; PRVC – Pressure regulated volume control; PSV– Pressure support ventilation; VCV – Volume controlled ventilation; PIP – Peak inspiratory pressure; Pplat – Plateau pressure

AMINOPHYLLINE

Intravenous aminophylline and theophylline are not recommended for use in SAE as they are associated with severe and potentially fatal side-effects, including hyperglycaemia, vomiting, arrhythmias and convulsions.[28] However, intravenous aminophylline can be considered in life-threatening asthma unresponsive to conventional therapy.[14,17,30] Do not load if oral theophylline was given in the 24 hours prior to presentation, and monitor plasma levels.[16]

LEUKOTRIENE RECEPTOR ANTAGONISTS (LTRAs)

The routine use of oral LTRAs has no role in the management of acute asthma. Intravenous treatment may reduce the risk of hospital admission but further studies are needed.[31]

ANTIBIOTICS

Routine use of antibiotics in patients with SAE is not recommended, unless there are signs suggestive of a bacterial infection.

OTHER NON-CONVENTIONAL INTERVENTIONS

Non-conventional interventions such as heliox, general anaesthesia, bronchoscopy, mucolytics and extracorporeal life support have been advocated but there is limited evidence for their use.[16]

Stepwise treatment for severe acute exacerbation of asthma in children is illustrated in Table III.

METHODS OF OXYGEN DELIVERY

Oxygen therapy should be initiated in all hypoxic patients via nasal cannulae or face mask (venturi mask or non-rebreather mask) and titrated to an oxygen saturation of 93–95% (adults) and 94–98% (children 6–11 years) with SAE.[1,7]

NON-INVASIVE VENTILATION

Non-invasive ventilation (NIV) in hypoxic paediatric patients with SAE is an attractive alternative to invasive mechanical ventilation (IMV) due its simplicity, tolerance and minimal side-effects, including barotrauma. Although there has been a widespread increase in the use of NIV for acute asthma in children over the past few years,[32] most authors are cautious about recommending its routine use.[1,7,33] NIV can be considered if conventional treatments fail and provided the patient remains closely monitored.[7] High-flow nasal cannula (HFNC) delivers heated and humidified oxygen at high flow rates, which limits the bronchoconstriction caused by cold dry gas and creates positive pharyngeal pressure to reduce the work of breathing.[34] Bilevel positive airway pressure (BiPAP) use has been found to be safe, has reduced PICU admissions and decreased hospital length of stay for SAE in children.[8] Nebulised treatments can be delivered through NIV circuits.[35]

INVASIVE MECHANICAL VENTIATION

Patients with SAE responding poorly to conventional treatment may require IMV. Acute severe asthma is characterised by increased airway resistance and the limitation of expiratory airflow, which leads to the incomplete exhalation of delivered tidal volume and dynamic lung hyperinflation.[36] Positive pressure ventilation with air trapping, pre-existing hypovolaemia secondary to poor oral intake and increased insensible water losses, all contribute to a risk of haemodynamic instability.

HOW TO INTUBATE

Peri-intubation is the most precarious time for a patient with acute life-threatening asthma. There is a risk of laryngospasm from airway handling, aspiration if the child has been feeding and haemodynamic collapse resulting in cardiac arrest.

Intubation procedure:

- Ensure all options to avoid intubation have been exhausted.
- Allow the most experienced clinician to perform the intubation.
- Discuss a backup plan should intubation fail.
- Ensure appropriate fluid resuscitation.
- Have intravenous adrenaline available for possible haemodynamic collapse. An intravenous adrenaline bolus will help with hypotension and act as a bronchodilator.
- Ensure sedation and suction are available and prepared.
- Ensure adequate pre-oxygenation.
- Rapid sequence induction with cricoid pressure is suggested.
- Use a large cuffed oral endotracheal tube (ETT) to facilitate suctioning of respiratory secretions. Nasal ETT is preferred in some units to assist with strapping of ETT to cheeks and allows for good oral hygiene but may be problematic in the case of large ETTs.[35] Cuffed ETTs are essential to deliver high airway pressures and to prevent air leaks.
- Intubation drugs of choice include Ketamine, which helps maintain blood pressure and is a bronchodilator,[35,37] and Suxamethonium.[16,35,38] Rocuronium can also be used and its extended duration of action will assist with initial setup of mechanical ventilation.[35]
- Inhalational gas induction causes bronchodilation and can be considered if available.
- Do not hyperventilate with a self-inflating bag resuscitator post intubation (this will lead to worsening of already existing undesirable air trapping).
- Place directly on the prepared ventilator.
- Manual chest decompression to allow trapped air to escape may be necessary and could prove life-saving.[16]
- Always perform a CXR post intubation to confirm ETT position.

HOW TO VENTILATE

The goals of mechanical ventilation are to optimise oxygenation, allow permissive hypercapnia and prevent barotrauma while maintaining venous return, cardiac output and blood pressure.[16]

Ventilation procedure:

- Neither pressure control ventilation (PCV) nor volume control ventilation (VCV) is proven to be superior in paediatric patients. Some units prefer pressure-regulated volume control (PRVC) where ventilators calculate the lowest peak inspiratory pressure (PIP) needed to deliver a safe tidal volume.[30,35]
- Titrate FiO_2 to keep SaO2 > 93% (adults), 94% (children).[1,7]
- Accept permissive hypercapnia – pH > 7.2.[39]
- Tidal volumes of 6–10 mL/kg.
- Start with a respiratory rate of 10–15 breaths/min; faster rates for younger children.
- Shortened I:E ratios of 1:4 to 1:5 to allow for sufficient exhalation before the next breath is delivered to avoid breath

stacking contributing to dynamic hyperinflation.[30,40,41]

- PIP pressures < 35–40 cmH_2O to avoid barotrauma.[9,16,40] Plateau pressures (Pplat) < 30 cmH_2O during volume-cycled ventilation.[36,38]
- Adequate positive end expiratory pressure (PEEP) to overcome or equal intrinsic PEEP is targeted but high levels of PEEP (above auto-PEEP) should be avoided.[41] Minimal PEEP stents small bronchi allowing gas to escape and prevents dynamic hyperinflation. PEEP of 1–5 cmH_20 has been used successfully without significant adverse effects.[35,41] This will reduce airway resistance, bronchodilate and reduce the work of breathing.
- Ensure adequate sedation to improve the mechanics and control of ventilation. A combination of fentanyl and midazolam is considered safe. Morphine-induced histamine release can theoretically worsen bronchospasm. The addition of oral clonidine improves sedation and may limit the need for muscle relaxants.[35] Ketamine has been used as an alternative as it has bronchodilatory effects, but it increases the risk of hypersecretion and hallucinations when given as an infusion.[17,30,37] Propofol can be considered in older children.[16]
- Use muscle relaxants in the acute phase at the lowest dose and for the shortest duration possible. This will lower the oxygen requirement and prevent patient–ventilator dyssynchrony. Avoid atracurium because of its dose-dependent histamine release properties. Terminate muscle relaxants as soon as possible to avoid associated possible critical illness myopathy, especially when coupled with corticosteroids, even though the reported incidence of this in children is low.[15,42]
- It is essential to adjust the ventilator settings dynamically, especially after the lung mechanics improve in response to treatment.

The complications of ventilation in intubated asthmatic patients include dislodged ETT, obstructed ETT (mucus plugging), pneumothorax, haemodynamic compromise and, rarely, myopathy.

CONCLUSION

The prevalence of asthma in South African children is increasing and they are at particular risk of having more severe symptoms and higher mortality compared to children in high-income countries. Whereas poor socio-economic status and a lack of access to treatment and appropriate care are large contributors, asthma education about common well-described but less-recognised symptoms of severity, including 'acute hysteria', and also evidence-based management protocols are essential to improve outcomes in children with life-threatening asthma, especially in LMIC countries such as South Africa.

DECLARATION OF CONFLICT OF INTEREST
The authors declare no conflict of interest.

This article has been peer reviewed.

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