VERSIO 1.2

MANAGING ACUTE ASTHMA IN ADULTS AND CHILDREN

CLINICAL MANAGEMENT

Managing acute asthma in clinical settings

FIRST AID

Community first aid

ABOUT

This PDF is a print-friendly reproduction of the content included in the Acute asthma section of the Australian Asthma Handbook at asthmahandbook.org.au/acute-asthma

Please note the content of this PDF reflects the Australian Asthma Handbook at publication of Version 1.2 (October 2016). For the most up-to-date content, please visit asthmahandbook.org.au

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ABBREVIATIONS

CFC  chlorofluorocarbon
COPD  chronic obstructive pulmonary disease
COX  cyclo-oxgenase
ED  emergency department
EIB  exercise-induced bronchoconstriction
FEV₁  forced expiratory volume over one second
FVC  forced vital capacity
FSANZ  Food Standards Australia and New Zealand
GORD  gastro-oesophageal reflux disease
HFA  formulated with hydrofluoroalkane propellant
ICS  inhaled corticosteroid
ICU  intensive care unit
IgE  Immunoglobulin E
IV  intravenous
LABA  long-acting beta₂-adrenergic receptor agonist
LAMA  long-acting muscarinic antagonist
LTRA  leukotriene receptor antagonist
MBS  Medical Benefits Scheme
NIPPV  non-invasive positive pressure ventilation
NSAIDs  nonsteroidal anti-inflammatory drugs
OCS  oral corticosteroids
OSA  obstructive sleep apnoea
PaCO  carbon dioxide partial pressure on blood gas analysis
PaO₂  oxygen partial pressure on blood gas analysis
PBS  Pharmaceutical Benefits Scheme
PEF  peak expiratory flow
pMDI  pressurised metered-dose inhaler or 'puffer'
SABA  short-acting beta₂-adrenergic receptor agonist
LAMA  long-acting muscarinic antagonist
TGA  Therapeutic Goods Administration

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ENDORSEMENT

The Australian Asthma Handbook has been officially endorsed by:

- The Royal Australian College of General Practitioners (RACGP)
- The Australian Primary Health Care Nurses Association (APNA)
- The Thoracic Society of Australia and New Zealand (TSANZ)

SPONSORS

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- Novartis Australia

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The Australian Asthma Handbook has been compiled by the National Asthma Council Australia for use by general practitioners, pharmacists, asthma educators, nurses and other health professionals and healthcare students. The information and treatment protocols contained in the Australian Asthma Handbook are based on current evidence and medical knowledge and practice as at the date of publication and to the best of our knowledge. Although reasonable care has been taken in the preparation of the Australian Asthma Handbook, the National Asthma Council Australia makes no representation or warranty as to the accuracy, completeness, currency or reliability of its contents.

The information and treatment protocols contained in the Australian Asthma Handbook are intended as a general guide only and are not intended to avoid the necessity for the individual examination and assessment of appropriate courses of treatment on a case-by-case basis. To the maximum extent permitted by law, acknowledging that provisions of the Australia Consumer Law may have application and cannot be excluded, the National Asthma Council Australia, and its employees, directors, officers, agents and affiliates exclude liability (including but not limited to liability for any loss, damage or personal injury resulting from negligence) which may arise from use of the Australian Asthma Handbook or from treating asthma according to the guidelines therein.

Revised Edition

The Australian Asthma Handbook, 1st Edition, published in 2005, has been revised for this edition. The information and treatment protocols contained in the Australian Asthma Handbook have been updated to reflect the most recent scientific evidence and best practice guidance. This edition of the Australian Asthma Handbook is intended as a general guide for those caring for people with asthma in Australia.
Managing acute asthma in adults and children

In this section

**Clinical management**
Managing acute asthma in clinical settings
https://www.asthmahandbook.org.au/acute-asthma/clinical

**First aid**
Community first aid
https://www.asthmahandbook.org.au/acute-asthma/first-aid
Managing acute asthma in clinical settings

Overview

Acute asthma management is based on:

- assessing severity (mild/moderate, severe or life-threatening) while starting bronchodilator treatment immediately
- administering oxygen therapy, if required, and titrating oxygen saturation to target of 92–95% (adults) or at least 95% (children)
- completing observations and assessments (when appropriate, based on clinical priorities determined by baseline severity)
- administering systemic corticosteroids within the first hour of treatment
- repeatedly reassessing response to treatment and either continuing treatment or adding on treatments, until acute asthma has resolved, or patient is transferred to an intensive care unit or admitted to hospital
- observing the patient for at least 1 hour after dyspnoea/respiratory distress has resolved, providing post-acute care and arranging follow-up.

**Figure. Managing acute asthma in adults**
Please view and print this figure separately: https://www.asthmahandbook.org.au/figure/show/65

**Figure. Managing acute asthma in children**
Please view and print this figure separately: https://www.asthmahandbook.org.au/figure/show/67

**Figure. Initial management of life-threatening acute asthma in adults and children**
Please view and print this figure separately: https://www.asthmahandbook.org.au/figure/show/94

**Note:** Definitions of severity classes for acute asthma used in this handbook may differ from those used in published clinical trials and other guidelines that focus on, are or restricted to, the management of acute asthma within emergency departments or acute care facilities. In this handbook, the severity of flare-ups and acute asthma is defined consistently across all Australian clinical settings (including community-based clinics and emergency departments). Accordingly, the classification of flare-ups and the classification of acute asthma overlap (e.g., a flare-up is considered to be at least ‘moderate’ if it is troublesome enough to cause the patient or carers to visit an emergency department or seek urgent treatment from primary care, yet it might be assessed as ‘mild’ acute asthma within acute services).

**Table. Severity classification for flare-ups (exacerbations)**

<table>
<thead>
<tr>
<th>Severity</th>
<th>Definition</th>
<th>Example/s</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mild</strong></td>
<td>Worsening of asthma control that is only just outside the normal range of variation for the individual (documented when patient is well)</td>
<td>More symptoms than usual, needing reliever more than usual (e.g., &gt;3 times within a week for a person who normally needs their reliever less often), waking up with asthma, asthma is interfering with usual activities A gradual reduction in PEF(^1) over several days</td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
<td>Events that are (all of):</td>
<td></td>
</tr>
</tbody>
</table>
Severity | Definition | Example/s
--- | --- | ---

<table>
<thead>
<tr>
<th>Severity</th>
<th>Definition</th>
<th>Example/s</th>
</tr>
</thead>
</table>
| Troublesome | • troublesome or distressing to the patient  
• require a change in treatment  
• not life-threatening  
• do not require hospitalisation. | More symptoms than usual, increasing difficulty breathing, waking often at night with asthma symptoms |
| Severe | Events that require urgent action by the patient (or carers) and health professionals to prevent a serious outcome such as hospitalisation or death from asthma | Needing reliever again within 3 hours, difficulty with normal activity |

† Applies to patients who monitor their asthma using a peak expiratory flow meter (single PEF measurements in clinic not recommended for assessing severity of flare-ups).

**Note:** the ATS/ERS Task Force recommended that severe exacerbations should be defined in clinical trials as the use of oral corticosteroids for 3 or more days. However, this definition is not applicable to clinical practice.


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In this handbook, the categories of ‘mild’ and ‘moderate’ acute asthma have been merged to avoid confusion between terminologies traditionally used at different levels of the health system. Mild acute asthma can usually be managed at home by following the person’s written asthma action plan.

See: Preparing written asthma action plans for adults.
See: Providing asthma management education for parents and children

### In this section

#### Primary assessment
Completing a rapid primary assessment and starting initial treatment

#### Bronchodilators
Giving bronchodilator treatment according to severity and age

#### Secondary assessment
Completing secondary assessments and reassessing severity

#### Corticosteroids
Starting systemic corticosteroid treatment

#### Response
<table>
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<th><strong>Assessing response to treatment</strong></th>
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</table>

<table>
<thead>
<tr>
<th><strong>Add-on treatment</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuing treatment and considering additional treatment</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th><strong>Post-acute care</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Providing post-acute care</td>
<td></td>
</tr>
</tbody>
</table>
Figure. Managing acute asthma in adults

For more details on the initial management of life-threatening acute asthma, see Initial management of life-threatening acute asthma in adults and children.
Figure. Managing acute asthma in children

For more details on the initial management of life-threatening acute asthma, see Initial management of life-threatening acute asthma in adults and children.

### IMMEDIATELY

**ASSESS SEVERITY AND START BRONCHODILATOR**

<table>
<thead>
<tr>
<th>Mild/Moderate</th>
<th>Severe</th>
<th>Life-threatening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can walk and speak whole sentences in one breath (Young children: can move about and speak in phrases)</td>
<td>Any of: unable to speak in sentences, visibly breathless, increased work of breathing, oxygen saturation 90–94%</td>
<td>Any of: drowsy, collapsed, exhausted, cyanotic, poor respiratory effort, oxygen saturation less than 90%</td>
</tr>
<tr>
<td>Give salbutamol (100 mcg per actuation) via pMDI plus spacer (plus mask for younger children) 6 years and over: 4–12 puffs 0–5 years: 2–4 puffs</td>
<td>Give salbutamol (100 mcg per actuation) via pMDI plus spacer (plus mask for younger children) 6 years and over: 12 puffs 0–5 years: 6 puffs OR If patient cannot breathe through spacer and mask, give salbutamol via intermittent nebulisation driven by oxygen: 6 years and over: 5 mg nebul 0–5 years: 2.5 mg nebul</td>
<td>Give salbutamol via continuous nebulisation driven by oxygen 6 years and over: use 2 x 5 mg nebulules 0–5 years: use 2 x 2.5 mg nebulules</td>
</tr>
</tbody>
</table>

> Asthma is less likely to be the cause of wheezing in infants less than 12 months old. Monitor closely. If symptoms do not respond, reconsider the diagnosis and contact a paediatrician.

### WITHIN MINUTES

**REASSESS SEVERITY**

Table. Secondary severity assessment of acute asthma in adults and children 6 years and over

| In non-acute care settings, arrange immediate transfer if no improvement |

**CONTINUE BRONCHODILATOR**

- Repeat dose every 20–30 mins for first hour if needed (or sooner as needed)
- Repeat dose every 20 minutes for first hour (3 doses) or sooner as needed

### IF POOR RESPONSE, ADD IPRATROPIUM BROMIDE

- 6 years and over: 8 puffs (160 mcg) via pMDI (21 mcg/actuation) 0–5 years: 4 puffs (80 mcg) via pMDI (21 mcg/actuation)
- OR 6 years and over: 500 mcg nebul via nebuliser added to nebulised salbutamol 0–5 years: 250 mcg nebul via nebuliser added to nebulised salbutamol

> Give dose every 20 minutes for first hour. Repeat every 4–6 hours as needed

### CONSIDER OTHER ADD-ON TREATMENT OPTIONS

Table. Add-on treatment options for acute asthma

- Arrange immediate transfer to higher-level care if no improvement or worsening

### WITHIN FIRST HOUR

**START SYSTEMIC CORTICOSTEROIDS**

- Oral prednisolone 2 mg/kg oral (maximum 50 mg) then 1 mg/kg on days 2 and 3
- OR, if oral route not possible
  - Hydrocortisone IV initial dose 8–10 mg/kg (max 300 mg), then 4–5 mg/kg every 6 hours on day 1, then every 12 hours on day 2, then once on day 3
  - OR Methylprednisolone IV initial dose 2 mg/kg (max 40 mg), then 1 mg/kg every 6 hours on day 1, then every 12 hours on day 2, then once on day 3

> For children 0–5 years, avoid systemic corticosteroids if mild/moderate wheezing responds to initial bronchodilator treatment

### REASSESS RESPONSE TO TREATMENT (1 HOUR AFTER STARTING BRONCHODILATOR)

- Perform spirometry (if child capable)
Figure. Initial management of life-threatening acute asthma in adults and children

Initial management of life-threatening acute asthma. This figure shows in more detail the first stages (‘immediate’ and ‘within minutes’) shown in the figures Managing acute asthma in adults and Managing acute asthma in children.

**SEVERITY ASSESSED AS LIFE-THREATENING ACUTE ASTHMA**

Any of these findings:
- drowsy
- collapsed
- exhausted
- cyanotic
- poor respiratory effort
- soft/absent breath sounds
- oxygen saturation <90%

**GIVE SALBUTAMOL VIA CONTINUOUS NEBULISATION**

- **CHILDREN 0–5 YEARS**
  - Salbutamol 2 x 2.5 mg nebulisers at a time
  - Use oxygen to drive nebuliser*
  - Maintain SaO₂ 95% or higher
- **CHILDREN 6–12 YEARS**
  - Salbutamol 2 x 5 mg nebulisers at a time
  - Use oxygen to drive nebuliser*
  - Maintain SaO₂ 95% or higher
- **ADULTS AND ADOLESCENTS**
  - Salbutamol 2 x 5 mg nebulisers at a time
  - Use oxygen to drive nebuliser*
  - Titrate oxygen to target SaO₂ ≥92%

*Piped oxygen or oxygen cylinder fitted with a high-flow regulator (6 L/min)

**ARRANGE IMMEDIATE TRANSFER TO HIGHER-LEVEL CARE AREA**

**NOTIFY SENIOR STAFF**

**REASSESS IMMEDIATELY AFTER STARTING SALBUTAMOL**

- Marked improvement
- Some improvement
- No improvement or worsening

**CONTINUE SALBUTAMOL AND MONITORING**

- **ADD IPRATROPIUM BROMIDE**
  
  *Add to nebuliser (repeat every 20 minutes for first hour)
  
  Adults, adolescents and children 6 years and over: 500 mcg
  
  Children 0–5 years: 250 mcg

**CONTINUE BRONCHODILATOR AND MONITORING**

When breathing improves, consider changing salbutamol route of delivery:

- **pMDI PLUS SPACER**
  
  Adults and children 6 years and over: 12 puffs (100 mcg/actuation) every 20 minutes
  
  Children 0–5 years: 6 puffs (100 mcg/actuation) every 20 minutes or

- **INTERMITTENT NEBULISATION**

**No improvement or worsening**

**ADD MAGNESIUM SULFATE IV**

* Dilute in compatible solution as single IV infusion over 20 minutes

- Adults and adolescents: 10 mmol
  
  Children 2-12 years: 0.1–0.2 mmol/kg (max 10 mmol)

**No improvement or worsening**

**CONTINUE SALBUTAMOL BY CONTINUOUS NEBULISATION**
CONSIDER THE NEED FOR NPPV OR INTUBATION AND VENTILATION

ARRANGE TRANSFER/RETRIEVAL TO ICU

* Salbutamol IV infusion can be considered in critical care units. Follow your hospital/organisation’s protocol for dosage and delivery.

Monitor blood electrolytes, heart rate and acid/base balance (blood lactate)

Salbutamol toxicity can occur with either the inhaled or IV route of administration. Risk may be increased when the inhaled and IV routes are used concomitantly.
Completing a rapid primary assessment and starting initial treatment

**Recommendations**

Assess severity of the acute asthma episode (moderate, severe or life-threatening) based on clinical observations and pulse oximetry measured while the person is breathing air, and administer a bronchodilator immediately.

**Notes**

- If oxygen therapy has already been started, it is not necessary to cease oxygen to measure pulse oximetry.
- Pregnancy is not a contraindication for bronchodilators in acute asthma.

**Table. Rapid primary assessment of acute asthma in adults and children**

<table>
<thead>
<tr>
<th>Mild/Moderate</th>
<th>Severe</th>
<th>Life-threatening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can walk, speak whole sentences in one breath</td>
<td>Any of these findings:</td>
<td>Any of these findings:</td>
</tr>
<tr>
<td>(For young children: can move around, speak in phrases)</td>
<td>- Use of accessory muscles of neck or intercostal muscles or 'tracheal tug' during inspiration or subcostal recession ('abdominal breathing')</td>
<td>- Reduced consciousness or collapse</td>
</tr>
<tr>
<td>Oxygen saturation &gt; 94%</td>
<td>- Unable to complete sentences in one breath due to dyspnoea</td>
<td>- Exhaustion</td>
</tr>
<tr>
<td></td>
<td>- Obvious respiratory distress</td>
<td>- Cyanosis</td>
</tr>
<tr>
<td></td>
<td>- Oxygen saturation 90–94%</td>
<td>- Oxygen saturation &lt;90%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Poor respiratory effort, soft/absent breath sounds</td>
</tr>
</tbody>
</table>

**Notes**

The severity category may change when more information is available (e.g. pulse oximetry, spirometry) or over time.

The presence of pulsus paradoxus (systolic paradox) is not a reliable indicator of the severity of acute asthma.

If oxygen therapy has already been started, it is not necessary to cease oxygen to measure pulse oximetry.

Oxygen saturation levels are a guide only and are not definitive; clinical judgment should be applied.

Definitions of severity classes for acute asthma used in this handbook may differ from those used in published clinical trials and other guidelines that focus on, are or restricted to, the management of acute asthma within emergency departments or acute care facilities.

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**Table. Initial bronchodilator treatment in acute asthma (adults and children 6 years and over)**

- Do not use IV short-acting beta\(_2\) agonists routinely for initial bronchodilator treatment.
- Do not give oral salbutamol.
- Monitor for salbutamol toxicity (e.g. tachycardia, tachypnoea, metabolic acidosis, hypokalaemia) – may occur with inhaled or IV salbutamol.

<table>
<thead>
<tr>
<th>Mild/Moderate</th>
<th>Severe</th>
<th>Life-threatening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Give salbutamol† 4-12 puffs (100 mcg/actuation) via pMDI and spacer</td>
<td>Give salbutamol† 12 puffs (100 mcg/actuation) via pMDI and spacer</td>
<td>Give salbutamol 2 x 5 mg nebules via continuous nebulisation driven by oxygen‡</td>
</tr>
<tr>
<td>Repeat every 20-30 minutes for the first hour if required (sooner, if needed to relieve breathlessness)</td>
<td>If patient unable to breathe through a spacer, give 5 mg nebule via nebuliser‡</td>
<td>Maintain oxygen saturations: Adults: 92% or higher Children: 95% or higher</td>
</tr>
<tr>
<td></td>
<td>Start oxygen therapy if oxygen saturation &lt;95% and titrate to target: Adults: 92–95% Children: 95% or higher</td>
<td>Arrange immediate transfer to higher-level care</td>
</tr>
<tr>
<td></td>
<td>Repeat salbutamol as needed. Give at least every 20 minutes for first hour (3 doses)</td>
<td>When dyspnoea improves, consider changing to salbutamol via pMDI plus spacer or intermittent nebuliser‡ (doses as for severe acute asthma)</td>
</tr>
</tbody>
</table>

† Give one puff at a time followed by 4 breaths (See Table. Using pressurised metered-dose inhalers in acute asthma)
‡ See Table. Using nebulisers in acute asthma

Note: To deliver nebulised bronchodilators in a patient receiving oxygen therapy, use an air-driven compressor nebuliser and administer oxygen by nasal cannulae.

Asset ID: 80

**Table. Initial bronchodilator treatment in acute asthma (children 0–5 years)**

- Do not use IV short-acting beta₂ agonists routinely for initial bronchodilator treatment.
- Do not give oral salbutamol.
- Monitor for salbutamol toxicity (e.g. tachycardia, tachypnoea, metabolic acidosis, hypokalaemia) – may occur with inhaled or IV salbutamol.
- Closely monitor level of consciousness, fatigue, oxygen saturation, respiratory rate and heart rate. If symptoms do not respond, contact a paediatrician or senior clinician and reconsider the diagnosis.
- In children under 12 months old, asthma is less likely to be the cause of wheezing than other conditions (e.g. bronchiolitis, pneumonia).
Mild/Moderate | Severe | Life-threatening
--- | --- | ---
Titrate to 95% or higher Repeat salbutamol as needed. Give at least every 20 minutes for first hour (3 doses) | When dyspnoea improves, consider changing to salbutamol via pMDI plus spacer or intermittent nebuliser‡ (doses as for severe acute asthma) | 

† Give one puff at a time followed by 4 breaths (See Table. Using pressurised metered-dose inhalers in acute asthma)
‡ See Table. Using nebulisers in acute asthma

**Table. Using pressurised metered-dose inhalers in acute asthma**

*Administration of salbutamol by health professionals for a patient with acute asthma*

1. Use a salbutamol pressurised metered-dose inhaler (100 mcg/actuation) with a spacer that has already been prepared (see note).
2. Shake inhaler and insert upright into spacer.
3. Place mouthpiece between the person's teeth and ask them to seal lips firmly around mouthpiece.
4. Fire one puff into the spacer.
5. Tell person to take 4 breaths in and out of the spacer.
6. Remove the spacer from mouth. Shake the inhaler after each puff before actuating again. (This can be done without detaching the pressurised metered-dose inhaler from the spacer.)

**Notes**

The process is repeated until the total dose is given (e.g 12 puffs for an adult, 6 puffs for a child). Different doses are recommended for patients and carers giving asthma first aid in the community.

New plastic spacers should be washed with detergent to remove electrostatic charge (and labelled), so they are ready for use when needed. In an emergency situation, if a pre-treated spacer is not available, prime the spacer before use by firing at least 10 puffs of salbutamol into the spacer. (This is an arbitrary number of actuations in the absence of evidence that would enable a precise guideline.)

Priming or washing spacers to reduce electrostatic charge before using for the first time is only necessary for standard plastic spacers; antistatic polymer spacers (e.g. Able A2A, AeroChamber Plus, Breathe Eazy, La Petit E-Chamber, La Grande E-Chamber, OptiChamber Diamond) and disposable cardboard spacers do not require treatment to reduce electrostatic charge.

For small children who cannot form a tight seal with their lips around the spacer mouthpiece, attach a well-fitted mask to the spacer.

**Table. Using nebulisers in acute asthma**

*Driving nebuliser*

Nebulisers can be driven by air, piped oxygen, or an oxygen cylinder fitted with a high-flow regulator capable of delivering >6 L/min.

*Intermittent nebulisation*

Use one nebul:

Adults: 5 mg nebul
<table>
<thead>
<tr>
<th>Age Group</th>
<th>Nebuliser Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children 6 years and over</td>
<td>5 mg nebule</td>
</tr>
<tr>
<td>Children 0–5 years</td>
<td>2.5 mg nebule</td>
</tr>
</tbody>
</table>

**Continuous nebulisation using nebules**

- Put two nebules into nebuliser chamber at a time and repeat to refill when used up.
- Adults: use two 5 mg nebules (10 mg) at a time
- Children 6 years and over: use two 5 mg nebules (10 mg) at a time
- Children 0–5 years: use two 2.5 mg nebules (5 mg) at a time

- If using oxygen to drive a nebuliser, do not exceed 8–10 L/minute and avoid over-oxygenation (increases risk of hypercapnoea).
- The use of nebulisers increases the risk (to staff and patients) of nosocomial aerosol infection. If using a nebuliser, follow your organisation’s infection control protocols to minimise spread of respiratory tract infections.

Asset ID: 73

**How this recommendation was developed**

Consensus

Based on clinical experience and expert opinion (informed by evidence, where available), with particular reference to the following source(s):

- Karpel *et al.* 1997
- Dhuper *et al.* 2011
- Cates *et al.* 2013
- Ferguson and Gidwani 2006
- Travers *et al.* 2012
- Salmeron *et al.* 1994
- Hodder *et al.* 2011
- O’Driscoll *et al.* 2008
- Global Initiative for Asthma (GINA) 2012
- British Thoracic Society (BTS), Scottish Intercollegiate Guidelines Network (SIGN) 2008
- Perrin *et al.* 2011
- Cyr *et al.* 1991
- Barry and O’Callaghan 1994
- Rau *et al.* 1996
- Ari *et al.* 2012
- Laube *et al.* 2011

Start oxygen therapy for all patients with severe or life-threatening acute asthma. Titrate oxygen saturation to target of 92–95% for adults and at least 95% for children.

- In adults, avoid over-oxygenation, because this increases the risk of hypercapnoea.
- For children, consider whether humidification of oxygen is indicated.

**How this recommendation was developed**

Consensus

Based on clinical experience and expert opinion (informed by evidence, where available), with particular reference to the following source(s):

- Brandão *et al.* 2011
- O’Driscoll *et al.* 2008
- Rodrigo *et al.* 2006
For patients with life-threatening asthma, arrange immediate transfer to the resuscitation area (or arrange transfer to acute service).

**Figure. Initial management of life-threatening acute asthma in adults and children**

Please view and print this figure separately: https://www.asthmahandbook.org.au/figure/show/94

"How this recommendation was developed"

Consensus

Based on clinical experience and expert opinion (informed by evidence, where available).

Identify and manage anaphylaxis according to national guidelines or your organisation’s protocols. Give adrenaline if anaphylaxis is suspected or cannot be excluded.

Note: Consider anaphylaxis if patient presents with urticaria or angioedema as well as respiratory signs/symptoms, and in patients with a history of allergies

"How this recommendation was developed"

Consensus

Based on clinical experience and expert opinion (informed by evidence, where available), with particular reference to the following source(s):

- Global Initiative for Asthma, 2012
- Singhi et al. 2006

More information

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**Anaphylaxis guidelines and resources**

- Go to: Australasian Society of Clinical Immunology and Allergy (ASCIA)’s [Anaphylaxis Health Professional Information Paper](https://www.ascia.org.au/publications/standards-and-guidelines/Anaphylaxis-Health-Professional-Information-Paper)
- Go to: Australasian Society of Clinical Immunology and Allergy (ASCIA)’s [Anaphylaxis Resources](https://www.ascia.org.au/publications/standards-and-guidelines/Anaphylaxis-Resources) for fact sheets and action plan templates

**Adrenaline in acute asthma**

Systemic adrenaline (intravenous in clinical settings with appropriately trained staff, or intramuscular) is indicated for patients with anaphylaxis and angioedema, but current evidence does not support its routine use in the management of acute asthma in the absence of anaphylaxis.

Nebulised adrenaline does not have a significant benefit over salbutamol or terbutaline in the management of moderate-to-severe acute asthma in adults and children.


**Assessment of oxygen status in acute asthma**

Hypoxia is the main cause of death that is due to acute asthma.

Routine objective assessment of oxygen saturation at initial assessment of acute asthma is needed because clinical signs may not correlate with hypoxaemia.

Pulse oximetry is the internationally accepted method for routine assessment of oxygen status in patients with acute asthma.
The risk of hypercapnoea increases when oxygen saturation falls below 92%. Pulse oximetry does not detect hypercapnoea, so blood gas analysis is necessary if hypercapnoea is suspected in patients with severe or life-threatening acute asthma.

**Oxygen therapy in acute asthma**

Oxygen is a treatment for hypoxaemia, not breathlessness. Oxygen has not been shown to improve the sensation of breathlessness in non-hypoxaemic patients. When oxygen supplementation is used, pulse oximetry is necessary to monitor oxygen status and titrate to target.

The aim of titrated oxygen therapy in acute care is to achieve normal or near-normal oxygen saturation, except in patients who are at risk of hypercapnoeic respiratory failure, such as patients with overlapping asthma and COPD.

**Adults**

In adults with acute asthma, titrated oxygen therapy using pulse oximetry to maintain oxygen saturation at 93–95% while avoiding hyperoxaemia achieves better physiological outcomes than 100% oxygen at high flow rate (8 L/min). High-concentration and high-flow oxygen therapy cause a clinically significant increase in blood CO₂ concentration in adults with acute asthma. National guidelines for the management of acute exacerbations of COPD recommend that hypoxic patients should be given controlled oxygen therapy via nasal prongs at 0.5–2.0 L/minute or a venturi mask at 24% or 28%, with target oxygen saturation of over 90% (PaO₂ > 50 mmHg, or 6.7 kPa). Excessive oxygen administration should be avoided because it can worsen hypercapnoea.

**Children**

Drying of the upper airway is a potential complication of oxygen therapy in children, which might contribute to bronchoconstriction. Humidified oxygen can be considered if necessary. Humidification is usually not needed for low flow oxygen (<4 L/minute in children or 2 L/minute in infants) for short term. Humidification may be considered if the oxygen is required for longer than 48 hours or if the nasal passages are becoming uncomfortable or dry. Guidance on oxygen delivery techniques and practical issues is available from Sydney Children's Hospital Network and The Royal Children's Hospital Melbourne.

**References**


Giving bronchodilator treatment according to severity and age

Recommendations

Give initial salbutamol by inhalation, using doses, routes of administration and dosing schedules according to the patient's age and the severity of acute asthma.

**Table. Rapid primary assessment of acute asthma in adults and children**

<table>
<thead>
<tr>
<th></th>
<th>Mild/Moderate</th>
<th>Severe</th>
<th>Life-threatening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can walk, speak whole sentences in one breath (For young children: can move around, speak in phrases)</td>
<td>Any of these findings:</td>
<td>Any of these findings:</td>
<td></td>
</tr>
<tr>
<td>Oxygen saturation &gt;94%</td>
<td>• Use of accessory muscles of neck or intercostal muscles or 'tracheal tug' during inspiration or subcostal recession ('abdominal breathing')</td>
<td>• Reduced consciousness or collapse</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Unable to complete sentences in one breath due to dyspnoea</td>
<td>• Exhaustion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Obvious respiratory distress</td>
<td>• Cyanosis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Oxygen saturation 90–94%</td>
<td>• Oxygen saturation &lt;90%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Notes</td>
<td>• Poor respiratory effort, soft/absent breath sounds</td>
<td></td>
</tr>
</tbody>
</table>

**Notes**

The severity category may change when more information is available (e.g. pulse oximetry, spirometry) or over time.

The presence of pulsus paradoxus (systolic paradox) is not a reliable indicator of the severity of acute asthma.

If oxygen therapy has already been started, it is not necessary to cease oxygen to measure pulse oximetry.

Oxygen saturation levels are a guide only and are not definitive; clinical judgment should be applied.

Definitions of severity classes for acute asthma used in this handbook may differ from those used in published clinical trials and other guidelines that focus on, are or restricted to, the management of acute asthma within emergency departments or acute care facilities.

Asset ID: 74

**Table. Initial bronchodilator treatment in acute asthma (adults and children 6 years and over)**

- Do not use IV short-acting beta₂ agonists routinely for initial bronchodilator treatment.
- Do not give oral salbutamol.
- Monitor for salbutamol toxicity (e.g. tachycardia, tachypnoea, metabolic acidosis, hypokalaemia) – may occur with inhaled or IV salbutamol.
<table>
<thead>
<tr>
<th><strong>Mild/Moderate</strong></th>
<th><strong>Severe</strong></th>
<th><strong>Life-threatening</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Give salbutamol†</strong> 4-12 puffs (100 mcg/actuation) via pMDI and spacer</td>
<td><strong>Give salbutamol†</strong> 12 puffs (100 mcg/actuation) via pMDI and spacer</td>
<td><strong>Give salbutamol 2 x 5 mg nebules via continuous nebulisation driven by oxygen‡</strong></td>
</tr>
</tbody>
</table>
| **Repeat every 20-30 minutes for the first hour if required (sooner, if needed to relieve breathlessness)** | **If patient unable to breathe through a spacer, give 5 mg nebule via nebuliser‡** | **Maintain oxygen saturations:**
| | **Start oxygen therapy if oxygen saturation <95% and titrate to target:** | **Adults: 92% or higher**
| | **Adults: 92–95%** | **Children: 95% or higher**
| | **Children: 95% or higher** | **Arrange immediate transfer to higher-level care**
| | **Repeat salbutamol as needed.** | **When dyspnoea improves, consider changing to salbutamol via pMDI plus spacer or intermittent nebuliser‡ (doses as for severe acute asthma)**
| | **Give at least every 20 minutes for first hour (3 doses)** | |

† Give one puff at a time followed by 4 breaths (See Table. Using pressurised metered-dose inhalers in acute asthma)
‡ See Table. Using nebulisers in acute asthma

**Note:** To deliver nebulised bronchodilators in a patient receiving oxygen therapy, use an air-driven compressor nebuliser and administer oxygen by nasal cannulae.

**Table. Initial bronchodilator treatment in acute asthma (children 0–5 years)**

- Do not use IV short-acting beta<sub>2</sub> agonists routinely for initial bronchodilator treatment.
- Do not give oral salbutamol.
- Monitor for salbutamol toxicity (e.g. tachycardia, tachypnoea, metabolic acidosis, hypokalaemia) – may occur with inhaled or IV salbutamol.
- Closely monitor level of consciousness, fatigue, oxygen saturation, respiratory rate and heart rate. If symptoms do not respond, contact a paediatrician or senior clinician and reconsider the diagnosis.
- In children under 12 months old, asthma is less likely to be the cause of wheezing than other conditions (e.g. bronchiolitis, pneumonia).
Repeat salbutamol as needed. Give at least every 20 minutes for first hour (3 doses)

intermittent nebuliser† (doses as for severe acute asthma)

† Give one puff at a time followed by 4 breaths (See Table. Using pressurised metered-dose inhalers in acute asthma)
‡ See Table. Using nebulisers in acute asthma

<table>
<thead>
<tr>
<th>Mild/Moderate</th>
<th>Severe</th>
<th>Life-threatening</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Repeat salbutamol as needed. Give at least every 20 minutes for first hour (3 doses)</td>
<td>intermittent nebuliser† (doses as for severe acute asthma)</td>
</tr>
</tbody>
</table>

Table. Using pressurised metered-dose inhalers in acute asthma

1. Use a salbutamol pressurised metered-dose inhaler (100 mcg/actuation) with a spacer that has already been prepared (see note).
2. Shake inhaler and insert upright into spacer.
3. Place mouthpiece between the person’s teeth and ask them to seal lips firmly around mouthpiece.
4. Fire one puff into the spacer.
5. Tell person to take 4 breaths in and out of the spacer.
6. Remove the spacer from mouth. Shake the inhaler after each puff before actuating again. (This can be done without detaching the pressurised metered-dose inhaler from the spacer.)

Notes
The process is repeated until the total dose is given (e.g. 12 puffs for an adult, 6 puffs for a child). Different doses are recommended for patients and carers giving asthma first aid in the community.

New plastic spacers should be washed with detergent to remove electrostatic charge (and labelled), so they are ready for use when needed. In an emergency situation, if a pre-treated spacer is not available, prime the spacer before use by firing at least 10 puffs of salbutamol into the spacer. (This is an arbitrary number of actuations in the absence of evidence that would enable a precise guideline.)

Priming or washing spacers to reduce electrostatic charge before using for the first time is only necessary for standard plastic spacers; antistatic polymer spacers (e.g. Able A2A, AeroChamber Plus, Breathe Eazy, La Petit E-Chamber, La Grande E-Chamber, OptiChamber Diamond) and disposable cardboard spacers do not require treatment to reduce electrostatic charge.

For small children who cannot form a tight seal with their lips around the spacer mouthpiece, attach a well-fitted mask to the spacer.

Table. Using nebulisers in acute asthma

Driving nebuliser
Nebulisers can be driven by air, piped oxygen, or an oxygen cylinder fitted with a high-flow regulator capable of delivering >6 L/min.

Intermittent nebulisation
Use one nebuile:
Adults: 5 mg nebuile
Children 6 years and over: 5 mg nebuile
Children 0–5 years: 2.5 mg nebuless

**Continuous nebulisation using nebulisers**

Put two nebulisers into nebuliser chamber at a time and repeat to refill when used up.

Adults: use two 5 mg nebulisers (10 mg) at a time

Children 6 years and over: use two 5 mg nebulisers (10 mg) at a time

Children 0–5 years: use two 2.5 mg nebulisers (5 mg) at a time

- If using oxygen to drive a nebuliser, do not exceed 8–10 L/minute and avoid over-oxygenation (increases risk of hypercapnoea).
- The use of nebulisers increases the risk (to staff and patients) of nosocomial aerosol infection. If using a nebuliser, follow your organisation’s infection control protocols to minimise spread of respiratory tract infections.

Asset ID: 73

**How this recommendation was developed**

**Based on selected evidence**

Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Camargo et al. 2003
- Cates et al. 2013
- Chandra et al. 2005
- Dhuper et al. 2011
- Direkwatanachai et al. 2011
- Emerman et al. 1999
- Fayaz et al. 2009
- Kaashmiri et al. 2010
- Karpel et al. 1997
- Travers et al. 2012
- Yasmin et al. 2012

For patients with severe acute asthma who are unable to breathe through a spacer, salbutamol can be given by intermittent nebulisation.

**Table. Using nebulisers in acute asthma**

<table>
<thead>
<tr>
<th>Driving nebuliser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nebulisers can be driven by air, piped oxygen, or an oxygen cylinder fitted with a high-flow regulator capable of delivering &gt;6 L/min.</td>
</tr>
</tbody>
</table>

**Intermittent nebulisation**

Use one nebuliser:

- **Adults:** 5 mg nebulus
- **Children 6 years and over:** 5 mg nebulus
- **Children 0–5 years:** 2.5 mg nebulus

**Continuous nebulisation using nebulisers**

Put two nebulisers into nebuliser chamber at a time and repeat to refill when used up.
Adults: use two 5 mg nebulues (10 mg) at a time
Children 6 years and over: use two 5 mg nebulues (10 mg) at a time
Children 0–5 years: use two 2.5 mg nebulues (5 mg) at a time

- If using oxygen to drive a nebuliser, do not exceed 8–10 L/minute and avoid over-oxygenation (increases risk of hypercapnoea).
- The use of nebulisers increases the risk (to staff and patients) of nosocomial aerosol infection. If using a nebuliser, follow your organisation’s infection control protocols to minimise spread of respiratory tract infections.

Asset ID: 73

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available), with particular reference to the following source(s):
- Camargo et al. 2003

For patients with life-threatening asthma, deliver salbutamol via continuous nebulisation driven by oxygen until breathing improves, then consider changing to a pressurised metered-dose inhaler plus spacer or intermittent nebuliser.

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available), with particular reference to the following source(s):
- Camargo et al. 2003

If using a nebuliser, follow your organisation’s infection control protocols to minimise spread of respiratory tract infections.

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available), with particular reference to the following source(s):
- Hui, 2013

To deliver intermittent nebulised bronchodilators in a patient receiving oxygen therapy, use an air-driven compressor nebuliser and administer oxygen by nasal cannulae. Titrate to oxygen saturation target of 92–95% in adults or at least 95% in children.

If needed, salbutamol can be delivered by piped (‘wall’) oxygen or an oxygen cylinder fitted with a high-flow regulator capable of delivering >6 L/min. The patient should be changed back to their original oxygen mask once nebulisation is complete.

How this recommendation was developed
Adapted from existing guidance
Based on reliable clinical practice guideline(s) or position statement(s):
- O’Driscoll et al. 2008
To deliver salbutamol in a patient undergoing non-invasive ventilation, either of the following options can be used:

- Deliver salbutamol by nebuliser via an attachment to the ventilator circuit. For optimal delivery of salbutamol, the nebuliser should be attached with the expiration port between the facemask and nebuliser.
- Briefly interrupt ventilation to deliver salbutamol via pressurised metered-dose inhaler and spacer.

**How this recommendation was developed**

**Consensus**

Based on clinical experience and expert opinion (informed by evidence, where available), with particular reference to the following source(s):

- Calvert et al. 2006

Do not give oral salbutamol.

**How this recommendation was developed**

**Consensus**

Based on clinical experience and expert opinion (informed by evidence, where available).

Do not use IV short-acting beta2 agonists routinely.

**How this recommendation was developed**

**Based on selected evidence**

Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Travers et al. 2012
- Travers et al. 2012

**More information**

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**Salbutamol in acute asthma: dosing regimens**

One placebo-controlled study showed that, for patients who showed clear improvement after the first dose of salbutamol via pressurised metered-dose inhaler and spacer, there was no advantage in repeating the dose more often than every 60 minutes until full recovery (extra doses can be given as needed). However, in patients who did not show a clear response to the first salbutamol dose, repeating the dose at intervals of 30 minutes or less was more effective than every 60 minutes.

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**Salbutamol in acute asthma: route of administration**

**Inhaler plus spacer, or nebuliser**

Salbutamol delivered via a pressurised metered-dose inhaler with spacer is at least as effective as salbutamol delivered via nebuliser in patients with moderate-to-severe acute asthma who do not require ventilation. The use of nebulisers increases the risk of transmitting respiratory infections to staff and other patients.

**Intravenous salbutamol**

Overall, intravenous short-acting beta2 agonists do not appear to be superior to inhaled short-acting beta2 agonist. Benefits have not been demonstrated in adults. Very limited evidence from one study suggested that the addition of IV salbutamol to inhaled salbutamol reduced recovery time in children with severe acute asthma in the emergency department.
However, there is a lack of consensus on the appropriate dose of IV salbutamol for children. \(^\text{18}\) Recommendations differ between guidelines in Australia \(^\text{19}\) and elsewhere. \(^\text{18}\) Doses have not been calculated based on age-specific pharmacokinetic and pharmacodynamic data. The doses recommended in guidelines are generally relatively higher than for adults on a micrograms per kilogram body weight basis.

Compared with inhaled salbutamol, intravenous salbutamol is associated with increased risk of adverse effects including tremor and hypokalaemia. \(^\text{10, 18}\) Concomitant use of the inhalation and IV routes may increase the risk of salbutamol toxicity. \(^\text{20}\)

**Note:** Salbutamol concentrate for infusion is available in 5 mL ampoules containing salbutamol sulfate equivalent to 5 mg (1 mg/mL) salbutamol in a sterile isotonic solution (Ventolin obstetric injection). Salbutamol for injection is also available in ampoules of salbutamol sulphate equivalent to 500 mcg salbutamol in 1 mL sterile isotonic solution (Ventolin injection).

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**Technical notes: pressurised metered-dose inhalers with spacers**

Manufacturers of most delivery devices recommend shaking the device before actuating. The physical characteristics of each formulation, including the effects of shaking, differ widely, \(^\text{21}\) but for simplicity it is best always to recommend shaking.

Pressurised metered-dose inhalers (except for those that are breath-actuated) can be used with a spacer. When a spacer is used with a pressurised metered-dose inhaler, delivery of the medicine to the patient’s airways is maximised when the patient takes a slow, deep breath from the spacer after each actuation. \(^\text{22, 23}\) Multiple actuations of a pressurised metered-dose inhaler into a spacer can reduce the amount of respirable medicine available because aerosol particles can agglomerate into larger particles or become attached to the spacer walls. \(^\text{22}\)

Therefore, the ideal way to deliver inhaled medicines via pressurised metered-dose inhaler and spacer is to shake the device, ask the person to breathe out all the way into the spacer, fire a single actuation into the spacer, and have the person immediately take a slow deep breath from the spacer, then hold their breath for 5 seconds. This process should be repeated until the total intended number of actuations is taken. Patients should be trained to follow these instructions when using their inhalers. Inhaling slowly with a single breath maximises delivery of the medicine to the lungs and minimises deposition in the upper airways when using a manually actuated pressurised metered-dose inhaler with or without a spacer, or when using a breath-actuated pressurised metered-dose inhaler. \(^\text{24}\) However, slow breathing may not be possible for patients with acute asthma. Tidal breathing through the spacer (e.g. four breaths in and out without removing the spacer) is used in acute asthma and for very young children. First aid instructions should include how to use inhaler and spacer.

In practice, optimal delivery of inhaled medicines involves a balance between maximising the proportion of respirable medicine and maximising efficiency of inhalation by the patient within real-world constraints. The optimal delivery of salbutamol in real-world circumstances is not well defined. For day-to-day use of salbutamol, most adults gain sufficient relief from symptoms when using a pressurised metered-dose inhaler on its own. A spacer may only be needed during a flare-up. By contrast, the use of a spacer is always recommended for inhaled corticosteroids delivered by manually actuated pressurised metered-dose inhalers, to reduce the risk of local adverse effects and increase delivery to the airways.

Many available in vitro studies of aerosol particle deposition in the airways were performed using older CFC-propelled formulations, which are now obsolete. Similar studies have not been performed for current non-CFC pressurised metered-dose inhalers.

Go to: National Asthma Council Australia’s [first aid charts](#)

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**Assessment of oxygen status in acute asthma**

Hypoxia is the main cause of death that is due to acute asthma. \(^\text{25}\)

Routine objective assessment of oxygen saturation at initial assessment of acute asthma is needed because clinical signs may not correlate with hypoxaemia.

Pulse oximetry is the internationally accepted method for routine assessment of oxygen status in patients with acute asthma. \(^\text{26}\)

The risk of hypercapnoea increases when oxygen saturation falls below 92%. \(^\text{27}\)

Pulse oximetry does not detect hypercapnoea, so blood gas analysis is necessary if hypercapnoea is suspected in patients with severe or life-threatening acute asthma.

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**Oxygen therapy in acute asthma**

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24
Oxygen is a treatment for hypoxaemia, not breathlessness. Oxygen has not been shown to improve the sensation of breathlessness in non-hypoxaemic patients. When oxygen supplementation is used, pulse oximetry is necessary to monitor oxygen status and titrate to target.

The aim of titrated oxygen therapy in acute care is to achieve normal or near-normal oxygen saturation, except in patients who are at risk of hypercapnoeic respiratory failure, such as patients with overlapping asthma and COPD.

**Adults**

In adults with acute asthma, titrated oxygen therapy using pulse oximetry to maintain oxygen saturation at 93–95% while avoiding hyperoxaemia achieves better physiological outcomes than 100% oxygen at high flow rate (8 L/min). High-concentration and high-flow oxygen therapy cause a clinically significant increase in blood CO₂ concentration in adults with acute asthma.

National guidelines for the management of acute exacerbations of COPD recommend that hypoxic patients should be given controlled oxygen therapy via nasal prongs at 0.5–2.0 L/minute or a venturi mask at 24% or 28%, with target oxygen saturation of over 90% (PaO₂ > 50 mmHg, or 6.7 kPa). Excessive oxygen administration should be avoided because it can worsen hypercapnoea.

**Children**

Drying of the upper airway is a potential complication of oxygen therapy in children, which might contribute to bronchoconstriction. Humidified oxygen can be considered if necessary. Humidification is usually not needed for low flow oxygen (<4 L/minute in children or 2 L/minute in infants) for short term. Humidification may be considered if the oxygen is required for longer than 48 hours or if the nasal passages are becoming uncomfortable or dry.

Guidance on oxygen delivery techniques and practical issues is available from Sydney Children's Hospital Network and The Royal Children's Hospital Melbourne.

**Non-invasive positive pressure ventilation in acute asthma**

**Efficacy**

Few randomised clinical trials have evaluated non-invasive positive pressure ventilation (biphasic positive airway pressure or continuous positive airway pressure) for adults with severe acute asthma. This technique has not been shown to reduce risk of death or the need for intubation, but may reduce hospital admissions, length of hospital stay and length of ICU stay. It may also improve lung function, but evidence is inconsistent.

**Delivering bronchodilators in patients undergoing noninvasive positive-pressure ventilation**

When delivering nebulised salbutamol while using noninvasive positive-pressure ventilation set at pressures commonly used in clinical practice, the amount of salbutamol inhaled is likely to be significantly higher than with a nebuliser alone (based on a bench model of a spontaneously breathing adult). This increase may be because the ventilator tubing acts as a spacer.

The position of the nebuliser in the ventilator circuit significantly affects the total dose of salbutamol inhaled. Salbutamol is delivered most effectively when the nebuliser is positioned immediately after the expiration port (i.e. starting from the facemask, the expiration port is positioned before the nebuliser).

**References**


Completing secondary assessments and reassessing severity

**Recommendations**

When practical after starting treatment, complete clinical assessments and reassess severity.

*Table. Secondary severity assessment of acute asthma in adults and children 6 years and over*

Please view and print this figure separately: https://www.asthmahandbook.org.au/table/show/63

*Table. Secondary severity assessment of acute asthma in children 0–5 years*

Please view and print this figure separately: https://www.asthmahandbook.org.au/table/show/64

*Table. Initial bronchodilator treatment in acute asthma (adults and children 6 years and over)*

- Do not use IV short-acting beta\_2 agonists routinely for initial bronchodilator treatment.
- Do not give oral salbutamol.
- Monitor for salbutamol toxicity (e.g. tachycardia, tachypnoea, metabolic acidosis, hypokalaemia) – may occur with inhaled or IV salbutamol.

<table>
<thead>
<tr>
<th>Mild/Moderate</th>
<th>Severe</th>
<th>Life-threatening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Give salbutamol^ 4-12 puffs (100 mcg/actuation) via pMDI and spacer</td>
<td>Give salbutamol^ 12 puffs (100 mcg/actuation) via pMDI and spacer</td>
<td>Give salbutamol 2 x 5 mg nebules via continuous nebulisation driven by oxygen^</td>
</tr>
<tr>
<td>Repeat every 20-30 minutes for the first hour if required (sooner, if needed to relieve breathlessness)</td>
<td>If patient unable to breathe through a spacer, give 5 mg nebule via nebuliser^</td>
<td>Maintain oxygen saturations:</td>
</tr>
<tr>
<td></td>
<td>Start oxygen therapy if oxygen saturation &lt;95% and titrate to target:</td>
<td>Adults: 92% or higher</td>
</tr>
<tr>
<td></td>
<td>Adults: 92–95%</td>
<td>Children: 95% or higher</td>
</tr>
<tr>
<td></td>
<td>Children: 95% or higher</td>
<td>Arrange immediate transfer to higher-level care</td>
</tr>
<tr>
<td></td>
<td>Repeat salbutamol as needed. Give at least every 20 minutes for first hour (3 doses)</td>
<td>When dyspnoea improves, consider changing to salbutamol via pMDI plus spacer or intermittent nebuliser^ (doses as for severe acute asthma)</td>
</tr>
</tbody>
</table>

\^ Give one puff at a time followed by 4 breaths (See *Table. Using pressurised metered-dose inhalers in acute asthma*)

\^ See *Table. Using nebulisers in acute asthma*

Note: To deliver nebulised bronchodilators in a patient receiving oxygen therapy, use an air-driven compressor nebuliser and administer oxygen by nasal cannulae.

Asset ID: 80
Table. Initial bronchodilator treatment in acute asthma (children 0–5 years)

- Do not use IV short-acting beta$_2$ agonists routinely for initial bronchodilator treatment.
- Do not give oral salbutamol.
- Monitor for salbutamol toxicity (e.g. tachycardia, tachypnoea, metabolic acidosis, hypokalaemia) – may occur with inhaled or IV salbutamol.
- Closely monitor level of consciousness, fatigue, oxygen saturation, respiratory rate and heart rate. If symptoms do not respond, contact a paediatrician or senior clinician and reconsider the diagnosis.
- In children under 12 months old, asthma is less likely to be the cause of wheezing than other conditions (e.g. bronchiolitis, pneumonia).

<table>
<thead>
<tr>
<th>Mild/Moderate</th>
<th>Severe</th>
<th>Life-threatening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Give salbutamol$^\dagger$ 2–6 puffs (100 mcg/actuation) via pMDI and spacer plus mask</td>
<td>Give salbutamol$^\dagger$ 6 puffs (100 mcg/actuation) via pMDI and spacer plus mask</td>
<td>Give salbutamol 2 x 2.5 mg nebules via continuous nebulisation driven by oxygen$^\ddagger$</td>
</tr>
<tr>
<td>Repeat every 20–30 minutes for the first hour if needed (sooner, if needed to relieve breathlessness)</td>
<td>If patient unable to breathe through a spacer, give 2.5 mg nebule via nebuliser$^\ddagger$</td>
<td>Maintain oxygen saturation at 95% or higher</td>
</tr>
<tr>
<td></td>
<td>Start supplementary oxygen if oxygen saturation &lt; 95%</td>
<td>Arrange immediate transfer to higher-level care</td>
</tr>
<tr>
<td></td>
<td>Titrate to 95% or higher</td>
<td>When dyspnoea improves, consider changing to salbutamol via pMDI plus spacer or intermittent nebuliser$^\ddagger$ (doses as for severe acute asthma)</td>
</tr>
<tr>
<td></td>
<td>Repeat salbutamol as needed. Give at least every 20 minutes for first hour (3 doses)</td>
<td></td>
</tr>
</tbody>
</table>

$^\dagger$ Give one puff at a time followed by 4 breaths (See Table. Using pressurised metered-dose inhalers in acute asthma)

$^\ddagger$ See Table. Using nebulisers in acute asthma

Asset ID: 81

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).

Complete a brief history, including:
- reliever taken for this episode (dose, number of doses, time of last dose)
- current asthma medicines (regular and as-needed, including type of devices used)
- what triggered this episode, if known (e.g. allergies, immediate hypersensitivity, medicines, respiratory infections. Note: acute asthma is rarely triggered by food allergies.)
- coexisting heart or lung disease, including chronic obstructive pulmonary disease.

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).

For adults and children, start titrated oxygen therapy for all patients with severe or life-threatening acute asthma. Maintain oxygen saturation of 92–95% for adults and at least 95% for children.
Excessive oxygen administration can lead to hypercapnoea in people with asthma and COPD.

Go to: The Thoracic Society of Australia and New Zealand oxygen guidelines for acute oxygen use in adults

How this recommendation was developed

Adapted from existing guidance

Based on reliable clinical practice guideline(s) or position statement(s):

- Global Initiative for Asthma, 2012
- Abramson et al. 2012
- O’Driscoll et al. 2008

Arrange chest X-ray if pneumonia, atelectasis, pneumothorax or pneumomediastinum is suspected.

How this recommendation was developed

Consensus

Based on clinical experience and expert opinion (informed by evidence, where available).

More information

Assessment of oxygen status in acute asthma

Hypoxia is the main cause of death that is due to acute asthma.

Routine objective assessment of oxygen saturation at initial assessment of acute asthma is needed because clinical signs may not correlate with hypoxaemia.

Pulse oximetry is the internationally accepted method for routine assessment of oxygen status in patients with acute asthma.

The risk of hypercapnoea increases when oxygen saturation falls below 92%.

Pulse oximetry does not detect hypercapnoea, so blood gas analysis is necessary if hypercapnoea is suspected in patients with severe or life-threatening acute asthma.

Oxygen therapy in acute asthma

Oxygen is a treatment for hypoxaemia, not breathlessness. Oxygen has not been shown to improve the sensation of breathlessness in non-hypoxaemic patients.

When oxygen supplementation is used, pulse oximetry is necessary to monitor oxygen status and titrate to target.

The aim of titrated oxygen therapy in acute care is to achieve normal or near-normal oxygen saturation, except in patients who are at risk of hypercapnoeaic respiratory failure, such as patients with overlapping asthma and COPD.

Adults

In adults with acute asthma, titrated oxygen therapy using pulse oximetry to maintain oxygen saturation at 93–95% while avoiding hyperoxaemia achieves better physiological outcomes than 100% oxygen at high flow rate (8 L/min).

High-concentration and high-flow oxygen therapy cause a clinically significant increase in blood CO₂ concentration in adults with acute asthma.

National guidelines for the management of acute exacerbations of COPD recommend that hypoxic patients should be given controlled oxygen therapy via nasal prongs at 0.5–2.0 L/minute or a venturi mask at 24% or 28%, with target oxygen saturation of over 90% (PaO₂ > 50 mmHg, or 6.7 kPa).

Excessive oxygen administration should be avoided because it can worsen hypercapnoea.

Go to: The COPD-X Concise Guide for Primary Care

Children
Drying of the upper airway is a potential complication of oxygen therapy in children, which might contribute to bronchoconstriction. Humidified oxygen can be considered if necessary. Humidification is usually not needed for low flow oxygen (<4 L/minute in children or 2 L/minute in infants) for short term. Humidification may be considered if the oxygen is required for longer than 48 hours or if the nasal passages are becoming uncomfortable or dry.

Guidance on oxygen delivery techniques and practical issues is available from Sydney Children’s Hospital Network and The Royal Children’s Hospital Melbourne.

Go to: Sydney Children’s Hospitals Network resource on oxygen therapy and delivery devices
Go to: The Royal Children’s Hospital Melbourne guideline on Oxygen delivery.

Spirometry in acute asthma

Utility
Assessment of response to treatment should include spirometry considered alongside clinical assessment. Clinical assessment alone may underestimate the severity of airflow limitation.

On its own, FEV₁ (measured by spirometry) at 1 hour after admission to the emergency department does not closely correlate with the need for hospital admission in adults with acute asthma as assessed clinically.

Feasibility and technique
Most adults with acute asthma can perform spirometry within the first hour of admission to the emergency department. (Hospital staff and primary care health professionals may need specific training in spirometry technique to be able to obtain acceptable spirometry in patients with acute asthma.)

Younger children (most children under 6 years) are unlikely to be able to perform spirometry.

It may not be feasible to apply standard spirometry technique and manoeuvre acceptability criteria in patients with acute asthma:

- 80% of patients older than 12 years with acute asthma can perform an FEV₁ manoeuvre. A forced exhalation from total lung capacity for 2 seconds is sufficient and provides useful information about the severity of airflow obstruction
- two attempts may suffice if patients are unable to make three attempts
- variability between manoeuvres of < 10% should be considered acceptable
- patients may not be able to tolerate nose clips
- patients are unlikely to be able to exhale for long enough to demonstrate the time-volume plateau. Although patients should aim for forced exhalation of at least 6 seconds, 2 seconds is acceptable for measuring FEV₁ in clinical assessment during acute asthma. A spirometry manoeuvre might be considered acceptable if back-extrapolated volume is either < 5% of FVC or 0.15 L (whichever is greater), or a time to peak flow < 120 ms.

Table. Tips for performing spirometry in patients with acute asthma

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Peak expiratory flow in acute asthma

Peak expiratory flow rate obtained using a peak flow meter underestimates the severity of airflow limitation in patients with acute asthma, compared with FEV₁ obtained by spirometry.

Peak expiratory flow is not a sensitive measure of small clinical improvements as perceived by the patient.
References

Starting systemic corticosteroid treatment

Recommendations

For adults, start systemic corticosteroids within 1 hour of presentation (unless contraindicated), regardless of severity at initial assessment.

Give starting dose of prednisolone 37.5–50 mg, then repeat each morning on second and subsequent days (total 5–10 days).

It is usually not necessary to taper the dose unless the duration of treatment exceeds 2 weeks.

Note: Pregnancy is not a contraindication for systemic corticosteroids. Oral prednisone or prednisolone is rated Category A for pregnancy.

How this recommendation was developed

Based on selected evidence

Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Cydulka and Emerman, 1998
- Dembla et al. 2011
- Hasegawa et al. 2000
- Hatton et al. 2005
- Jones et al. 2002
- Karan et al. 2002
- Kravitz et al. 2011
- Manser et al. 2001
- O’Driscoll et al. 1993
- Rowe et al. 2001
- Rowe et al. 2007

For children aged 6 years and over (and children aged 0–5 if acute wheezing is severe), start systemic corticosteroids within 1 hour of presentation (unless contraindicated).

Give prednisolone as a single starting dose of 2 mg/kg (maximum 50 mg) orally, then 1 mg/kg each morning for 2 days (total 3 days). A longer course (e.g. 5 days) may be needed for severe cases.

It is usually not necessary to taper the dose unless the duration of treatment exceeds 2 weeks.

- For children aged 0–5 years, systemic corticosteroids should generally be limited to those with severe acute wheezing to avoid over-use (particularly for those with intermittent viral-induced wheezing).

How this recommendation was developed

Adapted from existing guidance

Based on reliable clinical practice guideline(s) or position statement(s):

- Van Asperen et al. 2010

For adults, if corticosteroids cannot be given orally, give intravenously.

Give up to 100 mg hydrocortisone IV every 6 hours.
For children, if corticosteroids cannot be given orally, give intravenously.

Give either of the following:

• hydrocortisone IV initial dose 8–10 mg/kg (maximum 300 mg), and then 4–5 mg/kg (maximum 300 mg) every 6 hours on day 1, every 12 hours on day 2, once daily on day 3 and, if needed, once daily on days 4–5
• methylprednisolone IV initial dose 2 mg/kg (maximum 60 mg), and then 1 mg/kg (maximum 60 mg) every 6 hours on day 1, every 12 hours on day 2, once daily on day 3 and, if needed, once daily on days 4–5.

Do not use inhaled corticosteroids as a substitute for systemic corticosteroids.

How this recommendation was developed

Based on selected evidence
Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Chan et al. 2001\textsuperscript{13}
- Clark et al. 2005\textsuperscript{14}
- Cunnington et al. 2005\textsuperscript{15}
- Dembla et al. 2011\textsuperscript{2}
- Kravitz et al. 2011\textsuperscript{7}
- Lahn et al. 2004\textsuperscript{16}
- Razi and Moosavi, 2006\textsuperscript{17}

How this recommendation was developed

Adapted from existing guidance
Based on reliable clinical practice guideline(s) or position statement(s):

- Van Asperen et al. 2010\textsuperscript{12}

More information

**Systemic corticosteroids in acute asthma**

Systemic corticosteroids given within 1 hour of presentation to an emergency department reduce the need for hospital admission in patients with acute asthma, particularly if they have severe asthma or are not already taking systemic corticosteroids.\textsuperscript{10}

Oral prednisolone is as effective as intravenous or intramuscular corticosteroids during acute asthma in adults.\textsuperscript{14, 15, 17} Doses of up to 80 mg/day methylprednisolone (or up to 400 mg/day hydrocortisone) are adequate. Higher doses do not appear to be more effective in adults with acute asthma.\textsuperscript{8}

After an acute asthma episode, a short course of systemic corticosteroids reduces the risk of relapse, hospitalisations, and use of short-acting beta\textsubscript{2}-agonist, and appears to be well tolerated.\textsuperscript{11} Oral and intramuscular corticosteroids are both effective.\textsuperscript{11}
A course of 5–10 days is sufficient. In adults, a 5-day course of prednisolone 40 mg per day may be as effective as a 10-day course. In children, a 3-day course is generally effective, but 5 days may be needed for children with severe or life-threatening acute asthma. The majority of studies have used 2mg/kg of oral prednisolone (maximum 60 mg) given initially then 1mg/kg per day.

Abruptly ceasing a short (less than 2 weeks) course of oral prednisolone appears to be equally effective as tapering the dose, and does not suppress adrenal function.

Note: The recommendation in this Handbook for a maximum prednisolone dose of 50 mg for children is based on practical considerations, taking into account commercially available doses and strengths and consistency with the dose recommended for adults.

**Systemic corticosteroids in acute asthma: adverse effects**

Short-term use of oral corticosteroids is unlikely to cause harm – the majority of adverse effects are due to long-term high-dose use. Adverse effects associated with prednisone or prednisolone use include headache, nausea, vomiting, increased appetite, diarrhoea or constipation, vertigo, restlessness, insomnia and increased activity, salt and water retention, and increased blood pressure. High doses can be associated with behavioural changes, facial plethora, bruising and increased sweating.

In people with diabetes or impaired glucose tolerance, corticosteroids increase blood glucose levels. Impaired glucose tolerance is common among people aged over 65 years. In patients with diabetes or impaired glucose tolerance, blood glucose monitoring (e.g. morning and evening samples) may be indicated during treatment with oral corticosteroids.

Long-term use of oral corticosteroids increases the risk of cataracts and osteoporosis in older patients, and may increase body weight.

**Inhaled corticosteroids in acute asthma**

**Inhaled corticosteroid treatment in acute care**

Clinical trial evidence does not support the use of inhaled corticosteroids in place of systemic corticosteroid treatment in the treatment of acute asthma.

Some randomised clinical trials suggest that inhaled corticosteroid treatment may reduce hospital admission rates when given in addition to systemic corticosteroids, but the evidence is conflicting. Overall, evidence from randomised clinical trials does not show that inhaled corticosteroid therapy achieves clinically important improvement in lung function or clinical scores when used in acute asthma in addition to systemic corticosteroids.

**Inhaled corticosteroid treatment in post-acute care**

Current standard follow-up treatment after acute asthma includes a course of systemic corticosteroids, and continuation of inhaled corticosteroids for patients already taking this treatment.

Overall, evidence from randomised clinical trials suggests that inhaled corticosteroid treatment, given at discharge from the emergency department after acute asthma, does not provide additional short-term benefit in patients who are also receiving oral corticosteroids.

Some randomised clinical trials suggest that high-dose inhaled corticosteroid treatment at discharge from the emergency department may be as effective as oral corticosteroids in patients with mild acute asthma, but overall evidence does not support replacing oral corticosteroids with inhaled corticosteroids.

These clinical trials were designed to assess effects of inhaled corticosteroid in managing the current acute asthma episode. This evidence does not suggest that inhaled corticosteroids should be stopped after or during an acute asthma episode. Regular inhaled corticosteroid treatment is effective for preventing future flare-ups.

**References**


Assessing response to treatment

Recommendations

Assess clinical response to each dose of bronchodilator:

- If dyspnoea is partially relieved within first 5 minutes, reassess at 15 minutes.
- If dyspnoea is not relieved, repeat bronchodilator dose and consider add-on options.
- If condition deteriorates at any time, consider add-on treatment options.

Table. Add-on treatment options for acute asthma

Please view and print this figure separately: https://www.asthmahandbook.org.au/table/show/61

- Reduced wheezing alone is an unreliable indicator of improvement, as it may indicate deterioration

Q How this recommendation was developed

Consensus

Based on clinical experience and expert opinion (informed by evidence, where available).

Review treatment response again 10–20 minutes after third dose (approximately 1 hour after first dose). If dyspnoea persists, continue giving salbutamol every 20 minutes and consider add-on treatment options.

Q How this recommendation was developed

Based on selected evidence

Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Camargo et al. 2003
- Chandra et al. 2005
- Karpel et al. 1997
- Rodrigo and Rodrigo, 2002
- Shrestha et al. 1996

Perform baseline spirometry and record FEV₁ approximately 1 hour after giving initial bronchodilator treatment, if feasible.

Table. Tips for performing spirometry in patients with acute asthma

- Ask the patient to sit straight upright, either in a chair or on a stretcher with their legs over the side.
- Make sure the person forms a tight seal around the mouthpiece.
- Tell the patient to take as deep a breath as possible, then blast out air as fast and hard as they can, then keep blowing until asked to stop. Aim for exhalation of maximal force for at least 2 seconds (6 seconds if FVC is measured).
- You may need to give the patient lots of coaching, repeat instructions, and give immediate feedback on technique.
Patients with severe acute asthma are unlikely to be able to perform spirometry
Do not continue attempting to obtain a spirometry reading if the patient is distressed

How this recommendation was developed
Based on selected evidence
Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Arnold et al. 2012
- Emerman and Cydulka, 1995
- Karras et al. 2000
- Langhan and Spiro, 2009
- Schneider et al. 2011
- Silverman et al. 2007
- Wilson et al. 2003

If spirometry is not available, a peak expiratory flow meter can be used to assess initial response.
Note: PEF is not as accurate as spirometry for measuring lung function.

How this recommendation was developed
Based on selected evidence
Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Abisheganaden et al. 1998
- Geelhoed et al. 1990
- Henderson et al. 2010
- Ribeiro de Andrade et al. 2007

Obtain blood gas analysis in adults with features of life-threatening acute asthma (any of):

- unable to speak due to dyspnoea
- reduced consciousness or collapse
- exhaustion
- cyanosis
- oxygen saturation <92%
- poor respiratory effort
- cardiac arrhythmia.

How this recommendation was developed
Adapted from existing guidance
Based on reliable clinical practice guideline(s) or position statement(s):

- Global Initiative for Asthma, 2012

Monitor for signs of salbutamol toxicity (e.g. tachycardia, tachypnoea, metabolic acidosis).

How this recommendation was developed
Based on selected evidence
Admit patient to hospital if (any of):

- FEV$_1$ < 60% predicted at 1-hour check
- unable to lie flat without dyspnoea
- dyspnoea unresolved within 1–2 hours.

**How this recommendation was developed**

Consensus
Based on clinical experience and expert opinion (informed by evidence, where available), with particular reference to the following source(s):

- Wilson et al. 2003

**More information**

### Salbutamol in acute asthma: dosing regimens

One placebo-controlled study showed that, for patients who showed clear improvement after the first dose of salbutamol via pressurised metered-dose inhaler and spacer, there was no advantage in repeating the dose more often than every 60 minutes until full recovery (extra doses can be given as needed). However, in patients who did not show a clear response to the first salbutamol dose, repeating the dose at intervals of 30 minutes or less was more effective than every 60 minutes.

### Salbutamol in acute asthma: route of administration

**Inhaler plus spacer, or nebuliser**
Salbutamol delivered via a pressurised metered-dose inhaler with spacer is at least as effective as salbutamol delivered via nebuliser in patients with moderate-to-severe acute asthma who do not require ventilation. The use of nebulisers increases the risk of transmitting respiratory infections to staff and other patients.

**Intravenous salbutamol**
Overall, intravenous short-acting beta$_2$ agonists do not appear to be superior to inhaled short-acting beta$_2$ agonist. Benefits have not been demonstrated in adults. Very limited evidence from one study suggested that the addition of IV salbutamol to inhaled salbutamol reduced recovery time in children with severe acute asthma in the emergency department. However, there is a lack of consensus on the appropriate dose of IV salbutamol for children. Recommendations differ between guidelines in Australia and elsewhere. Doses have not been calculated based on age-specific pharmacokinetic and pharmacodynamic data. The doses recommended in guidelines are generally relatively higher than for adults on a micrograms per kilogram body weight basis.

Compared with inhaled salbutamol, intravenous salbutamol is associated with increased risk of adverse effects including tremor and hypokalaemia. Concomitant use of the inhalation and IV routes may increase the risk of salbutamol toxicity.

**Note:** Salbutamol concentrate for infusion is available in 5 mL ampoules containing salbutamol sulfate equivalent to 5 mg (1 mg/mL) salbutamol in a sterile isotonic solution (Ventolin obstetric injection). Salbutamol for injection is also available in ampoules of salbutamol sulphate equivalent to 500 mcg salbutamol in 1 mL sterile isotonic solution (Ventolin injection).

**Assessment of oxygen status in acute asthma**
Hypoxia is the main cause of death that is due to acute asthma. Routine objective assessment of oxygen saturation at initial assessment of acute asthma is needed because clinical signs may not correlate with hypoxaemia. Pulse oximetry is the internationally accepted method for routine assessment of oxygen status in patients with acute asthma. The risk of hypercapnoea increases when oxygen saturation falls below 92%. Pulse oximetry does not detect hypercapnoea, so blood gas analysis is necessary if hypercapnoea is suspected in patients with severe or life-threatening acute asthma.

**Oxygen therapy in acute asthma**

Oxygen is a treatment for hypoxaemia, not breathlessness. Oxygen has not been shown to improve the sensation of breathlessness in non-hypoxaemic patients. When oxygen supplementation is used, pulse oximetry is necessary to monitor oxygen status and titrate to target. The aim of titrated oxygen therapy in acute care is to achieve normal or near-normal oxygen saturation, except in patients who are at risk of hypercapnoeic respiratory failure, such as patients with overlapping asthma and COPD.

**Adults**

In adults with acute asthma, titrated oxygen therapy using pulse oximetry to maintain oxygen saturation at 93–95% while avoiding hyperoxaemia achieves better physiological outcomes than 100% oxygen at high flow rate (8 L/min). High-concentration and high-flow oxygen therapy cause a clinically significant increase in blood CO₂ concentration in adults with acute asthma. National guidelines for the management of acute exacerbations of COPD recommend that hypoxic patients should be given controlled oxygen therapy via nasal prongs at 0.5–2.0 L/minute or a venturi mask at 24% or 28%, with target oxygen saturation of over 90% (PaO₂ >50 mmHg, or 6.7 kPa). Excessive oxygen administration should be avoided because it can worsen hypercapnoea.

**Children**

Drying of the upper airway is a potential complication of oxygen therapy in children, which might contribute to bronchoconstriction. Humidified oxygen can be considered if necessary. Humidification is usually not needed for low flow oxygen (<4 L/minute in children or 2 L/minute in infants) for short term. Humidification may be considered if the oxygen is required for longer than 48 hours or if the nasal passages are becoming uncomfortable or dry.

Guidance on oxygen delivery techniques and practical issues is available from Sydney Children’s Hospital Network and The Royal Children’s Hospital Melbourne.

**Spirometry in acute asthma**

**Utility**

Assessment of response to treatment should include spirometry considered alongside clinical assessment. Clinical assessment alone may underestimate the severity of airflow limitation. On its own, FEV₁ (measured by spirometry) at 1 hour after admission to the emergency department does not closely correlate with the need for hospital admission in adults with acute asthma as assessed clinically.

**Feasibility and technique**

Most adults with acute asthma can perform spirometry within the first hour of admission to the emergency department. (Hospital staff and primary care health professionals may need specific training in spirometry technique to be able to obtain acceptable spirometry in patients with acute asthma.) Younger children (most children under 6 years) are unlikely to be able to perform spirometry. It may not be feasible to apply standard spirometry technique and manoeuvre acceptability criteria in patients with acute asthma.
• 80% of patients older than 12 years with acute asthma can perform an FEV\(_1\) manoeuvre. A forced exhalation from total lung capacity for 2 seconds is sufficient and provides useful information about the severity of airflow obstruction\(^\text{11}\).
• Two attempts may suffice if patients are unable to make three attempts\(^\text{11}\).
• Variability between manoeuvres of < 10% should be considered acceptable\(^\text{11}\).
• Patients may not be able to tolerate nose clips\(^\text{11}\).
• Patients are unlikely to be able to exhale for long enough to demonstrate the time-volume plateau. Although patients should aim for forced exhalation of at least 6 seconds, 2 seconds is acceptable for measuring FEV\(_1\) in clinical assessment during acute asthma.\(^\text{11}\). A spirometry manoeuvre might be considered acceptable if back-extrapolated volume is either < 5% of FVC or 0.15 L (whichever is greater), or a time to peak flow < 120 ms.\(^\text{11}\).

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- You may need to give the patient lots of coaching, repeat instructions, and give immediate feedback on technique.

Asset ID: 66

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**Peak expiratory flow in acute asthma**

Peak expiratory flow rate obtained using a peak flow meter underestimates the severity of airflow limitation in patients with acute asthma, compared with FEV\(_1\) obtained by spirometry.\(^\text{36}\)

Peak expiratory flow is not a sensitive measure of small clinical improvements as perceived by the patient.\(^\text{8}\)

**Heliox in acute asthma**

When giving nebulised bronchodilators in acute asthma, the use of helium-oxygen mixtures (heliox) to drive the nebuliser may be more effective than oxygen for improving lung function and reducing hospital admission rates, based on a meta-analysis of clinical trials in adults and children.\(^\text{37}\). However, the application of this finding to routine management of acute asthma is limited, because nebulisation is not routinely recommended in Australia the use of oxygen to drive nebulisers is not routinely recommended for adults who need nebulisation, and many patients do not require oxygen.

**Ipratropium in acute asthma**

Ipratropium bromide alone is less effective than salbutamol alone in acute asthma.\(^\text{38}\)

Early administration of ipratropium bromide in addition to beta\(_2\) agonists may reduce admission rates and improve lung function in children and adults with acute asthma, based on the findings of a systematic review of 32 randomised controlled trials.\(^\text{39}\)

However, ipratropium bromide does not appear to benefit patients with less severe acute asthma (patients with acute asthma assessed as ‘mild’ in randomised controlled trials, e.g. FEV\(_1\) > 70% predicted).\(^\text{39}\)

Ipratropium bromide may be effective in patients with tolerance to the bronchodilator effect of short-acting beta-agonists caused by beta-receptor down-regulation.\(^\text{40}\)

It is well tolerated in children with acute asthma.\(^\text{38}\)

**Theophyllines in acute asthma**

Aminophylline versus short-acting beta\(_2\) agonist
Intravenous aminophylline may be as effective as intravenous short-acting beta₂ agonist in the management of acute asthma in adults and children, but is associated with a higher rate of adverse effects including giddiness, nausea and vomiting.  

**Aminophylline plus beta₂ agonist (adults)**

Overall, evidence from randomised clinical trials in adults with acute asthma treated in emergency departments suggests that intravenous aminophylline given in addition to inhaled beta₂ agonists does not achieve greater bronchodilation or reduce hospital admissions, compared with inhaled beta₂ agonists alone. No sub-groups that benefit from intravenous aminophylline have been clearly identified. Aminophylline is associated with vomiting and cardiac arrhythmias. Theophylline is metabolised mainly by the liver and commonly interacts with other medicines. Its concentration in plasma should be monitored closely in older people or those with comorbid conditions.

- Avoid short-acting theophylline for a patient who is already using long-acting theophylline.

**Aminophylline plus beta₂ agonist (children)**

Overall, evidence from randomised clinical trials in children with acute asthma requiring hospital admission suggests that the addition of intravenous aminophylline to beta₂-agonists and corticosteroids, with or without muscarinic antagonists (anticholinergic bronchodilators), improves lung function within 6 hours of treatment, but does not appear to improve symptoms or shorten hospital stay. Aminophylline is associated with a significant increased risk of vomiting in children.

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**Magnesium sulfate in acute asthma**

**MgSO₄ versus beta₂ agonists**

Clinical trial evidence does not support the use of magnesium sulfate as a substitute for inhaled beta₂ agonists.

**Intravenous MgSO₄ plus beta₂ agonist**

In patients with life-threatening acute asthma (FEV₁ 25–30% predicted) or patients with a poor response to initial bronchodilator treatment, intravenous magnesium sulfate (2 g given as single infusion over 20 minutes) can reduce hospital admission rates. However, it may only be effective in patients with more severe acute asthma. In a recent large, well-conducted randomised controlled trial in adults with moderate-to-severe acute asthma treated in an emergency department (excluding those with life-threatening asthma), intravenous magnesium sulfate improved dyspnoea scores but did not reduce hospital admission rates.

In children, intravenous magnesium sulfate improves lung function and reduces the need for hospital admission. Fewer studies have been conducted in children under 6 years.

Intravenous magnesium sulfate is inexpensive and generally well tolerated.

**Inhaled MgSO₄ plus beta₂ agonist**

Overall, evidence from randomised controlled clinical trials suggests that nebulised magnesium sulfate in addition to beta₂ agonist (with or without ipratropium bromide) does not reduce hospital admissions or improve lung function in adults or children, compared with beta₂ agonist alone. However, the results of some clinical trials suggest that the addition of nebulised magnesium sulfate improves lung function in patients with severe acute asthma (FEV₁ < 50% predicted). In a recent large randomised controlled clinical trial in children, nebulised magnesium sulfate was associated with a small improvement in asthma symptom scores at 60 minutes. The effect was greatest in the subgroups of children with more severe acute asthma, and those with a shorter duration of symptoms.

A recent study showed no benefit in adults for hospitalisation or dyspnoea with add-on nebulised magnesium compared with standard therapy alone, but this study excluded patients with life-threatening acute asthma as defined in this handbook.

Fewer studies have been conducted in children than in adults.

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**Ketamine in acute asthma**

There is insufficient evidence from randomised clinical trials to assess the benefits of ketamine in the management of acute asthma. Available evidence does not demonstrate benefits in non-intubated children with acute asthma.
Ketamine has been suggested as a suitable option for pre-intubation sedation in patients with respiratory failure caused by acute asthma (where not contraindicated) because it stimulates the release of catecholamines and may contribute to bronchodilation through direct relaxation effect on bronchial smooth muscle. \(^5\) Adverse effects associated with ketamine include hypersecretion, hypotension and hypertension, arrhythmias, and hallucinations. \(^5\)

**Oral montelukast in acute asthma**

Evidence from randomised controlled clinical trials does not support routine use of oral leukotriene receptor agonists in acute asthma in adults or children. \(^5\)

In children with acute asthma, the addition of oral montelukast to usual care does not reduce hospital admission rates, based on the findings of a systematic review and meta-analysis. \(^5\)

In adults with acute asthma, the addition of oral montelukast to usual care may slightly reduce beta\(_2\) agonist requirement. \(^5\) The addition of oral zafirlukast was associated with improvement in lung function, compared with usual care. \(^5\)

**Antibiotics in acute asthma**

Antibiotics are not used routinely in the management of acute asthma but should be used if they would otherwise be indicated, e.g. for specific comorbidities or when there is evidence of an infective exacerbation or previous positive microbiology.

The role of atypical bacterial infections (e.g. *Chlamydyphila pneumonia*, *Mycoplasma pneumoniae*) in asthma is under investigation. Atypical bacterial infections may make acute asthma more severe, especially in patients with poorly controlled asthma. Macrolide antibiotics and telithromycin (a ketolide antibiotic not registered in Australia) are active against atypical bacteria and have anti-inflammatory activity. \(^5\)

Overall, evidence from randomised clinical trials does not support the routine use of antibiotics in managing acute asthma. Evidence from one clinical trial suggested that telithromycin might help improve asthma symptoms when given after acute asthma, but it was associated with nausea. \(^5\) \(^3\) \(^4\)

**The 'lie flat' test (adults)**

In adults, at 1 hour after initial treatment, the ability to lie flat without dyspnoea is a useful indicator of adequate recovery without the need for hospital admission, particularly when combined with adequate improvement in FEV\(_1\) measured by spirometry. \(^1\)

**References**

### Table. Add-on treatment options for acute asthma

<table>
<thead>
<tr>
<th>Agent</th>
<th>Recommended use in acute asthma</th>
<th>Administration and dosage</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inhaled ipratropium bromide</strong></td>
<td>Second-line bronchodilator if inadequate response to salbutamol</td>
<td></td>
<td>Use spacer (plus mask, if patient cannot use mouthpiece)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Via pMDI 21 mcg/actuation every 20 minutes for first hour</td>
<td>Adults and children 6 years and over: 8 puffs (\text{Adults and children 6 years and over: }) 8 puffs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repeat every 4 – 6 hours for 24 hours</td>
<td>Children 0–5 years: 4 puffs</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Via nebuliser every 20 minutes for first hour</td>
<td>If salbutamol is delivered by nebuliser, add to nebuliser solution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repeat every 4 – 6 hours</td>
<td></td>
</tr>
<tr>
<td><strong>IV magnesium sulfate</strong></td>
<td>Second-line bronchodilator in severe or life-threatening acute asthma, or when poor response to repeated maximal doses of other bronchodilators</td>
<td>IV infusion over 20 minutes</td>
<td>Avoid magnesium sulfate in children younger than 2 years Dilute in compatible solution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adults: 10 mmol (\text{Adults: }) 10 mmol</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Children 2 years and over: 0.1 – 0.2 mmol/kg (\text{Children 2 years and over: }) 0.1 – 0.2 mmol/kg</td>
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<tr>
<td></td>
<td></td>
<td>(maximum 10 mmol)</td>
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<tr>
<td><strong>IV salbutamol (only in ICU)</strong></td>
<td>Third-line bronchodilator in life-threatening acute asthma that has not responded to continuous nebulised salbutamol after considering other add-on treatment options</td>
<td>Follow hospital/organisation’s protocol</td>
<td>Use only in critical care units (e.g. emergency department, intensive care unit/high-dependency unit) Monitor blood electrolytes, heart rate and acid/base</td>
</tr>
<tr>
<td>Agent</td>
<td>Recommended use in acute asthma</td>
<td>Administration and dosage</td>
<td>Notes</td>
</tr>
<tr>
<td>-------</td>
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</tr>
<tr>
<td>Non-invasive positive pressure ventilation</td>
<td><strong>Consider if starting to tire or signs of respiratory failure</strong></td>
<td></td>
<td>balance (blood lactate) Reduce initial dose for older adults. Consider dose reduction for those with impaired renal function. Impaired liver function may result in accumulation of unmetabolised salbutamol</td>
</tr>
</tbody>
</table>

**Non-invasive positive pressure ventilation**

Consider if starting to tire or signs of respiratory failure

Do not sedate patient If no improvement, intubate and start mechanical ventilation
Continuing treatment and considering additional treatment

Recommendations

Consider add-on treatments based on response to initial doses of salbutamol.

**Table. Add-on treatment options for acute asthma**

Please view and print this figure separately: https://www.asthmahandbook.org.au/table/show/61

![How this recommendation was developed](https://www.asthmahandbook.org.au/table/show/61)

**Consensus**
Based on clinical experience and expert opinion (informed by evidence, where available).

If response to initial inhaled salbutamol is incomplete or poor, add inhaled ipratropium bromide and continue salbutamol as needed.

**Adults:** Give ipratropium bromide 8 puffs (21 mcg/actuation) via pressurised metered-dose inhaler and spacer every 20 minutes for first hour. Repeat 4–6 hourly for 24 hours.

If a nebuliser is being used to deliver salbutamol, 500 mcg ipratropium bromide can be added to the nebulised solution every 20 minutes for first hour. Repeat 4–6 hourly.

**Children 6–12 years:** Give ipratropium bromide 8 puffs (21 mcg/actuation) via pressurised metered-dose inhaler and spacer every 20 minutes for first hour. Repeat 4–6 hourly for 24 hours.

If a nebuliser is being used to deliver salbutamol, 500 mcg ipratropium bromide can be added to the nebulised solution every 20 minutes for first hour. Repeat 4–6 hourly.

**Children 0–5 years:** Give ipratropium bromide 4 puffs (21 mcg/actuation) via pressurised metered-dose inhaler and spacer (+ mask if needed) every 20 minutes for first hour. Repeat 4–6 hourly for 24 hours.

If a nebuliser is being used to deliver salbutamol, 250 mcg ipratropium bromide can be added to the nebulised solution every 20 minutes for first hour. Repeat 4–6 hourly.

![How this recommendation was developed](https://www.asthmahandbook.org.au/table/show/61)

**Based on selected evidence**

Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Iramain *et al*. 2011
- Rodrigo and Castro-Rodriguez, 2005
- Teoh *et al*. 2012

Montelukast is not recommended for the management of acute asthma in adults or children in acute care settings.

![How this recommendation was developed](https://www.asthmahandbook.org.au/table/show/61)

**Based on selected evidence**

Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Adachi *et al*. 2012
- Watts and Chavasse, 2012
For adults with severe or life-threatening acute asthma, or with poor response to repeated maximal doses of other bronchodilators, consider intravenous magnesium sulfate.

Give magnesium sulfate 10 mmol diluted in a compatible solution as a single infusion over 20 minutes.

- Intravenous magnesium sulfate may be associated with hypotension

Table. How to administer intravenous magnesium sulfate
Please view and print this figure separately: https://www.asthmahandbook.org.au/table/show/95

How this recommendation was developed
Based on selected evidence
Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Global Initiative for Asthma, 2012
- Mohammed and Goodacre, 2007
- Powell et al. 2012
- Song and Chang, 2012

For children 2 years and older with poor response to initial bronchodilator therapy, consider intravenous magnesium sulfate.

Give magnesium sulfate 0.1–0.2 mmol/kg (maximum 10 mmol) diluted in a compatible solution as a single infusion over 20 minutes.

Do not use intravenous magnesium sulfate in children younger than 2 years.

- Intravenous magnesium sulfate may be associated with hypotension

Table. How to administer intravenous magnesium sulfate
Please view and print this figure separately: https://www.asthmahandbook.org.au/table/show/95

How this recommendation was developed
Based on selected evidence
Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Global Initiative for Asthma, 2012
- Mohammed and Goodacre, 2007
- Powell et al. 2012

In critical care units (e.g. emergency department, intensive care unit, high-dependency unit), IV salbutamol can be considered for patients with life-threatening acute asthma that has not responded to continuous nebulised salbutamol, after considering other add-on treatment options.

- Salbutamol toxicity may occur with either the inhaled or IV route of administration. Risk may be increased when the inhaled and IV routes are used concomitantly.

Table. Add-on treatment options for acute asthma Please view and print this figure separately: https://www.asthmahandbook.org.au/table/show/61
Table. Add-on treatment options for acute asthma

**Add-on treatment options for acute asthma**

<table>
<thead>
<tr>
<th>Agent</th>
<th>Recommended use in acute asthma</th>
<th>Administration and dosage</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhaled ipratropium bromide</td>
<td>Second-line bronchodilator if inadequate response to salbutamol</td>
<td>Via pMDI</td>
<td>Adults and children 6 years and over: 8 puffs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repeat every 4–6 hours</td>
<td>Children 0–5 years: 4 puffs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adult use: 4 puffs</td>
<td>Use spacer (plus mask, if patient cannot use mouthpiece)</td>
</tr>
<tr>
<td>IV magnesium sulfate</td>
<td>Second-line bronchodilator in severe or life-threatening acute asthma, or when poor response to repeated maximal doses of other bronchodilators</td>
<td>IV infusion over 20 minutes</td>
<td>Adults: 10 mmol</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Children 2 years and over: 0.1–0.2 mmol/kg (maximum 10 mmol)</td>
</tr>
<tr>
<td>IV salbutamol (only in ICU)</td>
<td>Third-line bronchodilator in life-threatening acute asthma that has not responded to continuous nebulised salbutamol after considering other add-on treatment options</td>
<td>Follow hospital/organisation's protocol</td>
<td>Avoid magnesium sulfate in children younger than 2 years</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Dilute in compatible solution</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Use only in critical care units (e.g. emergency department, intensive care unit/high-dependency unit)</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>Monitor blood electrolytes, heart rate and acid/base balance (blood lactate)</td>
</tr>
</tbody>
</table>
Agent | Recommended use in acute asthma | Administration and dosage | Notes |
---|---|---|---|
 | | | Reduce initial dose for older adults. Consider dose reduction for those with impaired renal function. Impaired liver function may result in accumulation of unmetabolised salbutamol |

**Non-invasive positive pressure ventilation** | **Consider if starting to tire or signs of respiratory failure** | | Do not sedate patient If no improvement, intubate and start mechanical ventilation |

**How this recommendation was developed**

Based on selected evidence

Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Travers et al. 2012
- Travers et al. 2012
- Abramson et al. 2001

If using IV salbutamol to manage acute asthma, follow your hospital/organisation’s protocol for dosage and delivery. If no local protocol is available, use the following as a guide:

Using a 1 mg/mL (1000 mcg/mL) salbutamol concentrate for infusion, prepare a solution of 5 mg in 50 mL normal saline. Deliver by continuous infusion or bolus.

**Children 2–12 years:**

Loading dose of 5 mcg/kg/minute (maximum 200 mcg/minute) for 1 hour and then infusion of 1–2 mcg/kg/minute (maximum 80 mcg/minute).

**Adults and children older than 12 years:**

As continuous infusion: initial loading dose of 200 mcg over 1 minute and then start infusion at 5 mcg/minute (can increase to 10 mcg/minute, then up to 20 mcg/minute every 15–30 minutes according to response) As bolus: 250 mcg over 5 minutes.
• The initial dose should be reduced for older adults. Dose reduction may be needed for people with impaired renal function. Impaired liver function may result in accumulation of unmetabolised salbutamol. Refer to TGA-approved product information.

Monitor blood electrolytes, heart rate and acid/base balance (blood lactate).

• Salbutamol toxicity can occur with either the inhaled or IV route of administration. Risk may be increased when the inhaled and IV routes are used concomitantly.

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available), with particular reference to the following source(s):

• GlaxoSmithKline Australia Pty Ltd 2008\textsuperscript{13}

If the patient is starting to tire, or shows signs of respiratory failure, consider noninvasive positive pressure ventilation. For patients with respiratory arrest, acute respiratory failure that does not respond to treatment, severe exhaustion suggesting impending respiratory arrest, or failure of noninvasive positive pressure ventilation, start mechanical ventilation.

How this recommendation was developed
Based on selected evidence
Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

• Brandao et al. 2009\textsuperscript{14}
• Gupta et al. 2010\textsuperscript{15}
• Lim et al. 2012\textsuperscript{16}
• Soroksky et al. 2010\textsuperscript{17}
• Soma et al. 2008\textsuperscript{18}
• Williams et al. 2011\textsuperscript{19}

If intubation is needed, ketamine can be considered.

How this recommendation was developed
Based on selected evidence
Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

• Jat and Chawla, 2012\textsuperscript{20}

If dyspnoea does not respond to treatment, consider transfer to an intensive care unit.

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).

Admit patient to hospital if (any of):

• \( FEV_1 < 60\% \) predicted at 1-hour check
• Unable to lie flat without dyspnoea
• Dyspnoea unresolved within 1–2 hours.
More information

**Ipratropium in acute asthma**

Ipratropium bromide alone is less effective than salbutamol alone in acute asthma. Early administration of ipratropium bromide in addition to beta₂ agonists may reduce admission rates and improve lung function in children and adults with acute asthma, based on the findings of a systematic review of 32 randomised controlled trials. However, ipratropium bromide does not appear to benefit patients with less severe acute asthma (patients with acute asthma assessed as ‘mild’ in randomised controlled trials, e.g. FEV₁ >70% predicted). Ipratropium bromide may be effective in patients with tolerance to the bronchodilator effect of short-acting beta-agonists caused by beta-receptor down-regulation. It is well tolerated in children with acute asthma.

**Magnesium sulfate in acute asthma**

MgSO₄ versus beta₂ agonists

Clinical trial evidence does not support the use of magnesium sulfate as a substitute for inhaled beta₂ agonists. In patients with life-threatening acute asthma (FEV₁ 25–30% predicted) or patients with a poor response to initial bronchodilator treatment, intravenous magnesium sulfate (2 g given as single infusion over 20 minutes) can reduce hospital admission rates. However, it may only be effective in patients with more severe acute asthma. In a recent large, well-conducted randomised controlled trial in adults with moderate-to-severe acute asthma treated in an emergency department (excluding those with life-threatening asthma), intravenous magnesium sulfate improved dyspnoea scores but did not reduce hospital admission rates.  

In children, intravenous magnesium sulfate improves lung function and reduces the need for hospital admission. Fewer studies have been conducted in children under 6 years. Intravenous magnesium sulfate is inexpensive and generally well tolerated.

Inhaled MgSO₄ plus beta₂ agonist

Overall, evidence from randomised controlled clinical trials suggests that nebulised magnesium sulfate in addition to beta₂ agonist (with or without ipratropium bromide) does not reduce hospital admissions or improve lung function in adults or children, compared with beta₂ agonist alone. However, the results of some clinical trials suggest that the addition of nebulised magnesium sulfate improves lung function in patients with severe acute asthma (FEV₁ <50% predicted). In a recent large randomised controlled clinical trial in children, nebulised magnesium sulfate was associated with a small improvement in asthma symptom scores at 60 minutes. The effect was greatest in the subgroups of children with more severe acute asthma, and those with a shorter duration of symptoms. A recent study showed no benefit in adults for hospitalisation or dyspnoea with add-on nebulised magnesium compared with standard therapy alone, but this study excluded patients with life-threatening acute asthma as defined in this handbook.

Fewer studies have been conducted in children than in adults.
**Salbutamol in acute asthma: route of administration**

**Inhaler plus spacer, or nebuliser**
Salbutamol delivered via a pressurised metered-dose inhaler with spacer is at least as effective as salbutamol delivered via nebuliser in patients with moderate-to-severe acute asthma who do not require ventilation.\(^25, 26, 28\) The use of nebulisers increases the risk of transmitting respiratory infections to staff and other patients.

**Intravenous salbutamol**
Overall, intravenous short-acting beta\(_2\) agonists do not appear to be superior to inhaled short-acting beta\(_2\) agonist.\(^10\) Benefits have not been demonstrated in adults.\(^10\) Very limited evidence from one study suggested that the addition of IV salbutamol to inhaled salbutamol reduced recovery time in children with severe acute asthma in the emergency department.\(^10\)

However, there is a lack of consensus on the appropriate dose of IV salbutamol for children.\(^29\) Recommendations differ between guidelines in Australia\(^30\) and elsewhere.\(^29\) Doses have not been calculated based on age-specific pharmacokinetic and pharmacodynamic data. The doses recommended in guidelines are generally relatively higher than for adults on a micrograms per kilogram body weight basis.

Compared with inhaled salbutamol, intravenous salbutamol is associated with increased risk of adverse effects including tremor and hypokalaemia.\(^10, 29\) Concomitant use of the inhalation and IV routes may increase the risk of salbutamol toxicity.\(^12\)

**Note:** Salbutamol concentrate for infusion is available in 5 mL ampoules containing salbutamol sulfate equivalent to 5 mg (1 mg/mL) salbutamol in a sterile isotonic solution (Ventolin obstetric injection). Salbutamol for injection is also available in ampoules of salbutamol sulphate equivalent to 500 mcg salbutamol in 1 mL sterile isotonic solution (Ventolin injection).

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**Adrenaline in acute asthma**
Systemic adrenaline (intravenous in clinical settings with appropriately trained staff, or intramuscular) is indicated for patients with anaphylaxis and angioedema,\(^6, 31\) but current evidence does not support its routine use in the management of acute asthma in the absence of anaphylaxis.\(^6\)

Nebulised adrenaline does not have a significant benefit over salbutamol or terbutaline in the management of moderate-to-severe acute asthma in adults and children.\(^32\)

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**Theophyllines in acute asthma**

**Aminophylline versus short-acting beta\(_2\) agonist**
Intravenous aminophylline may be as effective as intravenous short-acting beta\(_2\) agonist in the management of acute asthma in adults and children, but is associated with a higher rate of adverse effects including giddiness, nausea and vomiting.\(^11\)

**Aminophylline plus beta\(_2\) agonist (adults)**
Overall, evidence from randomised clinical trials in adults with acute asthma treated in emergency departments suggests that intravenous aminophylline given in addition to inhaled beta\(_2\) agonists does not achieve greater bronchodilation or reduce hospital admissions, compared with inhaled beta\(_2\) agonists alone.\(^33\) No sub-groups that benefit from intravenous aminophylline have been clearly identified.\(^33\) Aminophylline is associated with vomiting and cardiac arrhythmias.\(^33\)

Theophylline is metabolised mainly by the liver and commonly interacts with other medicines. Its concentration in plasma should be monitored closely in older people or those with comorbid conditions.\(^34\)

- Avoid short-acting theophylline for a patient who is already using long-acting theophylline.

**Aminophylline plus beta\(_2\) agonist (children)**
Overall, evidence from randomised clinical trials in children with acute asthma requiring hospital admission suggests that the addition of intravenous aminophylline to beta\(_2\)-agonists and corticosteroids, with or without muscarinic antagonists (anticholinergic bronchodilators), improves lung function within 6 hours of treatment, but does not appear to improve symptoms or shorten hospital stay.\(^35\) Aminophylline is associated with a significant increased risk of vomiting in children.\(^35\)
Heliox in acute asthma

When giving nebulised bronchodilators in acute asthma, the use of helium-oxygen mixtures (heliox) to drive the nebuliser may be more effective than oxygen for improving lung function and reducing hospital admission rates, based on a meta-analysis of clinical trials in adults and children. However, the application of this finding to routine management of acute asthma is limited, because nebulisation is not routinely recommended in Australia; the use of oxygen to drive nebulisers is not routinely recommended for adults who need nebulisation, and many patients do not require oxygen.

Ketamine in acute asthma

There is insufficient evidence from randomised clinical trials to assess the benefits of ketamine in the management of acute asthma. Available evidence does not demonstrate benefits in non-intubated children with acute asthma. Ketamine has been suggested as a suitable option for pre-intubation sedation in patients with respiratory failure caused by acute asthma (where not contraindicated) because it stimulates the release of catecholamines and may contribute to bronchodilation through direct relaxation effect on bronchial smooth muscle. Adverse effects associated with ketamine include hypersecretion, hypotension and hypertension, arrhythmias, and hallucinations.

Oral montelukast in acute asthma

Evidence from randomised controlled clinical trials does not support routine use of oral leukotriene receptor agonists in acute asthma in adults or children.

In children with acute asthma, the addition of oral montelukast to usual care does not reduce hospital admission rates, based on the findings of a systematic review and meta-analysis.

In adults with acute asthma, the addition of oral montelukast to usual care may slightly reduce beta2 agonist requirement. The addition of oral zafirlukast was associated with improvement in lung function, compared with usual care.

Antibiotics in acute asthma

Antibiotics are not used routinely in the management of acute asthma but should be used if they would otherwise be indicated, e.g. for specific comorbidities or when there is evidence of an infective exacerbation or previous positive microbiology.

The role of atypical bacterial infections (e.g. Chlamydophyla pneumonia, Mycoplasma pneumonae) in asthma is under investigation. Atypical bacterial infections may make acute asthma more severe, especially in patients with poorly controlled asthma. Macrolide antibiotics and telithromycin (a ketolide antibiotic not registered in Australia) are active against atypical bacteria and have anti-inflammatory activity.

Overall, evidence from randomised clinical trials does not support the routine use of antibiotics in managing acute asthma. Evidence from one clinical trial suggested that telithromycin might help improve asthma symptoms when given after acute asthma, but it was associated with nausea.

Non-invasive positive pressure ventilation in acute asthma

Efficacy

Few randomised clinical trials have evaluated non-invasive positive pressure ventilation (biphasic positive airway pressure or continuous positive airway pressure) for adults with severe acute asthma. This technique has not been shown to reduce risk of death or the need for intubation, but may reduce hospital admissions, length of hospital stay and length of ICU stay. It may also improve lung function, but evidence is inconsistent.

Delivering bronchodilators in patients undergoing noninvasive positive-pressure ventilation

When delivering nebulised salbutamol while using noninvasive positive-pressure ventilation set at pressures commonly used in clinical practice, the amount of salbutamol inhaled is likely to be significantly higher than with a nebuliser alone (based on a bench model of a spontaneously breathing adult). This increase may be because the ventilator tubing acts as a spacer.

The position of the nebuliser in the ventilator circuit significantly affects the total dose of salbutamol inhaled. Salbutamol is delivered most effectively when the nebuliser is positioned immediately after the expiration port (i.e. starting from the facemask, the expiration port is positioned before the nebuliser).
The ‘lie flat’ test (adults)

In adults, at 1 hour after initial treatment, the ability to lie flat without dyspnoea is a useful indicator of adequate recovery without the need for hospital admission, particularly when combined with adequate improvement in FEV₁ measured by spirometry.²¹

References


## Table. How to administer intravenous magnesium sulfate

<table>
<thead>
<tr>
<th>Product</th>
<th>Concentration</th>
<th>Compatible fluids</th>
<th>Infusion instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Magnesium sulfate concentrated injection</strong></td>
<td>2.465 g/5 mL (49.3%)</td>
<td>NaCl 0.9% HARTMANN'S solution</td>
<td>Each 5 mL ampoule should be diluted by adding at least 7.5 mL of a compatible solution Administer over 20 minutes</td>
</tr>
<tr>
<td></td>
<td>Each 5 mL ampoule contains 10 mmol of magnesium ions</td>
<td>Glucose 5% in water Glucose 5% in NaCl 0.9%</td>
<td></td>
</tr>
<tr>
<td><strong>Magnesium sulfate heptahydrate 50%</strong></td>
<td>Each 5 mL vial contains approximately 10 mmol of magnesium ions</td>
<td>NaCl 0.9% Hartmann's solution</td>
<td>Each 5 mL vial should be diluted by adding at least 7.5 mL of a compatible solution</td>
</tr>
<tr>
<td><strong>concentrated injection</strong></td>
<td>Each 10 mL vial contains approximately 20 mmol (40 mEq) of magnesium ions</td>
<td>Glucose 5% in water Glucose 5% in NaCl 0.9%</td>
<td>Each 10 mL vial should be diluted with at least 15 mL of a compatible solution Administer over 20 minutes</td>
</tr>
<tr>
<td><strong>(2.5 g/5 mL and 5 g/10 mL)</strong></td>
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</tr>
</tbody>
</table>

Asset ID: 95
Providing post-acute care

Recommendations

After dyspnoea or difficulty breathing has resolved and symptoms have stabilised, observe the patient for at least 1 hour.

**How this recommendation was developed**

Consensus

Based on clinical experience and expert opinion (informed by evidence, where available).

If the patient is already using (or has been prescribed) inhaled corticosteroids, check adherence and inhaler technique, and instruct them to continue their inhaled corticosteroid.

**How this recommendation was developed**

Based on selected evidence

Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Edmonds et al. 2012

For adults who have not been prescribed inhaled corticosteroids, prescribe inhaled corticosteroid and arrange comprehensive assessment in 2–4 weeks to review the treatment regimen (e.g. refer to person’s GP or arrange specialist assessment).

**How this recommendation was developed**

Based on selected evidence

Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Edmonds et al. 2012

For children not currently taking a preventer, consider whether preventer treatment is indicated. Arrange a follow-up appointment in 2–4 weeks to review the treatment regimen (e.g. refer to child’s GP or arrange specialist assessment).

**How this recommendation was developed**

Based on selected evidence

Based on a limited structured literature review or published systematic review, which identified the following relevant evidence:

- Edmonds et al. 2012

For patients treated in acute care services, complete all of the following:
• Ensure that the patient (or carer) is able to monitor and manage asthma at home.
• Check the patient has a reliever medicine and assess their inhaler technique.
• Provide a spacer, if needed.
• Advise patient (or carer) to make an appointment with their usual GP within 2–4 weeks (or earlier if necessary).
• For patients with severe acute asthma or a previous presentation, consider arranging referral to a consultant/respiratory physician.
• Provide an interim asthma action plan, including instructions on when and how to reduce reliever dose and instructions on preventer use. Explain that the person needs their own written asthma action plan prepared by their usual doctor (e.g. GP or respiratory physician).
• Provide a copy of the discharge summary to the patient’s usual GP.

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).

At the follow-up review, the patient’s usual doctor (e.g. GP) should:
• try to identify trigger factors associated with the acute asthma episode
• review the written asthma action plan
• review the person’s reliever use and give instructions about when to go back to usual as-needed reliever regimen
• review the person’s regular medicines regimen
• offer specialist review if the person has had more than one emergency visit to health services for acute asthma within the previous 12 months or repeated corticosteroid treatments.

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).

Routine treatment with antibiotics is not recommended after acute asthma.

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available), with particular reference to the following source(s):
• Black, 2007
• Fonseca-Aten et al. 2006
• Graham et al. 2001
• Johnston, 2006
• Johnston et al. 2006
• Koutsoubari et al. 2012

More information

Interim asthma action plans
The purpose of the interim action plan is to provide written instructions until the person returns to their usual doctor or nurse practitioner for review of their written asthma action plan.
The interim action plan should include (all of):
• the patient’s name
• instructions for oral corticosteroid course (dose, duration, when to take)
• instructions for reliever dose in immediate post-acute period (dose, how to take including use of spacer, duration of this dose)
Antibiotics in acute asthma

Antibiotics are not used routinely in the management of acute asthma but should be used if they would otherwise be indicated, e.g. for specific comorbidities or when there is evidence of an infective exacerbation or previous positive microbiology.

The role of atypical bacterial infections (e.g. *Chlamydophyla pneumonia*, *Mycoplasma pneumoniae*) in asthma is under investigation. Atypical bacterial infections may make acute asthma more severe, especially in patients with poorly controlled asthma. Macrolide antibiotics and telithromycin (a ketolide antibiotic not registered in Australia) are active against atypical bacteria and have anti-inflammatory activity.\(^5\)

Overall, evidence from randomised clinical trials does not support the routine use of antibiotics in managing acute asthma. Evidence from one clinical trial suggested that telithromycin might help improve asthma symptoms when given after acute asthma, but it was associated with nausea.\(^2,6\)

References

Community first aid

For first aid instructions for patients, parents and community members:

► See: First aid instructions for patients, parents and community members

For information on preparing a written asthma action plan to guide self-management:

► See: Preparing written asthma action plans for adults
   See: Providing asthma management education for parents and children