Acute severe childhood asthma

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Asthma is the most common chronic disease of South African children, affecting 10-20% of the population. Correct treatment of chronic asthma with regular anti-inflammatory controller therapy prevents symptoms, asthma exacerbations, hospitalisation and mortality.

Modern treatment of asthma focuses on an assessment of asthma control in order to enable the child to lead a normal life by:

• Growing and developing normally
• Attending school regularly
• Sleeping well at night
• Participating in sport and activities
• Staying out of hospital.

With good controller treatment, less acute attacks of severe asthma will take place. However, to ensure fewer hospitalisations and less mortality, optimal treatment of acute attacks by families and health care professionals is critical.

Prompt treatment of acute severe asthma is very important. Asthma is a preventable cause of childhood death. Parents and children must know exactly what to do when an acute attack occurs, and when to seek medical attention. This is very important if the child is using a home nebuliser as many parents continue to administer dose after dose of bronchodilator medication that does not provide oxygen. Failure to improve after a single dose of bronchodilator, or a peak flow reading that is 30% below the expected level, are indications for hospital admission.

All children who have life-threatening asthma, or those with oxygen saturations < 94%, should receive high-flow oxygen via a mask or nasal prong oxygen to obtain saturations ≥ 95%. Other indicators of a severe attack include tachycardia (bradycardia preterminally), tachypnoea, volume of wheezing (silent chest due to no/minimal air entry), decreased level of consciousness or agitation, use of accessory respiration muscles, pulsus paradoxus and inability to talk or feed due to breathlessness.

Inhaled short-acting β₂-agonists should be started as early as possible in an exacerbation. The bronchodilator may be given by means of a nebuliser, or with a metered dose inhaler and spacer combination. A metered dose inhaler given via a spacer is more effective, as well as more cost-effective than the nebuliser, provided that the patient is not acutely dyspnoeic, and that the medication is given in an adequate dosage. A usual dose of salbutamol via a nebuliser is 1.25-2.5 mg, and each dose of salbutamol via a metered dose inhaler is only 100 µg, so more puffs than usual of the metered dose inhaler are required to achieve an equivalent, or superior clinical effect, to a nebuliser (at doses that are still lower than that given via the nebuliser).

For very mild symptoms two to four puffs of a short-acting β₂-agonist actuated into the spacer may be sufficient, but for mild-moderate asthma exacerbations (attacks) a higher dose is required. For children below four years old, six puffs may be recommended, but children who are older than four should receive 10 puffs for asthma attacks. The puffs should not be actuated all at once, but at intervals of about 10 seconds between puffs, and at least five breaths of tidal breathing should follow each actuation (Figure 1).

If the acute asthma attack is severe or life-threatening, the short-acting β₂-agonist should be administered at intervals of 20-30 minutes by means of an oxygen-driven nebulizer. Ipratropium bromide should be added if there is a poor response to the initial doses of β₂ agonist, or on initial commencement of therapy if the attack is severe or life-threatening (Figure 2).

Systemic corticosteroids should be administered early in the acute exacerbation. The oral route is the preferred route of administration of corticosteroids. Oral prednisone or prednisolone (1-2 mg/kg) should be given for three to five days. There is no need to taper the dose. Intravenous alternatives include hydrocortisone, methylprednisolone and dexamethasone.
Mild-moderate asthma management

**Multidosing with salbutamol metered dose inhaler and spacer:**
- **Age < 4:** 6 puffs
- **Age > 4:** 10 puffs
  - Administer 1 puff at a time via spacer allowing at least 6 breaths per puff.
  - Shake inhaler between each puff.

**Oral prednisolone (2 mg/kg, max 40 mg)**

**Good response/stable**
- Yes: **Salbutamol metered dose inhaler multidosing:** 6 or 10 puffs via spacer.
- No: **Admit to ward.** Continue salbutamol metered dose inhaler multidosing: 6 or 10 puffs via spacer 1-4 hourly depending on clinical condition. Monitor peak flow rates (age > 6).

**Severe asthma flowchart**

- **Severe asthma:** One or more of following features:
  - Cyanosis OR saturation < 94% OR previous intensive care unit admission OR drowsy or confused OR silent chest OR marked tachycardia OR pulsus paradoxus OR impaired speech or feeding OR peak expiratory flow < 60%.

- **Mild-moderate asthma:** All of the features below:
  - No cyanosis, saturation > 94%, no previous intensive care unit admission, normal conscious level, good air entry, no marked tachycardia, no pulsus paradoxus, normal speech and feeding, peak expiratory flow > 60%.

**Good response:** No tachypnoea, minimal wheeze, no recurrences, able to speak and feed, peak expiratory flow > 80%, saturation > 94% in room air.

**Incomplete/poor response:** Tachypnoea, wheezing, recurrences, impaired speech or feeding, peak expiratory flow < 80%, saturation < 94% in room air.

Consider discharge when patient has a good response and does not need metered dose inhaler and spacer more than 4 hourly. Review pre-event asthma control and modify maintenance (controller) treatment. Fill in an asthma action/management plan. Ensure appropriate follow-up.

**Figure 1:** Mild-moderate asthma management
Severe asthma management

Mild-moderate

Mild-moderate asthma protocol

Triage

Severe asthma

Oxygen saturation ≤ 94%: Give oxygen via face mask and reservoir bag while preparing nebuliser.

Nebulise (together). Give 3 doses in first hour.
(3 doses may be completed on ward if improves during this time).

Oxygen flow rate > 6 l/minute. Fill volume 4 ml using normal saline as diluent.
Higher doses possible if minimal air entry.

1-2 years: Salbutamol 5 mg/ml: 2.5 mg (½ ml) (or fenoterol 1 mg/ml: 0.5 mg; ½ ml) and ipratropium 0.25 mg/ml: 125 µg (½ ml).
≥ 3 years: Salbutamol 5 mg/ml: 5 mg (1 ml) (or fenoterol 1 mg/ml: 1 ml; 1 ml) and ipratropium 0.25 mg/ml: 250 µg (1 ml).

Site IV cannula. Steroids for 5-7 days: Oral prednisolone (2 mg/kg, maximum dose 40 mg).
If vomiting/too unwell for oral medication: IVI dexamethasone 0.6 mg/kg daily until orals tolerated

Continuous saturation, heart and respiratory rate monitoring.
Complete 3 nebulisers.
Reassess.

Nebulise Salbutamol Half-hourly.
Ipratropium bromide 4-6 hourly.

Good response/ stable

Convert to salbutamol metered dose inhaler and spacer multidose (6 or 10 puffs) up to hourly.

Transfer to ward.
Mild-moderate asthma protocol.

Improving

Continuous saturation, heart and respiratory rate monitoring.
Complete 3 nebulisers.
Reassess.

Not improving.
Admit to high care.

Review diagnosis.
Consider pneumothorax.
Blood gas.

High care.¹
Continuous nebulised salbutamol 1 hour.²
AND/OR
Single dose intravenous salbutamol 15 µg/kg in 10 ml saline over 10 minutes.³
AND/OR
Single dose MgSO₄ 50% solution (2 mmol/ml) 0.1 ml/kg (50 mg/kg) (maximum 2 g) in 20 ml saline⁴ over 20 minutes.⁵

Improving

Deteriorating
OR CO₂ > 6
OR CO₂ rising.

Intensive care unit.⁶
Salbutamol load 5-10 µg/kg/minute.⁷
1 mg/ml solution at 0.3-0.6 ml/kg/hour for 1 hour.
Salbutamol infusion 1-5 µg/kg/minute.⁸
1 mg/ml solution at 0.06-0.3 ml/kg/hour.

Not improving

Severe asthma: One or more of following features: Cyanosis OR saturation < 94% OR previous intensive care unit admission OR drowsy or confused OR silent chest OR marked tachycardia OR pulsus paradoxus OR impaired speech or feeding, OR peak expiratory flow < 60%.

Incomplete/poor response: Tachypnoea, wheezing, recurrences, impaired speech or feeding, peak expiratory flow < 80%, saturation < 94% in room air.

Notes
1. These may be commenced in the emergency department, should there be delay in transfer to the ward, providing the child is closely monitored.
2. Continuous nebulised salbutamol can be best achieved by refilling the nebuliser well using a cut feeding tube to prevent any disconnection of continuous oxygen delivery. Refill contents up to 6 ml when 2 ml remains.
3. Make up to a total volume of 10 ml and give through syringe driver at 60 ml/hour.
4. Make up to a total volume of 2 ml and give through syringe driver at 60 ml/hour.
5. If intravenous magnesium has a good effect, a continuous infusion can be continued. Use MgSO₄ 50% solution (2 mmol/ml) at 0.06 ml/kg/hour (30mg/kg/hour) to keep Mg between 1.5 and 2.3 mmol/l.
6. There is no role for aminophylline outside the intensive care unit (ICU). In ICU, it may occasionally have a role to play to prevent intubation if all other measures have failed.
7. Load children with salbutamol, even if they have already received the smaller single-dose intravenous salbutamol over 10 minutes.
8. A patient must be closely monitored during salbutamol infusion with K+ and lactic acidosis measured 6 hourly.

Figure 2: Severe asthma management
Dehydration may occur because of poor fluid intake, sweating, and hyperventilation. Care should be taken not to overhydrate the child. It is best to provide only the normal fluid requirements for the child, usually in the form of a paediatric maintenance solution, or half-Darrow’s-dextrose given intravenously.

Further commonly used options include intravenous magnesium sulphate and intravenous salbutamol. Intravenous aminophylline is less commonly given due to the narrow therapeutic range and potential for severe side-effects. The management algorithm can be applied in most hospitals. If there are concerns about response to treatment, the child must be referred to a specialist centre for further management.

No child should be discharged from hospital until recovery is adequate and the peak flow is above 80% of predicted.

Parental education and action plans
As with any long-term disease, the parent and the child should be educated about all aspects of asthma. Parents cannot be expected to follow a routine that involves the regular use of medication over a prolonged period if they do not understand why this is necessary. It is important to emphasise that children with asthma are able to lead a normal life with appropriate therapy. These children should be encouraged to participate in all sporting activities, particularly swimming. The primary care doctor should not hesitate to call in the specialist, social worker or psychologist if this is required in difficult cases.

An action plan should include instructions for both daily management (medication and environmental control measures) and guidelines on actions to manage worsening asthma. The plan should indicate the signs and symptoms used to recognise loss of asthma control, and what emergency and ongoing actions to take. Written asthma plans are particularly recommended for all patients on Level 2 or 3 therapy, and for those who have had a recent exacerbation, or who have poorly controlled asthma.

The National Asthma Education programme (www.asthma.co.za) provides free patient and doctor educational materials, and runs an asthma certificate course to teach doctors and nurses how to assess asthma, and to educate patients about how to use their medication to achieve optimum asthma control.