VERSION 2.0

MANAGEMENT

Children
ABBREVIATIONS

CFC  chlorofluorocarbon
COPD  chronic obstructive pulmonary disease
COX  cyclo-oxygenase
DXA  dual-energy X-ray absorptiometry
ED  emergency department
EIB  exercise-induced bronchoconstriction
FEV₁  forced expiratory volume over one second
FEV₆  forced expiratory volume over six seconds
FSANZ  Food Standards Australia and New Zealand
FVC  forced vital capacity
GORD  gastro-oesophageal reflux disease
HFA  formulated with hydrofluoralkane propellant
ICS  inhaled corticosteroid
ICU  intensive care unit
IgE  Immunoglobulin E
IL  interleukin
IU  international units
IV  intravenous
LABA  long-acting β₂-adrenergic receptor agonist
LAMA  long-acting muscarinic antagonist
LTRA  leukotriene receptor antagonist
MBS  Medical Benefits Scheme
NHMRC  National Health and Medical Research Council
NIPPV  non-invasive positive pressure ventilation
NSAIDs  nonsteroidal anti-inflammatory drugs
OCS  oral corticosteroids
OSA  obstructive sleep apnoea
PaCO₂  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’
PPE  personal protective equipment
SABA  short-acting β₂-adrenergic receptor agonist
SAMi  short-acting muscarinic antagonist
SaO₂  oxygen saturation
SpO₂  peripheral capillary oxygen saturation measured by pulse oximetry
TGA  Therapeutic Goods Administration

RECOMMENDED CITATION

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DISCLAIMER

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, 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.
Managing asthma in children

Overview

*Children aged 0–12 months*

Wheezing infants aged less than 12 months old should not be treated for asthma. Wheezing in this age group is most commonly due to acute viral bronchiolitis or to small and/or floppy airways.

Advice should be obtained from a paediatric respiratory physician or paediatrician before administering short-acting beta2 agonists, systemic corticosteroids or inhaled corticosteroids to an infant under 12 months.

Children with clinically significant wheezing that necessitates hospitalisation or occurs frequently (e.g. more than once per 6 weeks) should be referred to a paediatric respiratory physician or paediatrician.

▶ Go to: Paediatric Research in Emergency Departments International Collaborative (PREDICT) Australasian bronchiolitis guideline

*Children aged 1–5 years*

Many infants and preschoolers wheeze when they have viral respiratory infections, even if they do not have asthma.

As-needed salbutamol should be used to relieve symptoms during wheezing episodes in children with wheezing that has been shown to be salbutamol-responsive in a treatment trial.

A small proportion of infants and preschoolers may also need regular preventer treatment for preschool wheeze (e.g. those who have recurrent symptoms between viral respiratory infections.)

| Table. Classification of preschool wheeze and indications for preventer treatment in children aged 1–5 |
|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| **Severity of flare-ups** | **Frequency of symptoms** |
| | **Symptoms every 6 months or less** | **Symptoms every 3–4 months** | **Symptoms every 4–6 weeks** | **Symptoms at least once per week** |
| **Mild flare-ups** (managed with salbutamol in community) | Not indicated | Not indicated | Consider | Indicated |
| **Moderate–severe flare-ups** (require ED care/oral corticosteroids) | Indicated | Indicated | Indicated | Indicated |
| **Life-threatening flare-ups** | Indicated | Indicated | Indicated | Indicated |
Severity of flare-ups | Frequency of symptoms
---|---|---|---|---

Symptoms every 6 months or less | Symptoms every 3–4 months | Symptoms every 4–6 weeks | Symptoms at least once per week

(require hospitalisation or PICU)

PICU: paediatric intensive care unit; ED: emergency department

Indicated: Prescribe preventer and monitor as a treatment trial. Discontinue if ineffective.

Not indicated: Preventer is unlikely to be beneficial

Consider prescribing preventer according to overall risk for severe flare-ups

**Symptoms:** wheeze, cough or breathlessness. May be triggered by viral infection, exercise or inhaled allergens

**Flare-up:** increase in symptoms from usual day-to-day symptoms (ranging from worsening asthma over a few days to an acute asthma episode)

Preventer options: an inhaled corticosteroid (low dose) or montelukast

[!] Advise parents/carers about potential adverse behavioural and/or neuropsychiatric effects of montelukast

**Notes:**
Preventer medication is unlikely to be beneficial in a child whose symptoms do not generally respond to salbutamol

In children taking preventer, symptoms should be managed with a short-acting inhaled beta_2_ agonist reliever (e.g. when child shows difficulty breathing).

*Last reviewed version 2.0*

*Asset ID: 20*

**Table. Classification of asthma and indications for initiating preventer treatment in children aged 6–11**

<table>
<thead>
<tr>
<th>Severity of flare-ups</th>
<th>Average frequency of flare-ups and symptoms between flare-ups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrequent intermittent</td>
<td></td>
</tr>
<tr>
<td>Flare-ups every 6 weeks or less and no symptoms between flare-ups</td>
<td></td>
</tr>
<tr>
<td>Frequent intermittent</td>
<td></td>
</tr>
<tr>
<td>Flare-ups more than once every 6 weeks and no symptoms between flare-ups</td>
<td></td>
</tr>
<tr>
<td>Persistent</td>
<td></td>
</tr>
</tbody>
</table>
| Between flare-ups (any of):
  * Daytime symptoms‡ more than once per week
  * Night-time symptoms‡ more than

*Figure. Stepped approach to adjusting asthma medication in children aged 1-5 years*

*Please view and print this figure separately: [http://www.asthmahandbook.org.au/figure/show/18]*

**Children aged 6 years and over**

The diagnosis of asthma can be made with more certainty in school-aged children. In this age group, the presence of reversible expiratory airflow limitation on spirometry supports the diagnosis of asthma.

All school-aged children with asthma need a reliever to use when they have asthma symptoms.

Regular preventer treatment is indicated for those with frequent intermittent asthma (flare-ups every 6 weeks or more often) or persistent asthma symptoms (daytime asthma symptoms more than once per week or night-time symptoms more than twice per month) and those with severe flare-ups, irrespective of the frequency of flare-ups or symptoms between flare-ups.
General principles of asthma treatment in children

Aim for good control of asthma symptoms

Try to identify what triggers asthma symptoms (e.g. allergens).

Manage comorbid conditions that affect asthma (e.g. allergic rhinitis).

Show parents and children (if old enough) when and how to take reliever medicine.

Monitor regularly and adjust the treatment regimen to maintain good control of symptoms and prevent flare-ups, while minimising the dose of inhaled corticosteroids (if needed).

Provide parents/carers and children with information and skills to manage their asthma, including:

- a written asthma action plan to follow when symptoms worsen
- information about reducing exposure to triggers, where appropriate (e.g. all tobacco smoke, but allergens only when likely to be helpful

Preventer should be started as a treatment trial. Assess response after 4–6 weeks and review before prescribing long term.

ED: emergency department

Indicated: Prescribe preventer and monitor as a treatment trial. At follow-up, discontinue if ineffective

Not indicated: Preventer is unlikely to be beneficial

Consider prescribing preventer according to overall risk for severe flare-ups

† Symptoms between flare-ups. A flare-up is defined as a period of worsening asthma symptoms, from mild (e.g. symptoms that are just outside the normal range of variation for the child, documented when well) to severe (e.g. events that require urgent action by parents/carers and health professionals to prevent a serious outcome such as hospitalisation or death from asthma).

Last reviewed version 2.0

Asset ID: 16

**Figure. Stepped approach to adjusting asthma medication in children aged 6-11 years**

Please view and print this figure separately: http://www.asthmahandbook.org.au/figure/show/120
and cost-effective)
See: Asthma triggers

- training in correct use of medicines, including inhaler technique
- information and support to maximise adherence.
- advice about avoidance of tobacco smoke, healthy eating, physical activity, healthy weight and immunisation.

### Table. Definition of levels of recent asthma symptom control in children (regardless of current treatment regimen)

<table>
<thead>
<tr>
<th>Good control</th>
<th>Partial control</th>
<th>Poor control</th>
</tr>
</thead>
<tbody>
<tr>
<td>All of:</td>
<td>Any of:</td>
<td>Either of:</td>
</tr>
</tbody>
</table>
| - Daytime symptoms† ≤ 2 days per week (lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)  
- No limitation of activities‡  
- No symptoms§ during night or when wakes up  
- Need for SABA reliever# ≤ 2 days per week | - Daytime symptoms† > 2 days per week (lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)  
- Any limitation of activities*  
- Any symptoms during night or when wakes up††  
- Need for SABA reliever# > 2 days per week | - Daytime symptoms† > 2 days per week (lasting from minutes to hours or recurring, and partially or fully relieved by SABA reliever)  
- ≥ 3 features of partial control within the same week |

SABA: short-acting beta2 agonist
† e.g. wheezing or breathing problems
‡ child is fully active; runs and plays without symptoms
§ including no coughing during sleep
# not including doses taken prophylactically before exercise. (Record this separately and take into account when assessing management.)
* e.g. wheeze or breathlessness during exercise, vigorous play or laughing
†† e.g. waking with symptoms of wheezing or breathing problems

**Notes:**
Recent asthma control is based on symptoms over the previous 4 weeks. Each child’s risk factors for future asthma outcomes should also be assessed and taken into account in management.

**Validated questionnaires can be used for assessing recent symptom control:**
Test for Respiratory and Asthma Control in Kids (TRACK) for children < 5 years
Childhood Asthma Control Test (C-ACT) for children aged 4–11 years

**Last reviewed version 2.0**

### Table. Definitions of ICS dose levels in children

<table>
<thead>
<tr>
<th>Inhaled corticosteroid</th>
<th>Daily dose (microg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Beclometasone dipropionate†</td>
<td>100–200</td>
</tr>
<tr>
<td>Budesonide</td>
<td>200–400</td>
</tr>
</tbody>
</table>
### Inhaled corticosteroid

<table>
<thead>
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<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Ciclesonide ‡</td>
<td>80–160</td>
</tr>
<tr>
<td>Fluticasone propionate</td>
<td>100–200</td>
</tr>
</tbody>
</table>

† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)
‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

**Source**
Last reviewed version 2.0
Asset ID: 21

**Figure. Stepped approach to adjusting asthma medication in children aged 1-5 years**
Please view and print this figure separately: [http://www.asthmahandbook.org.au/figure/show/18](http://www.asthmahandbook.org.au/figure/show/18)

**Figure. Stepped approach to adjusting asthma medication in children aged 6-11 years**
Please view and print this figure separately: [http://www.asthmahandbook.org.au/figure/show/120](http://www.asthmahandbook.org.au/figure/show/120)

### In this section

**Management: ages 1–5**
Managing wheezing and asthma in children aged 1–5 years, including use of relievers and preventers, reviewing and adjusting initial treatment, managing flare-ups and managing severe asthma

**Management: age 6 and over**
Managing asthma in children aged 6 years and over, including use of relievers and preventers, reviewing and adjusting initial treatment, managing flare-ups and managing severe asthma

**Administering medicines**
Administering inhaled medicines correctly in children, including the use of inhalers, spacers and masks

**Routine asthma reviews**
Planning and conducting routine asthma review for children with asthma or preschool wheeze

**Triggers**
Managing triggers in children with asthma or preschool wheeze
Education
Providing asthma management education for parents and older children
Figure. Stepped approach to adjusting asthma medication in children aged 1-5 years

**Medication**

1. **As-needed reliever only**
   - SABA
   - Advise/prescribe reliever to be carried at all times
   - Assess each patient's individual risk factors and comorbidities
   - Ask parents about their goals and concerns, and implement shared decision-making
   - Provide education and a written asthma action plan
   - Most children

2. **Regular preventer (+ reliever as needed)**
   - Preclude options:
     - ICS (low dose)
     - Montelukast
   - Some children

3. **Stepped-up regular preventer (+ reliever as needed)**
   - Preclude options:
     - ICS (low dose) + montelukast
     - ICS (high paediatric dose)§
   - Very few children

**At this step $^5$

- Monitor and adjust to maintain control at lowest effective dose
- Consider referral

- Table. Reviewing and adjusting preventer treatment for children aged 1 - 5 years
- Consultation with a specialist is recommended before prescribing high-dose inhaled corticosteroids in children aged 5 and under.

**Add-on specialised treatments**

- Monitor reliever use
- Consider need for preventer
- Table. Definition of levels of recent asthma symptom control in children (regardless of current treatment regimen)
- Table. Risk factors for life-threatening asthma flare-ups

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**Table. Definition of levels of recent asthma symptom control in children (regardless of current treatment regimen)**

- As-needed reliever only
- Monitor reliever use
- Consider need for preventer
- Table. Definition of levels of recent asthma symptom control in children (regardless of current treatment regimen)
- Table. Risk factors for life-threatening asthma flare-ups

**Before considering stepping up, check symptoms are due to asthma, inhaler technique is correct, and adherence is adequate**

**At this step $^5$**

- Monitor and adjust to maintain control at lowest effective dose
- Consider referral

- Table. Reviewing and adjusting preventer treatment for children aged 1 - 5 years
- Consultation with a specialist is recommended before prescribing high-dose inhaled corticosteroids in children aged 5 and under.

---

**Table. Risk factors for life-threatening asthma flare-ups**

- Very few children
- Most children
- All patients

---

ICS: inhaled corticosteroid; SABA: short-acting beta₂ agonist; LABA: long-acting beta₂ agonist

§ At all steps: Review recent symptom control and risk regularly. Manage flare-ups with extra treatment when they occur. Manage exercise-related asthma symptoms as indicated.

$^5$ At all steps: Review recent symptom control and risk regularly. Manage flare-ups with extra treatment when they occur. Manage exercise-related asthma symptoms as indicated.
Figure. Stepped approach to adjusting asthma medication in children aged 6-11 years

Stepped-up regular preventer (+ reliever as needed)
Preventer options:
- ICS (high paediatric dose)
- ICS/LABA combination (low dose)
- ICS (low dose) + montelukast

Regular preventer (+ reliever as needed)
Preventer options:
- ICS (low dose)
- Montelukast

As-needed reliever only
SABA

At this step
- Monitor and adjust to maintain control at lowest effective dose
- Consider referral

Medication
- Advise/prescribe reliever to be carried at all times
- Assess each patient’s individual risk factors and comorbidities
- Ask parents (and children, when appropriate) about their goals and concerns, and implement shared decision-making
- Provide education and a written asthma action plan

All patients

- ICS: inhaled corticosteroid; SABA: short-acting beta₂ agonist; LABA: long-acting beta₂ agonist
- § At all steps: Review recent symptom control and risk regularly. Manage flare-ups with extra treatment when they occur. Manage exercise-related asthma symptoms as indicated.

Before considering stepping up, check symptoms are due to asthma, inhaler technique is correct, and adherence is adequate. Consider modifiable factors contributing to asthma symptoms (e.g. exposure to tobacco smoke or allergens, obesity or overweight).

Consider stepping up if good control is not achieved despite good adherence and correct inhaler technique.

Consider stepping down when asthma is stable and well controlled for more than 6 months.
Managing wheezing and asthma in children aged 1–5 years

In this section

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Link</th>
</tr>
</thead>
</table>
Prescribing reliever and considering regular preventer treatment for children aged 1–5 years

Recommendations

For children with recurrent wheezing, when the diagnosis of asthma is uncertain, ask parents/carers about the frequency and severity of symptoms and what seems to trigger them.

Identify:

- whether wheezing only occurs for a few days at a time when the child has a cold, or if the child coughs or wheezes at other times (e.g. when playing actively or laughing)
- whether there is increased work of breathing at these times (e.g. increased respiratory rate, tracheal tug, subcostal and intercostal recession, shortness of breath).

Table. Classification of preschool wheeze and indications for preventer treatment in children aged 1–5

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PICU: paediatric intensive care unit; ED: emergency department

Indicated: Prescribe preventer and monitor as a treatment trial. Discontinue if ineffective.

Not indicated: Preventer is unlikely to be beneficial
Consider prescribing preventer according to overall risk for severe flare-ups
Symptoms: wheeze, cough or breathlessness. May be triggered by viral infection, exercise or inhaled allergens
Flare-up: increase in symptoms from usual day-to-day symptoms (ranging from worsening asthma over a few days to an acute asthma episode)
Preventer options: an inhaled corticosteroid (low dose) or montelukast

[!] Advise parents/carers about potential adverse behavioural and/or neuropsychiatric effects of montelukast

Notes:
Preventer medication is unlikely to be beneficial in a child whose symptoms do not generally respond to salbutamol
In children taking preventer, symptoms should be managed with a short-acting inhaled beta2 agonist reliever (e.g. when child shows difficulty breathing).

Last reviewed version 2.0
Asset ID: 20

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

- Brand et al. 2008¹
- Brand et al. 2014²

When the diagnosis of asthma is more certain, assess the frequency and severity of wheezing, other symptoms and flare-ups.

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*Last reviewed version 2.0*

Asset ID: 20

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

*Last reviewed version 2.0*

If the diagnosis of asthma was made in the past or elsewhere, confirm the diagnosis, if possible.

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

*Last reviewed version 2.0*

Discuss the goals of asthma treatment with the child’s parents/carers. Explain that the overall aims of treatment are to reduce the risk of flare-ups, make sure asthma does not interfere with play or preschool attendance, and minimise the side effects of treatment by using the lowest level of medication required to maintain good asthma control.

Ask parents about their own goals for the child’s health and about their beliefs and concerns about medication.

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

*Last reviewed version 2.0*

For all children with asthma or salbutamol-responsive preschool wheeze, prescribe a reliever suitable for the child’s age: salbutamol 2–4 puffs (100 microg per puff) as needed via pressurised metered-dose inhaler plus spacer and face mask for children aged 1–2 years or pressurised metered-dose inhaler plus spacer for children aged 3–5 years (if able to cooperate).
Educate parents/carers how and when to give reliever, and advise them to carry reliever (and spacer, if needed) at all times to use when needed to manage symptoms.

- Reliever should be used when wheezing episodes are associated with increased work of breathing. It should not be used for cough in the absence of other symptoms. In infants, it should not be used for noisy breathing when the child shows no increased work of breathing.

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).
Last reviewed version 2.0

Consider regular preventer treatment according to the child’s age, frequency of symptoms, severity of flare-ups, and risk factors for severe flare-ups.

Consider regular preventer treatment for children with frequent symptoms (e.g. wheeze, cough or breathlessness at least once per week) or a history of severe flare-ups (e.g. requiring emergency department visits, intensive care or hospitalisation)

- Regular preventer is not recommended for children younger than 12 months, except on the advice of a specialist.

Note: This assessment should be based on overall pattern of symptoms including frequency of flare-ups and symptoms between flare-ups, not on symptoms seen during a flare-up.

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[!] Advise parents/carers about potential adverse behavioural and/or neuropsychiatric effects of montelukast
Notes:
Preventer medication is unlikely to be beneficial in a child whose symptoms do not generally respond to salbutamol
In children taking preventer, symptoms should be managed with a short-acting inhaled beta_2 agonist reliever (e.g. when child shows difficulty breathing).

Table. Risk factors for life-threatening asthma flare-ups in children

Asthma-related factors
Poor asthma control
Admission to hospital in preceding 12 months
History of intubation for acute asthma
Over-use of short-acting beta_2 agonist reliever
Abnormal spirometry findings
Reversible expiratory airflow limitation on spirometry despite treatment
Poor adherence to preventer
Incorrect inhaler technique for preventer
Poor adherence to asthma action plan
Exposure to clinically relevant allergens
Exposure to tobacco smoke

Other clinical factors
Allergies to foods, insects, medicines
Obesity

Family-related factors
Frequent failure to attend consultations/lack of follow-up after an acute flare-up
Significant parental psychological or socioeconomic problems
Parent/carer unequipped to manage asthma emergency

How this recommendation was developed
Adapted from existing guidance
Based on reliable clinical practice guideline(s) or position statement(s)
- van Asperen et al. 2010^3
- Brand et al. 2014^2

For children aged 12 months to less than 2 years, consider a treatment trial with a low dose of inhaled corticosteroids only if any of the following apply:
• Symptoms (wheezing, cough, breathlessness) occur at least once per week and frequently disrupt child’s sleeping or play.
• Flare-ups are generally severe enough to require ED or oral corticosteroids.
• The child has had a flare-up that required hospitalisation or ICU.

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Consider prescribing preventer according to overall risk for severe flare-ups
Symptoms: wheeze, cough or breathlessness. May be triggered by viral infection, exercise or inhaled allergens
Flare-up: increase in symptoms from usual day-to-day symptoms (ranging from worsening asthma over a few days to an acute asthma episode)
Preventer options: an inhaled corticosteroid (low dose) or montelukast
[!] Advise parents/carers about potential adverse behavioural and/or neuropsychiatric effects of montelukast

Notes:
Preventer medication is unlikely to be beneficial in a child whose symptoms do not generally respond to salbutamol
In children taking preventer, symptoms should be managed with a short-acting inhaled beta2 agonist reliever (e.g. when child shows difficulty breathing).

*Last reviewed version 2.0*

**Asset ID:** 20

*How this recommendation was developed*  
Consensus
For children aged 2 years and older with frequent symptoms (e.g. wheeze, cough or breathlessness at least once per week) or a history of severe flare-ups (e.g. requiring emergency department visits or oral corticosteroids), consider a treatment trial of regular preventer with either of:

- montelukast
- an inhaled corticosteroid (low dose).

- Advise parents/carers about potential adverse behavioural and/or neuropsychiatric effects of montelukast.

> Go to: [Therapeutic Goods Administration alert](https://www.tga.gov.au).

### Table. Classification of preschool wheeze and indications for preventer treatment in children aged 1–5

<table>
<thead>
<tr>
<th>Severity of flare-ups</th>
<th>Frequency of symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Symptoms every 6 months or less</td>
</tr>
<tr>
<td>Mild flare-ups</td>
<td>Not indicated</td>
</tr>
<tr>
<td>(managed with salbutamol in community)</td>
<td></td>
</tr>
<tr>
<td>Moderate–severe flare-ups</td>
<td>Indicated</td>
</tr>
<tr>
<td>(require ED care/oral corticosteroids)</td>
<td></td>
</tr>
<tr>
<td>Life-threatening flare-ups</td>
<td>Indicated</td>
</tr>
<tr>
<td>(require hospitalisation or PICU)</td>
<td></td>
</tr>
</tbody>
</table>

PICU: paediatric intensive care unit; ED: emergency department

**Indicated:** Prescribe preventer and monitor as a treatment trial. Discontinue if ineffective.

**Not indicated:** Preventer is unlikely to be beneficial

**Consider prescribing preventer according to overall risk for severe flare-ups**

**Symptoms:** wheeze, cough or breathlessness. May be triggered by viral infection, exercise or inhaled allergens

**Flare-up:** increase in symptoms from usual day-to-day symptoms (ranging from worsening asthma over a few days to an acute asthma episode)

**Preventer options:** an inhaled corticosteroid (low dose) or montelukast

[*] Advise parents/carers about potential adverse behavioural and/or neuropsychiatric effects of montelukast
Notes:
Preventer medication is unlikely to be beneficial in a child whose symptoms do not generally respond to salbutamol.

In children taking preventer, symptoms should be managed with a short-acting inhaled beta2 agonist reliever (e.g. when child shows difficulty breathing).

Table. Definitions of ICS dose levels in children

<table>
<thead>
<tr>
<th>Inhaled corticosteroid</th>
<th>Daily dose (microg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Beclometasone dipropionate †</td>
<td>100–200</td>
</tr>
<tr>
<td></td>
<td>&gt;200 (maximum 400)</td>
</tr>
<tr>
<td>Budesonide</td>
<td>200–400</td>
</tr>
<tr>
<td></td>
<td>&gt;400 (maximum 800)</td>
</tr>
<tr>
<td>Ciclesonide ‡</td>
<td>80–160</td>
</tr>
<tr>
<td></td>
<td>&gt;160 (maximum 320)</td>
</tr>
<tr>
<td>Fluticasone propionate</td>
<td>100–200</td>
</tr>
<tr>
<td></td>
<td>&gt;200 (maximum 500)</td>
</tr>
</tbody>
</table>

† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)
‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

Source

An inhaled corticosteroid should be considered as the first choice preventer for those with symptoms that are frequent (e.g. daytime or night-time symptoms at least once per week), symptoms that restrict activity or sleep, or a history of severe flare-ups (e.g. requiring treatment in the emergency department or hospital admission).

An inhaled corticosteroid could also be preferable when either of the following are present:

- atopy
- raised blood eosinophil count (if known; this test is not recommended routinely).
When starting preventer for the first time for a child aged 2 years or over, the choice of agent can be guided by the following considerations.

Montelukast might be considered as alternative to an inhaled corticosteroid when any of the following apply:

- The child is unable or refuses to use pMDI + spacer/mask.
- The child has significant allergic rhinitis that requires treatment.
- Parents, despite education about risks and benefits, decline inhaled corticosteroids or are significantly concerned about their adverse effects (poor adherence is likely in this context).

### Table. Definitions of ICS dose levels in children

<table>
<thead>
<tr>
<th>Inhaled corticosteroid</th>
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</tr>
</thead>
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<td></td>
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</tr>
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<td>100–200</td>
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</tr>
<tr>
<td>Fluticasone propionate</td>
<td>100–200</td>
</tr>
</tbody>
</table>

† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)

‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

**Source**


**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):

- Castro-Rodriguez et al. 2018⁴
- Fitzpatrick et al. 2016⁵
- Szefer et al. 2013⁶
- Bacharier et al. 2008⁷
- Kooi et al. 2008⁸
- Knorrr et al. 2001⁹
- Brodlie et al. 2015¹⁰

**For children aged 2 years and older with symptoms that are frequent (e.g. every day, or night-time symptoms at least once per week), symptoms that restrict activity or sleep), or a history of severe flare-ups (e.g. requiring treatment in the emergency department or hospital admission), consider an inhaled corticosteroid (low dose) as first-choice preventer.**

### Table. Definitions of ICS dose levels in children
### Inhaled corticosteroid

<table>
<thead>
<tr>
<th></th>
<th>Daily dose (microg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)</td>
<td>Low</td>
</tr>
</tbody>
</table>

‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

**Source**


Last reviewed version 2.0

Asset ID: 21

When prescribing montelukast, start as a treatment trial. Review effects at 4–6 weeks and discontinue if no response.

**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
- Brand *et al.* 2014

Last reviewed version 2.0

When dispensing montelukast in pharmacies, counsel parents/carers about behavioural and/or neuropsychiatric effects of montelukast and provide the consumer medicines information leaflet.

**How this recommendation was developed**

**Evidence-based recommendation**

Based on literature search and formulated by multidisciplinary working group

Key evidence considered:

- Fitzpatrick *et al.* 2016
- Szefer *et al.* 2013
- Bacharier *et al.* 2008
- Kooi *et al.* 2008
- Knorr *et al.* 2001
- Brodlie *et al.* 2015

Last reviewed version 2.0

When prescribing montelukast, warn parents/carers that behavioural and/or neuropsychiatric effects of montelukast are possible, but do not occur in the majority of children. Explain that if these adverse effects occur, they are typically seen within the first 2 weeks of starting regular treatment but resolve soon after discontinuing.

When dispensing montelukast in pharmacies, counsel parents/carers about behavioural and/or neuropsychiatric effects of montelukast and provide the consumer medicines information leaflet.

Go to: TGA alert

**How this recommendation was developed**

**Evidence-based recommendation**

Based on literature search and formulated by multidisciplinary working group

Key evidence considered:

- Bernard *et al.* 2017
- Aldea Perona *et al.* 2016
- Wallerstedt *et al.* 2009
- Philip *et al.* 2009
When prescribing regular inhaled corticosteroids, begin with a low dose.

**Table. Definitions of ICS dose levels in children**

<table>
<thead>
<tr>
<th>Inhaled corticosteroid</th>
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</tbody>
</table>

† Dose equivalents for *Qvar* (TGA-registered CFC-free formulation of beclometasone dipropionate)

‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

Source


Last reviewed version 2.0

Asset ID: 21

How this recommendation was developed

Adapted from existing guidance

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

- van Asperen et al. 2010³

Last reviewed version 2.0

More information

**Short-acting beta-2 agonist relievers for children: 1–5 years**

**Infants under 12 months**

In infants under 12 months, bronchiolitis is the most likely cause of acute respiratory distress. Bronchodilators are not recommended in children under 12 months old, consistent with current guidelines for the management of acute bronchiolitis.¹⁹

**Children aged 1–5 years**

Inhaled short-acting beta₂ agonists are effective bronchodilators in children aged 1–5 years.¹

Short-acting beta₂ agonists may be less effective for wheezing in children under 2 years old than in older children.²⁰ However, many
clinical trials in infants have included those with bronchiolitis, so there is limited evidence for the effects of short-acting beta2 agonists specifically in asthma.\textsuperscript{20} Studies conducted in emergency departments have shown that short-acting beta2 agonists are more effective than placebo in controlling acute wheeze in children under 2 years, but may not achieve clinically significant improvements.\textsuperscript{20}

Inhaled short-acting beta2 agonists are generally well tolerated in children aged 1–5 years.\textsuperscript{1} Adverse effects can include muscle tremor, headache, palpitations and agitation. Muscle tremor and agitation are common with initial use of standard doses, but often settle over time. Serious adverse effects such as hypokalaemia have been reported at very high doses.\textsuperscript{1}

Oral short-acting beta2 agonists are associated with adverse effects\textsuperscript{1} and should not be used for the treatment of asthma in any age group.

**Administration of inhaled medicines in children: 6 years and over**

Parents, carers and children need training to use inhaler devices correctly, including inhaler technique, and care and cleaning of inhalers and spacers.

School-aged children (depending on the child’s age, ability, and with individualised training) can learn to use a range of inhaler types, including manually actuated pressurised metered-dose inhalers with spacers, breath-actuated pressurised metered-dose inhalers (e.g. Autohaler), and dry-powder inhalers (e.g. Accuhaler, Turbuhaler).\textsuperscript{21, 22, 23, 24, 25}

**Table. Types of inhaler devices for delivering asthma and COPD medicines**

Please view and print this figure separately: http://www.asthmahandbook.org.au/table/show/75

A pressurised metered-dose inhaler and spacer is an appropriate first choice for most children.\textsuperscript{23}

School-aged children are unlikely to use their inhaler device correctly without careful training and repeated checking.\textsuperscript{26}

▶ Go to: National Asthma Council Australia’s [How to use a puffer and spacer for kids](https://www.nationalasthma.org.au/health-professionals/asthma-management/training-tools/inhaler-device-training/inhaler-device-training-for-children-and-adolescents) video

▶ Go to: National Asthma Council Australia’s information paper for health professionals on [Inhaler technique for people with asthma or COPD](https://www.nationalasthma.org.au/health-professionals/asthma-management/inhaler-technique/inhaler-technique-for-people-with-asthma-or-copd)

**Correct use of inhaler devices**

Checking and correcting inhaler technique is essential to effective asthma management.

Most patients with asthma or COPD do not use their inhalers properly,\textsuperscript{27, 28, 29, 30} and most have not had their technique checked or corrected by a health professional.

Incorrect inhaler technique when using maintenance treatments increases the risk of severe flare-ups and hospitalisation for people with asthma or COPD.\textsuperscript{27, 28, 31, 32, 33, 34}

Poor asthma symptom control is often due to incorrect inhaler technique.\textsuperscript{35, 36}

Incorrect inhaler technique when using inhaled corticosteroids increases the risk of local side effects like dysphonia and oral thrush.

The steps for using an inhaler device correctly differ between brands. Checklists of correct steps for each inhaler type and how-to videos are available from the National Asthma Council website.

▶ Go to: National Asthma Council Australia’s [Using your inhaler](https://www.nationalasthma.org.au/health-professionals/asthma-management/inhaler-technique/using-your-inhaler) webpage for information, patient resources and videos on inhaler technique

▶ Go to: National Asthma Council Australia’s information paper for health professionals on [Inhaler technique for people with asthma or COPD](https://www.nationalasthma.org.au/health-professionals/asthma-management/inhaler-technique/inhaler-technique-for-people-with-asthma-or-copd)


**Preparation of new spacers before first use**

Spacers are made of plastic, antistatic polymer/polycarbonate polyurethane, or cardboard.

**Plastic spacers (e.g. Breath-A-Tech, Volumatic)**

Electrostatic surface charge on new spacers made of plastic (e.g. Breath-A-Tech, Volumatic) reduces the proportion of medicine available for delivery to the airway. This charge can be reduced by washing the plastic spacer in dishwashing liquid and allowing it to air dry or drip-dry without rinsing or wiping.\textsuperscript{1}
Alternatively, priming the spacer by actuating the device several times into the spacer also overcomes the charge, but this wastes medicine. The optimal number of actuations for priming is not known and the findings of in vitro studies vary widely. One study (using older, CFC-based formulations of asthma medicines) reported that up to 40 actuations fired into a new plastic spacer overcame the effect of the electrostatic charge. Others have concluded that the electrostatic charge on plastic spacers does not reduce in vivo efficacy of bronchodilator therapy in children with asthma. The number of actuations necessary may be known when the results of recent studies become available.

When a new plastic spacer must be used immediately (e.g., for a person with asthma symptoms), patients, parents and carers should follow the manufacturer’s priming instructions. In hospitals and emergency departments, a new spacer that has not been pre-treated by washing can be primed using multiple (at least 10) puffs of salbutamol. (This is an arbitrary number of actuations in the absence of evidence that would enable a precise guideline.)

Non-plastic spacers

Disposable cardboard spacers (e.g., DispozABLE, LiteAire) and polyurethane/antistatic polymer spacers (e.g., Able A2A, AeroChamber Plus, La Petite E-Chamber, La Grande E-Chamber) do not require preparation before first use.

Note: The term ‘priming’ is also used for the preparation process that is necessary for new pressurised metered-dose inhalers that have not been used for more than a week. This involves first actuating the inhaler into the air (away from the patient). Users should follow the manufacturer’s instructions for the particular brand of inhaler, which specify the number of actuations required.

Classification of symptom patterns in children

The pattern and severity of symptoms in a child with asthma or preschool wheeze is a guide to initial treatment.

<table>
<thead>
<tr>
<th>Severity of flare-ups</th>
<th>Frequency of symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Symptoms every 6 months or less</td>
</tr>
<tr>
<td>Mild flare-ups (managed with salbutamol in community)</td>
<td>Not indicated</td>
</tr>
<tr>
<td>Moderate–severe flare-ups (require ED care/oral corticosteroids)</td>
<td>Indicated</td>
</tr>
<tr>
<td>Life-threatening flare-ups (require hospitalisation or PICU)</td>
<td>Indicated</td>
</tr>
</tbody>
</table>

PICU: paediatric intensive care unit; ED: emergency department

Indicated: Prescribe preventer and monitor as a treatment trial. Discontinue if ineffective.
Not indicated: Preventer is unlikely to be beneficial
Consider prescribing preventer according to overall risk for severe flare-ups

**Symptoms:** wheeze, cough or breathlessness. May be triggered by viral infection, exercise or inhaled allergens

**Flare-up:** increase in symptoms from usual day-to-day symptoms (ranging from worsening asthma over a few days to an acute asthma episode)

Preventer options: an inhaled corticosteroid (low dose) or montelukast

[!] Advise parents/carers about potential adverse behavioural and/or neuropsychiatric effects of montelukast

**Notes:**
Preventer medication is unlikely to be beneficial in a child whose symptoms do not generally respond to salbutamol.
In children taking preventer, symptoms should be managed with a short-acting inhaled beta2 agonist reliever (e.g. when child shows difficulty breathing).

_Last reviewed version 2.0_
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**Table. Definitions of asthma patterns in children aged 6 years and over not taking regular preventer**

<table>
<thead>
<tr>
<th>Category</th>
<th>Pattern and intensity of symptoms (when not taking regular treatment)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infrequent intermittent asthma †</strong></td>
<td>Symptom-free for at least 6 weeks at a time (flare-ups up to once every 6 weeks on average but no symptoms between flare-ups)</td>
</tr>
<tr>
<td><strong>Frequent intermittent asthma</strong></td>
<td>Flare-ups more than once every 6 weeks on average but no symptoms between flare-ups</td>
</tr>
<tr>
<td><strong>Persistent asthma</strong></td>
<td><strong>Mild</strong></td>
</tr>
<tr>
<td></td>
<td>FEV$_1$ ≥80% predicted and at least one of:</td>
</tr>
<tr>
<td></td>
<td>● Daytime symptoms‡ more than once per week but not every day</td>
</tr>
<tr>
<td></td>
<td>● Night-time symptoms‡ more than twice per month but not every week</td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
<td>Any of:</td>
</tr>
<tr>
<td></td>
<td>● FEV$_1$ &lt;80% predicted‡</td>
</tr>
<tr>
<td></td>
<td>● Daytime symptoms‡ daily</td>
</tr>
<tr>
<td></td>
<td>● Night-time symptoms‡ more than once per week</td>
</tr>
<tr>
<td></td>
<td>● Symptoms sometimes restrict activity or sleep</td>
</tr>
<tr>
<td><strong>Severe</strong></td>
<td>Any of:</td>
</tr>
<tr>
<td></td>
<td>● FEV$_1$ ≤60% predicted‡</td>
</tr>
<tr>
<td></td>
<td>● Daytime symptoms‡ continual</td>
</tr>
<tr>
<td></td>
<td>● Night-time symptoms‡ frequent</td>
</tr>
<tr>
<td></td>
<td>● Flare-ups frequent</td>
</tr>
<tr>
<td></td>
<td>● Symptoms frequently restrict activity or sleep</td>
</tr>
</tbody>
</table>

† It may not be appropriate to make the diagnosis of asthma in children aged 6 or older who wheeze only during upper respiratory tract infections. These children can be considered to have episodic (viral) wheeze.
‡ Symptoms between flare-ups. A flare-up is defined as a period of worsening asthma symptoms, from mild (e.g. symptoms that are just outside the normal range of variation for the child, documented when well) to severe (e.g. events that require urgent action by parents and health professionals to prevent a serious outcome such as hospitalisation or death from asthma).

Table. Classification of asthma and indications for initiating preventer treatment in children aged 6–11

<table>
<thead>
<tr>
<th>Severity of flare-ups</th>
<th>Average frequency of flare-ups and symptoms between flare-ups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Infrequent intermittent Flare-ups every 6 weeks or less and no symptoms between flare-ups</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild flare-ups</td>
<td>Not indicated</td>
</tr>
<tr>
<td>(almost always managed with salbutamol in community)</td>
<td></td>
</tr>
<tr>
<td>Moderate–severe flare-ups</td>
<td>Consider</td>
</tr>
<tr>
<td>(&gt;2 in past year requiring ED or oral corticosteroids)</td>
<td></td>
</tr>
<tr>
<td>Life-threatening flare-ups</td>
<td>Indicated</td>
</tr>
<tr>
<td>(require hospitalisation or PICU)</td>
<td></td>
</tr>
</tbody>
</table>

Preventer should be started as a treatment trial. Assess response after 4–6 weeks and review before prescribing long term.
ED: emergency department

Indicated: Prescribe preventer and monitor as a treatment trial. At follow-up, discontinue if ineffective

Not indicated: Preventer is unlikely to be beneficial

Consider prescribing preventer according to overall risk for severe flare-ups

† Symptoms between flare-ups. A flare-up is defined as a period of worsening asthma symptoms, from mild (e.g. symptoms that are just outside the normal range of variation for the child, documented when well) to severe (e.g. events that require urgent action by parents/carers and health professionals to prevent a serious outcome such as hospitalisation or death from asthma).

Last reviewed version 2.0
Asset ID: 16

For children already taking regular preventer treatment, adjustments to the treatment regimen are based on finding the lowest dose of medicines that will maintain good control of symptoms.

Last reviewed version 2.0

Wheezing phenotypes in preschool children

Longitudinal population-based cohort studies39, 40 of preschool children with wheezing have identified various long-term patterns (wheezing phenotypes).1

Table. Systems for retrospectively classifying the duration of childhood wheeze

<table>
<thead>
<tr>
<th>Classification system/source</th>
<th>Phenotypes identified</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tucson Children’s Respiratory Study † ‡</td>
<td><strong>Transient wheeze</strong></td>
<td>Wheezing commences before the age of 3 years and disappear by age 6 years</td>
</tr>
<tr>
<td></td>
<td><strong>Persistent wheeze</strong></td>
<td>Wheezing continues until up to or after age 6 years</td>
</tr>
<tr>
<td></td>
<td><strong>Late-onset wheeze</strong></td>
<td>Wheezing starts after age 3 years.</td>
</tr>
<tr>
<td>Avon Longitudinal Study of Parents and Children §</td>
<td><strong>Transient early wheeze</strong></td>
<td>Wheezing mainly occurs before 18 months, then mainly disappears by age 3.5 years. Not associated with hypersensitivity to airborne allergens</td>
</tr>
<tr>
<td></td>
<td><strong>Prolonged early wheeze</strong></td>
<td>Wheezing occurs mainly between age 6 months and 4.5 years, then mainly disappears before child’s 6th birthday. Not associated with hypersensitivity to airborne allergens. Associated with a higher risk of airway hyperresponsiveness and reduced lung function at age 8–9 years, compared with never/infrequent wheeze phenotype</td>
</tr>
<tr>
<td></td>
<td><strong>Intermediate-onset wheeze</strong></td>
<td>Wheezing begins sometime after age 18 months and before 3.5 years. Strongly associated with atopy (especially house mite, cat allergen), higher risk of airway hyperresponsiveness and reduced lung function at age 8–9 years, compared with never/infrequent wheeze phenotype</td>
</tr>
<tr>
<td></td>
<td><strong>Late-onset wheeze</strong></td>
<td>Wheezing mainly begins after age 3.5 years</td>
</tr>
</tbody>
</table>
### Classification system/source

<table>
<thead>
<tr>
<th>Phenotypes identified</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly associated with atopy (especially house mite, cat allergen, grass pollen)</td>
<td></td>
</tr>
<tr>
<td><strong>Persistent wheeze</strong></td>
<td>Wheezing mainly begins after 6 months and continues through to primary school</td>
</tr>
<tr>
<td></td>
<td>Strongly associated with atopy</td>
</tr>
</tbody>
</table>

### Notes

Terms can only be identified after the child has stopped wheezing for several years and cannot be applied to a preschool child.

Transient wheeze, persistent wheeze and late-onset wheeze can be episodic or multiple-trigger wheeze.#

### Sources


Asset ID: 10

Early childhood wheezing phenotypes cannot be recognised or applied clinically, because they are recognised retrospectively.¹ In an individual child with episodic wheeze, it is not possible to accurately predict epidemiological phenotype from clinical phenotype.¹

Currently available tools for predicting whether a wheezing preschool child will have asthma at school age (e.g. the Asthma Predictive Index⁴¹) have limited clinical value.⁴²

### Inhaled corticosteroids for children: efficacy

#### Role in treatment asthma in children

The effectiveness of ICS in children appears to depend on several factors including the child's age, which triggers are causing symptoms, wheezing phenotype, tobacco smoke exposure and genotype.⁴³ Overall, inhaled corticosteroids seem to be more effective in older children and those with more severe disease.³

Early introduction of inhaled corticosteroid for children with recurrent wheeze does not prevent airway remodelling, improve long-term lung function or prevent the onset of persistent asthma, according to current evidence from long-term randomised controlled clinical trials in preschool children and school-aged children with intermittent or mild persistent asthma.³

Current evidence does not support planned seasonal use of inhaled corticosteroids in children not taking preventer at other times.⁴⁴

#### Children aged 1–5 years

**Intermittent wheeze/asthma**

In preschool children who only have wheezing episodes with viral respiratory infections, limited available evidence suggests that regular treatment with inhaled corticosteroids does not reduce the risk of hospitalisation, flare-ups that require oral corticosteroid use, or reduce the frequency and duration of acute episodes.⁴³,⁴⁵ Inhaled corticosteroid treatment does not reduce these children's risk of developing persistent wheeze by age 6 years.¹

**Persistent wheeze/asthma**
In preschool children who have episodes of wheezing from time to time, but also cough and wheezes at other times when they do not have a viral cold (e.g. when cries, plays or laughs), regular inhaled corticosteroids are moderately effective in controlling symptoms, though less effective than in older children. When wheeze improves markedly during a short treatment trial (e.g. 3 months), it is not possible to tell whether improvement was due to the treatment or spontaneous resolution of symptoms. However, this can be clarified by stopping inhaled corticosteroid treatment, monitoring symptoms, and re-starting.

In infants and preschoolers with persistent wheezing or asthma of at least 6 months’ duration, regular treatment with inhaled corticosteroids improves wheezing, asthma symptoms and lung function, and reduces flare-ups.

**Children aged 6 years and over**

Most clinical trials of regular inhaled corticosteroid treatment in children have been conducted among children with asthma symptoms every week or more often (‘persistent asthma’). Beclometasone dipropionate, budesonide, ciclesonide and fluticasone propionate have all been shown to be effective in children. There have been relatively fewer studies of ciclesonide in children, but, overall, randomised clinical trials show that it is equally effective as budesonide or fluticasone propionate in improving asthma symptoms and reducing flare-ups. In some studies, ciclesonide was associated with less adrenal suppression or height than comparator inhaled corticosteroids.

In a study of school-aged children with more than 2 days per week with symptoms, night waking more than twice per month due to asthma symptoms, or needing regular preventer, regular low-dose daily inhaled corticosteroid treatment reduced the rate of flare-ups that require treatment with oral corticosteroids, compared with no regular preventer treatment and as-needed short-acting beta2 agonist for wheezing episodes. In a study of children aged 4–11 years with asthma diagnosed within the previous 2 years and symptoms more than weekly in the previous 3 months, regular preventer was associated with a reduction in serious flare-ups, school absence due to asthma, an increase in symptom-free days, and improved lung function, compared with placebo.

The Thoracic Society of Australia and New Zealand’s current position statement on the use of inhaled corticosteroids in children recommends regular treatment with inhaled corticosteroid:

- as a first-choice preventer for children with asthma symptoms at least daily or night-time symptoms at least twice per week between flare-ups
- as an alternative to cromones (nedocromil or sodium cromoglycate) or montelukast in children with any daytime or night-time symptoms between flare-ups, or those with flare-ups every 6 weeks or more.

**Doses**

In the majority of children, asthma control can be achieved with any of the following initial doses:

- budesonide up to 400 microg/day
- beclometasone (Qvar) up to 200 microg/day
- ciclesonide up to 160 microg/day
- fluticasone propionate up to 200 microg/day.

If these doses do not achieve control of symptoms, possible explanations include alternative diagnoses, adherence, incorrect inhaler technique, psychosocial factors and exposure to tobacco smoke or other triggers such as allergens.

Dose–response studies of inhaled corticosteroids show that the maximal efficacy is generally achieved at a dose equivalent to approximately 200 microg/day fluticasone propionate, while the risk of adrenal suppression increases exponentially at doses above 500 microg/day. Therefore (based on theoretical equivalents between different agents), upper limits of daily doses for children are:

- budesonide 800 microg/day
- beclometasone dipropionate [Qvar] 400 microg/day
- ciclesonide 320 microg/day
- fluticasone propionate 500 microg/day.

Higher doses are unlikely to be more effective, and are likely to cause systemic effects.

Most studies of inhaled corticosteroids in children have used twice-daily dosing. Fluticasone propionate is only approved for twice-daily dosing, but the other inhaled corticosteroids are approved for once daily dosing. Ciclesonide is effective when given once daily.

**Note**: Do not use beclometasone dose recommendations from outdated or overseas guidelines based on older formulations containing CFC propellant – doses are different.

**Table. Definitions of ICS dose levels in children**

<table>
<thead>
<tr>
<th>Inhaled corticosteroid</th>
<th>Daily dose (microg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

Ta b l e. D e f i n i t i o n s o f I C S d o s e l e v e l s i n c h i l d r e n
<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beclometasone dipropionate †</strong></td>
<td>100–200</td>
<td>&gt;200 (maximum 400)</td>
</tr>
<tr>
<td><strong>Budesonide</strong></td>
<td>200–400</td>
<td>&gt;400 (maximum 800)</td>
</tr>
<tr>
<td><strong>Ciclesonide ‡</strong></td>
<td>80–160</td>
<td>&gt;160 (maximum 320)</td>
</tr>
<tr>
<td><strong>Fluticasone propionate</strong></td>
<td>100–200</td>
<td>&gt;200 (maximum 500)</td>
</tr>
</tbody>
</table>

† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)
‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

Source

Inhaled corticosteroids for children: adverse effects

Local adverse effects
Hoarseness and pharyngeal candidiasis are not commonly reported among preschool children or school-aged children talking inhaled corticosteroids.1, 3, 51

Topical effects can be reduced by use of spacer devices (which reduce oropharyngeal deposition), and by mouth-rinsing and spitting after use.3 Immediate quick mouth-rinsing removes more residual medicine in the mouth than delayed rinsing.52

There is limited evidence that inhaled asthma medication can affect dental health.3, 53 Mouth rinsing might reduce this risk.

Systemic adverse effects
Systemic effects of inhaled corticosteroids in children depend on the dose, but clinically significant adverse effects are uncommon.3 The use of spacers and mouth rinsing will not reduce systemic effects, but the use of a spacer may increase efficacy so that a lower dose is required.

Growth
Short-term suppression of linear growth has been demonstrated in children taking inhaled corticosteroids.54,55 The effect seems to be maximal during the first year of therapy and only one study has reported an effect in subsequent years of treatment.55 A Cochrane systematic review concluded that regular use of inhaled corticosteroid at low or medium daily doses is associated with a mean reduction of 0.48 cm per year in linear growth velocity and 0.61 cm less gain in height during 1 year of treatment in children with mild to moderate persistent asthma.55

One study of patients who participated in a clinical trial of inhaled corticosteroids as children, reported a reduction in adult height of approximately 1 cm,54, 56, 57, 58 whereas several studies have reported that children taking inhaled corticosteroids attained normal adult height.59, 60, 61

The effect is dose-dependent57,58 and may be more likely in children who begin inhaled corticosteroid treatment before age 10.56

Other factors affect growth in children with asthma. Uncontrolled asthma itself reduces growth and final adult height.60 One study found that inhaled corticosteroid equivalent to budesonide 400 microg/day affected growth less than low socioeconomic status.61

Bone density
Inhaled corticosteroids have not been associated with effects on bone density or fractures in children.3 However, data from a recent study in Australia suggested asthma itself is associated with increased incidence of fractures in children, independent of medication.62

Given that the total dose of corticosteroids (both inhaled corticosteroids and oral corticosteroids) influences bone health, the aim of
Asthma management is to maintain symptom control using the lowest inhaled corticosteroid dose required, and to avoid repeated courses of oral corticosteroids.

**Adrenal suppression**

Biochemical testing in a research setting suggests that hypothalamic–pituitary–adrenal axis suppression may occur in up to two-thirds of children treated with inhaled corticosteroids, and may occur at even low doses. The risk is higher among children receiving concomitant intranasal steroids and those with lower body mass index, and is influenced by genetics.

Clinical adrenal insufficiency in children taking inhaled corticosteroids is rare but has been reported, including cases in Australia. Most cases have involved children given more than 500 microg per day fluticasone propionate.

Adrenal suppression is associated with hypoglycaemia, hypotension, weakness, failure to grow, and is potentially fatal. Hypothalamic–pituitary–adrenal axis suppression may not be detected until adrenal crisis is precipitated by physical stress.

Written information (e.g. a steroid alert card) can be prepared for children receiving long-term high-dose inhaled corticosteroids. Parents/carers can be instructed to present the card if the child ever needs to go to the emergency department (for any reason) or be admitted to hospital. A steroid alert card should state that child has asthma and the inhaled corticosteroid dose. A medical alert bracelet could also be considered.

There are no nationally accepted protocols for routine assessment of adrenal function in primary care because it has not yet been possible to identify precisely which children should be tested, to interpret test results reliably, to identify the appropriate interval for retesting, and because a clinical benefit has not been clearly demonstrated.

Regular monitoring of height might help detect adrenal suppression, based on the findings of a study in which a reduction in linear growth velocity occurred before adrenal suppression.

### Table. Definitions of ICS dose levels in children

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† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)

‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

**Source**


Last reviewed version 2.0

Asset ID: 21


Last reviewed version 2.0

**Montelukast for children: efficacy**

- Montelukast use has been associated with behavioural and/or neuropsychiatric adverse effects, including suicidality.

▸ Go to: [TGA alert](http://www.tga.gov.au/alert)
Overview
Montelukast is a leukotriene receptor antagonist preventer. It is registered by the TGA for the treatment of asthma in children aged 2 years and older, and for the symptomatic treatment of allergic rhinitis. Montelukast can be used as an alternative to inhaled corticosteroids or as an add-on treatment in a child already taking regular inhaled corticosteroids.

However, it is not effective for all children. Overall, only approximately 20–30% of children will respond to montelukast treatment. The effect is thought to depend mainly on the child’s genotype. Clinically, it is not possible to predict accurately which children will benefit most from montelukast treatment.

Montelukast as first-line preventer in children aged 2–5 years

Viral-induced wheezing
Overall, regular maintenance montelukast treatment does not reduce the risk of wheezing episodes requiring oral corticosteroid treatment among preschool children who only have wheezing episodes when they have viral upper respiratory tract infections. However, montelukast may be effective for some children. Some randomised controlled trials have reported a reduction the risk of flare-ups in preschool children with intermittent asthma/wheeze, while others have not.

Persistent asthma or wheezing
A systematic review comparing montelukast with inhaled corticosteroids in preschoolers with asthma or recurrent wheezing requiring daily preventer treatment reported that inhaled corticosteroids appeared to achieve better symptom control and reduce flare-ups (including severe flare-ups requiring treatment with systemic corticosteroids). However, results were inconsistent and meta-analysis was not possible due to heterogeneity of outcomes measured in available clinical trials.

Some preschool children with persistent asthma/wheeze respond to montelukast. A crossover study in preschool children with persistent asthma/wheeze reported that some children showed their best response to montelukast, while most responded better to regular inhaled corticosteroids.5 Predictors of a better response to inhaled corticosteroids than montelukast were aeroallergen hypersensitivity and blood eosinophilia (eosinophil counts ≥ 300/μL).5 However, routine blood eosinophil count is not feasible or recommended for this purpose.

Montelukast as first-line preventer children aged 6 years and over
In school-aged children with persistent asthma, inhaled corticosteroids are more effective overall than montelukast in improving lung function and controlling asthma symptoms. However, symptoms will respond to a treatment trial of montelukast in approximately one-quarter to one-third of children, and some may benefit more than from an inhaled corticosteroid. More severe asthma and markers of allergic inflammation may predict a better response to inhaled corticosteroids.

Montelukast as add-on treatment
A systematic review of studies in children over 6 years and adolescents with mild-to-moderate persistent asthma found that the addition of montelukast to inhaled corticosteroids did reduce flare-ups requiring oral corticosteroids or hospital admissions for asthma, compared with the same or an increased dose. In a study comparing step-up treatments in children with asthma symptoms uncontrolled by low-dose inhaled corticosteroids, the addition of a long-acting beta2 agonist was effective in more children than either montelukast or increasing the dose of inhaled corticosteroid for controlling asthma symptoms and preventing flare-ups requiring systemic corticosteroids. However, some studies in school-aged children with persistent asthma already taking regular inhaled corticosteroids have reported that add-on montelukast reduced the risk of flare-ups and exercise-induced asthma symptoms. Not all children will respond.

In a small study in children with persistent asthma already taking regular inhaled corticosteroids who were homozygous for the Arg16 genotype, montelukast was more effective as an add-on therapy than long-acting beta2 agonist in reducing symptoms, reliever use and days absent from school due to asthma, depending on the child’s beta receptor genotype. However, children were given inhaled corticosteroid and long-acting beta2 agonists in separate inhalers, which is known to be associated with increased risks.

However, genotyping is not currently feasible in clinical practice. In practice, a treatment trial of 4–6 weeks can determine which preventer is suitable for controlling a child’s asthma symptoms, but longer treatment may be required to evaluate effect on flare-ups, because flare-ups may be independent of symptom control.

Exercise-induced symptoms
In school-aged children who experience exercise-induced symptoms despite taking regular inhaled corticosteroids, the addition of montelukast is effective in controlling symptoms, but not all children experience a response.

See: Investigation and management of exercise-induced bronchoconstriction
Short-term use in the management of flare-ups

Some, but not all studies suggest that a short course of montelukast, introduced at the first signs of an upper respiratory tract infection, may be effective in controlling flare-ups. An Australian study reported that this strategy could achieve a small reduction in symptoms, school absence and medical consultations in preschool and school-aged children with episodic wheeze.85

However, the evidence is inconsistent, with some studies showing no benefit.76,86, 87, 88, 7 The findings of one study suggested that whether or not intermittent montelukast is effective in wheezing children aged 5 years and under depends on genotype.72

Montelukast is not TGA-approved or PBS-subsidised for intermittent use.

Note: PBS status as at March 2019: Montelukast is not subsidised by the PBS for adolescents 15 years and over.

Montelukast for children: behavioural and/or neuropsychiatric adverse effects

Montelukast is generally very well tolerated. Behavioural and psychiatric adverse effects were rare in clinical trials.89, 90 However, post-marketing surveillance reports have identified behavioural and/or neuropsychiatric adverse effects associated with montelukast use in some children.13

Behavioural treatment-associated effects are difficult to assess in young children. No factors have been identified to predict which children are at risk.

Reported adverse events include nightmares, sleep disturbance, anxiety, irritability, aggression and depression.13, 91, 11,12

Suicidal ideation has been reported in adolescents and adults taking montelukast.12 A nested case-control study concluded that children with asthma aged 5–18 years taking leukotriene receptor antagonists were not at increased risk of suicide attempts.93

Reported adverse effects are usually mild.11 The majority occur within 7–14 days of starting montelukast.13, 11 but some may appear after several months.12

Behavioural and/or neuropsychiatric adverse effects typically disappear within 4 days of stopping montelukast treatment.11 There is no evidence of long term effects.

The TGA recommends that clinicians treating children with montelukast should educate caregivers about these potential adverse effects and should consider providing them with the CMI. Advise them to seek medical advice if they have any concerns.

Go to: TGA's 2018 safety review of montelukast

‘Wheeze-detecting’ devices

Some hand-held devices and smart phone applications are marketed for detecting and measuring wheeze by audio recording and analysis.

There is not enough evidence to recommend these devices and apps for use in monitoring asthma symptoms or asthma control in adults or children, or in distinguishing wheeze from other airway sounds in children.

- Reliance on these devices could result in over- or under-treatment.

References


87. Capsomidas, A., Tighe, M., Archimedes. Question 2. Is oral montelukast beneficial in treating acute asthma exacerbations in
Other regular treatments in children aged 1–5 years

Recommendations

Cromones can be considered for children who are unable to tolerate montelukast or where a nonsteroidal treatment option is preferred.

For children aged 1-2 years, sodium cromoglycate can be considered.

For children 2 years and older, sodium cromoglycate or nedocromil can be considered.

Note: Cromone inhaler device mouthpieces require meticulous daily washing to avoid blocking.

How this recommendation was developed

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

Last reviewed version 2.0

Inhaled corticosteroid/long-acting beta$_2$ agonist combinations are not recommended for children aged 5 years and under, unless on the advice of a paediatric physician or paediatrician.

Note: The combination of fluticasone propionate and salmeterol xinafoate in a single inhaler is approved by TGA for use in children aged 4 years and over. Other inhaled corticosteroid/long-acting beta$_2$ agonist combinations are not recommended for children younger than 12 years.

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$^1$

Last reviewed version 2.0

Regular treatment with a theophyllines (aminophylline or theophylline) is not recommended for children aged 5 years and under.

How this recommendation was developed

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

• Brand et al. 2008$^2$

Last reviewed version 2.0

Ipratropium is not recommended for the regular management of asthma in children aged 5 years and under.

Note: Ipratropium is used in the management of acute asthma.

How this recommendation was developed

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

• Brand et al. 2008$^2$
More information

Cromones for children

0-5 years
Few clinical trials have assessed the use of inhaled sodium cromoglycate in preschool children and none have assessed nedocromil.2 Overall, sodium cromoglycate has not been shown to be effective in preschool children with multiple-trigger wheeze.2, 3 However, cromones are well tolerated and registered for use in infants. Therefore, a treatment trial can be considered before considering other preventers, particularly for children less than 2 years old.

6 years and over
Cromones are rarely prescribed in school-aged children. Inhaled sodium cromoglycate might be effective in school-aged children, but interpretations of available evidence are inconsistent.1 Sodium cromoglycate is less effective than inhaled corticosteroid in achieving asthma control and improving lung function in children with persistent asthma.4
Nedocromil sodium appears to be have some benefit in children with persistent asthma, but its relative effectiveness compared with inhaled corticosteroids is not clear.5 Long-term (4–6 years) treatment with budesonide achieved better asthma control than long-term nedocromil in children with mild-to-moderate asthma aged 5–12 in a randomised placebo-controlled clinical trial.6

Practical issues
Cromones (sodium cromoglycate and nedocromil) may not be practical for most patients, because they require three–four times daily dosing until control is gained, and inhaler devices for cromones tend to block easily unless the mouthpiece is washed every day and dried for 24 hours before re-use.1 Nedocromil can cause an unusual or unpleasant taste7 and is not tolerated by some children.

Inhaled corticosteroid/long-acting beta-2 agonist combinations for children aged 4–11 years
The combination of salmeterol plus fluticasone propionate in a single inhaler is TGA-registered for use in children 4 years and older.

Efficacy
A very large (n=6208) randomised controlled trial in children aged 4–11 years reported that, unlike in adults, the combination of inhaled corticosteroid and long-acting beta2 agonist was not associated with a significant reduction in severe flare-ups, compared with inhaled corticosteroid alone.8 Combination treatment was not associated with an increase in in symptom-free days or a reduction in reliever use, compared with inhaled corticosteroid alone.8

Safety
Clinical response to long-acting beta2 agonists partly depends on genetics. A beta2 receptor genotype (Arg16 polymorphism in the beta2 receptor gene) pre-disposes children with asthma to down-regulation of the beta2 receptor and increased susceptibility to flare-ups during regular treatment with regular long-acting beta2 agonists.9, 10 However, routine genetic testing to tailor asthma therapy is not yet available in clinical practice.

Earlier systematic reviews and meta-analyses led to concern about the possibility that the use of long-acting beta-agonists (even in combination with inhaled corticosteroids) might even increase the risk of flare-ups that require treatment with oral steroids or hospital admission, or of severe flare-ups.1, 11, 12 A meta-analysis commissioned by the US Food and Drug Administration found that the use of long-acting beta2 agonists was associated with increased risk of severe asthma-associated adverse events (both overall and among the subset of people using concomitant inhaled corticosteroid and long-acting beta2 agonist), and that this risk was greatest in children aged 4–11 years.12 However, the increased risk was only seen in studies where inhaled corticosteroid was not provided, or where inhaled corticosteroid and long-acting beta2 agonist were not combined in a single inhaler (i.e. where there was the possibility of selective non-adherence to the inhaled corticosteroid).

The PBAC Post-market review of medicines used to treat asthma in children13 concluded that there was insufficient evidence to ascertain whether tolerance to long-acting beta2 agonist could explain why it is less effective than montelukast and inhaled corticosteroids in managing exercise-induced asthma symptoms.13
A very large randomised controlled trial of children aged 4–11 years, stratified by asthma symptom control and pre-study treatment, found no increased risk of serious adverse outcomes with combination fluticasone propionate and salmeterol in a single inhaler, compared with fluticasone propionate alone. Subsequent to the publication of this and similar studies in adults, regulators in the USA and Australia removed previous ‘black box’ warnings from combination inhaled corticosteroid–long-acting beta2 agonist products for asthma.

PBS status as at March 2019: All formulations that contain a combination of inhaled corticosteroid plus long-acting beta2 agonist are listed as ‘Authority required - streamlined’. Patient using these combinations for asthma must have previously had frequent episodes of asthma while receiving treatment with oral corticosteroids or optimal doses of inhaled corticosteroids.

Last reviewed version 2.0

References

Reviewing initial treatment in children aged 1–5 years

Recommendations

When prescribing any preventer medicine for a child, consider each adjustment to the regimen as a treatment trial: monitor response continually, review within 4–6 weeks (or earlier as needed in response to parents' concerns), and adjust treatment according to response.

Table. Reviewing and adjusting preventer treatment for children aged 1–5 years
Please view and print this figure separately: http://www.asthmahandbook.org.au/table/show/25

Figure. Stepped approach to adjusting asthma medication in children aged 1-5 years
Please view and print this figure separately: http://www.asthmahandbook.org.au/figure/show/18

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).
Last reviewed version 2.0

If symptoms are not controlled during treatment with a preventer (despite good adherence and correct inhaler technique), consider whether they may be due to comorbidity or an alternative diagnosis such as rhinosinusitis or suppurative lung disease.

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).
Last reviewed version 2.0

If treatment-related behavioural and/or neuropsychiatric symptoms are suspected in a child taking montelukast, discontinue treatment and advise parents/carers to monitor and treat asthma symptoms with reliever while off preventer treatment.

If unsure whether a change in behaviour could be due to medication or normal for age, consider stopping for a short time (e.g. 1 week or more) and re-starting to monitor effects.

Go to: TGA alert

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).
Last reviewed version 2.0

If parents/carers report behavioural changes possibly related to treatment in a child taking regular inhaled corticosteroids, consider reducing the dose, changing to a different corticosteroid and monitoring effect, or trialling a different preventer.
If cough is the predominant symptom, carefully reassess the diagnosis before changing treatment. Do not use inhaled corticosteroids specifically for cough. Refer to national guidelines for diagnosis and management of cough.

► Go to: Australian Cough Guidelines

How this recommendation was developed
Adapted from existing guidance
Based on reliable clinical practice guideline(s) or position statement(s):
- Gibson et al. 2010
- van Asperen et al. 2010

Last reviewed version 2.0

More information

Classification of recent asthma symptom control in children
Ongoing review of asthma involves both assessing recent asthma symptom control and assessing risks for poor asthma outcomes such as flare-ups and adverse effects of medicines.
Recent asthma symptom control is assessed according to the frequency of asthma symptoms over the previous 4 weeks.

Table. Definition of levels of recent asthma symptom control in children (regardless of current treatment regimen)

<table>
<thead>
<tr>
<th>Good control</th>
<th>Partial control</th>
<th>Poor control</th>
</tr>
</thead>
<tbody>
<tr>
<td>All of:</td>
<td>Any of:</td>
<td>Either of:</td>
</tr>
<tr>
<td>- Daytime symptoms† ≤ 2 days per week (lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)</td>
<td>- Daytime symptoms† &gt; 2 days per week (lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)</td>
<td>- Daytime symptoms† &gt; 2 days per week (lasting from minutes to hours or recurring, and partially or fully relieved by SABA reliever)</td>
</tr>
<tr>
<td>- No limitation of activities‡</td>
<td>- Any limitation of activities*</td>
<td>- ≥ 3 features of partial control within the same week</td>
</tr>
<tr>
<td>- No symptoms§ during night or when wakes up</td>
<td>- Any symptoms during night or when wakes up††</td>
<td></td>
</tr>
<tr>
<td>- Need for SABA reliever# ≤ 2 days per week</td>
<td>- Need for SABA reliever# &gt; 2 days per week</td>
<td>- Need for SABA reliever# within the same week</td>
</tr>
</tbody>
</table>

SABA: short-acting beta₂ agonist
† e.g. wheezing or breathing problems
‡ child is fully active; runs and plays without symptoms
§ including no coughing during sleep
# not including doses taken prophylactically before exercise. (Record this separately and take into account when assessing management.)
* e.g. wheeze or breathlessness during exercise, vigorous play or laughing
†† e.g. waking with symptoms of wheezing or breathing problems

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

Last reviewed version 2.0
Recent asthma control is based on symptoms over the previous 4 weeks. Each child’s risk factors for future asthma outcomes should also be assessed and taken into account in management.

Vali**d**ated questionnaires can be used for assessing recent symptom control:
- Test for Respiratory and Asthma Control in Kids (TRACK) for children < 5 years
- Childhood Asthma Control Test (C-ACT) for children aged 4–11 years

<table>
<thead>
<tr>
<th>Table. Risk factors for life-threatening asthma flare-ups in children</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asthma-related factors</strong></td>
</tr>
<tr>
<td>Poor asthma control</td>
</tr>
<tr>
<td>Admission to hospital in preceding 12 months</td>
</tr>
<tr>
<td>History of intubation for acute asthma</td>
</tr>
<tr>
<td>Over-use of short-acting beta2 agonist reliever</td>
</tr>
<tr>
<td>Abnormal spirometry findings</td>
</tr>
<tr>
<td>Reversible expiratory air flow limitation on spirometry despite treatment</td>
</tr>
<tr>
<td>Poor adherence to preventer</td>
</tr>
<tr>
<td>Incorrect inhaler technique for preventer</td>
</tr>
<tr>
<td>Poor adherence to asthma action plan</td>
</tr>
<tr>
<td>Exposure to clinically relevant allergens</td>
</tr>
<tr>
<td>Exposure to tobacco smoke</td>
</tr>
<tr>
<td><strong>Other clinical factors</strong></td>
</tr>
<tr>
<td>Allergies to foods, insects, medicines</td>
</tr>
<tr>
<td>Obesity</td>
</tr>
<tr>
<td><strong>Family-related factors</strong></td>
</tr>
<tr>
<td>Frequent failure to attend consultations/lack of follow-up after an acute flare-up</td>
</tr>
<tr>
<td>Significant parental psychological or socioeconomic problems</td>
</tr>
<tr>
<td>Parent/carer unequipped to manage asthma emergency</td>
</tr>
</tbody>
</table>

Montelukast for children: behavioural and/or neuropsychiatric adverse effects

Montelukast is generally very well tolerated. Behavioural and psychiatric adverse effects were rare in clinical trials. However, post-marketing surveillance reports have identified behavioural and/or neuropsychiatric adverse effects associated with montelukast use in some children. Behavioural treatment-associated effects are difficult to assess in young children. No factors have been identified to predict which children are at risk.

Reported adverse events include nightmares, sleep disturbance, anxiety, irritability, aggression and depression. Suicidal ideation has been reported in adolescents and adults taking montelukast. A nested case-control study concluded that children with asthma aged 5–18 years taking leukotriene receptor antagonists were not at increased risk of suicide attempts.

Reported adverse effects are usually mild. The majority occur within 7–14 days of starting montelukast, but some may appear after several months.

Behavioural and/or neuropsychiatric adverse effects typically disappear within 4 days of stopping montelukast treatment. There is no evidence of long term effects.

The TGA recommends that clinicians treating children with montelukast should educate caregivers about these potential adverse
Inhaled corticosteroids for children: adverse effects

Local adverse effects

Hoarseness and pharyngeal candidiasis are not commonly reported among preschool children or school-aged children talking inhaled corticosteroids.\(^1\),\(^2\),\(^12\)

Topical effects can be reduced by use of spacer devices (which reduce oropharyngeal deposition), and by mouth-rinsing and spitting after use.\(^2\) Immediate quick mouth-rinsing removes more residual medicine in the mouth than delayed rinsing.\(^13\)

There is limited evidence that inhaled asthma medication can affect dental health.\(^2\),\(^14\) Mouth rinsing might reduce this risk.

Systemic adverse effects

Systemic effects of inhaled corticosteroids in children depend on the dose, but clinically significant adverse effects are uncommon.\(^2\)

The use of spacers and mouth rinsing will not reduce systemic effects, but the use of a spacer may increase efficacy so that a lower dose is required.

Growth

Short-term suppression of linear growth has been demonstrated in children taking inhaled corticosteroids.\(^15\),\(^16\) The effect seems to be maximal during the first year of therapy and only one study has reported an effect in subsequent years of treatment.\(^16\) A Cochrane systematic review concluded that regular use of inhaled corticosteroid at low or medium daily doses is associated with a mean reduction of 0.48 cm per year in linear growth velocity and 0.61 cm less gain in height during 1 year of treatment in children with mild to moderate persistent asthma.\(^16\)

One study of patients who participated in a clinical trial of inhaled corticosteroids as children, reported a reduction in adult height of approximately 1 cm,\(^15\),\(^17\),\(^18\),\(^19\) whereas several studies have reported that children taking inhaled corticosteroids attained normal adult height.\(^20\),\(^21\),\(^22\)

The effect is dose-dependent\(^18\),\(^19\) and may be more likely in children who begin inhaled corticosteroid treatment before age 10.\(^17\)

Other factors affect growth in children with asthma. Uncontrolled asthma itself reduces growth and final adult height.\(^21\) One study found that inhaled corticosteroid equivalent to budesonide 400 microg/day affected growth less than low socioeconomic status.\(^22\)

Bone density

Inhaled corticosteroids have not been associated with effects on bone density or fractures in children.\(^2\) However, data from a recent study in Australia suggested asthma itself is associated with increased incidence of fractures in children, independent of medication.\(^23\)

Given that the total dose of corticosteroids (both inhaled corticosteroids and oral corticosteroids) influences bone health, the aim of asthma management is to maintain symptom control using the lowest inhaled corticosteroid dose required, and to avoid repeated courses of oral corticosteroids.

Adrenal suppression

Biochemical testing in a research setting suggests that hypothalamic–pituitary–adrenal axis suppression may occur in up to two-thirds of children treated with inhaled corticosteroids, and may occur at even low doses.\(^24\) The risk is higher among children receiving concomitant intranasal steroids and those with lower body mass index,\(^24\) and is influenced by genetics.\(^25\)

Clinical adrenal insufficiency in children taking inhaled corticosteroids is rare but has been reported,\(^26\),\(^27\),\(^28\) including cases in Australia.\(^28\) Most cases have involved children given more than 500 microg per day fluticasone propionate.\(^26\)

Adrenal suppression is associated with hypoglycaemia, hypotension, weakness, failure to grow, and is potentially fatal. Hypothalamic–pituitary–adrenal axis suppression may not be detected until adrenal crisis is precipitated by physical stress.\(^29\)

Written information (e.g. a steroid alert card) can be prepared for children receiving long-term high-dose inhaled corticosteroids. Parents/carers can be instructed to present the card if the child ever needs to go to the emergency department (for any reason) or be admitted to hospital. A steroid alert card should state that child has asthma and the inhaled corticosteroid dose. A medical alert bracelet could also be considered.

There are no nationally accepted protocols for routine assessment of adrenal function in primary care because it has not yet been possible to identify precisely which children should be tested, to interpret test results reliably, to identify the appropriate interval for retesting, and because a clinical benefit has not been clearly demonstrated.

Regular monitoring of height might help detect adrenal suppression, based on the findings of a study in which a reduction in linear
growth velocity occurred before adrenal suppression.30

Table. Definitions of ICS dose levels in children

<table>
<thead>
<tr>
<th>Inhaled corticosteroid</th>
<th>Daily dose (microg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Beclometasone dipropionate †</td>
<td>100–200</td>
</tr>
<tr>
<td>Budesonide</td>
<td>200–400</td>
</tr>
<tr>
<td>Ciclesonide ‡</td>
<td>80–160</td>
</tr>
<tr>
<td>Fluticasone propionate</td>
<td>100–200</td>
</tr>
</tbody>
</table>

† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)
‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

Source
van Asperen PP, Mellis CM, Sly PD, Robertson C. The role of corticosteroids in the management of childhood asthma. The Thoracic Society of Australia and New Zealand, 2010. Available from:

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Administration of inhaled medicines in children: 1-5 years
To use inhaler devices correctly, parents and children need training in inhaler technique and in the care and cleaning of inhalers and spacers.

Children need careful supervision when taking their inhaled medicines (e.g. at preschool), especially when using a reliever for acute asthma symptoms.

Types of inhalers suitable for preschool children
Preschool children cannot use pressurised metered-dose inhalers properly unless a spacer is attached (with mask when necessary), because it is difficult for them to coordinate inspiratory effort with actuating the device.11 Note that breath-actuated pressurised metered-dose inhalers cannot be used with a spacer.

Dry-powder inhalers are usually ineffective for preschool children because they cannot generate sufficient inspiratory airflow.11 Drug delivery is very variable in young children with any type of inhaler, including pressurised metered dose inhalers and spacers.31 Filter studies have shown high day-to-day variability in delivered doses in preschool children.11 This variation might explain fluctuations in effectiveness, even if the child’s parents have been trained to use the device correctly.

Table. Types of inhaler devices for delivering asthma and COPD medicines
Please view and print this figure separately: http://www.asthmahandbook.org.au/table/show/75

Pressurised metered-dose inhalers plus spacers for relievers
During acute wheezing episodes, delivery of short-acting beta2 agonist to airways is more effective with a pressurised metered-dose inhaler plus spacer than with a nebuliser.11 In older children, salbutamol has also been associated with a greater increase in heart rate when delivered by nebuliser than when delivered by pressurised metered-dose inhaler plus spacer.32

When administering salbutamol to relieve asthma symptoms in a preschool child, the standard recommendation is to shake the
inhaler, actuate one puff at a time into the spacer and have the child take 4–6 breaths in and out of the spacer (tidal breathing). Fewer breaths may suffice; in children with asthma aged 2–7 years (not tested during an acute asthma episode), the number of tidal breaths needed to inhale salbutamol adequately from a spacer has been estimated at 2 breaths for small-volume spacers, 2 breaths for a spacer made from a 500-mL modified soft drink bottle, and 3 breaths for a large (Volumatic) spacer.34

**Face masks for infants**

When using a spacer with face mask (e.g. for an infant too young or uncooperative to be able to use a mouthpiece), effective delivery of medicine to the airways depends on a tight seal around the face.

When masks are used for inhaled corticosteroids, there is a risk of exposure to eyes and skin if the seal over the mouth and nose is not adequate. Parents should be advised to wash the child's face after administering inhaled corticosteroids by mask.

Babies are unlikely to inhale enough medicine while crying. The use of a spacer and face mask for a crying infant may require patience and skill: the child can be comforted (e.g. held by a parent, in own pram, or sitting on the floor) while the mask is kept on, and the actuation carefully timed just before the next intake of breath. Most infants will tolerate the spacer and mask eventually. The child may be more likely to accept the spacer and mask if allowed to handle them first (and at other times), if the devices are personalised (e.g. with stickers), or if the mask has a scent associated with the mother (e.g. lip gloss). The use of a spacer with a coloured valve allows parents to see the valve move as the child breathes in and out.

► Go to: National Asthma Council Australia's information paper for health professionals on [Inhaler technique for people with asthma or COPD](#)

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**Correct use of inhaler devices**

Checking and correcting inhaler technique is essential to effective asthma management.

Most patients with asthma or COPD do not use their inhalers properly, and most have not had their technique checked or corrected by a health professional.

Incorrect inhaler technique when using maintenance treatments increases the risk of severe flare-ups and hospitalisation for people with asthma or COPD.

Poor asthma symptom control is often due to incorrect inhaler technique. Incorrect inhaler technique when using inhaled corticosteroids increases the risk of local side effects like dysphonia and oral thrush.

The steps for using an inhaler device correctly differ between brands. Checklists of correct steps for each inhaler type and how-to videos are available from the National Asthma Council website.

► Go to: National Asthma Council Australia's [Using your inhaler](#) webpage for information, patient resources and videos on inhaler technique

► Go to: National Asthma Council Australia's information paper for health professionals on [Inhaler technique for people with asthma or COPD](#)

► Go to: NPS MedicineWise information on [Inhaler devices for respiratory medicines](#)

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**Step-up options in children with asthma that is not controlled by low-dose inhaled corticosteroids**

In children whose asthma is inadequately controlled by low-dose inhaled corticosteroids alone (and adherence is good, inhaler technique is correct and diagnosis has been confirmed), treatment options include:

- increasing the inhaled corticosteroid dose
- adding montelukast
- switching to inhaled corticosteroid/long-acting beta2 agonist combination.

<table>
<thead>
<tr>
<th>Option</th>
<th>TGA-registered indications for add-on therapy</th>
<th>PBS considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-dose ICS</td>
<td>N/A</td>
<td>Subsidised</td>
</tr>
</tbody>
</table>

**Table. Step-up options for children when good asthma control is not achieved with low-dose ICS**
**Option** | **TGA-registered indications for add-on therapy** | **PBS considerations**
---|---|---
*ICS plus montelukast* | 2 years and over | 2–5 years: not subsidised*  
6–14 years: not subsidised unless for exercise-induced bronchoconstriction despite ICS treatment†  
15 years and over: not subsidised‡

*ICS/long-acting beta₂ agonist combination* | 4 years and over for fluticasone propionate/salmeterol xinafoate  
12 years and over for budesonide/formoterol fumarate dihydrate | Subsidised

- Advise parents about potential adverse psychiatric effects of montelukast

* Montelukast is not subsidised for use in combination with other preventers or for children who require inhaled corticosteroids.
† Montelukast is subsidised for prevention of exercise-induced asthma if asthma is otherwise well controlled while taking optimal-dose inhaled corticosteroids – it is not otherwise subsidised in combination with inhaled corticosteroids (or inhaled corticosteroid/long-acting beta₂ agonist combinations).
‡ Montelukast is not subsidised for people aged over 15 years.

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In the majority of children with persistent asthma that requires preventive treatment, control can be achieved with one of these options.²

Few studies have been conducted in preschool-aged children. The preferred step-up option for children aged 6–12 years is controversial and guidelines differ in their recommendations.⁴⁵

**Increasing inhaled corticosteroid dose versus adding a long-acting beta₂ agonist**

In school-aged children with persistent asthma taking regular inhaled corticosteroid, the addition of a long-acting beta₂ agonist does not reduce the rate of asthma flare-ups requiring systemic steroids compared with the same or higher doses of inhaled corticosteroid.⁴⁶,⁴⁷ However, the long-acting beta₂ agonist–inhaled corticosteroid was superior for improving lung function.⁴⁶ Growth is reduced in children treated with higher-dose inhaled corticosteroid, compared with those taking same dose plus a long-acting beta₂ agonist.⁴⁶

Adolescents may benefit more from combination inhaled corticosteroid/long-acting beta₂ agonist treatment than children under 12 years. In adolescents with persistent asthma that is not controlled by a low dose of inhaled corticosteroids, the combination of a long-acting beta₂ agonist and an inhaled corticosteroid is modestly more effective in reducing the risk of flare-ups requiring oral corticosteroids than a higher dose of inhaled corticosteroids.⁴⁸

**Adding montelukast versus adding a long-acting beta-2 agonist or increasing inhaled corticosteroid dose**

**Children aged 1–5 years**

In one study in children aged 5 years or less with persistent asthma/wheeze requiring preventer treatment, raised blood eosinophil levels and atopy predicted better short-term response to high-dose inhaled corticosteroid than to montelukast.⁴⁹ However, routine eosinophil counts are currently not recommended to guide treatment in children.

In children aged 1–5 years with asthma/wheeze that is not adequately controlled by low-dose inhaled corticosteroid alone, adding montelukast is preferable to increasing the dose of inhaled corticosteroids when the safety profiles of these options are compared.⁵⁰ Long-acting beta₂ agonists are not recommended for this age group.

- Montelukast use has been associated with behavioural and/or neuropsychiatric adverse effects.

Go to: [TGA alert](#)

Note: Montelukast is TGA-approved for children aged 2 years and over.
Children aged 6 years and over

Among children 6 years and over with asthma that is not controlled by low-dose inhaled corticosteroids, the optimal regimen varies between individuals. In one study of children selected for high adherence with maintenance treatment, short-term responses varied between individuals: in some children the best response was achieved by adding a long-acting beta2 agonist, in others by adding montelukast, and in others by increasing the dose of inhaled corticosteroid.

Note: The use of inhaled corticosteroids and long-acting beta2 agonists in separate inhalers is not recommended for either children or adults because of the potential for increased risk due to selective non-adherence to the inhaled corticosteroid.

Overall, the addition of montelukast to an inhaled corticosteroid does not reduce the need for rescue oral corticosteroids or hospital admission, compared with the same or an increased dose of inhaled corticosteroids, in children aged 6 years and over or adolescents with mild-to-moderate asthma.

For children aged 6–14 years with persistent asthma and exercise-induced bronchoconstriction, adding montelukast is more effective in protecting against exercise-induced bronchoconstriction than switching to a combination of inhaled corticosteroid and a long-acting beta2 agonist. The use of montelukast also avoids beta-receptor tolerance associated with long-acting beta2 agonists, so a short-acting beta2 agonist taken after exercise produces a greater bronchodilator response than it does in children taking regular long-acting beta2 agonist.

A treatment trial of montelukast for 4–6 weeks is the best option when effects on exercise-induced symptoms and safety are also considered.

- Montelukast use has been associated with behavioural and/or neuropsychiatric adverse effects.

Genetic influence on effect of long-acting beta2 agonists

Clinical response to long-acting beta2 agonists partly depends on genetics. A beta2-receptor genotype (Arg16 polymorphism in the beta2 receptor gene) pre-disposes children with asthma to down-regulation of the beta2 receptor and increased susceptibility to flare-ups during regular treatment with regular long-acting beta2 agonists. However, routine genetic testing to tailor asthma therapy is not yet available in clinical practice.

Montelukast use has been associated with behavioural and/or neuropsychiatric adverse effects, including suicidality.

Overview

Montelukast is a leukotriene receptor antagonist preventer. It is registered by the TGA for the treatment of asthma in children aged 2 years and older, and for the symptomatic treatment of allergic rhinitis. Montelukast can be used as an alternative to inhaled corticosteroids or as an add-on treatment in a child already taking regular inhaled corticosteroids. However, it is not effective for all children. Overall, only approximately 20–30% of children will respond to montelukast treatment. The effect is thought to depend mainly on the child's genotype. Clinically, it is not possible to predict accurately which children will benefit most from montelukast treatment.

Montelukast as first-line preventer in children aged 2–5 years

Viral-induced wheezing

Overall, regular maintenance montelukast treatment does not reduce the risk of wheezing episodes requiring oral corticosteroid treatment among preschool children who only have wheezing episodes when they have viral upper respiratory tract infections.

However, montelukast may be effective for some children. Some randomised controlled trials have reported a reduction the risk of flare-ups in preschool children with intermittent asthma/wheeze, while others have not.

Persistent asthma or wheezing

A systematic review comparing montelukast with inhaled corticosteroids in preschoolers with asthma or recurrent wheezing requiring...
daily preventer treatment\textsuperscript{63} reported that inhaled corticosteroids appeared to achieve better symptom control and reduce flare-ups (including severe flare-ups requiring treatment with systemic corticosteroids). However, results were inconsistent and meta-analysis was not possible due to heterogeneity of outcomes measured in available clinical trials.\textsuperscript{63}

Some preschool children with persistent asthma/wheeze respond to montelukast. A crossover study in preschool children with persistent asthma/wheeze reported that some children showed their best response to montelukast, while most responded better to regular inhaled corticosteroids.\textsuperscript{49} Predictors of a better response to inhaled corticosteroids than montelukast were aeroallergen hypersensitivity and blood eosinophilia (eosinophil counts \(\geq 300/\mu\text{L}\)).\textsuperscript{49} However, routine blood eosinophil count is not feasible or recommended for this purpose.

**Montelukast as first-line preventer children aged 6 years and over**

In school-aged children with persistent asthma, inhaled corticosteroids are more effective overall than montelukast in improving lung function and controlling asthma symptoms.\textsuperscript{64, 53}

However, symptoms will respond to a treatment trial of montelukast in approximately one-quarter to one-third of children,\textsuperscript{64, 65, 66} and some may benefit more than from an inhaled corticosteroid.\textsuperscript{64} More severe asthma and markers of allergic inflammation may predict a better response to inhaled corticosteroids.\textsuperscript{64}

**Montelukast as add-on treatment**

A systematic review of studies in children over 6 years and adolescents with mild-to-moderate persistent asthma found that the addition of montelukast to inhaled corticosteroids did reduce flare-ups requiring oral corticosteroids or hospital admissions for asthma, compared with the same or an increased dose.\textsuperscript{53}

In a study comparing step-up treatments in children with asthma symptoms uncontrolled by low-dose inhaled corticosteroids, the addition of a long-acting beta\(_2\) agonist was effective in more children than either montelukast or increasing the dose of inhaled corticosteroid for controlling asthma symptoms and preventing flare-ups requiring systemic corticosteroids.\textsuperscript{67} However, some studies in school-aged children with persistent asthma already taking regular inhaled corticosteroids have reported that add-on montelukast reduced the risk of flare-ups\textsuperscript{67, 68} and exercise-induced asthma symptoms.\textsuperscript{68} Not all children will respond.

In a small study in children with persistent asthma already taking regular inhaled corticosteroids who were homozygous for the Arg16 genotype, montelukast was more effective as an add-on therapy than long-acting beta\(_2\) agonist in reducing symptoms, reliever use and days absent from school due to asthma, depending on the child’s beta receptor genotype.\textsuperscript{55} However, children were given inhaled corticosteroid and long-acting beta\(_2\) agonists in separate inhalers, which is which is known to be associated with increased risks. However, genotyping it is not currently feasible in clinical practice. In practice, a treatment trial of 4–6 weeks can determine which preventer is suitable for controlling a child’s asthma symptoms,\textsuperscript{64} but longer treatment may be required to evaluate effect on flare-ups, because flare-ups may be independent of symptom control.

**Exercise-induced symptoms**

In school-aged children who experience exercise-induced symptoms despite taking regular inhaled corticosteroids, the addition of montelukast is effective in controlling symptoms, but not all children experience a response.\textsuperscript{69, 70}

See: Investigation and management of exercise-induced bronchoconstriction

**Short-term use in the management of flare-ups**

Some, but not all studies suggest that a short course of montelukast, introduced at the first signs of an upper respiratory tract infection, may be effective in controlling flare-ups. An Australian study reported that this strategy could achieve a small reduction in symptoms, school absence and medical consultations in preschool and school-aged children with episodic wheeze.\textsuperscript{71}

However, the evidence is inconsistent, with some studies showing no benefit.\textsuperscript{62, 72, 73, 74, 75} The findings of one study suggested that whether or not intermittent montelukast is effective in wheezing children aged 5 years and under depends on genotype.\textsuperscript{58}

Montelukast is not TGA-approved or PBS-subsidised for intermittent use.

**Note:** PBS status as at March 2019: Montelukast is not subsidised by the PBS for adolescents 15 years and over.

*Last reviewed version 2.0*

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**Approaches to assessment and monitoring of asthma control in children**

Assessment of asthma control in children is based mainly on:

- recent asthma symptom control (assessed by the frequency and severity of symptoms between flare-ups)
- the degree to which asthma symptoms affect daily activities such as interference with physical activity or missed school days)
- the frequency of flare-ups
- spirometry in children who are able to perform the test reliably.
Standardised questionnaires

Questionnaire-based instruments have been validated for assessing asthma control in children:

- **Test for Respiratory and Asthma Control in Kids (TRACK)** for children less than 5 years old – consists of five questions about frequency of respiratory symptoms (wheeze, cough, shortness of breath), activity limitation, and night-time awakenings in the past 4 weeks, rescue medication use in the past 3 months, and oral corticosteroid use in the previous year.76, 77 A lower score indicates worse asthma control.
- **Childhood Asthma Control Test (C-ACT)** for children aged 4–11 years – consists of seven items: three for the parent/carer (about the child’s symptoms over the previous 4 weeks) and four for the child.78, 79 A lower score indicates worse asthma control. **Note**: C-ACT is intended for US use.

Lung function tests

Frequent spirometry to guide asthma treatment in children has not been shown to achieve superior outcomes to symptom-based treatment.80 Current evidence does not support use of home spirometers to guide asthma treatment in children.81 However, low FEV₁ predicts clinically significant flare-ups, so spirometry should be performed at asthma reviews for children who are old enough to do the test. The quality and utility of spirometry depends on the skill, clinical expertise and experience of the person doing and interpreting spirometry.

The results of one study in children aged 6–16 years with moderate atopic asthma suggest that asthma treatment guided by airway hyperresponsiveness (measured by bronchial provocation testing) may have a benefit over symptom-guided treatment in improving lung, but this effect was lost after 3–7 years of usual care.82, 83 Repeated bronchial provocation testing is not feasible in clinical practice.

Measures of airway inflammation

Measures of airway inflammation (e.g. sputum eosinophil count, exhaled nitric oxide measurement) are not recommended in primary care to guide treatment decisions, but are increasingly used in specialist clinics.

Asthma treatment guided by sputum eosinophil count has been shown to reduce the frequency of flare-ups in adults with asthma, but there is insufficient evidence to ascertain its value for children.84 Exhaled nitric oxide measurement may be useful in guiding asthma management in some children. In children not taking inhaled corticosteroid, a high nitric oxide level probably predicts a good short-term response to inhaled corticosteroid treatment,85 but it does not distinguish between asthma and eosinophilic bronchitis and is often high in children with atopy. There is insufficient evidence to ascertain whether a low exhaled nitric oxide level predicts successful withdrawal from inhaled corticosteroids without asthma relapse,85 or safety of treating asthma without inhaled corticosteroids.

A Cochrane review86 found that exhaled nitric oxide-guided management was significantly better than other approaches to adjusting medicines for reducing the number of children with flare-ups and the number of children who needed oral corticosteroids, but did not reduce the frequency of flare-ups or the rate of flare-ups requiring hospitalisation, improve lung function or symptoms scores, or reduce inhaled corticosteroid doses. The authors concluded that it could not be recommended for all children but may be beneficial for a subset not yet defined.86

Towards personalised asthma care

Emerging understanding of asthma phenotypes and of genetic factors that predict therapeutic response to preventer options is leading to the possibility of personalised, genomics-based treatment for asthma in children.87 In the near future, individual tailored therapy is may replace the standardised step model based on population data.

**Common reasons for poor response to preventer treatment**

Apparent lack of response to asthma treatment is commonly due to one or more of the following:88

- poor adherence (which may be due to lack of perceived need for the medication, concern about potential or actual side-effects, cost of medicines, a busy lifestyle, misunderstanding of the purpose and effects of asthma medicines, or inability to follow the medical instructions)
- poor inhaler technique
- mishandling devices (e.g. failure to clean spacer, allowing mouthpiece of dry-powder inhalers to become blocked)
- incorrect dose or frequency
- empty inhaler
- expired medicines
- continued exposure to smoke or allergen triggers.

Failure to identify these causes before adjusting medicines could result in over-medication with preventers.
Managing cough in children

When cough is the predominant symptom in a young child, careful assessment is needed to avoid making an incorrect diagnosis of asthma, or instigating inappropriate treatment. Cough alone (recurrent non-specific cough) is most likely due to recurrent viral bronchitis, which is unresponsive to both bronchodilators and preventive therapy including inhaled corticosteroids. Recurrent non-specific cough usually resolves by age 6 or 7 years and leaves no residual pulmonary pathology.

If cough is a problem for a child with known asthma, it should be managed according to national Cough in Children and Adults: Diagnosis and Assessment (CICADA) guidelines.1

- There are significant concerns about use of cough medicines in children.

Go to: Australian Cough Guidelines
Go to: Therapeutic Goods Administration (TGA) recommendations on the use of cough and cold medicines in children

References

44. Hardwell, A., Barber, V., Hargaden, T., et al. Technique training does not improve the ability of most patients to use pressurised metered-dose inhalers (pMDIs). Prim Care Respir J. 2011; 20: 92-6. Available from: http://www.nature.com/articles/pcrj201088
46. Chauhan BF, Charlton and Ni Chroinin M et al. Addition of long-acting beta2-agonists to inhaled corticosteroids for chronic asthma


Stepping down treatment in children aged 1–5 years

Recommendations

If symptoms have been well controlled for at least 6 months in a child taking regular inhaled corticosteroid treatment, consider reducing the dose.

Monitor symptom control within 4–6 weeks after stepping down.

Do not attempt to step down treatment at the start of the preschool year or during the child’s peak asthma season (if there is a predictable seasonal pattern).

How this recommendation was developed

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

- Brand et al. 2008
- van Asperen et al. 2010

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If symptoms have been well controlled for at least 6 months in a child taking regular treatment with a fixed-dose combination of inhaled corticosteroid–long-acting beta2 agonist, consider switching to inhaled corticosteroid only.

Monitor symptom control within 4–6 weeks after stepping down.

Do not attempt to step down treatment at the start of the preschool year or during the child’s peak asthma season (if there is a predictable seasonal pattern). Take into account previous treatment response, the result of any previous attempts to step down, and changes in the child’s environment that could affect exposure to triggers.

- Combination inhaled corticosteroid plus long-acting beta2 agonist is not recommended for children younger than 6 years.

How this recommendation was developed

Consensus recommendation following inconclusive literature search
Based on clinical experience and expert opinion after literature review yielded insufficient evidence for an evidence-based recommendation
Key evidence considered:

- Kew et al. 2015
- Rank et al. 2015

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If symptoms are well controlled for at least 6 months on the lowest available inhaled corticosteroid dose, consider stopping treatment and monitor for symptoms and flare-ups.

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
- Brand et al. 2008
Stepping down preventer treatment in children
Stepping down can be considered when asthma has been well controlled for 6 months (depending on severity of previous symptoms). This will help identify the minimal dose or regimen needed to maintain control and may minimise the risk of treatment-related adverse effects and help identify the minimal dose or regimen needed to maintain control.
Children who have stable asthma are at increased risk of a flare-up when stepping down treatment, so close monitoring is needed. Stepping down should not be attempted at the beginning of the school year.5

Stepping down from regular inhaled corticosteroid
For children already taking the lowest available dose, options are stop preventer treatment entirely, or switch to montelukast. Few studies have compared different options for stepping down.
Children may be at higher risk of a flare-up or loss of asthma control after stopping low-dose inhaled corticosteroid treatment.6, 7, 8

Stepping down from regular inhaled corticosteroid plus long-acting beta-2 agonist
Options for stepping down from regular treatment with a combination inhaled corticosteroid and long-acting beta2 agonist are to reduce the inhaled corticosteroid dose or switch to inhaled corticosteroid only (i.e. discontinue the long-acting beta2 agonist).
There is insufficient evidence from randomised trials on which to base recommendations on whether and how to discontinue long-acting beta2 agonist treatment in children once good asthma control has been achieved with the combination of inhaled corticosteroid and long-acting beta2 agonist.9
In a study of children aged 4–11 years whose asthma was well controlled while using a combination of inhaled corticosteroid and long-acting beta2-agonist, stepping down to inhaled corticosteroid monotherapy was associated with a higher rate of flare-ups than continuing on combination therapy.10
In a study of children aged 5–15 years with well-controlled asthma, halving the inhaled corticosteroid component and discontinuing the long-acting beta2 agonist had equivalent outcomes for asthma symptoms and lung function.11
In a study of children with asthma well controlled on twice-daily fluticasone propionate, switching to montelukast was associated with a higher rate of treatment failure and poorer asthma control than halving the fluticasone dose and adding salmeterol.12

Stepping down from montelukast
In children taking montelukast, treatment can be stopped abruptly.
Asthma control should be monitored and the child’s written asthma action plan updated to ensure parents/carers know how to manage symptoms.

Inhaled corticosteroids for children: adverse effects
Local adverse effects
Hoarseness and pharyngeal candidiasis are not commonly reported among preschool children or school-aged children taking inhaled corticosteroids.1, 2, 13
Topical effects can be reduced by use of spacer devices (which reduce oropharyngeal deposition), and by mouth-rinsing and spitting after use.2 Immediate quick mouth-rinsing removes more residual medicine in the mouth than delayed rinsing.14
There is limited evidence that inhaled asthma medication can affect dental health.2, 15 Mouth rinsing might reduce this risk.

Systemic adverse effects
Systemic effects of inhaled corticosteroids in children depend on the dose, but clinically significant adverse effects are uncommon.2
The use of spacers and mouth rinsing will not reduce systemic effects, but the use of a spacer may increase efficacy so that a lower dose is required.

Growth
Short-term suppression of linear growth has been demonstrated in children taking inhaled corticosteroids.16, 17 The effect seems to be
maximal during the first year of therapy and only one study has reported an effect in subsequent years of treatment. A Cochrane systematic review concluded that regular use of inhaled corticosteroid at low or medium daily doses is associated with a mean reduction of 0.48 cm per year in linear growth velocity and 0.61 cm less gain in height during 1 year of treatment in children with mild to moderate persistent asthma.

One study of patients who participated in a clinical trial of inhaled corticosteroids as children, reported a reduction in adult height of approximately 1 cm, whereas several studies have reported that children taking inhaled corticosteroids attained normal adult height.

The effect is dose-dependent and may be more likely in children who begin inhaled corticosteroid treatment before age 10. Other factors affect growth in children with asthma. Uncontrolled asthma itself reduces growth and final adult height. One study found that inhaled corticosteroid equivalent to budesonide 400 microg/day affected growth less than low socioeconomic status.

Bone density

Inhaled corticosteroids have not been associated with effects on bone density or fractures in children. However, data from a recent study in Australia suggested asthma itself is associated with increased incidence of fractures in children, independent of medication.

Given that the total dose of corticosteroids (both inhaled corticosteroids and oral corticosteroids) influences bone health, the aim of asthma management is to maintain symptom control using the lowest inhaled corticosteroid dose required, and to avoid repeated courses of oral corticosteroids.

Adrenal suppression

Biochemical testing in a research setting suggests that hypothalamic–pituitary–adrenal axis suppression may occur in up to two-thirds of children treated with inhaled corticosteroids, and may occur at even low doses. The risk is higher among children receiving concomitant intranasal steroids and those with lower body mass index, and is influenced by genetics. Clinical adrenal insufficiency in children taking inhaled corticosteroids is rare but has been reported, including cases in Australia. Most cases have involved children given more than 500 microg per day fluticasone propionate.

Adrenal suppression is associated with hypoglycaemia, hypotension, weakness, failure to grow, and is potentially fatal. Hypothalamic–pituitary–adrenal axis suppression may not be detected until adrenal crisis is precipitated by physical stress. Written information (e.g. a steroid alert card) can be prepared for children receiving long-term high-dose inhaled corticosteroids. Parents/carers can be instructed to present the card if the child ever needs to go to the emergency department (for any reason) or be admitted to hospital. A steroid alert card should state that child has asthma and the inhaled corticosteroid dose. A medical alert bracelet could also be considered.

There are no nationally accepted protocols for routine assessment of adrenal function in primary care because it has not yet been possible to identify precisely which children should be tested, to interpret test results reliably, to identify the appropriate interval for retesting, and because a clinical benefit has not been clearly demonstrated.

Regular monitoring of height might help detect adrenal suppression, based on the findings of a study in which a reduction in linear growth velocity occurred before adrenal suppression.

<table>
<thead>
<tr>
<th>Inhaled corticosteroid</th>
<th>Daily dose (microg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low</strong></td>
<td><strong>High</strong></td>
</tr>
<tr>
<td><strong>Beclometasone dipropionate †</strong></td>
<td>100–200</td>
</tr>
<tr>
<td><strong>Budesonide</strong></td>
<td>200–400</td>
</tr>
<tr>
<td><strong>Ciclesonide ‡</strong></td>
<td>80–160</td>
</tr>
<tr>
<td><strong>Fluticasone propionate</strong></td>
<td>100–200</td>
</tr>
</tbody>
</table>

† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)
‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

Source
Classification of recent asthma symptom control in children

Ongoing review of asthma involves both assessing recent asthma symptom control and assessing risks for poor asthma outcomes such as flare-ups and adverse effects of medicines.

Recent asthma symptom control is assessed according to the frequency of asthma symptoms over the previous 4 weeks.

Table. Definition of levels of recent asthma symptom control in children (regardless of current treatment regimen)

<table>
<thead>
<tr>
<th>Good control</th>
<th>Partial control</th>
<th>Poor control</th>
</tr>
</thead>
<tbody>
<tr>
<td>All of:</td>
<td>Any of:</td>
<td>Either of:</td>
</tr>
<tr>
<td>• Daytime symptoms‡ ≤2 days per week</td>
<td>• Daytime symptoms‡ &gt;2 days per week</td>
<td>• Daytime symptoms‡ &gt;2 days per week (lasting from minutes to hours or recurring, and partially or fully relieved by SABA reliever)</td>
</tr>
<tr>
<td>(lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)</td>
<td>• Any limitation of activities*</td>
<td>• ≥3 features of partial control within the same week</td>
</tr>
<tr>
<td>• No limitation of activities‡</td>
<td>• Any symptoms during night or when wakes up†</td>
<td></td>
</tr>
<tr>
<td>• No symptoms§ during night or when wakes up</td>
<td>• Need for SABA reliever# ≤2 days per week</td>
<td></td>
</tr>
<tr>
<td>• Need for SABA reliever# ≤2 days per week</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SABA: short-acting beta₂ agonist

† e.g. wheezing or breathing problems
‡ child is fully active; runs and plays without symptoms
§ including no coughing during sleep
# not including doses taken prophylactically before exercise. (Record this separately and take into account when assessing management.)
* e.g. wheeze or breathlessness during exercise, vigorous play or laughing
†† e.g. waking with symptoms of wheezing or breathing problems

Notes:
Recent asthma control is based on symptoms over the previous 4 weeks. Each child’s risk factors for future asthma outcomes should also be assessed and taken into account in management.

Validated questionnaires can be used for assessing recent symptom control:
Test for Respiratory and Asthma Control in Kids (TRACK) for children < 5 years
Childhood Asthma Control Test (C-ACT) for children aged 4–11 years
### Table. Risk factors for life-threatening asthma flare-ups in children

**Asthma-related factors**
- Poor asthma control
- Admission to hospital in preceding 12 months
- History of intubation for acute asthma
- Over-use of short-acting beta_2_ agonist reliever
- Abnormal spirometry findings
- Reversible expiratory airflow limitation on spirometry despite treatment
- Poor adherence to preventer
- Incorrect inhaler technique for preventer
- Poor adherence to asthma action plan
- Exposure to clinically relevant allergens
- Exposure to tobacco smoke

**Other clinical factors**
- Allergies to foods, insects, medicines
- Obesity

**Family-related factors**
- Frequent failure to attend consultations/lack of follow-up after an acute flare-up
- Significant parental psychological or socioeconomic problems
- Parent/carer unequipped to manage asthma emergency

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### Approaches to assessment and monitoring of asthma control in children

Assessment of asthma control in children is based mainly on:

- recent asthma symptom control (assessed by the frequency and severity of symptoms between flare-ups)
- the degree to which asthma symptoms affect daily activities such as interference with physical activity or missed school days
- the frequency of flare-ups
- spirometry in children who are able to perform the test reliably.

#### Standardised questionnaires

Questionnaire-based instruments have been validated for assessing asthma control in children:

- [Test for Respiratory and Asthma Control in Kids (TRACK)](#) for children less than 5 years old – consists of five questions about frequency of respiratory symptoms (wheeze, cough, shortness of breath), activity limitation, and night-time awakenings in the past 4 weeks, rescue medication use in the past 3 months, and oral corticosteroid use in the previous year.\(^{32,33}\) A lower score indicates worse asthma control.
- [Childhood Asthma Control Test (C-ACT)](#) for children aged 4–11 years – consists of seven items: three for the parent/carer (about the child’s symptoms over the previous 4 weeks) and four for the child.\(^{34,35}\) A lower score indicates worse asthma control. **Note:** C-ACT is intended for US use.

#### Lung function tests

Frequent spirometry to guide asthma treatment in children has not been shown to achieve superior outcomes to symptom-based treatment.\(^{36}\) Current evidence does not support use of home spirometers to guide asthma treatment in children.\(^{37}\) However, low FEV\(_1\) predicts clinically significant flare-ups, so spirometry should be performed at asthma reviews for children who are old enough to do the test. The quality and utility of spirometry depends on the skill, clinical expertise and experience of the person doing and interpreting spirometry.
The results of one study in children aged 6–16 years with moderate atopic asthma suggest that asthma treatment guided by airway hyperresponsiveness (measured by bronchial provocation testing) may have a benefit over symptom-guided treatment in improving lung, but this effect was lost after 3–7 years of usual care. Repeated bronchial provocation testing is not feasible in clinical practice.

### Measures of airway inflammation

Measures of airway inflammation (e.g. sputum eosinophil count, exhaled nitric oxide measurement) are not recommended in primary care to guide treatment decisions, but are increasingly used in specialist clinics.

Asthma treatment guided by sputum eosinophil count has been shown to reduce the frequency of flare-ups in adults with asthma, but there is insufficient evidence to ascertain its value for children.

Exhaled nitric oxide measurement may be useful in guiding asthma management in some children. In children not taking inhaled corticosteroid, a high nitric oxide level probably predicts a good short-term response to inhaled corticosteroid treatment, but it does not distinguish between asthma and eosinophilic bronchitis and is often high in children with atopy. There is insufficient evidence to ascertain whether a low exhaled nitric oxide level predicts successful withdrawal from inhaled corticosteroids without asthma relapse, or safety of treating asthma without inhaled corticosteroids.

A Cochrane review found that exhaled nitric oxide-guided management was significantly better than other approaches to adjusting medicines for reducing the number of children with flare-ups and the number of children who needed oral corticosteroids, but did not reduce the frequency of flare-ups or the rate of flare-ups requiring hospitalisation, improve lung function or symptoms scores, or reduce inhaled corticosteroid doses. The authors concluded that it could not be recommended for all children but may be beneficial for a subset not yet defined.

### Towards personalised asthma care

Emerging understanding of asthma phenotypes and of genetic factors that predict therapeutic response to preventer options is leading to the possibility of personalised, genomics-based treatment for asthma in children. In the near future, individual tailored therapy may replace the standardised step model based on population data.

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### 'Wheeze-detecting' devices

Some hand-held devices and smart phone applications are marketed for detecting and measuring wheeze by audio recording and analysis.

There is not enough evidence to recommend these devices and apps for use in monitoring asthma symptoms or asthma control in adults or children, or in distinguishing wheeze from other airway sounds in children.

- Reliance on these devices could result in over- or under-treatment.

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### References


Managing flare-ups in children aged 1–5 years

Recommendations

Manage wheezing with an inhaled short-acting beta$_2$ agonist bronchodilator (reliever) as needed for relief of symptoms, according to age and clinical significance. Educate parents/carers how and when to give reliever.

Note: The recommended dose for non-emergency bronchodilator in children aged 1–5 years is salbutamol 2–4 puffs (100 microg per puff) as needed, 1 puff at a time, via pressurised metered-dose inhaler plus spacer and face mask for infants aged 1–2 years or pressurised metered-dose inhaler plus spacer for children aged 3–5 years (if able to cooperate). Repeat as needed.

- Do not prescribe oral salbutamol. Inhalation is the recommended route for delivering relievers for all children and adults.

**How this recommendation was developed**

Consensus

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

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For children with acute asthma/wheezing that is associated with increased work of breathing and is severe enough to require hospital admission, consider a course of oral corticosteroids, e.g. 1 mg/kg prednisolone (maximum 50 mg) each morning for 3 days.

**How this recommendation was developed**

Consensus recommendation following inconclusive literature search

Based on clinical experience and expert opinion after literature review yielded insufficient evidence for an evidence-based recommendation

Key evidence considered:

- Foster et al. 2018
- van Asperen et al. 2010
- Panickar et al. 2009
- Chang et al. 2008
- Smith et al. 2003
- Rowe et al. 2001

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For wheezing children younger than 6 years, do not instruct parents/carers to start a course of oral corticosteroids at their own discretion and do not prescribe or recommend oral corticosteroids to be started at home as part of the child’s written asthma action plan.

Instruct parents/carers to seek medical advice each time.

**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
- Brand et al. 2014
If oral corticosteroids are needed to manage severe acute flare-ups, reassess regular medicine regimen (including adherence and inhaler technique) and consider specialist referral.

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

Do not prescribe long-term oral corticosteroids without specialist assessment by a paediatric respiratory physician.

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

Advise parents/carers that children taking a preventer medicine should continue taking it during wheezing episodes.

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

In children not taking regular preventer treatment, do not initiate inhaled corticosteroid treatment to manage worsening asthma symptoms or wheeze or during an acute flare-up, and do not recommend intermittent use of inhaled corticosteroids as part of a written asthma action plan.

How this recommendation was developed
Consensus recommendation following inconclusive literature search
Based on clinical experience and expert opinion after literature review yielded insufficient evidence for an evidence-based recommendation
Key evidence considered:
- Kew et al. 2016
- Chong et al. 2015
- Yousef et al. 2012

For a child taking low-dose inhaled corticosteroid regularly, do not prescribe high-dose inhaled corticosteroids to manage worsening asthma symptoms or wheeze, and do not recommend that parents/carers give children high doses of inhaled corticosteroid treatment during wheezing episodes (e.g. as part of a written asthma action plan).

<table>
<thead>
<tr>
<th>Table. Definitions of ICS dose levels in children</th>
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<tbody>
<tr>
<td>Inhaled corticosteroid</td>
</tr>
<tr>
<td>------------------------</td>
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<td></td>
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<td></td>
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<tr>
<td>-------------------------</td>
</tr>
<tr>
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</table>

† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)
‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

Source

Last reviewed version 2.0
Asset ID: 21

How this recommendation was developed
Consensus recommendation following inconclusive literature search
Based on clinical experience and expert opinion after literature review yielded insufficient evidence for an evidence-based recommendation
Key evidence considered:
- Kew et al. 2016
- Chong et al. 2015
- Yousef et al. 2012

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For children with intermittent asthma symptoms and no interval symptoms for whom regular preventer is not indicated, a short course of montelukast at the onset of worsening asthma or wheezing can be considered (e.g. continue for 7 days or until symptoms have resolved for 48 hours). Advise parents/carers that montelukast does not work for all children.

How this recommendation was developed
Consensus recommendation following inconclusive literature search
Based on clinical experience and expert opinion after literature review yielded insufficient evidence for an evidence-based recommendation
Key evidence considered:
- Watts et al. 2012
- Capsomidis & Tighe. 2010
- Schuh et al. 2009
- Robertson et al. 2007
- Nwokoro et al. 2014
- Valovirta et al. 2011
- Bacharier et al. 2008
- Harmanci et al. 2006

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More information

**Short-acting beta-2 agonist relievers for children: 1–5 years**

**Infants under 12 months**

In infants under 12 months, bronchiolitis is the most likely cause of acute respiratory distress. Bronchodilators are not recommended in children under 12 months old, consistent with current guidelines for the management of acute bronchiolitis.\(^{20}\)

**Children aged 1–5 years**

Inhaled short-acting beta\(_2\) agonists are effective bronchodilators in children aged 1–5 years.\(^{21}\)

Short-acting beta\(_2\) agonists may be less effective for wheezing in children under 2 years old than in older children.\(^{22}\) However, many clinical trials in infants have included those with bronchiolitis, so there is limited evidence for the effects of short-acting beta\(_2\) agonists specifically in asthma.\(^ {22}\) Studies conducted in emergency departments have shown that short-acting beta\(_2\) agonists are more effective than placebo in controlling acute wheeze in children under 2 years, but may not achieve clinically significant improvements.\(^ {22}\)

Inhaled short-acting beta\(_2\) agonists are generally well tolerated in children aged 1–5 years.\(^ {21}\) Adverse effects can include muscle tremor, headache, palpitations and agitation. Muscle tremor and agitation are common with initial use of standard doses, but often settle over time. Serious adverse effects such as hypokalaemia have been reported at very high doses.\(^ {21}\)

Oral short-acting beta\(_2\) agonists are associated with adverse effects\(^ {21}\) and should not be used for the treatment of asthma in any age group.

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**Administration of inhaled medicines in children: 1-5 years**

To use inhaler devices correctly, parents and children need training in inhaler technique and in the care and cleaning of inhalers and spacers.

Children need careful supervision when taking their inhaled medicines (e.g. at preschool), especially when using a reliever for acute asthma symptoms.

**Types of inhalers suitable for preschool children**

Preschool children cannot use pressurised metered-dose inhalers properly unless a spacer is attached (with mask when necessary), because it is difficult for them to coordinate inspiratory effort with actuating the device.\(^ {21}\) Note that breath-actuated pressurised metered-dose inhalers cannot be used with a spacer.

Dry-powder inhalers are usually ineffective for preschool children because they cannot generate sufficient inspiratory air flow.\(^ {21}\)

Drug delivery is very variable in young children with any type of inhaler, including pressurised metered dose inhalers and spacers.\(^ {23}\)

Filter studies have shown high day-to-day variability in delivered doses in preschool children.\(^ {21}\) This variation might explain fluctuations in effectiveness, even if the child’s parents have been trained to use the device correctly.

**Table. Types of inhaler devices for delivering asthma and COPD medicines**

Please view and print this figure separately: http://www.asthmahandbook.org.au/table/show/75

**Pressurised metered-dose inhalers plus spacers for relievers**

During acute wheezing episodes, delivery of short-acting beta\(_2\) agonist to airways is more effective with a pressurised metered-dose inhaler plus spacer than with a nebuliser.\(^ {21}\) In older children, salbutamol has also been associated with a greater increase in heart rate when delivered by nebuliser than when delivered by pressurised metered-dose inhaler plus spacer.\(^ {24}\)

When administering salbutamol to relieve asthma symptoms in a preschool child, the standard recommendation is to shake the inhaler, actuate one puff at a time into the spacer and have the child take 4–6 breaths in and out of the spacer (tidal breathing).\(^ {25}\) Fewer breaths may suffice; in children with asthma aged 2–7 years (not tested during an acute asthma episode), the number of tidal breaths needed to inhale salbutamol adequately from a spacer has been estimated at 2 breaths for small-volume spacers, 2 breaths for a spacer made from a 500-mL modified soft drink bottle, and 3 breaths for a large (Volumatic) spacer.\(^ {26}\)

**Face masks for infants**

When using a spacer with face mask (e.g. for an infant too young or uncooperative to be able to use a mouthpiece), effective delivery of medicine to the airways depends on a tight seal around the face.

When masks are used for inhaled corticosteroids, there is a risk of exposure to eyes and skin if the seal over the mouth and nose is not adequate. Parents should be advised to wash the child’s face after administering inhaled corticosteroids by mask.
Babies are unlikely to inhale enough medicine while crying. The use of a spacer and face mask for a crying infant may require patience and skill: the child can be comforted (e.g. held by a parent, in own pram, or sitting on the floor) while the mask is kept on, and the actuation carefully timed just before the next intake of breath. Most infants will tolerate the spacer and mask eventually. The child may be more likely to accept the spacer and mask if allowed to handle them first (and at other times), if the devices are personalised (e.g. with stickers), or if the mask has a scent associated with the mother (e.g. lip gloss). The use of a spacer with a coloured valve allows parents to see the valve move as the child breathes in and out.

**Preparation of new spacers before first use**

Spacers are made of plastic, antistatic polymer/polycarbonate polyurethane, or cardboard.

**Plastic spacers (e.g. Breath-A-Tech, Volumatic)**

Electrostatic surface charge on new spacers made of plastic (e.g. Breath-A-Tech, Volumatic) reduces the proportion of medicine available for delivery to the airway. This charge can be reduced by washing the plastic spacer in dishwashing liquid and allowing it to air dry or drip-dry without rinsing or wiping.

Alternatively, priming the spacer by actuating the device several times into the spacer also overcomes the charge, but this wastes medicine. The optimal number of actuations for priming is not known and the findings of in vitro studies vary widely. One study (using older, CFC-based formulations of asthma medicines) reported that up to 40 actuations fired into a new plastic spacer overcame the effect of the electrostatic charge. Others have concluded that the electrostatic charge on plastic spacers does not reduce in vivo efficacy of bronchodilator therapy in children with asthma. The number of actuations necessary may be known when the results of recent studies become available.

When a new plastic spacer must be used immediately (e.g. for a person with asthma symptoms), patients, parents and carers should follow the manufacturer's priming instructions. In hospitals and emergency departments, a new spacer that has not been pre-treated by washing can be primed using multiple (at least 10) puffs of salbutamol. (This is an arbitrary number of actuations in the absence of evidence that would enable a precise guideline.)

**Non-plastic spacers**

Disposable cardboard spacers (e.g. DispozABLE, LiteAire) and polyurethane/antistatic polymer spacers (e.g. Able A2A, AeroChamber Plus, La Petite E-Chamber, La Grande E-Chamber) do not require preparation before first use.

**Note:** The term ‘priming’ is also used for the preparation process that is necessary for new pressurised metered-dose inhalers that have not been used for more than a week. This involves first actuating the inhaler into the air (away from the patient). Users should follow the manufacturer's instructions for the particular brand of inhaler, which specify the number of actuations required.

**Parent/carer-initiated oral corticosteroids for wheezing and asthma flare-ups**

- Oral corticosteroids are associated with adverse effects on behaviour and bone health. Frequent courses may affect the hypothalamus–pituitary–adrenal axis.

**Children aged 1–5 years**

Short courses of oral corticosteroids initiated by parents/carers in response to children's wheezing, or at the first sign of a cold, are not effective in managing symptoms in preschool children.

There is inconsistent evidence for the benefits of systemic corticosteroids in preschool children with acute viral-induced wheezing presenting to acute care services. Current evidence does not strongly support their use in this age group.

The Thoracic Society of Australia and New Zealand position statement on the use of corticosteroids in children recommends that oral corticosteroid treatment in preschool children, particularly those with intermittent viral-induced wheezing, should be limited to children with wheeze severe enough to need admission to hospital.

**Children aged 6 years and over**

A Cochrane systematic review found that there was insufficient evidence supporting the use of parent-initiated courses of oral corticosteroids in school-aged children, although some clinical trials have reported benefits.

In a clinical trial in children aged 6–14 years with a history of recurrent episodes of acute asthma, short courses of oral prednisolone (1 mg/kg a day), initiated by parents in response to an asthma flare-ups, reduced asthma symptoms and the number of missed school
days. Another quasi-experimental study found that home initiation of corticosteroids reduced the rate of emergency department visits among school-aged children with moderate-to-severe persistent asthma, compared with rates pre-intervention. The Thoracic Society of Australia and New Zealand position statement on the use of corticosteroids in children recommends a short course of systemic corticosteroid therapy for children with moderate-to-severe acute asthma or when there is an incomplete response to beta-agonists, and does not recommend against parent/carer-initiated courses.

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**Oral corticosteroids for children: adverse effects**

Oral corticosteroids may have adverse psychiatric effects in children, including aggression and hyperactivity. Effects in the general population include euphoria, hypomania, depression, disturbances of mood, cognition, sleep and behaviour. A short course of oral corticosteroid therapy (less than 2 weeks) is associated with little risk of long-term suppression of the hypothalamus–pituitary–adrenal axis. However, risk can accumulate if frequent courses (four or more per year) are given. Recurrent courses of oral corticosteroids may also affect bone mineral density, especially in boys.

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**Increasing the inhaled corticosteroid dose to control flare-ups in children**

In children taking regular inhaled corticosteroid-containing preventers, there is conflicting evidence for whether, and by how much, the dose should be increased when symptoms worsen or at the onset of an acute flare-up. Overall, current evidence from highly controlled randomised controlled trials does not support increasing the dose of inhaled corticosteroid as part of a self-initiated action plan to manage flare-ups in children younger than 12 years. There is some evidence that high doses of inhaled steroids used pre-emptively might be effective in preventing severe acute asthma in children aged under 5 years, based on studies in children not taking regular inhaled corticosteroids. However, very high pre-emptive doses affect children’s growth and are not recommended. Recent randomised controlled trials reported a lack of effect with a range of dose increases:

- A five-fold increase in the inhaled corticosteroid dose at early signs of worsening asthma did not reduce the rate of severe acute asthma in children aged 5–11 years with well-controlled asthma while taking maintenance inhaled corticosteroid treatment (with high adherence). This strategy was associated with a small reduction in linear growth.
- Dose increases of four or eight times usual inhaled corticosteroid maintenance dose at the onset of an acute flare-up in children aged 2–17 years did not reduce requirement for oral corticosteroids, compared with doubling the dose.

A Cochrane systematic review in children and adults reported that increasing the inhaled corticosteroid dose did not prevent severe flare-ups, regardless of how soon the increase was initiated after the onset of symptoms or the magnitude of the dose increase (doubling versus quadrupling). The results did not differ between children under 15 and adults or older adolescents. However, there were too few studies in children to make firm conclusions.

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**Montelukast for children: efficacy**

- Montelukast use has been associated with behavioural and/or neuropsychiatric adverse effects, including suicidality.

Go to: TGA alert

**Overview**

Montelukast is a leukotriene receptor antagonist preventer. It is registered by the TGA for the treatment of asthma in children aged 2 years and older, and for the symptomatic treatment of allergic rhinitis. Montelukast can be used as an alternative to inhaled corticosteroids or as an add-on treatment in a child already taking regular inhaled corticosteroids. However, it is not effective for all children. Overall, only approximately 20–30% of children will respond to montelukast treatment. The effect is thought to depend mainly on the child’s genotype. Clinically, it is not possible to predict accurately which children will benefit most from montelukast treatment.

**Montelukast as first-line preventer in children aged 2–5 years**

**Viral-induced wheezing**
Overall, regular maintenance montelukast treatment does not reduce the risk of wheezing episodes requiring oral corticosteroid treatment among preschool children who only have wheezing episodes when they have viral upper respiratory tract infections.\(^{45}\) However, montelukast may be effective for some children. Some randomised controlled trials have reported a reduction the risk of flare-ups in preschool children with intermittent asthma/wheeze,\(^{46,47}\) while others have not.\(^{17}\)

**Persistent asthma or wheezing**

A systematic review comparing montelukast with inhaled corticosteroids in preschoolers with asthma or recurrent wheezing requiring daily preventer treatment\(^{48}\) reported that inhaled corticosteroids appeared to achieve better symptom control and reduce flare-ups (including severe flare-ups requiring treatment with systemic corticosteroids). However, results were inconsistent and meta-analysis was not possible due to heterogeneity of outcomes measured in available clinical trials.\(^{48}\)

Some preschool children with persistent asthma/wheeze respond to montelukast. A crossover study in preschool children with persistent asthma/wheeze reported that some children showed their best response to montelukast, while most responded better to regular inhaled corticosteroids.\(^{49}\) Predictors of a better response to inhaled corticosteroids than montelukast were aeroallergen hypersensitivity and blood eosinophilia (eosinophil counts \(\geq 300/\mu L\)).\(^{47}\) However, routine blood eosinophil count is not feasible or recommended for this purpose.

**Montelukast as first-line preventer children aged 6 years and over**

In school-aged children with persistent asthma, inhaled corticosteroids are more effective overall than montelukast in improving lung function and controlling asthma symptoms.\(^{50,52}\) However, symptoms will respond to a treatment trial of montelukast in approximately one-quarter to one-third of children,\(^{50,53,54}\) and some may benefit more than from an inhaled corticosteroid.\(^{50}\) More severe asthma and markers of allergic inflammation may predict a better response to inhaled corticosteroids.\(^{50}\)

**Montelukast as add-on treatment**

A systematic review of studies in children over 6 years and adolescents with mild-to-moderate persistent asthma found that the addition of montelukast to inhaled corticosteroids did reduce flare-ups requiring oral corticosteroids or hospital admissions for asthma, compared with the same or an increased dose.\(^{52}\)

In a study comparing step-up treatments in children with asthma symptoms uncontrolled by low-dose inhaled corticosteroids, the addition of a long-acting beta\(_2\) agonist was effective in more children than either montelukast or increasing the dose of inhaled corticosteroid for controlling asthma symptoms and preventing flare-ups requiring systemic corticosteroids.\(^{55}\) However, some studies in school-aged children with persistent asthma already taking regular inhaled corticosteroids have reported that add-on montelukast reduced the risk of flare-ups\(^{55,56}\) and exercise-induced asthma symptoms.\(^{56}\) Not all children will respond.

In a small study in children with persistent asthma already taking regular inhaled corticosteroids who were homozygous for the Arg16 genotype, montelukast was more effective as an add-on therapy than long-acting beta\(_2\) agonist in reducing symptoms, reliever use and days absent from school due to asthma, depending on the child’s beta receptor genotype.\(^{44}\) However, children were given inhaled corticosteroid and long-acting beta\(_2\) agonists in separate inhalers, which is known to be associated with increased risks. However, genotyping it is not currently feasible in clinical practice. In practice, a treatment trial of 4–6 weeks can determine which preventer is suitable for controlling a child’s asthma symptoms,\(^{50}\) but longer treatment may be required to evaluate effect on flare-ups, because flare-ups may be independent of symptom control.

**Exercise-induced symptoms**

In school-aged children who experience exercise-induced symptoms despite taking regular inhaled corticosteroids, the addition of montelukast is effective in controlling symptoms, but not all children experience a response.\(^{57,58}\)

See: [Investigation and management of exercise-induced bronchoconstriction](#)

**Short-term use in the management of flare-ups**

Some, but not all studies suggest that a short course of montelukast, introduced at the first signs of an upper respiratory tract infection, may be effective in controlling flare-ups. An Australian study reported that this strategy could achieve a small reduction in symptoms, school absence and medical consultations in preschool and school-aged children with episodic wheeze.\(^{15}\)

However, the evidence is inconsistent, with some studies showing no benefit.\(^{17,12,13,14,18}\) The findings of one study suggested that whether or not intermittent montelukast is effective in wheezing children aged 5 years and under depends on genotype.\(^{16}\)

Montelukast is not TGA-approved or PBS-subsidised for intermittent use.

**Note:** PBS status as at March 2019: Montelukast is not subsidised by the PBS for adolescents 15 years and over.

*Last reviewed version 2.0*
Certain types of thunderstorms in spring or early summer in regions with high grass pollen concentrations in the air can cause life-threatening allergic asthma flare-ups in individuals sensitised to rye grass, even if they have not had asthma before. Sensitisation to rye grass allergen is almost universal in patients who have reported flare-ups consistent with thunderstorm asthma in Australia. People with allergic rhinitis and allergy to ryegrass pollen (i.e. most people with springtime allergic rhinitis symptoms) are at risk of thunderstorm asthma if they live in, or are travelling to, a region with seasonal high grass pollen levels – even if they have never had asthma symptoms before. This includes people with undiagnosed asthma, no previous asthma, known asthma. Lack of inhaled corticosteroid preventer treatment has been identified as a risk factor. Epidemics of thunderstorm asthma can occur when such a storm travels across a region and triggers asthma in many susceptible individuals. Epidemic thunderstorm asthma events are uncommon, but when they occur they can make a high demand on ambulance and health services. Data from thunderstorm asthma epidemics suggest that the risk of asthma flare-ups being triggered by a thunderstorm is highest in adults who are sensitised to grass pollen and have seasonal allergic rhinitis (with or without known asthma). The worst outcomes are seen in people with poorly controlled asthma. Treatment with an inhaled corticosteroid asthma preventer was significantly protective in a well-conducted Australian case-control study. There is insufficient evidence to determine whether intranasal corticosteroids help protect against thunderstorm asthma. Intranasal corticosteroids reduce symptoms of allergic rhinitis and limited indirect evidence suggests they may protect against asthma flare-ups in people not taking inhaled corticosteroids. The effectiveness of specific allergen immunotherapy in protecting against thunderstorm asthma has not been evaluated in randomised clinical trials, but data from a small Australian open-label study suggest that short-term treatment with five-grass sublingual immunotherapy may have been protective in individuals.

Last reviewed version 2.0

Asthma triggers in children: respiratory tract infections
Viral respiratory infections, such as the common cold, are a frequent cause of wheezing and asthma flare-ups in children, especially in preschool children. The findings of observational cohort studies and limited randomised controlled trials show that influenza vaccination reduces the number, frequency and duration of asthma flare-ups in children, and lower the rate of emergency department visits and hospitalisation for asthma. Although bacterial respiratory infections may also trigger wheezing, antibiotics are not routinely indicated for asthma flare-ups or wheezing, and should only be given if they would otherwise be indicated.

Last reviewed version 2.0

Asthma triggers in children: environmental allergens
There is insufficient evidence on which to base recommendations for the reduction of exposure to environmental allergens in the treatment of wheezing in preschool children.

Last reviewed version 2.0

Asthma triggers in children: tobacco smoke
There is consistent, high-quality evidence that exposure to environmental tobacco smoke can both cause and worsen wheezing in preschool children. The introduction of environmental tobacco controls has led to significant reduction in asthma hospitalisations among children.

Last reviewed version 2.0
References


Managing severe asthma in children aged 1–5 years

Recommendations

If asthma symptoms remain uncontrolled (persisting symptoms or flare-ups) despite maximal regular preventer treatment:

- assess adherence
- check inhaler technique
- review the diagnosis
- assess comorbidity (e.g. allergic rhinitis)
- check whether the child is exposed to environmental triggers (e.g. allergens, cigarette smoke)
- check that the dose and regimen is appropriate.

Table. Reviewing and adjusting preventer treatment for children aged 1–5 years
Please view and print this figure separately: http://www.asthmahandbook.org.au/table/show/25

Figure. Stepped approach to adjusting asthma medication in children aged 1-5 years
Please view and print this figure separately: http://www.asthmahandbook.org.au/figure/show/18

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):
- Chung et al. 2014
- Bush et al. 2011
- Bush et al. 2010

Last reviewed version 2.0

If good asthma control is still not achieved after eliminating common reasons for treatment failure, consider referral to a paediatric respiratory physician or paediatrician.

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

Last reviewed version 2.0

More information

Step-up options in children with asthma that is not controlled by low-dose inhaled corticosteroids

In children whose asthma is inadequately controlled by low-dose inhaled corticosteroids alone (and adherence is good, inhaler technique is correct and diagnosis has been confirmed), treatment options include:

- increasing the inhaled corticosteroid dose
- adding montelukast
- switching to inhaled corticosteroid/long-acting beta₂ agonist combination.
### Table. Step-up options for children when good asthma control is not achieved with low-dose ICS

<table>
<thead>
<tr>
<th>Option</th>
<th>TGA-registered indications for add-on therapy</th>
<th>PBS considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-dose ICS</td>
<td>N/A</td>
<td>Subsidised</td>
</tr>
<tr>
<td>ICS plus montelukast</td>
<td>2 years and over</td>
<td>2–5 years: not subsidised*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6–14 years: not subsidised unless for exercise-induced bronchoconstriction despite ICS treatment†</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 years and over: not subsidised‡</td>
</tr>
<tr>
<td>ICS/long-acting beta&lt;sub&gt;2&lt;/sub&gt; agonist combination</td>
<td>4 years and over for fluticasone propionate/salmeterol xinafoate</td>
<td>Subsidised</td>
</tr>
<tr>
<td></td>
<td>12 years and over for budesonide/formoterol fumarate dihydrate</td>
<td></td>
</tr>
</tbody>
</table>

- Advise parents about potential adverse psychiatric effects of montelukast

* Montelukast is not subsidised for use in combination with other preventers or for children who require inhaled corticosteroids.
† Montelukast is subsidised for prevention of exercise-induced asthma if asthma is otherwise well controlled while taking optimal-dose inhaled corticosteroids – it is not otherwise subsidised in combination with inhaled corticosteroids (or inhaled corticosteroid/long-acting beta<sub>2</sub> agonist combinations).
‡ Montelukast is not subsidised for people aged over 15 years.

Asset ID: 27

In the majority of children with persistent asthma that requires preventive treatment, control can be achieved with one of these options.4

Few studies have been conducted in preschool-aged children. The preferred step-up option for children aged 6–12 years is controversial and guidelines differ in their recommendations.5

### Increasing inhaled corticosteroid dose versus adding a long-acting beta<sub>2</sub> agonist

In school-aged children with persistent asthma taking regular inhaled corticosteroid, the addition of a long-acting beta<sub>2</sub> agonist does not reduce the rate of asthma flare-ups requiring systemic steroids compared with the same or higher doses of inhaled corticosteroid.6, 7 However, the long-acting beta<sub>2</sub> agonist–inhaled corticosteroid was superior for improving lung function.6 Growth is reduced in children treated with higher-dose inhaled corticosteroid, compared with those taking same dose plus a long-acting beta<sub>2</sub> agonist.6

Adolescents may benefit more from combination inhaled corticosteroid/long-acting beta<sub>2</sub> agonist treatment than children under 12 years. In adolescents with persistent asthma that is not controlled by a low dose of inhaled corticosteroids, the combination of a long-acting beta<sub>2</sub> agonist and an inhaled corticosteroid is modestly more effective in reducing the risk of flare-ups requiring oral corticosteroids than a higher dose of inhaled corticosteroids.8

### Adding montelukast versus adding a long-acting beta-2 agonist or increasing inhaled corticosteroid dose

#### Children aged 1–5 years

In one study in children aged 5 years or less with persistent asthma/wheeze requiring preventer treatment, raised blood eosinophil levels and atopy predicted better short-term response to high-dose inhaled corticosteroid than to montelukast.9 However, routine eosinophil counts are not currently recommended to guide treatment in children.

In children aged 1–5 years with asthma/wheeze that is not adequately controlled by low-dose inhaled corticosteroid alone, adding montelukast is preferable to increasing the dose of inhaled corticosteroids when the safety profiles of these options are compared.10
Long-acting beta\textsubscript{2} agonists are not recommended for this age group.

- Montelukast use has been associated with behavioural and/or neuropsychiatric adverse effects.

\textgreater Go to: TGA alert

Note: Montelukast is TGA-approved for children aged 2 years and over.

### Children aged 6 years and over

Among children 6 years and over with asthma that is not controlled by low-dose inhaled corticosteroids, the optimal regimen varies between individuals.\textsuperscript{11} In one study of children selected for high adherence with maintenance treatment, short-term responses varied between individuals: in some children the best response was achieved by adding a long-acting beta\textsubscript{2} agonist, in others by adding montelukast, and in others by increasing the dose of inhaled corticosteroid.\textsuperscript{11}

Note: The use of inhaled corticosteroids and long-acting beta\textsubscript{2} agonists in separate inhalers is not recommended for either children or adults because of the potential for increased risk due to selective non-adherence to the inhaled corticosteroid.\textsuperscript{12}

Overall, the addition of montelukast to an inhaled corticosteroid does not reduce the need for rescue oral corticosteroids or hospital admission, compared with the same or an increased dose of inhaled corticosteroids, in children aged 6 years and over or adolescents with mild-to-moderate asthma.\textsuperscript{13}

For children aged 6–14 years with persistent asthma and exercise-induced bronchoconstriction, adding montelukast is more effective in protecting against exercise-induced bronchoconstriction than switching to a combination of inhaled corticosteroid and a long-acting beta\textsubscript{2} agonist.\textsuperscript{14} The use of montelukast also avoids beta-receptor tolerance associated with long-acting beta\textsubscript{2} agonists, so a short-acting beta\textsubscript{2} agonist taken after exercise produces a greater bronchodilator response than it does in children taking regular long-acting beta\textsubscript{2} agonist.\textsuperscript{14}

A treatment trial of montelukast for 4–6 weeks is the best option when effects on exercise-induced symptoms and safety are also considered.\textsuperscript{10}

- Montelukast use has been associated with behavioural and/or neuropsychiatric adverse effects.

\textgreater Go to: TGA alert

See: Investigation and management of exercise-induced bronchoconstriction

### Genetic influence on effect of long-acting beta\textsubscript{2} agonists

Clinical response to long-acting beta\textsubscript{2} agonists partly depends on genetics. A beta\textsubscript{2} receptor genotype (Arg16 polymorphism in the beta\textsubscript{2} receptor gene) pre-disposes children with asthma to down-regulation of the beta\textsubscript{2} receptor and increased susceptibility to flare-ups during regular treatment with regular long-acting beta\textsubscript{2}agonists.\textsuperscript{15} However, routine genetic testing to tailor asthma therapy is not yet available in clinical practice.

*Last reviewed version 2.0*

### Definitions of severe and difficult-to-treat asthma

Although most people's asthma can be effectively treated with currently available medicines, a substantial subset of people have uncontrolled asthma (as indicated by persisting symptoms, low lung function and/or flare-ups) despite treatment. These patients are described as having difficult-to-treat asthma.

Some patients with difficult-to-treat asthma have severe asthma. Asthma severity is classified retrospectively according to the level of treatment needed to achieve or maintain good asthma control, rather than by the intensity or frequency of symptoms.\textsuperscript{16} International guidelines have been published for the assessment and management of patients with severe asthma.\textsuperscript{1} ‘Severe asthma’ (also called severe refractory asthma or ‘severe treatment-resistant asthma’) is defined as asthma for which good control is not achieved despite the highest level of recommended treatment, or asthma for which control can be maintained only with the highest level of recommended treatment.\textsuperscript{1} It is estimated that 5–10\% of patients with asthma have severe asthma.\textsuperscript{3}

Not all patients with difficult-to-treat asthma have severe asthma. 'Difficult-to-treat asthma' includes asthma that is uncontrolled due to adherence issues, inappropriate or incorrect use of medicines, environmental triggers or comorbidities. Patients whose asthma control improves rapidly with correction of such problems are not considered to have severe asthma.\textsuperscript{1}

Treatment-resistant asthma or severe refractory asthma can only be diagnosed after confirming the diagnosis, confirming good adherence to high-dose inhaled corticosteroid and correct inhaler technique, excluding alternative or overlapping diagnoses, identifying and minimising exposure to preventable triggers including allergens, irritants and medicines that cause bronchoconstriction, managing comorbidities, and closely monitoring for at least 6 months.\textsuperscript{17, 1}

Omalizumab is a treatment option for some adults, adolescents and children with severe asthma.
The definition of severe asthma proposed by the World Health Organization (WHO) Consultation on Severe Asthma for global use is 'uncontrolled asthma which can result in risk of frequent severe exacerbations (or death) and/or adverse reactions to medications and/or chronic morbidity (including impaired lung function or reduced lung growth in children)'\textsuperscript{18} The WHO definition of severe asthma includes a category called 'severe untreated asthma', a term recommended only for use in countries that lack access to standard asthma medications such as inhaled corticosteroids.

Patients with severe symptoms due to untreated asthma may be found, after starting regular treatment, to have mild asthma (i.e. asthma that is easily controlled with low-dose inhaled corticosteroids).\textsuperscript{16}

- Go to: European Respiratory Society and American Thoracic Society guidelines on definition, evaluation and treatment of severe asthma

**Common reasons for poor response to preventer treatment**

Apparent lack of response to asthma treatment is commonly due to one or more of the following:\textsuperscript{3}

- poor adherence (which may be due to lack of perceived need for the medication, concern about potential or actual side-effects, cost of medicines, a busy lifestyle, misunderstanding of the purpose and effects of asthma medicines, or inability to follow the medical instructions)
- poor inhaler technique
- mishandling devices (e.g. failure to clean spacer, allowing mouthpiece of dry-powder inhalers to become blocked)
- incorrect dose or frequency
- empty inhaler
- expired medicines
- continued exposure to smoke or allergen triggers.

Failure to identify these causes before adjusting medicines could result in over-medication with preventers.

- Go to: Management challenges

**Correct use of inhaler devices**

Checking and correcting inhaler technique is essential to effective asthma management.

Most patients with asthma or COPD do not use their inhalers properly,\textsuperscript{19, 20, 21, 22} and most have not had their technique checked or corrected by a health professional.

Incorrect inhaler technique when using maintenance treatments increases the risk of severe flare-ups and hospitalisation for people with asthma or COPD.\textsuperscript{19, 20, 23, 24, 25, 26} Poor asthma symptom control is often due to incorrect inhaler technique.\textsuperscript{27, 28}

Incorrect inhaler technique when using inhaled corticosteroids increases the risk of local side effects like dysphonia and oral thrush.

The steps for using an inhaler device correctly differ between brands. Checklists of correct steps for each inhaler type and how-to videos are available from the National Asthma Council website.

- Go to: National Asthma Council Australia’s Using your inhaler webpage for information, patient resources and videos on inhaler technique
- Go to: National Asthma Council Australia’s information paper for health professionals on Inhaler technique for people with asthma or COPD
- Go to: NPS MedicineWise information on Inhaler devices for respiratory medicines

**Inhaled corticosteroid/long-acting beta-2 agonist combinations for children aged 4–11 years**

The combination of salmeterol plus fluticasone propionate in a single inhaler is TGA-registered for use in children 4 years and older.

**Efficacy**

A very large (n=6208) randomised controlled trial in children aged 4–11 years reported that, unlike in adults, the combination of inhaled corticosteroid and long-acting beta\textsubscript{2} agonist was not associated with a significant reduction in severe flare-ups, compared with inhaled corticosteroid alone.\textsuperscript{29} Combination treatment was not associated with an increase in in symptom-free days or a reduction in reliever use, compared with inhaled corticosteroid alone.\textsuperscript{29}

**Safety**
Clinical response to long-acting beta2 agonists partly depends on genetics. A beta2 receptor genotype (Arg16 polymorphism in the beta2 receptor gene) predisposes children with asthma to down-regulation of the beta2 receptor and increased susceptibility to flare-ups during regular treatment with regular long-acting beta2 agonists. However, routine genetic testing to tailor asthma therapy is not yet available in clinical practice.

Earlier systematic reviews and meta-analyses led to concern about the possibility that the use of long-acting beta-agonists (even in combination with inhaled corticosteroids) might even increase the risk of flare-ups that require treatment with oral steroids or hospital admission, or of severe flare-ups. A meta-analysis commissioned by the US Food and Drug Administration found that the use of long-acting beta2 agonists was associated with increased risk of severe asthma-associated adverse events (both overall and among the subset of people using concomitant inhaled corticosteroid and long-acting beta2 agonist), and that this risk was greatest in children aged 4–11 years. However, the increased risk was only seen in studies where inhaled corticosteroid was not provided, or where inhaled corticosteroid and long-acting beta2 agonist were not combined in a single inhaler (i.e. where there was the possibility of selective non-adherence to the inhaled corticosteroid).

The PBAC Post-market review of medicines used to treat asthma in children concluded that there was insufficient evidence to ascertain whether tolerance to long-acting beta2 agonist could explain why it is less effective than montelukast and inhaled corticosteroids in managing exercise-induced asthma symptoms. A very large randomised controlled trial of children aged 4–11 years, stratified by asthma symptom control and pre-study treatment, found no increased risk of serious adverse outcomes with combination fluticasone propionate and salmeterol in a single inhaler, compared with fluticasone propionate alone. Subsequent to the publication of this and similar studies in adults, regulators in the USA and Australia removed previous ‘black box’ warnings from combination inhaled corticosteroid–long-acting beta2 agonist products for asthma.

PBS status as at March 2019: All formulations that contain a combination of inhaled corticosteroid plus long-acting beta2 agonist are listed as ‘Authority required - streamlined’. Patient using these combinations for asthma must have previously had frequent episodes of asthma while receiving treatment with oral corticosteroids or optimal doses of inhaled corticosteroids.

Last reviewed version 2.0

Specific allergen immunotherapy (desensitisation)

- Specific allergen immunotherapy should not be started unless the patient has stable asthma, including spirometry-demonstrated forced expiratory volume in 1 second (FEV1) greater than 80% predicted for subcutaneous immunotherapy and greater than 70% predicted for sublingual immunotherapy. For patients with unstable asthma (e.g. frequent symptoms, marked variability in airflow measured by spirometry or peak flow monitor), the risks of treatment should be considered. These patients will need specialist supervision during treatment.

Options available in Australia

Two forms of specific allergen immunotherapy are available:

- sublingual immunotherapy
- subcutaneous immunotherapy.

Both forms of specific allergen immunotherapy require 3–5 years of treatment. Specific allergy immunotherapy can be repeated.

Although some specific allergen therapies can be prescribed by primary care health professionals, it is recommended that they are initiated under the care of an allergy specialist (allergist or clinical immunologist), where possible.

Commercial allergen preparations for immunotherapy are available in Australia for aeroallergens including house dust mite, pollens (e.g. grass, tree and weed pollens), animal dander and moulds.

Go to: ASCIA’s Allergen Immunotherapy fact sheet for patients
Go to: ASCIA’s Allergen immunotherapy e-training for health professionals

Overview of efficacy

There is strong evidence that allergen immunotherapy is effective in the treatment of seasonal and perennial allergic rhinitis. There is less evidence supporting specific allergen immunotherapy in children than in adults. Specific allergen immunotherapy in children with seasonal allergic rhinoconjunctivitis might prevent development of asthma. Single-allergen specific allergen immunotherapy is effective in patients sensitised to one allergen and those sensitised to multiple allergens. In selected cases more than one allergen may be administered as separate extracts. There is weak evidence for the efficacy of allergen mixes.

A systematic review of studies directly comparing subcutaneous immunotherapy and sublingual immunotherapy in the treatment of allergic rhinoconjunctivitis and asthma found:
low-grade evidence that subcutaneous immunotherapy is more effective than sublingual immunotherapy for reducing asthma symptoms and for reducing a combined measure of rhinitis symptoms and medication use

Sublingual immunotherapy is associated with a lower rate of severe adverse effects (anaphylaxis and death) than subcutaneous immunotherapy, based on indirect comparison.47, 48, 49

Sublingual immunotherapy

Sublingual immunotherapy (self-administered at home) is effective for the treatment of allergic rhinitis in adults and children.50, 51 The greatest benefits have been demonstrated in those with allergies to temperate grass pollens or house dust mite.51 Therapeutic Goods Administration (TGA)-approved indications for commercially available preparations vary according to age group.

The extract must be held under the tongue without swallowing for 2 minutes (liquid extracts) or 1 minute (tablets).

Sublingual immunotherapy is generally well tolerated.50 Local adverse effects are common in children receiving sublingual immunotherapy.47 Systemic adverse reactions, such as anaphylaxis, are very rare.47 The majority of adverse events occur soon after beginning treatment.51

TGA-approved indications

Asthma: Acarizax (house dust mite) is indicated for adults 18–65 years with house dust mite allergic asthma that is not well controlled by inhaled corticosteroids and is associated with mild-to-severe house dust mite allergic rhinitis.52 It is contraindicated in patients with FEV1 <70% predicted after adequate treatment, and for patients who have experienced a severe flare-up within the previous 3 months.52

Allergic rhinitis: Several commercial preparations of aeroallergens for sublingual immunotherapy in patients with allergic rhinitis are used in Australia, including:

- Acarizax (house dust mite) – indicated for adults 18–65 years with persistent moderate to severe house dust mite allergic rhinitis despite symptomatic treatment.52
- Actair (house dust mite) – indicated for the treatment of house dust mite allergic rhinitis with or without conjunctivitis in adults and adolescents over 12 years diagnosed with house dust mite allergy.53
- Grazax (Timothy grass [Phleum pratense] pollen extract) – indicated for adults, adolescents and children older than 5 years with allergic rhinitis induced by Timothy grass54
- Oralair tablets (mix of grass pollens) – indicated for adults and children over 5 years with grass pollen allergic rhinitis.55

Various single allergens and/or multiple allergen mixes are available for use as advised by the treating allergist, available as liquid extracts. Age restrictions vary between products.

Note: PBS status as at October 2016: Treatment with sublingual immunotherapy specific allergen preparations is not subsidised by the PBS.

Subcutaneous immunotherapy

Subcutaneous immunotherapy involves injections in which the dose is gradually increased at regular intervals (usually weekly), or until a therapeutic/maintenance dose is reached. This can take approximately 3–6 months.56 Treatment is then continued for a further 3–5 years.

Subcutaneous immunotherapy is generally not suitable for younger children (e.g. less than 7 years) because they may not be able to tolerate frequent injections.

Several commercial preparations of aeroallergens for subcutaneous immunotherapy are available in Australia, including various single allergens and/or multiple allergen mixes for use as advised by the treating allergist. Age restrictions vary between products.

Subcutaneous immunotherapy is effective for the treatment of allergic rhinitis and asthma, particularly when single-allergen immunotherapy regimens are used.48 There is strong evidence that it reduces asthma symptoms, asthma medication usage, rhinitis/rhinocconjunctivitis symptoms, conjunctivitis symptoms, and rhinitis/rhinocconjunctivitis disease-specific quality of life, in comparison to placebo or usual care.48 There is also moderate evidence that subcutaneous immunotherapy reduces rhinitis/rhinocconjunctivitis medication usage.48

Subcutaneous immunotherapy is associated with local adverse effects (e.g. injection-site swelling) and, less frequently, serious systemic adverse effects.47, 51 The most common systemic reactions are respiratory symptoms. There have been few reports of anaphylaxis.47

Note: PBS status as at March 2019: Treatment with subcutaneous specific allergen immunotherapy preparations is not subsidised by the PBS.

Oral corticosteroids for children: adverse effects

Oral corticosteroids may have adverse psychiatric effects in children, including aggression and hyperactivity.57 Effects in the general population include euphoria, hypomania, depression, disturbances of mood, cognition, sleep and behaviour.58
A short course of oral corticosteroid therapy (less than 2 weeks) is associated with little risk of long-term suppression of the hypothalamus–pituitary–adrenal axis. However, risk can accumulate if frequent courses (four or more per year) are given.

Recurrent courses of oral corticosteroids may also affect bone mineral density, especially in boys.

References


Managing asthma in children aged 6 years and over

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<tr>
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<th>Managing difficult-to-treat and severe asthma in children aged 6 years and over</th>
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<tr>
<td></td>
<td><a href="http://www.asthmahandbook.org.au/management/children/6-years-and-over/severe-asthma">http://www.asthmahandbook.org.au/management/children/6-years-and-over/severe-asthma</a></td>
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</tbody>
</table>
## Assessing symptoms and control in children 6 years and over

### Recommendations

For children with a new asthma diagnosis or those not taking regular preventer treatment, assess frequency and severity of symptoms and flare-ups.

Note: This assessment should be based on overall pattern of symptoms including frequency of flare-ups and symptoms between flare-ups, not on symptoms seen during a flare-up.

### Table. Classification of asthma and indications for initiating preventer treatment in children aged 6–11

<table>
<thead>
<tr>
<th>Severity of flare-ups</th>
<th>Average frequency of flare-ups and symptoms between flare-ups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Infrequent intermittent Flare-ups every 6 weeks or less and no symptoms between flare-ups</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild flare-ups</td>
<td>Not indicated</td>
</tr>
<tr>
<td>(almost always managed with salbutamol in community)</td>
<td></td>
</tr>
<tr>
<td>Moderate–severe flare-ups</td>
<td>Consider</td>
</tr>
<tr>
<td>(&gt;2 in past year requiring ED or oral corticosteroids)</td>
<td></td>
</tr>
</tbody>
</table>
Life-threatening flare-ups (require hospitalisation or PICU) | Indicated | Indicated | Indicated
--- | --- | --- | ---

Preventer should be started as a treatment trial. Assess response after 4–6 weeks and review before prescribing long term.

ED: emergency department

Indicated: Prescribe preventer and monitor as a treatment trial. At follow-up, discontinue if ineffective

Not indicated: Preventer is unlikely to be beneficial

Consider prescribing preventer according to overall risk for severe flare-ups

‡ Symptoms between flare-ups. A flare-up is defined as a period of worsening asthma symptoms, from mild (e.g. symptoms that are just outside the normal range of variation for the child, documented when well) to severe (e.g. events that require urgent action by parents/carers and health professionals to prevent a serious outcome such as hospitalisation or death from asthma).

*Last reviewed version 2.0
Asset ID: 16

How this recommendation was developed

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

*Last reviewed version 2.0

Assess level of recent asthma symptom control.

Notes: If reliable equipment and appropriately trained staff are available, spirometry can be performed in primary care. If not, refer to an appropriate provider such as an accredited respiratory function laboratory.

Most children aged 6 and older can perform spirometry reliably.

Table. Definition of levels of recent asthma symptom control in children (regardless of current treatment regimen)

<table>
<thead>
<tr>
<th>Good control</th>
<th>Partial control</th>
<th>Poor control</th>
</tr>
</thead>
<tbody>
<tr>
<td>All of:</td>
<td>Any of:</td>
<td>Either of:</td>
</tr>
<tr>
<td>- Daytime symptoms † ≤ 2 days per week (lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)</td>
<td>- Daytime symptoms † &gt; 2 days per week (lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)</td>
<td>- Daytime symptoms † &gt; 2 days per week (lasting from minutes to hours or recurring, and partially or fully relieved by SABA reliever)</td>
</tr>
<tr>
<td>- No limitation of activities ‡</td>
<td>- Any limitation of activities §</td>
<td>- ≥ 3 features of partial control within the same week</td>
</tr>
<tr>
<td>- No symptoms § during night or when wakes up</td>
<td>- Any symptoms during night or when wakes up † †</td>
<td></td>
</tr>
<tr>
<td>- Need for SABA reliever # ≤ 2 days per week</td>
<td>- Need for SABA reliever # &gt; 2 days per week</td>
<td></td>
</tr>
</tbody>
</table>

SABA: short-acting beta_2 agonist

† e.g. wheezing or breathing problems
‡ child is fully active; runs and plays without symptoms
§ including no coughing during sleep
# not including doses taken prophylactically before exercise. (Record this separately and take into account when assessing management.)

* e.g. wheeze or breathlessness during exercise, vigorous play or laughing

†† e.g. waking with symptoms of wheezing or breathing problems

Notes:

Recent asthma control is based on symptoms over the previous 4 weeks. Each child’s risk factors for future asthma outcomes should also be assessed and taken into account in management.

Validated questionnaires can be used for assessing recent symptom control:

- Test for Respiratory and Asthma Control in Kids (TRACK) for children < 5 years
- Childhood Asthma Control Test (C-ACT) for children aged 4–11 years

How this recommendation was developed

Consensus recommendation following inconclusive literature search

Based on clinical experience and expert opinion after literature review yielded insufficient evidence for an evidence-based recommendation

Key evidence considered:

- Abramson et al. 2015
- Deschildre et al. 2012
- Haahtela et al. 2006

Assess risk factors for flare-ups.
Table. Risk factors for life-threatening asthma flare-ups in children

**Asthma-related factors**
- Poor asthma control
- Admission to hospital in preceding 12 months
- History of intubation for acute asthma
- Over-use of short-acting beta_2_ agonist reliever
- Abnormal spirometry findings
  - Reversible expiratory airflow limitation on spirometry despite treatment
- Poor adherence to preventer
- Incorrect inhaler technique for preventer
- Poor adherence to asthma action plan
- Exposure to clinically relevant allergens
- Exposure to tobacco smoke

**Other clinical factors**
- Allergies to foods, insects, medicines
- Obesity

**Family-related factors**
- Frequent failure to attend consultations/lack of follow-up after an acute flare-up
- Significant parental psychological or socioeconomic problems
- Parent/carer unequipped to manage asthma emergency

Last reviewed version 2.0
Asset ID: 116

**How this recommendation was developed**

Consensus

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

Last reviewed version 2.0

Perform spirometry in children able to do this test reliably.

If spirometry is normal, it should be repeated at planned asthma reviews at least yearly.

If spirometry is abnormal, it should be checked again 4–6 weeks after starting treatment or changing the treatment regimen.

**How this recommendation was developed**

Consensus recommendation following inconclusive literature search

Based on clinical experience and expert opinion after literature review yielded insufficient evidence for an evidence-based recommendation

Key evidence considered:

- Abramson et al. 2015^1
- Deschildre et al. 2012^2
- Hahtela et al. 2006^3

Last reviewed version 2.0

If the diagnosis of asthma was made elsewhere, confirm the diagnosis, if possible.

**How this recommendation was developed**
## Classification of symptom patterns in children

The pattern and severity of symptoms in a child with asthma or preschool wheeze is a guide to initial treatment.

### Table. Classification of preschool wheeze and indications for preventer treatment in children aged 1–5

<table>
<thead>
<tr>
<th>Severity of flare-ups</th>
<th>Frequency of symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Symptoms every 6 months or less</td>
</tr>
<tr>
<td><strong>Mild flare-ups</strong></td>
<td>Not indicated</td>
</tr>
<tr>
<td><em>(managed with salbutamol in community)</em></td>
<td></td>
</tr>
<tr>
<td><strong>Moderate–severe flare-ups</strong></td>
<td>Indicated</td>
</tr>
<tr>
<td><em>(require ED care/oral corticosteroids)</em></td>
<td></td>
</tr>
<tr>
<td><strong>Life-threatening flare-ups</strong></td>
<td>Indicated</td>
</tr>
<tr>
<td><em>(require hospitalisation or PICU)</em></td>
<td></td>
</tr>
</tbody>
</table>

**PICU:** paediatric intensive care unit; **ED:** emergency department

**Indicated:** Prescribe preventer and monitor as a treatment trial. Discontinue if ineffective.

**Not indicated:** Preventer is unlikely to be beneficial

**Consider prescribing preventer according to overall risk for severe flare-ups**

**Symptoms:** wheeze, cough or breathlessness. May be triggered by viral infection, exercise or inhaled allergens

**Flare-up:** increase in symptoms from usual day-to-day symptoms (ranging from worsening asthma over a few days to an acute asthma episode)

**Preventer options:** an inhaled corticosteroid (low dose) or montelukast

[!] **Advise parents/carers about potential adverse behavioural and/or neuropsychiatric effects of montelukast**

**Notes:**

Preventer medication is unlikely to be beneficial in a child whose symptoms do not generally respond to salbutamol

---

**Consensus**

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

_Last reviewed version 2.0_
In children taking preventer, symptoms should be managed with a short-acting inhaled beta2 agonist reliever (e.g. when child shows difficulty breathing).

Last reviewed version 2.0
Asset ID: 20

<table>
<thead>
<tr>
<th>Category</th>
<th>Pattern and intensity of symptoms (when not taking regular treatment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrequent intermittent asthma †</td>
<td>Symptom-free for at least 6 weeks at a time (flare-ups up to once every 6 weeks on average but no symptoms between flare-ups)</td>
</tr>
<tr>
<td>Frequent intermittent asthma</td>
<td>Flare-ups more than once every 6 weeks on average but no symptoms between flare-ups</td>
</tr>
</tbody>
</table>

**Persistent asthma**  
*Mild*  
FEV$_1$ ≥80% predicted and at least one of:  
- Daytime symptoms‡ more than once per week but not every day  
- Night-time symptoms‡ more than twice per month but not every week

*Moderate*  
Any of:  
- FEV$_1$$<80\%$ predicted‡  
- Daytime symptoms‡ daily  
- Night-time symptoms‡ more than once per week  
- Symptoms sometimes restrict activity or sleep

*Severe*  
Any of:  
- FEV$_1$$\leq60\%$ predicted‡  
- Daytime symptoms‡ continual  
- Night-time symptoms‡ frequent  
- Flare-ups frequent  
- Symptoms frequently restrict activity or sleep

† It may not be appropriate to make the diagnosis of asthma in children aged 6 or older who wheeze only during upper respiratory tract infections. These children can be considered to have episodic (viral) wheeze.

‡ Symptoms between flare-ups. A flare-up is defined as a period of worsening asthma symptoms, from mild (e.g. symptoms that are just outside the normal range of variation for the child, documented when well) to severe (e.g. events that require urgent action by parents and health professionals to prevent a serious outcome such as hospitalisation or death from asthma).

Asset ID: 15

<table>
<thead>
<tr>
<th>Average frequency of flare-ups and symptoms between flare-ups</th>
</tr>
</thead>
</table>
### Severity of flare-ups

<table>
<thead>
<tr>
<th></th>
<th>Infrequent intermittent</th>
<th>Frequent intermittent</th>
<th>Persistent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flare-ups every 6 weeks or less and no symptoms between flare-ups</td>
<td>Flare-ups more than once every 6 weeks and no symptoms between flare-ups</td>
<td>Between flare-ups (any of):</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Daytime symptoms‡ more than once per week</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Night-time symptoms‡ more than twice per month</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Symptoms restrict activity or sleep</td>
</tr>
</tbody>
</table>

| Mild flare-ups          | Not indicated           | Consider              | Indicated |
| (almost always managed with salbutamol in community) |

| Moderate–severe flare-ups | Consider | Indicated | Indicated |
| (>2 in past year requiring ED or oral corticosteroids) |

| Life-threatening flare-ups | Indicated | Indicated | Indicated |
| (require hospitalisation or PICU) |

Preventer should be started as a treatment trial. Assess response after 4–6 weeks and review before prescribing long term.

ED: emergency department

Indicated: Prescribe preventer and monitor as a treatment trial. At follow-up, discontinue if ineffective

Not indicated: Preventer is unlikely to be beneficial

Consider prescribing preventer according to overall risk for severe flare-ups

‡ Symptoms between flare-ups. A flare-up is defined as a period of worsening asthma symptoms, from mild (e.g. symptoms that are just outside the normal range of variation for the child, documented when well) to severe (e.g. events that require urgent action by parents/carers and health professionals to prevent a serious outcome such as hospitalisation or death from asthma).

*Last reviewed version 2.0*

*Asset ID: 16*

For children already taking regular preventer treatment, adjustments to the treatment regimen are based on finding the lowest dose of medicines that will maintain good control of symptoms.

*Last reviewed version 2.0*
Approaches to assessment and monitoring of asthma control in children

Assessment of asthma control in children is based mainly on:

- recent asthma symptom control (assessed by the frequency and severity of symptoms between flare-ups)
- the degree to which asthma symptoms affect daily activities such as interference with physical activity or missed school days)
- the frequency of flare-ups
- spirometry in children who are able to perform the test reliably.

Standardised questionnaires

Questionnaire-based instruments have been validated for assessing asthma control in children:

- **Test for Respiratory and Asthma Control in Kids (TRACK)** for children less than 5 years old - consists of five questions about frequency of respiratory symptoms (wheeze, cough, shortness of breath), activity limitation, and night-time awakenings in the past 4 weeks, rescue medication use in the past 3 months, and oral corticosteroid use in the previous year. A lower score indicates worse asthma control.
- **Childhood Asthma Control Test (C-ACT)** for children aged 4–11 years - consists of seven items: three for the parent/carer (about the child’s symptoms over the previous 4 weeks) and four for the child. A lower score indicates worse asthma control. **Note:** C-ACT is intended for US use.

Lung function tests

Frequent spirometry to guide asthma treatment in children has not been shown to achieve superior outcomes to symptom-based treatment. Current evidence does not support use of home spirometers to guide asthma treatment in children. However, low FEV\(_1\) predicts clinically significant flare-ups, so spirometry should be performed at asthma reviews for children who are old enough to do the test.

The quality and utility of spirometry depends on the skill, clinical expertise and experience of the person doing and interpreting spirometry.

The results of one study in children aged 6–16 years with moderate atopic asthma suggest that asthma treatment guided by airway hyperresponsiveness (measured by bronchial provocation testing) may have a benefit over symptom-guided treatment in improving lung, but this effect was lost after 3–7 years of usual care. Repeated bronchial provocation testing is not feasible in clinical practice.

Measures of airway inflammation

Measures of airway inflammation (e.g. sputum eosinophil count, exhaled nitric oxide measurement) are not recommended in primary care to guide treatment decisions, but are increasingly used in specialist clinics.

Asthma treatment guided by sputum eosinophil count has been shown to reduce the frequency of flare-ups in adults with asthma, but there is insufficient evidence to ascertain its value for children.

Exhaled nitric oxide measurement may be useful in guiding asthma management in some children. In children not taking inhaled corticosteroid, a high nitric oxide level probably predicts a good short-term response to inhaled corticosteroid treatment, but it does not distinguish between asthma and eosinophilic bronchitis and is often high in children with atopy. There is insufficient evidence to ascertain whether a low exhaled nitric oxide level predicts successful withdrawal from inhaled corticosteroids without asthma relapse, or safety of treating asthma without inhaled corticosteroids.

A Cochrane review found that exhaled nitric oxide-guided management was significantly better than other approaches to adjusting medicines for reducing the number of children with flare-ups and the number of children who needed oral corticosteroids, but did not reduce the frequency of flare-ups or the rate of flare-ups requiring hospitalisation, improve lung function or symptoms scores, or reduce inhaled corticosteroid doses. The authors concluded that it could not be recommended for all children but may be beneficial for a subset not yet defined.

Towards personalised asthma care

Emerging understanding of asthma phenotypes and of genetic factors that predict therapeutic response to preventer options is leading to the possibility of personalised, genomics-based treatment for asthma in children. In the near future, individual tailored therapy is may replace the standardised step model based on population data.

Role of spirometry in the diagnosis of asthma in children

Generally, spirometry cannot be performed to acceptable standards in children younger than 4–5 years.

Some older children cannot perform spirometry either. However, children who are unable to perform spirometry satisfactorily on their first visit are often able to perform the test correctly at the next visit.
Normal spirometry in a child, especially when asymptomatic, does not exclude the diagnosis of asthma. FEV₁ is often normal in children with persistent asthma.

Reduced FEV₁ alone does not indicate that a child has asthma, because it may be seen with other lung diseases (or be due to poor spirometric technique). However, reduced ratio of FEV₁ to FVC for age indicates expiratory airflow limitation.

A significant increase in FEV₁ (>12% from baseline) after administering a bronchodilator (e.g. 2–4 puffs of salbutamol 100 microg/actuation) indicates that airflow limitation is reversible and supports the diagnosis of asthma. However, an absent response to bronchodilators does not exclude asthma.

In children with asthma, bronchodilator reversibility is also predictive of a good lung function response to inhaled corticosteroids.16

- Go to: National Asthma Council Australia’s Spirometry Resources

Managing cough in children

When cough is the predominant symptom in a young child, careful assessment is needed to avoid making an incorrect diagnosis of asthma, or instigating inappropriate treatment.17 Cough alone (recurrent non-specific cough) is most likely due to recurrent viral bronchitis, which is unresponsive to both bronchodilators and preventive therapy including inhaled corticosteroids. Recurrent non-specific cough usually resolves by age 6 or 7 years and leaves no residual pulmonary pathology.

If cough is a problem for a child with known asthma, it should be managed according to national Cough in Children and Adults: Diagnosis and Assessment (CICADA) guidelines.17

- There are significant concerns about use of cough medicines in children.

References


Prescribing reliever and considering regular preventer treatment for children 6 years and over

Recommendations

Discuss the goals of asthma treatment with the child’s parents/carers and the child (as appropriate to the child’s age and maturity). Explain that the overall aims of treatment are to reduce the risk of flare-ups, make sure asthma does not interfere with sport, play or school attendance, and to minimise the side effects of treatment by using the lowest level of medication required to maintain good asthma control.

*Figure. Stepped approach to adjusting asthma medication in children aged 6-11 years*

Please view and print this figure separately: http://www.asthmahandbook.org.au/figure/show/120

*How this recommendation was developed*
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).
Last reviewed version 2.0

For all children, prescribe a reliever for as-needed relief of symptoms. Educate children and parents/carers how and when to use reliever, and advise them to carry reliever (and spacer) at all times.

Advise that reliever should not be used regularly.

*Table. Non-emergency use of bronchodilators (relievers) in children aged 6–11 years*

<table>
<thead>
<tr>
<th>Option</th>
<th>Dose</th>
<th>Mode of delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Salbutamol</em></td>
<td>100 microg per actuation (puff)</td>
<td>2–4 puffs as needed (one at a time)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repeat if needed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pressurised metered-dose inhaler plus spacer</td>
</tr>
<tr>
<td><em>Terbutaline</em></td>
<td>500 microg/actuation</td>
<td>1–2 actuations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repeat if needed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dry-powder inhaler†</td>
</tr>
</tbody>
</table>

Note: This table lists usual doses to be administered by parents/carers in the community to manage symptoms as needed. Higher during may be given during acute asthma, including emergencies.

† If able to use this type of inhaler correctly

- Do not prescribe oral salbutamol.

Last reviewed version 2.0
Asset ID: 28

*How this recommendation was developed*
Consensus
Consider regular preventer treatment according to pattern of symptoms. Explain to parents/carers that preventer treatment should be taken every day and continued long term.

**Table. Classification of asthma and indications for initiating preventer treatment in children aged 6–11**

| Severity of flare-ups | Average frequency of flare-ups and symptoms between flare-ups | Infrequent intermittent Flare-ups every 6 weeks or less and no symptoms between flare-ups | Frequent intermittent Flare-ups more than once every 6 weeks and no symptoms between flare-ups | Persistent Between flare-ups (any of):
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Daytime symptoms‡ more than once per week</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Symptoms restrict activity or sleep</td>
</tr>
<tr>
<td>Mild flare-ups</td>
<td></td>
<td>Not indicated</td>
<td>Consider</td>
<td>Indicated</td>
</tr>
<tr>
<td>(almost always managed with salbutamol in community)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate–severe flare-ups</td>
<td></td>
<td>Consider</td>
<td>Indicated</td>
<td>Indicated</td>
</tr>
<tr>
<td>(&gt;2 in past year requiring ED or oral corticosteroids)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life-threatening flare-ups</td>
<td></td>
<td>Indicated</td>
<td>Indicated</td>
<td>Indicated</td>
</tr>
<tr>
<td>(require hospitalisation or PICU)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Preventer should be started as a treatment trial. Assess response after 4–6 weeks and review before prescribing long term.

ED: emergency department

Indicated: Prescribe preventer and monitor as a treatment trial. At follow-up, discontinue if ineffective

Not indicated: Preventer is unlikely to be beneficial

Consider prescribing preventer according to overall risk for severe flare-ups

† Symptoms between flare-ups. A flare-up is defined as a period of worsening asthma symptoms, from mild (e.g. symptoms that are just outside the normal range of variation for the child, documented when well) to severe (e.g. events that require urgent action by parents/carers and health professionals to prevent a serious outcome such as hospitalisation or death from asthma).

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

Table. Definitions of ICS dose levels in children

<table>
<thead>
<tr>
<th>Inhaled corticosteroid</th>
<th>Daily dose (microg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Beclometasone dipropionate †</td>
<td>100–200</td>
</tr>
<tr>
<td>Budesonide</td>
<td>200–400</td>
</tr>
<tr>
<td>Ciclesonide ‡</td>
<td>80–160</td>
</tr>
<tr>
<td>Fluticasone propionate</td>
<td>100–200</td>
</tr>
</tbody>
</table>

† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)

‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

Source


How this recommendation was developed
When starting preventer for the first time, the choice of agent can be guided by the following considerations.

An inhaled corticosteroid should be considered as the first choice preventer for those with symptoms that are frequent (e.g. daytime or night-time symptoms at least once per week), symptoms that restrict activity or sleep, or a history of severe flare-ups (e.g. requiring treatment in the emergency department or hospital admission).

An inhaled corticosteroid could also be preferable when either of the following are present:

- atopy
- raised blood eosinophil count (if known; this test is not recommended routinely).

When starting preventer for the first time for a child aged 2 years or over, the choice of agent can be guided by the following considerations.

Montelukast might be considered as alternative to an inhaled corticosteroid when any of the following apply:

- The child is unable or refuses to use pMDI + spacer/mask.
- The child has significant allergic rhinitis that requires treatment.
- Parents, despite education about risks and benefits, decline inhaled corticosteroids or are significantly concerned about their adverse effects (poor adherence is likely in this context).

How this recommendation was developed

Consensus recommendation following inconclusive literature search

Based on clinical experience and expert opinion after literature review yielded insufficient evidence for an evidence-based recommendation

Key evidence considered:

- Chauhan et al. 2013
- Ciółkowski et al. 2014
- Nagao et al. 2018
- Nwokoro et al. 2014
- Valovirta et al. 2011
- Pike et al. 2018
- Ducharme et al. 2012
- Garcia Garcia et al. 2005
- Luskin et al. 2003
- Sorkness et al. 2007
- Zeiger et al. 2006
- Ostrom et al. 2005
- Grzelewski & Stelmach 2009

Last reviewed version 2.0
When prescribing montelukast, start as a treatment trial. Review effects at 4–6 weeks and discontinue if no response. (The response to montelukast may be genotype dependent.)

- Advise parents/carers about potential adverse psychiatric effects of montelukast.

▶ Go to: TGA alert

How this recommendation was developed

Evidence-based recommendation

Based on literature search and formulated by multidisciplinary working group

Key evidence considered:
- Chauhan et al. 2013
- Ciółkowski et al. 2014
- Nagao et al. 2018
- Nwokoro et al. 2014
- Valovirta et al. 2011
- Pike et al. 2018
- Ducharme et al. 2012
- Garcia Garcia et al. 2005
- Luskin et al. 2003
- Sorkness et al. 2007
- Zeiger et al. 2006
- Ostrom et al. 2005
- Grzelewski & Stelmach 2009
- Stelmach et al. 2008
- Knorr et al. 1998
- Becker et al. 2004

Last reviewed version 2.0

When prescribing montelukast, warn parents/carers that behavioural and/or neuropsychiatric effects of montelukast are possible, but do not occur in the majority of children. Explain that if these adverse effects occur, they are typically seen within the first 2 weeks of starting regular treatment but resolve soon after discontinuing.

When dispensing montelukast in pharmacies, counsel parents/carers about behavioural and/or neuropsychiatric effects of montelukast and provide the consumer medicines information leaflet.

▶ Go to: TGA alert

How this recommendation was developed

Evidence-based recommendation

Based on literature search and formulated by multidisciplinary working group

Key evidence considered:
- Bernard et al. 2017
- Wallerstedt et al. 2009
- Philip et al. 2009
- Philip et al. 2009
- Ali et al. 2015
- Therapeutic Goods Administration
- Schumock et al. 2012
When prescribing regular inhaled corticosteroids, begin with a low dose.

Table. Definitions of ICS dose levels in children

<table>
<thead>
<tr>
<th>Inhaled corticosteroid</th>
<th>Daily dose (microg)</th>
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† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)
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Source

Table. Classification of asthma and indications for initiating preventer treatment in children aged 6–11

<table>
<thead>
<tr>
<th>Severity of flare-ups</th>
<th>Average frequency of flare-ups and symptoms between flare-ups</th>
</tr>
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<tbody>
<tr>
<td><strong>Infrequent intermittent</strong></td>
<td>Flare-ups every 6 weeks or less and no symptoms between flare-ups</td>
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<td><strong>Frequent intermittent</strong></td>
<td>Flare-ups more than once every 6 weeks and no symptoms between flare-ups</td>
</tr>
<tr>
<td><strong>Persistent</strong></td>
<td>Between flare-ups (any of):</td>
</tr>
<tr>
<td></td>
<td>• Daytime symptoms‡ more than once per week</td>
</tr>
<tr>
<td></td>
<td>• Night-time symptoms‡ more than twice per month</td>
</tr>
<tr>
<td></td>
<td>• Symptoms restrict activity or sleep</td>
</tr>
<tr>
<td>Mild flare-ups</td>
<td>Not indicated</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>(almost always managed with salbutamol in community)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moderate–severe flare-ups</th>
<th>Consider</th>
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<th>Indicated</th>
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<tbody>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Life-threatening flare-ups</th>
<th>Indicated</th>
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<th>Indicated</th>
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<tr>
<td>(require hospitalisation or PICU)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Preventer should be started as a treatment trial. Assess response after 4–6 weeks and review before prescribing long term.

ED: emergency department

Indicated: Prescribe preventer and monitor as a treatment trial. At follow-up, discontinue if ineffective

Not indicated: Preventer is unlikely to be beneficial

Consider prescribing preventer according to overall risk for severe flare-ups

‡ Symptoms between flare-ups. A flare-up is defined as a period of worsening asthma symptoms, from mild (e.g. symptoms that are just outside the normal range of variation for the child, documented when well) to severe (e.g. events that require urgent action by parents/carers and health professionals to prevent a serious outcome such as hospitalisation or death from asthma).

Last reviewed version 2.0

Asset ID: 16

**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

Last reviewed version 2.0

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Do not routinely prescribe theophyllines (aminophylline or theophylline) for children.

Note: Theophyllines are sometimes prescribed by specialists for children with severe asthma.

**How this recommendation was developed**

Consensus

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

Last reviewed version 2.0

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Ipratropium is not recommended for the regular management of asthma in children.

Note: Ipratropium is used in the management of 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):
Classification of recent asthma symptom control in children

Ongoing review of asthma involves both assessing recent asthma symptom control and assessing risks for poor asthma outcomes such as flare-ups and adverse effects of medicines.

Recent asthma symptom control is assessed according to the frequency of asthma symptoms over the previous 4 weeks.

Table. Definition of levels of recent asthma symptom control in children (regardless of current treatment regimen)

<table>
<thead>
<tr>
<th>Good control</th>
<th>Partial control</th>
<th>Poor control</th>
</tr>
</thead>
<tbody>
<tr>
<td>All of:</td>
<td>Any of:</td>
<td>Either of:</td>
</tr>
<tr>
<td>- Daytime symptoms(^\d) ≤ 2 days per week (lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)</td>
<td>- Daytime symptoms(^\d) &gt; 2 days per week (lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)</td>
<td>- Daytime symptoms(^\d) &gt; 2 days per week (lasting from minutes to hours or recurring, and partially or fully relieved by SABA reliever)</td>
</tr>
<tr>
<td>- No limitation of activities(^\d)</td>
<td>- Any limitation of activities(^*)</td>
<td>- ≥ 3 features of partial control within the same week</td>
</tr>
<tr>
<td>- No symptoms(^\d) during night or when wakes up</td>
<td>- Any symptoms during night or when wakes up(^\d)</td>
<td></td>
</tr>
<tr>
<td>- Need for SABA reliever(^#) ≤ 2 days per week</td>
<td>- Need for SABA reliever(^#) &gt; 2 days per week</td>
<td></td>
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</tbody>
</table>

SABA: short-acting beta\(_2\) agonist
\(^\d\) e.g. wheezing or breathing problems
\(^\d\) child is fully active; runs and plays without symptoms
\(^\d\) including no coughing during sleep
\(^\#\) not including doses taken prophylactically before exercise. (Record this separately and take into account when assessing management.)
\(^*\) e.g. wheeze or breathlessness during exercise, vigorous play or laughing
\(^\d\)\(^\d\) e.g. waking with symptoms of wheezing or breathing problems

Notes:

Recent asthma control is based on symptoms over the previous 4 weeks. Each child’s risk factors for future asthma outcomes should also be assessed and taken into account in management.

Validated questionnaires can be used for assessing recent symptom control:
Test for Respiratory and Asthma Control in Kids (TRACK) for children < 5 years
Childhood Asthma Control Test (C-ACT) for children aged 4–11 years

Table. Risk factors for life-threatening asthma flare-ups in children

Asthma-related factors

Poor asthma control
Admission to hospital in preceding 12 months
History of intubation for acute asthma
Over-use of short-acting beta2 agonist reliever
Abnormal spirometry findings
Reversible expiratory airflow limitation on spirometry despite treatment
Poor adherence to preventer
Incorrect inhaler technique for preventer
Poor adherence to asthma action plan
Exposure to clinically relevant allergens
Exposure to tobacco smoke

Other clinical factors
Allergies to foods, insects, medicines
Obesity

Family-related factors
Frequent failure to attend consultations/lack of follow-up after an acute flare-up
Significant parental psychological or socioeconomic problems
Parent/carer unequipped to manage asthma emergency

Table. Definition of levels of recent asthma symptom control in children (regardless of current treatment regimen)

<table>
<thead>
<tr>
<th>Good control</th>
<th>Partial control</th>
<th>Poor control</th>
</tr>
</thead>
<tbody>
<tr>
<td>All of:</td>
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<tr>
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<td>- Any symptoms during night or when wakes up††</td>
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<td>- Need for SABA reliever‡ ≤ 2 days per week</td>
<td>- Need for SABA reliever‡ &gt; 2 days per week</td>
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</tbody>
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Short-acting beta-2 agonist relievers for children: 6 years and over
Inhaled short-acting beta2 agonists is the major class of bronchodilators used for relief of symptoms in asthma.30
Children with well-controlled asthma need little or no reliever (on no more than 2 days per week).
Increased use of short-acting beta2 agonists for relief of asthma symptoms, especially daily use, indicates deterioration of asthma control.31, 32
Dispensing of 3 or more canisters in a year (average 1.6 puffs per day) is associated with increased risk of flare-ups.33 Dispensing 12 or more canisters in a year (average 6.6 puffs per day) is associated with increased risk of asthma death.2
SABA: short-acting beta2 agonist
† e.g. wheezing or breathing problems
‡ child is fully active; runs and plays without symptoms
§ including no coughing during sleep
# not including doses taken prophylactically before exercise. (Record this separately and take into account when assessing management.)
* e.g. wheeze or breathlessness during exercise, vigorous play or laughing
†† e.g. waking with symptoms of wheezing or breathing problems

Notes:
Recent asthma control is based on symptoms over the previous 4 weeks. Each child’s risk factors for future asthma outcomes should also be assessed and taken into account in management.

Validated questionnaires can be used for assessing recent symptom control:
Test for Respiratory and Asthma Control in Kids (TRACK) for children < 5 years
Childhood Asthma Control Test (C-ACT) for children aged 4–11 years

Table. Types of inhaler devices for delivering asthma and COPD medicines
Please view and print this figure separately: http://www.asthmahandbook.org.au/table/show/75

A pressurised metered-dose inhaler and spacer is an appropriate first choice for most children.36
School-aged children are unlikely to use their inhaler device correctly without careful training and repeated checking.39

Correct use of inhaler devices
Checking and correcting inhaler technique is essential to effective asthma management.
Most patients with asthma or COPD do not use their inhalers properly,40,41,42,43 and most have not had their technique checked or corrected by a health professional.
Incorrect inhaler technique when using maintenance treatments increases the risk of severe flare-ups and hospitalisation for people with asthma or COPD.40,41,44,45,46,47
Poor asthma symptom control is often due to incorrect inhaler technique.48,49
Incorrect inhaler technique when using inhaled corticosteroids increases the risk of local side effects like dysphonia and oral thrush.
The steps for using an inhaler device correctly differ between brands. Checklists of correct steps for each inhaler type and how-to videos are available from the National Asthma Council website.

Administration of inhaled medicines in children: 6 years and over
Parents, carers and children need training to use inhaler devices correctly, including inhaler technique, and care and cleaning of inhalers and spacers.
School-aged children (depending on the child’s age, ability, and with individualised training) can learn to use a range of inhaler types, including manually actuated pressurised metered-dose inhalers with spacers, breath-actuated pressurised metered-dose inhalers (e.g. Autohaler), and dry-powder inhalers (e.g. Accuhaler, Turbuhaler).34,35,36,37,38
**Preparation of new spacers before first use**

Spacers are made of plastic, antistatic polymer/polycarbonate polyurethane, or cardboard.

**Plastic spacers (e.g. Breath-A-Tech, Volumatic)**

Electrostatic surface charge on new spacers made of plastic (e.g. Breath-A-Tech, Volumatic) reduces the proportion of medicine available for delivery to the airway. This charge can be reduced by washing the plastic spacer in dishwashing liquid and allowing it to air dry or drip-dry without rinsing or wiping.50

Alternatively, priming the spacer by actuating the device several times into the spacer also overcomes the charge, but this wastes medicine. The optimal number of actuations for priming is not known and the findings of in vitro studies vary widely. One study (using older, CFC-based formulations of asthma medicines) reported that up to 40 actuations fired into a new plastic spacer overcame the effect of the electrostatic charge.51 Others have concluded that the electrostatic charge on plastic spacers does not reduce in vivo efficacy of bronchodilator therapy in children with asthma.52 The number of actuations necessary may be known when the results of recent studies become available.

When a new plastic spacer must be used immediately (e.g. for a person with asthma symptoms), patients, parents and carers should follow the manufacturer’s priming instructions. In hospitals and emergency departments, a new spacer that has not been pre-treated by washing can be primed using multiple (at least 10) puffs of salbutamol. (This is an arbitrary number of actuations in the absence of evidence that would enable a precise guideline.)

**Non-plastic spacers**

Disposable cardboard spacers (e.g. DispozABLE, LiteAire) and polyurethane/antistatic polymer spacers (e.g. Able A2A, AeroChamber Plus, La Petite E-Chamber, La Grande E-Chamber) do not require preparation before first use.50

**Note:** The term ‘priming’ is also used for the preparation process that is necessary for new pressurised metered-dose inhalers that have not been used for more than a week. This involves first actuating the inhaler into the air (away from the patient). Users should follow the manufacturer’s instructions for the particular brand of inhaler, which specify the number of actuations required.

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**Montelukast for children: efficacy**

- Montelukast use has been associated with behavioural and/or neuropsychiatric adverse effects, including suicidality.

  [Go to: TGA alert]

**Overview**

Montelukast is a leukotriene receptor antagonist preventer. It is registered by the TGA for the treatment of asthma in children aged 2 years and older, and for the symptomatic treatment of allergic rhinitis.53

Montelukast can be used as an alternative to inhaled corticosteroids or as an add-on treatment in a child already taking regular inhaled corticosteroids.

However, it is not effective for all children. Overall, only approximately 20–30% of children will respond to montelukast treatment. The effect is thought to depend mainly on the child’s genotype.54, 55 Clinically, it is not possible to predict accurately which children will benefit most from montelukast treatment.

**Montelukast as first-line preventer in children aged 2–5 years**

**Viral-induced wheezing**

Overall, regular maintenance montelukast treatment does not reduce the risk of wheezing episodes requiring oral corticosteroid treatment among preschool children who only have wheezing episodes when they have viral upper respiratory tract infections.56

However, montelukast may be effective for some children. Some randomised controlled trials have reported a reduction the risk of flare-ups in preschool children with intermittent asthma/wheeze,57, 4 while others have not.6

**Persistent asthma or wheezing**

A systematic review comparing montelukast with inhaled corticosteroids in preschoolers with asthma or recurrent wheezing requiring daily preventer treatment58 reported that inhaled corticosteroids appeared to achieve better symptom control and reduce flare-ups (including severe flare-ups requiring treatment with systemic corticosteroids). However, results were inconsistent and meta-analysis was not possible due to heterogeneity of outcomes measured in available clinical trials.58

Some preschool children with persistent asthma/wheeze respond to montelukast. A crossover study in preschool children with persistent asthma/wheeze reported that some children showed their best response to montelukast, while most responded better to
regular inhaled corticosteroids. Predictors of a better response to inhaled corticosteroids than montelukast were aeroallergen hypersensitivity and blood eosinophilia (eosinophil counts ≥ 300/μL). However, routine blood eosinophil count is not feasible or recommended for this purpose.

**Montelukast as first-line preventer children aged 6 years and over**

In school-aged children with persistent asthma, inhaled corticosteroids are more effective overall than montelukast in improving lung function and controlling asthma symptoms. However, symptoms will respond to a treatment trial of montelukast in approximately one-quarter to one-third of children, and some may benefit more than from an inhaled corticosteroid. More severe asthma and markers of allergic inflammation may predict a better response to inhaled corticosteroids.

**Montelukast as add-on treatment**

A systematic review of studies in children over 6 years and adolescents with mild-to-moderate persistent asthma found that the addition of montelukast to inhaled corticosteroids did reduce flare-ups requiring oral corticosteroids or hospital admissions for asthma, compared with the same or an increased dose.

In a study comparing step-up treatments in children with asthma symptoms uncontrolled by low-dose inhaled corticosteroids, the addition of a long-acting beta2 agonist was effective in more children than either montelukast or increasing the dose of inhaled corticosteroid for controlling asthma symptoms and preventing flare-ups requiring systemic corticosteroids. However, some studies in school-aged children with persistent asthma already taking regular inhaled corticosteroids have reported that add-on montelukast reduced the risk of flare-ups and exercise-induced asthma symptoms. Not all children will respond.

In a small study in children with persistent asthma already taking regular inhaled corticosteroids who were homozygous for the Arg16 genotype, montelukast was more effective as an add-on therapy than long-acting beta2 agonist in reducing symptoms, reliever use and days absent from school due to asthma, depending on the child’s beta receptor genotype. However, children were given inhaled corticosteroid and long-acting beta2 agonists in separate inhalers, which is known to be associated with increased risks. Genotyping it is not currently feasible in clinical practice. In practice, a treatment trial of 4–6 weeks can determine which preventer is suitable for controlling a child’s asthma symptoms, but longer treatment may be required to evaluate effect on flare-ups, because flare-ups may be independent of symptom control.

**Exercise-induced symptoms**

In school-aged children who experience exercise-induced symptoms despite taking regular inhaled corticosteroids, the addition of montelukast is effective in controlling symptoms, but not all children experience a response.

See: Investigation and management of exercise-induced bronchoconstriction

**Short-term use in the management of flare-ups**

Some, but not all studies suggest that a short course of montelukast, introduced at the first signs of an upper respiratory tract infection, may be effective in controlling flare-ups. An Australian study reported that this strategy could achieve a small reduction in symptoms, school absence and medical consultations in preschool and school-aged children with episodic wheeze.

However, the evidence is inconsistent, with some studies showing no benefit. The findings of one study suggested that whether or not intermittent montelukast is effective in wheezing children aged 5 years and under depends on genotype. Montelukast is not TGA-approved or PBS-subsidised for intermittent use.

**Montelukast for children: behavioural and/or neuropsychiatric adverse effects**

Montelukast is generally very well tolerated. Behavioural and psychiatric adverse effects were rare in clinical trials. However, post-marketing surveillance reports have identified behavioural and/or neuropsychiatric adverse effects associated with montelukast use in some children. Behavioural treatment-associated effects are difficult to assess in young children. No factors have been identified to predict which children are at risk.

Reported adverse events include nightmares, sleep disturbance, anxiety, irritability, aggression and depression. Suicidal ideation has been reported in adolescents and adults taking montelukast. A nested case-control study concluded that children with asthma aged 5–18 years taking leukotriene receptor antagonists were not at increased risk of suicide attempts.

Reported adverse events are usually mild. The majority occur within 7–14 days of starting montelukast, but some may appear after several months.
Inhaled corticosteroids for children: efficacy

Role in treatment asthma in children

The effectiveness of ICS in children appears to depend on several factors including the child’s age, which triggers are causing symptoms, wheezing phenotype, tobacco smoke exposure and genotype.\textsuperscript{76} Overall, inhaled corticosteroids seem to be more effective in older children and those with more severe disease.\textsuperscript{1}

Early introduction of inhaled corticosteroid for children with recurrent wheeze does not prevent airway remodelling, improve long-term lung function or prevent the onset of persistent asthma, according to current evidence from long-term randomised controlled clinical trials in preschool children and school-aged children with intermittent or mild persistent asthma.\textsuperscript{1}

Current evidence does not support planned seasonal use of inhaled corticosteroids in children not taking preventer at other times.\textsuperscript{77}

Children aged 1–5 years

Intermittent wheeze/asthma

In preschool children who only have wheezing episodes with viral respiratory infections, limited available evidence suggests that regular treatment with inhaled corticosteroids does not reduce the risk of hospitalisation, flare-ups that require oral corticosteroid use, or reduce the frequency and duration of acute episodes.\textsuperscript{76,78} Inhaled corticosteroid treatment does not reduce these children’s risk of developing persistent wheeze by age 6 years.\textsuperscript{50}

Persistent wheeze/asthma

In preschool children who have episodes of wheezing from time to time, but also cough and wheezes at other times when they do not have a viral cold (e.g. when cries, plays or laughs), regular inhaled corticosteroids are moderately effective in controlling symptoms, though less effective than in older children.\textsuperscript{50} When wheeze improves markedly during a short treatment trial (e.g. 3 months), it is not possible to tell whether improvement was due to the treatment or spontaneous resolution of symptoms.\textsuperscript{50} However, this can be clarified by stopping inhaled corticosteroid treatment, monitoring symptoms, and re-starting.

In infants and preschoolers with persistent wheezing or asthma of at least 6 months’ duration, regular treatment with inhaled corticosteroids improves wheezing, asthma symptoms and lung function, and reduces flare-ups.\textsuperscript{1,79}

Children aged 6 years and over

Most clinical trials of regular inhaled corticosteroid treatment in children have been conducted among children with asthma symptoms every week or more often (‘persistent asthma’).\textsuperscript{1}

Beclometasone dipropionate, budesonide, ciclesonide and fluticasone propionate have all been shown to be effective in children. There have been relatively fewer studies of ciclesonide in children,\textsuperscript{1} but, overall, randomised clinical trials show that it is equally effective as budesonide or fluticasone propionate in improving asthma symptoms and reducing flare-ups.\textsuperscript{80} In some studies, ciclesonide was associated with less adrenal suppression or height than comparator inhaled corticosteroids.\textsuperscript{80}

In a study of school-aged children with more than 2 days per week with symptoms, night waking more than twice per month due to asthma symptoms, or needing regular preventer, regular low-dose daily inhaled corticosteroid treatment reduced the rate of flare-ups that require treatment with oral corticosteroids, compared with no regular preventer treatment and as-needed short-acting beta\textsubscript{2} agonist for wheezing episodes.\textsuperscript{81}

In a study of children aged 4–11 years with asthma diagnosed within the previous 2 years and symptoms more than weekly in the previous 3 months, regular preventer was associated with a reduction in serious flare-ups, school absence due to asthma, an increase in symptom-free days, and improved lung function, compared with placebo.\textsuperscript{82,83}

The Thoracic Society of Australia and New Zealand’s current position statement on the use of inhaled corticosteroids in children\textsuperscript{1} recommends regular treatment with inhaled corticosteroid:
- as a first-choice preventer for children with asthma symptoms at least daily or night-time symptoms at least twice per week between flare-ups
- as an alternative to cromones (nedocromil or sodium cromoglycate) or montelukast in children with any daytime or night-time
symptoms between flare-ups, or those with flare-ups every 6 weeks or more.

**Doses**

In the majority of children, asthma control can be achieved with any of the following initial doses:

- budesonide up to 400 microg/day
- beclometasone (Qvar) up to 200 microg/day
- ciclesonide up to 160 microg/day
- fluticasone propionate up to 200 microg/day.

If these doses do not achieve control of symptoms, possible explanations include alternative diagnoses, adherence, incorrect inhaler technique, psychosocial factors and exposure to tobacco smoke or other triggers such as allergens.

Dose–response studies of inhaled corticosteroids show that the maximal efficacy is generally achieved at a dose equivalent to approximately 200 microg/day fluticasone propionate, while the risk of adrenal suppression increases exponentially at doses above 500 microg/day. Therefore (based on theoretical equivalents between different agents), upper limits of daily doses for children are:

- budesonide 800 microg/day
- beclometasone dipropionate [Qvar] 400 microg/day
- ciclesonide 320 microg/day
- fluticasone propionate 500 microg/day.

Higher doses are unlikely to be more effective, and are likely to cause systemic effects.

Most studies of inhaled corticosteroids in children have used twice-daily dosing. Fluticasone propionate is only approved for twice-daily dosing, but the other inhaled corticosteroids are approved for once daily. Ciclesonide is effective when given once daily.

**Note:** Do not use beclometasone dose recommendations from outdated or overseas guidelines based on older formulations containing CFC propellant – doses are different.

### Table. Definitions of ICS dose levels in children

<table>
<thead>
<tr>
<th>Inhaled corticosteroid</th>
<th>Daily dose (microg)</th>
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† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)

‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

**Source**


Last reviewed version 2.0
Asset ID: 21

**Inhaled corticosteroids for children: adverse effects**

**Local adverse effects**

Hoarseness and pharyngeal candidiasis are not commonly reported among preschool children or school-aged children taking inhaled
Topical effects can be reduced by use of spacer devices (which reduce oropharyngeal deposition), and by mouth-rinsing and spitting after use. Immediate quick mouth-rinsing removes more residual medicine in the mouth than delayed rinsing.

There is limited evidence that inhaled asthma medication can affect dental health. Mouth rinsing might reduce this risk.

**Systemic adverse effects**

Systemic effects of inhaled corticosteroids in children depend on the dose, but clinically significant adverse effects are uncommon. The use of spacers and mouth rinsing will not reduce systemic effects, but the use of a spacer may increase efficacy so that a lower dose is required.

**Growth**

Short-term suppression of linear growth has been demonstrated in children taking inhaled corticosteroids. The effect seems to be maximal during the first year of therapy and only one study has reported an effect in subsequent years of treatment. A Cochrane systematic review concluded that regular use of inhaled corticosteroid at low or medium daily doses is associated with a mean reduction of 0.48 cm per year in linear growth velocity and 0.61 cm less gain in height during 1 year of treatment in children with mild to moderate persistent asthma.

One study of patients who participated in a clinical trial of inhaled corticosteroids as children, reported a reduction in adult height of approximately 1 cm, whereas several studies have reported that children taking inhaled corticosteroids attained normal adult height. The effect is dose-dependent and may be more likely in children who begin inhaled corticosteroid treatment before age 10. Other factors affect growth in children with asthma. Uncontrolled asthma itself reduces growth and final adult height.

**Bone density**

Inhaled corticosteroids have not been associated with effects on bone density or fractures in children. However, data from a recent study in Australia suggested asthma itself is associated with increased incidence of fractures in children, independent of medication. Given that the total dose of corticosteroids (both inhaled corticosteroids and oral corticosteroids) influences bone health, the aim of asthma management is to maintain symptom control using the lowest inhaled corticosteroid dose required, and to avoid repeated courses of oral corticosteroids.

**Adrenal suppression**

Biochemical testing in a research setting suggests that hypothalamic–pituitary–adrenal axis suppression may occur in up to two-thirds of children treated with inhaled corticosteroids, and may occur at even low doses. The risk is higher among children receiving concomitant intranasal steroids and those with lower body mass index, and is influenced by genetics.

Clinical adrenal insufficiency in children taking inhaled corticosteroids is rare but has been reported, including cases in Australia. Most cases have involved children given more than 500 microg per day fluticasone propionate. Adrenal suppression is associated with hypoglycaemia, hypotension, weakness, failure to grow, and is potentially fatal. Hypothalamic–pituitary–adrenal axis suppression may not be detected until adrenal crisis is precipitated by physical stress.

Written information (e.g. a steroid alert card) can be prepared for children receiving long-term high-dose inhaled corticosteroids. Parents/carers can be instructed to present the card if the child ever needs to go to the emergency department (for any reason) or be admitted to hospital. A steroid alert card should state that child has asthma and the inhaled corticosteroid dose. A medical alert bracelet could also be considered.

There are no nationally accepted protocols for routine assessment of adrenal function in primary care because it has not yet been possible to identify precisely which children should be tested, to interpret test results reliably, to identify the appropriate interval for retesting, and because a clinical benefit has not been clearly demonstrated.

Regular monitoring of height might help detect adrenal suppression, based on the findings of a study in which a reduction in linear growth velocity occurred before adrenal suppression.

### Table. Definitions of ICS dose levels in children

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† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)
‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

Source

Last reviewed version 2.0
Asset ID: 21

**Tiotropium for children aged 6 years and over**

Tiotropium (5 microg administered via mist inhaler as two puffs once daily) is approved by TGA for use in children aged 6 years and older with moderate-to-severe asthma.

Tiotropium is subsidised by then PBS for children aged 6–17 years when used in combination with maintenance ICS+LABA treatment, for patients with severe asthma treated by, or in consultation with, a specialist (respiratory physician, paediatric respiratory physician, clinical immunologist, allergist, paediatrician or general physician experienced in severe asthma management), with frequent moderate exacerbations or ≥ one documented severe exacerbation that required systemic corticosteroids in the previous 12 months despite maintenance treatment with a medium-to-high dose of inhaled corticosteroid in combination with a long-acting beta2 agonist, and correct inhaler technique has been assessed, demonstrated and documented (see PBS for details).

▶ Go to: PBS listings

**Children aged 6–11**

A systematic review of three randomised controlled trials reported that, in children aged 6–11 years with moderate-to-severe symptomatic asthma, tiotropium improved lung function, improved symptoms, and reduced the rate of flare-ups. Tiotropium was generally well tolerated.

▶ Go to: Australian Cough Guidelines

**Managing cough in children**

When cough is the predominant symptom in a young child, careful assessment is needed to avoid making an incorrect diagnosis of asthma, or instigating inappropriate treatment. Cough alone (recurrent non-specific cough) is most likely due to recurrent viral bronchitis, which is unresponsive to both bronchodilators and preventive therapy including inhaled corticosteroids. Recurrent non-specific cough usually resolves by age 6 or 7 years and leaves no residual pulmonary pathology.

If cough is a problem for a child with known asthma, it should be managed according to national Cough in Children and Adults: Diagnosis and Assessment (CICADA) guidelines.

- There are significant concerns about use of cough medicines in children.

▶ Go to: Australian Cough Guidelines
References


49. Hardwell, A., Barber, V., Hargadon, T, et al. Technique training does not improve the ability of most patients to use pressurised metered-dose inhalers (pMDIs). Prim Care Respir J. 2011; 20: 92-6. Available from: http://www.nature.com/articles/prcj201088


52. Dompeling E, Oudesluys-Murphy AM, Janssens HM, et al. Randomised controlled study of clinical efficacy of spacer therapy in
... with regard to electrostatic charge. Arch Dis Child. 2001; 84: 178-182. Available from: http://adc.bmj.com/content/84/2/178.full
Reviewing initial treatment in children aged 6 years and over

Recommendations

When prescribing any preventer medicine for a child, consider each adjustment to the regimen as a treatment trial: monitor response continually, review within 4–6 weeks (or earlier as needed in response to parents' concerns), and adjust treatment according to response.

Table. Reviewing and adjusting preventer treatment for children aged 6–11 years
Please view and print this figure separately: http://www.asthmahandbook.org.au/table/show/26

Figure. Stepped approach to adjusting asthma medication in children aged 6-11 years
Please view and print this figure separately: http://www.asthmahandbook.org.au/figure/show/120

If good asthma symptom control has not been achieved by an initial low dose of inhaled corticosteroids, do not increase the dose or change the regimen until you have (all of):

- checked adherence to the inhaled corticosteroid
- checked the child’s inhaler technique
- assessed exposure to environmental triggers (e.g. allergens, cigarette smoke)
- reviewed the diagnosis (consider whether symptoms may be due to a comorbidity or alternative diagnosis such as rhinosinusitis, de-conditioning, obesity or upper airway dysfunction).

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Source

How this recommendation was developed

Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).
Last reviewed version 2.0
If asthma is not well controlled by regular low-dose inhaled corticosteroid treatment (and adherence is good, inhaler technique is correct and diagnosis has been confirmed), consider one of the following options:

- Increase the inhaled corticosteroid dose.
- Continue low-dose inhaled corticosteroid and add montelukast.
- Switch to an inhaled corticosteroid/long-acting beta₂ agonist combination at low dose.

Note: TGA-registered indications for inhaled corticosteroid/long-acting beta2 agonist combinations differ between products.

- Advise parents/carers about potential adverse psychiatric effects of montelukast.

Go to: [TGA alert](#)

### Table. Definitions of ICS dose levels in children

<table>
<thead>
<tr>
<th>Inhaled corticosteroid</th>
<th>Daily dose (microg)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td><strong>Beclometasone dipropionate†</strong></td>
<td>100–200</td>
</tr>
<tr>
<td><strong>Budesonide</strong></td>
<td>200–400</td>
</tr>
<tr>
<td><strong>Ciclesonide ‡</strong></td>
<td>80–160</td>
</tr>
<tr>
<td><strong>Fluticasone propionate</strong></td>
<td>100–200</td>
</tr>
</tbody>
</table>

† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)

‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

Source


Last reviewed version 2.0

Asset ID: 21

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### 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

Last reviewed version 2.0

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### How this recommendation was developed

Consensus recommendation following inconclusive literature search

Based on clinical experience and expert opinion after literature review yielded insufficient evidence for an evidence-based recommendation
In children taking regular inhaled corticosteroid treatment, the dose of inhaled corticosteroid should be adjusted to the lowest dose needed to maintain control.

- **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

Last reviewed version 2.0

Long-acting beta2 agonists for children must not be prescribed in a separate inhaler, but only as a fixed-dose combination with an inhaled corticosteroid.

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

Last reviewed version 2.0

When reviewing treatment for a child taking a combination of inhaled corticosteroid and long acting beta2 agonist, ask parents/carers whether symptoms of wheeze or breathlessness resolve rapidly when the child is given short-acting beta2 agonist reliever.

If you suspect reduced response to short-acting beta2 agonist in a child treated with combination inhaled corticosteroid and long-acting beta2 agonist, consider obtaining a specialist opinion.

- **How this recommendation was developed**
  - Consensus recommendation following inconclusive literature search
    - Based on clinical experience and expert opinion after literature review yielded insufficient evidence for an evidence-based recommendation
  - Key evidence considered:
    - Carroll et al. 2010
    - Fogel et al. 2010
    - Adler et al. 2006
    - PBS 2017

Last reviewed version 2.0

In children with persistent exercise-induced respiratory symptoms despite regular treatment with inhaled corticosteroids, consider adding montelukast (children 6–14 years).

Advise parents/carers that not all children experience asthma improvement with montelukast.

Review response within 4–6 weeks and discontinue if no response.

Key evidence considered:
- Stempel et al. 2016
- Chang et al. 2014
- Malka et al. 2014
- Rabinovitch et al. 2014
- van Asperen et al. 2010
- Lemanske et al. 2010
- Papadopoulos et al. 2009

Last reviewed version 2.0
Advise parents/carers about potential adverse psychiatric effects of montelukast.

If treatment-related behavioural and/or neuropsychiatric symptoms are suspected in a child taking montelukast, discontinue treatment and advise parents/carers to monitor and treat asthma symptoms while off treatment.

If unsure whether a change in behaviour could be due to medication, consider stopping for a short time (e.g. 1 week or more) and re-starting to monitor effects.

If parents/carers report behavioural changes possibly related to treatment in a child taking regular inhaled corticosteroids, consider reducing the dose, changing to a different corticosteroid and monitoring effect, or trialling a different preventer.

More information

**Approaches to assessment and monitoring of asthma control in children**

Assessment of asthma control in children is based mainly on:

- recent asthma symptom control (assessed by the frequency and severity of symptoms between flare-ups)
- the degree to which asthma symptoms affect daily activities such as interference with physical activity or missed school days)
- the frequency of flare-ups
- spirometry in children who are able to perform the test reliably.

**Standardised questionnaires**

Questionnaire-based instruments have been validated for assessing asthma control in children:

- **Test for Respiratory and Asthma Control in Kids (TRACK)** for children less than 5 years old – consists of five questions about frequency of respiratory symptoms (wheeze, cough, shortness of breath), activity limitation, and night-time awakenings in the past 4 weeks, rescue medication use in the past 3 months, and oral corticosteroid use in the previous year. A lower score indicates worse asthma control.
- **Childhood Asthma Control Test (C-ACT)** for children aged 4–11 years – consists of seven items: three for the parent/carer (about the
Lung function tests

Frequent spirometry to guide asthma treatment in children has not been shown to achieve superior outcomes to symptom-based treatment.\(^{17}\) Current evidence does not support use of home spirometers to guide asthma treatment in children.\(^{18}\) However, low \(\text{FEV}_1\) predicts clinically significant flare-ups, so spirometry should be performed at asthma reviews for children who are old enough to do the test.

The quality and utility of spirometry depends on the skill, clinical expertise and experience of the person doing and interpreting spirometry.

The results of one study in children aged 6–16 years with moderate atopic asthma suggest that asthma treatment guided by airway hyperresponsiveness (measured by bronchial provocation testing) may have a benefit over symptom-guided treatment in improving lung, but this effect was lost after 3–7 years of usual care.\(^{19,20}\) Repeated bronchial provocation testing is not feasible in clinical practice.

Measures of airway inflammation

Measures of airway inflammation (e.g. sputum eosinophil count, exhaled nitric oxide measurement) are not recommended in primary care to guide treatment decisions, but are increasingly used in specialist clinics.

Asthma treatment guided by sputum eosinophil count has been shown to reduce the frequency of flare-ups in adults with asthma, but there is insufficient evidence to ascertain its value for children.\(^{21}\)

Exhaled nitric oxide measurement may be useful in guiding asthma management in some children. In children not taking inhaled corticosteroid, a high nitric oxide level probably predicts a good short-term response to inhaled corticosteroid treatment,\(^{22}\) but it does not distinguish between asthma and eosinophilic bronchitis and is often high in children with atopy. There is insufficient evidence to ascertain whether a low exhaled nitric oxide level predicts successful withdrawal from inhaled corticosteroids without asthma relapse,\(^{22}\) or safety of treating asthma without inhaled corticosteroids.

A Cochrane review\(^{23}\) found that exhaled nitric oxide-guided management was significantly better than other approaches to adjusting medicines for reducing the number of children with flare-ups and the number of children who needed oral corticosteroids, but did not reduce the frequency of flare-ups or the rate of flare-ups requiring hospitalisation, improve lung function or symptoms scores, or reduce inhaled corticosteroid doses. The authors concluded that it could not be recommended for all children but may be beneficial for a subset not yet defined.\(^{23}\)

Towards personalised asthma care

Emerging understanding of asthma phenotypes and of genetic factors that predict therapeutic response to preventer options is leading to the possibility of personalised, genomics-based treatment for asthma in children.\(^{24}\) In the near future, individual tailored therapy is may replace the standardised step model based on population data.

Table. Definition of levels of recent asthma symptom control in children (regardless of current treatment regimen)

<table>
<thead>
<tr>
<th>Good control</th>
<th>Partial control</th>
<th>Poor control</th>
</tr>
</thead>
<tbody>
<tr>
<td>All of:</td>
<td>Any of:</td>
<td>Either of:</td>
</tr>
<tr>
<td>- Daytime symptoms(^{†}) (\leq) 2 days per week (lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)</td>
<td>- Daytime symptoms(^{†}) &gt;2 days per week (lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)</td>
<td>- Daytime symptoms(^{†}) &gt;2 days per week (lasting from minutes to hours or recurring, and partially or fully relieved by SABA reliever)</td>
</tr>
<tr>
<td>- No limitation of activities(^‡)</td>
<td>- Any limitation of activities(^*)</td>
<td>(\geq) 3 features of partial control within the same week</td>
</tr>
<tr>
<td>- No symptoms(^§) during night or</td>
<td>- Any symptoms during night or</td>
<td></td>
</tr>
</tbody>
</table>

\(^{†}\) child's symptoms over the previous 4 weeks) and four for the child.\(^{15,16}\) A lower score indicates worse asthma control. **Note:** C-ACT is intended for US use.
<table>
<thead>
<tr>
<th>Good control</th>
<th>Partial control</th>
<th>Poor control</th>
</tr>
</thead>
<tbody>
<tr>
<td>when wakes up</td>
<td>when wakes up††</td>
<td></td>
</tr>
<tr>
<td>• Need for SABA reliever# ≤2 days</td>
<td>• Need for SABA</td>
<td></td>
</tr>
<tr>
<td>per week</td>
<td>reliever# &gt;2 daysper week</td>
<td></td>
</tr>
</tbody>
</table>

SABA: short-acting beta2 agonist
† e.g. wheezing or breathing problems
‡ child is fully active; runs and plays without symptoms
§ including no coughing during sleep
# not including doses taken prophylactically before exercise. (Record this separately and take into account when assessing management.)
* e.g. wheeze or breathlessness during exercise, vigorous play or laughing
†† e.g. waking with symptoms of wheezing or breathing problems

Notes:
Recent asthma control is based on symptoms over the previous 4 weeks. Each child’s risk factors for future asthma outcomes should also be assessed and taken into account in management.

Valued questionnaires can be used for assessing recent symptom control:
Test for Respiratory and Asthma Control in Kids (TRACK) for children < 5 years
Childhood Asthma Control Test (C-ACT) for children aged 4–11 years

Table. Risk factors for life-threatening asthma flare-ups in children

**Asthma-related factors**
Poor asthma control
Admission to hospital in preceding 12 months
History of intubation for acute asthma
Over-use of short-acting beta2 agonist reliever
Abnormal spirometry findings
Reversible expiratory airflow limitation on spirometry despite treatment
Poor adherence to preventer
Incorrect inhaler technique for preventer
Poor adherence to asthma action plan
Exposure to clinically relevant allergens
Exposure to tobacco smoke

**Other clinical factors**
Allergies to foods, insects, medicines
Obesity

**Family-related factors**
Frequent failure to attend consultations/lack of follow-up after an acute flare-up
Significant parental psychological or socioeconomic problems
Parent/carer unequipped to manage asthma emergency
Montelukast for children: efficacy

- Montelukast use has been associated with behavioural and/or neuropsychiatric adverse effects, including suicidality.

Overview

Montelukast is a leukotriene receptor antagonist preventer. It is registered by the TGA for the treatment of asthma in children aged 2 years and older, and for the symptomatic treatment of allergic rhinitis. Montelukast can be used as an alternative to inhaled corticosteroids or as an add-on treatment in a child already taking regular inhaled corticosteroids. However, it is not effective for all children. Overall, only approximately 20–30% of children will respond to montelukast treatment. The effect is thought to depend mainly on the child's genotype. Clinically, it is not possible to predict accurately which children will benefit most from montelukast treatment.

Montelukast as first-line preventer in children aged 2–5 years

Viral-induced wheezing

Overall, regular maintenance montelukast treatment does not reduce the risk of wheezing episodes requiring oral corticosteroid treatment among preschool children who only have wheezing episodes when they have viral upper respiratory tract infections. However, montelukast may be effective for some children. Some randomised controlled trials have reported a reduction in the risk of flare-ups in preschool children with intermittent asthma/wheeze, while others have not.

Persistent asthma or wheezing

A systematic review comparing montelukast with inhaled corticosteroids in preschoolers with asthma or recurrent wheezing requiring daily preventer treatment reported that inhaled corticosteroids appeared to achieve better symptom control and reduce flare-ups (including severe flare-ups requiring treatment with systemic corticosteroids). However, results were inconsistent and meta-analysis was not possible due to heterogeneity of outcomes measured in available clinical trials.

Some preschool children with persistent asthma/wheeze respond to montelukast. A crossover study in preschool children with persistent asthma/wheeze reported that some children showed their best response to montelukast, while most responded better to regular inhaled corticosteroids. Predictors of a better response to inhaled corticosteroids than montelukast were aeroallergen hypersensitivity and blood eosinophilia (eosinophil counts ≥ 300/μL). However, routine blood eosinophil count is not feasible or recommended for this purpose.

Montelukast as first-line preventer children aged 6 years and over

In school-aged children with persistent asthma, inhaled corticosteroids are more effective overall than montelukast in improving lung function and controlling asthma symptoms. However, symptoms will respond to a treatment trial of montelukast in approximately one-quarter to one-third of children, and some may benefit more than from an inhaled corticosteroid. More severe asthma and markers of allergic inflammation may predict a better response to inhaled corticosteroids.

Montelukast as add-on treatment

A systematic review of studies in children over 6 years and adolescents with mild-to-moderate persistent asthma found that the addition of montelukast to inhaled corticosteroids did reduce flare-ups requiring oral corticosteroids or hospital admissions for asthma, compared with the same or an increased dose. In a study comparing step-up treatments in children with asthma symptoms uncontrolled by low-dose inhaled corticosteroids, the addition of a long-acting beta2 agonist was effective in more children than either montelukast or increasing the dose of inhaled corticosteroid for controlling asthma symptoms and preventing flare-ups requiring systemic corticosteroids. However, some studies in school-aged children with persistent asthma already taking regular inhaled corticosteroids have reported that add-on montelukast reduced the risk of flare-ups and exercise-induced asthma symptoms. Not all children will respond.

In a small study in children with persistent asthma already taking regular inhaled corticosteroids who were homozygous for the Arg16 genotype, montelukast was more effective as an add-on therapy than long-acting beta2 agonist in reducing symptoms, reliever use and days absent from school due to asthma, depending on the child's beta receptor genotype. However, children were given inhaled corticosteroid and long-acting beta2 agonists in separate inhalers, which is known to be associated with increased risks.

However, genotyping is not currently feasible in clinical practice. In practice, a treatment trial of 4–6 weeks can determine which preventer is suitable for controlling a child's asthma symptoms, but longer treatment may be required to evaluate effect on flare-ups.
because flare-ups may be independent of symptom control.

**Exercise-induced symptoms**

In school-aged children who experience exercise-induced symptoms despite taking regular inhaled corticosteroids, the addition of montelukast is effective in controlling symptoms, but not all children experience a response.\textsuperscript{12, 41}

See: *Investigation and management of exercise-induced bronchoconstriction*

**Short-term use in the management of flare-ups**

Some, but not all studies suggest that a short course of montelukast, introduced at the first signs of an upper respiratory tract infection, may be effective in controlling flare-ups. An Australian study reported that this strategy could achieve a small reduction in symptoms, school absence and medical consultations in preschool and school-aged children with episodic wheeze.\textsuperscript{42}

However, the evidence is inconsistent, with some studies showing no benefit.\textsuperscript{32, 43, 44, 45, 46} The findings of one study suggested that whether or not intermittent montelukast is effective in wheezing children aged 5 years and under depends on genotype.\textsuperscript{27}

Montelukast is not TGA-approved or PBS-subsidised for intermittent use.

**Note:** PBS status as at March 2019: Montelukast is not subsidised by the PBS for adolescents 15 years and over.

**Montelukast for children: behavioural and/or neuropsychiatric adverse effects**

Montelukast is generally very well tolerated. Behavioural and psychiatric adverse effects were rare in clinical trials.\textsuperscript{47, 48} However, post-marketing surveillance reports have identified behavioural and/or neuropsychiatric adverse effects associated with montelukast use in some children.\textsuperscript{49}

Behavioural treatment-associated effects are difficult to assess in young children. No factors have been identified to predict which children are at risk.

Reported adverse events include nightmares, sleep disturbance, anxiety, irritability, aggression and depression.\textsuperscript{49, 50, 36, 52}

Suicidal ideation has been reported in adolescents and adults taking montelukast.\textsuperscript{52} A nested case-control study concluded that children with asthma aged 5–18 years taking leukotriene receptor antagonists were not at increased risk of suicide attempts.\textsuperscript{53}

Reported adverse effects are usually mild.\textsuperscript{36} The majority occur within 7–14 days of starting montelukast,\textsuperscript{49, 36} but some may appear after several months.\textsuperscript{52}

Behavioural and/or neuropsychiatric adverse effects typically disappear within 4 days of stopping montelukast treatment.\textsuperscript{36} There is no evidence of long term effects.

The TGA recommends that clinicians treating children with montelukast should educate caregivers about these potential adverse effects and should consider providing them with the CMI. Advise them to seek medical advice if they have any concerns.

Go to: TGA’s 2018 *safety review of montelukast*

**Inhaled corticosteroids for children: adverse effects**

**Local adverse effects**

Hoarseness and pharyngeal candidiasis are not commonly reported among preschool children or school-aged children talking inhaled corticosteroids.\textsuperscript{54, 1, 55}

Topical effects can be reduced by use of spacer devices (which reduce oropharyngeal deposition), and by mouth-rinsing and spitting after use.\textsuperscript{1} Immediate quick mouth-rinsing removes more residual medicine in the mouth than delayed rinsing.\textsuperscript{56}

There is limited evidence that inhaled asthma medication can affect dental health.\textsuperscript{1, 57} Mouth rinsing might reduce this risk.

**Systemic adverse effects**

Systemic effects of inhaled corticosteroids in children depend on the dose, but clinically significant adverse effects are uncommon.\textsuperscript{1}

The use of spacers and mouth rinsing will not reduce systemic effects, but the use of a spacer may increase efficacy so that a lower dose is required.

**Growth**

Short-term suppression of linear growth has been demonstrated in children taking inhaled corticosteroids.\textsuperscript{58, 59} The effect seems to be maximal during the first year of therapy and only one study has reported an effect in subsequent years of treatment.\textsuperscript{59} A Cochrane
systematic review concluded that regular use of inhaled corticosteroid at low or medium daily doses is associated with a mean reduction of 0.48 cm per year in linear growth velocity and 0.61 cm less gain in height during 1 year of treatment in children with mild to moderate persistent asthma.59

One study of patients who participated in a clinical trial of inhaled corticosteroids as children, reported a reduction in adult height of approximately 1 cm,58, 60, 61, 62 whereas several studies have reported that children taking inhaled corticosteroids attained normal adult height.63, 64, 65

The effect is dose-dependent61,62 and may be more likely in children who begin inhaled corticosteroid treatment before age 10.60

Other factors affect growth in children with asthma. Uncontrolled asthma itself reduces growth and final adult height.64 One study found that inhaled corticosteroid equivalent to budesonide 400 microg/day affected growth less than low socioeconomic status.65

**Bone density**

Inhaled corticosteroids have not been associated with effects on bone density or fractures in children.1 However, data from a recent study in Australia suggested asthma itself is associated with increased incidence of fractures in children, independent of medication.66

Given that the total dose of corticosteroids (both inhaled corticosteroids and oral corticosteroids) influences bone health, the aim of asthma management is to maintain symptom control using the lowest inhaled corticosteroid dose required, and to avoid repeated courses of oral corticosteroids.

**Adrenal suppression**

Biochemical testing in a research setting suggests that hypothalamic–pituitary–adrenal axis suppression may occur in up to two-thirds of children treated with inhaled corticosteroids, and may occur at even low doses.67 The risk is higher among children receiving concomitant intranasal steroids and those with lower body mass index,67 and is influenced by genetics.68

Clinical adrenal insufficiency in children taking inhaled corticosteroids is rare but has been reported,69, 70, 71 including cases in Australia.71 Most cases have involved children given more than 500 microg per day fluticasone propionate.69

Adrenal suppression is associated with hypoglycaemia, hypotension, weakness, failure to grow, and is potentially fatal. Hypothalamic–pituitary–adrenal axis suppression may not be detected until adrenal crisis is precipitated by physical stress.72

Written information (e.g. a steroid alert card) can be prepared for children receiving long-term high-dose inhaled corticosteroids. Parents/carers can be instructed to present the card if the child ever needs to go to the emergency department (for any reason) or be admitted to hospital. A steroid alert card should state that child has asthma and the inhaled corticosteroid dose. A medical alert bracelet could also be considered.

There are no nationally accepted protocols for routine assessment of adrenal function in primary care because it has not yet been possible to identify precisely which children should be tested, to interpret test results reliably, to identify the appropriate interval for retesting, and because a clinical benefit has not been clearly demonstrated.

Regular monitoring of height might help detect adrenal suppression, based on the findings of a study in which a reduction in linear growth velocity occurred before adrenal suppression.73

### Table. Definitions of ICS dose levels in children

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</tr>
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</table>

† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)
‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

Source
van Asperen PP, Mellis CM, Sly PD, Robertson C. The role of corticosteroids in the management of childhood asthma. The Thoracic
Step-up options in children with asthma that is not controlled by low-dose inhaled corticosteroids

In children whose asthma is inadequately controlled by low-dose inhaled corticosteroids alone (and adherence is good, inhaler technique is correct and diagnosis has been confirmed), treatment options include:

- increasing the inhaled corticosteroid dose
- adding montelukast
- switching to inhaled corticosteroid/long-acting beta2 agonist combination.

### Table. Step-up options for children when good asthma control is not achieved with low-dose ICS

<table>
<thead>
<tr>
<th>Option</th>
<th>TGA-registered indications for add-on therapy</th>
<th>PBS considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High-dose ICS</strong></td>
<td>N/A</td>
<td>Subsidised</td>
</tr>
<tr>
<td><strong>ICS plus montelukast</strong></td>
<td>2 years and over</td>
<td>2–5 years: not subsidised*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6–14 years: not subsidised unless for</td>
</tr>
<tr>
<td></td>
<td></td>
<td>exercise-induced bronchoconstriction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>despite ICS treatment†</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 years and over: not subsidised‡</td>
</tr>
<tr>
<td><strong>ICS/long-acting beta2 agonist combination</strong></td>
<td>4 years and over for fluticasone propionate/salmeterol xinafoate</td>
<td>Subsidised</td>
</tr>
<tr>
<td></td>
<td>12 years and over for budesonide/formoterol fumarate dihydrate</td>
<td></td>
</tr>
</tbody>
</table>

- Advise parents about potential adverse psychiatric effects of montelukast

* Montelukast is not subsidised for use in combination with other preventers or for children who require inhaled corticosteroids.

† Montelukast is subsidised for prevention of exercise-induced asthma if asthma is otherwise well controlled while taking optimal-dose inhaled corticosteroids – it is not otherwise subsidised in combination with inhaled corticosteroids (or inhaled corticosteroid/long-acting beta2 agonist combinations).

‡ Montelukast is not subsidised for people aged over 15 years.

In the majority of children with persistent asthma that requires preventive treatment, control can be achieved with one of these options.†

Few studies have been conducted in preschool-aged children. The preferred step-up option for children aged 6–12 years is controversial and guidelines differ in their recommendations.⁷⁴

**Increasing inhaled corticosteroid dose versus adding a long-acting beta2 agonist**

In school-aged children with persistent asthma taking regular inhaled corticosteroid, the addition of a long-acting beta2 agonist does
not reduce the rate of asthma flare-ups requiring systemic steroids compared with the same or higher doses of inhaled corticosteroid. However, the long-acting beta_2 agonist–inhaled corticosteroid was superior for improving lung function. Growth is reduced in children treated with higher-dose inhaled corticosteroid, compared with those taking same dose plus a long-acting beta_2 agonist.

Adolescents may benefit more from combination inhaled corticosteroid/long-acting beta_2 agonist treatment than children under 12 years. In adolescents with persistent asthma that is not controlled by a low dose of inhaled corticosteroids, the combination of a long-acting beta_2 agonist and an inhaled corticosteroid is modestly more effective in reducing the risk of flare-ups requiring oral corticosteroids than a higher dose of inhaled corticosteroids.

Adding montelukast versus adding a long-acting beta-2 agonist or increasing inhaled corticosteroid dose

Children aged 1–5 years

In one study in children aged 5 years or less with persistent asthma/wheeze requiring preventer treatment, raised blood eosinophil levels and atopy predicted better short-term response to high-dose inhaled corticosteroid than to montelukast. However, routine eosinophil counts are currently not recommended to guide treatment in children.

In children aged 1–5 years with asthma/wheeze that is not adequately controlled by low-dose inhaled corticosteroid alone, adding montelukast is preferable to increasing the dose of inhaled corticosteroids when the safety profiles of these options are compared. Long-acting beta_2 agonists are not recommended for this age group.

- Montelukast use has been associated with behavioural and/or neuropsychiatric adverse effects.

   Go to: TGA alert

Note: Montelukast is TGA-approved for children aged 2 years and over.

Children aged 6 years and over

Among children 6 years and over with asthma that is not controlled by low-dose inhaled corticosteroids, the optimal regimen varies between individuals. In one study of children selected for high adherence with maintenance treatment, short-term responses varied between individuals: in some children the best response was achieved by adding a long-acting beta_2 agonist, in others by adding montelukast, and in others by increasing the dose of inhaled corticosteroid.

Note: The use of inhaled corticosteroids and long-acting beta_2 agonists in separate inhalers is not recommended for either children or adults because of the potential for increased risk due to selective non-adherence to the inhaled corticosteroid.

Overall, the addition of montelukast to an inhaled corticosteroid does not reduce the need for rescue oral corticosteroids or hospital admission, compared with the same or an increased dose of inhaled corticosteroids, in children aged 6 years and over or adolescents with mild-to-moderate asthma.

For children aged 6–14 years with persistent asthma and exercise-induced bronchoconstriction, adding montelukast is more effective in protecting against exercise-induced bronchoconstriction than switching to a combination of inhaled corticosteroid and a long-acting beta_2 agonist. The use of montelukast also avoids beta-receptor tolerance associated with long-acting beta_2 agonists, so a short-acting beta_2 agonist taken after exercise produces a greater bronchodilator response than it does in children taking regular long-acting beta_2 agonist.

A treatment trial of montelukast for 4–6 weeks is the best option when effects on exercise-induced symptoms and safety are also considered.

- Montelukast use has been associated with behavioural and/or neuropsychiatric adverse effects.

   Go to: TGA alert

See: Investigation and management of exercise-induced bronchoconstriction

Genetic influence on effect of long-acting beta_2 agonists

Clinical response to long-acting beta_2 agonists partly depends on genetics. A beta_2 receptor genotype (Arg16 polymorphism in the beta_2 receptor gene) pre-disposes children with asthma to down-regulation of the beta_2 receptor and increased susceptibility to flare-ups during regular treatment with regular long-acting beta_2 agonists. However, routine genetic testing to tailor asthma therapy is not yet available in clinical practice.

Last reviewed version 2.0

Inhaled corticosteroid/long-acting beta-2 agonist combinations for children aged 4–11 years
The combination of salmeterol plus fluticasone propionate in a single inhaler is TGA-registered for use in children 4 years and older.

**Efficacy**

A very large (n=6208) randomised controlled trial in children aged 4–11 years reported that, unlike in adults, the combination of inhaled corticosteroid and long-acting beta<sub>2</sub> agonist was not associated with a significant reduction in severe flare-ups, compared with inhaled corticosteroid alone. Combination treatment was not associated with an increase in symptom-free days or a reduction in reliever use, compared with inhaled corticosteroid alone.

**Safety**

Clinical response to long-acting beta<sub>2</sub> agonists partly depends on genetics. A beta<sub>2</sub> receptor genotype (Arg16 polymorphism in the beta<sub>2</sub> receptor gene) pre-disposes children with asthma to down-regulation of the beta<sub>2</sub> receptor and increased susceptibility to flare-ups during regular treatment with regular long-acting beta<sub>2</sub> agonists. However, routine genetic testing to tailor asthma therapy is not yet available in clinical practice.

Earlier systematic reviews and meta-analyses led to concern about the possibility that the use of long-acting beta-agonists (even in combination with inhaled corticosteroids) might even increase the risk of flare-ups that require treatment with oral steroids or hospital admission, or of severe flare-ups. A meta-analysis commissioned by the US Food and Drug Administration found that the use of long-acting beta<sub>2</sub> agonists was associated with increased risk of severe asthma-associated adverse events (both overall and among the subset of people using concomitant inhaled corticosteroid and long-acting beta<sub>2</sub> agonist), and that this risk was greatest in children aged 4–11 years. However, the increased risk was only seen in studies where inhaled corticosteroid was not provided, or where inhaled corticosteroid and long-acting beta<sub>2</sub> agonist were not combined in a single inhaler (i.e. where there was the possibility of selective non-adherence to the inhaled corticosteroid).

The PBAC Post-market review of medicines used to treat asthma in children concluded that there was insufficient evidence to ascertain whether tolerance to long-acting beta<sub>2</sub> agonist could explain why it is less effective than montelukast and inhaled corticosteroids in managing exercise-induced asthma symptoms.

A very large randomised controlled trial of children aged 4–11 years, stratified by asthma symptom control and pre-study treatment, found no increased risk of serious adverse outcomes with combination fluticasone propionate and salmeterol in a single inhaler, compared with fluticasone propionate alone. Subsequent to the publication of this and similar studies in adults, regulators in the USA and Australia removed previous 'black box' warnings from combination inhaled corticosteroid–long-acting beta<sub>2</sub> agonist products for asthma.

PBS status as at March 2019: All formulations that contain a combination of inhaled corticosteroid plus long-acting beta<sub>2</sub> agonist are listed as 'Authority required - streamlined'. Patient using these combinations for asthma must have previously had frequent episodes of asthma while receiving treatment with oral corticosteroids or optimal doses of inhaled corticosteroids.

Last reviewed version 2.0

References

9. Fogel, R. B., Rosario, N., Aristizabal, G., et al. Effect of montelukast or salmeterol added to inhaled fluticasone on exercise-induced...


Stepping down treatment in children aged 6 years and over

Recommendations

If symptoms have been well controlled for at least 6 months in a child taking regular inhaled corticosteroid treatment, consider reducing the dose.

Monitor symptom control and perform spirometry within 4–6 weeks after stepping down.

Do not attempt to step down treatment at the start of the school year or during the child’s peak asthma season (if there is a predictable seasonal pattern).

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

Last reviewed version 2.0

If symptoms have been well controlled for at least 6 months in a child taking regular treatment with a combination of inhaled corticosteroid and long-acting beta2 agonist, consider halving the dose.

If the inhaled corticosteroid dose is already low, replace inhaled corticosteroid plus long-acting beta2 agonist with low-dose inhaled corticosteroid alone.

Monitor symptom control within 4–6 weeks after stepping down.

Do not attempt to step down treatment at the start of the preschool year or during the child’s peak asthma season (if there is a predictable seasonal pattern). Take into account previous treatment response, the result of any previous attempts to step down, and changes in the child’s environment that could affect exposure to triggers.

How this recommendation was developed
Consensus recommendation following inconclusive literature search
Based on clinical experience and expert opinion after literature review yielded insufficient evidence for an evidence-based recommendation

Key evidence considered:

- Akashi et al. 2016
- Rank et al. 2015
- Rank et al. 2013

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If symptoms are well controlled for at least 6 months on the lowest available inhaled corticosteroid dose, consider stopping treatment.

Monitor symptom control and perform spirometry within 4–6 weeks after stepping down.

Do not attempt to step down treatment at the start of the school year or during the child’s peak asthma season (if there is a predictable seasonal pattern).

How this recommendation was developed
Consensus recommendation following inconclusive literature search
Based on clinical experience and expert opinion after literature review yielded insufficient evidence for an evidence-based...
More information

**Stepping down preventer treatment in children**
Stepping down can be considered when asthma has been well controlled for 6 months (depending on severity of previous symptoms). This will help identify the minimal dose or regimen needed to maintain control and may minimise the risk of treatment-related adverse effects and help identify the minimal dose or regimen needed to maintain control.

Children who have stable asthma are at increased risk of a flare-up when stepping down treatment, so close monitoring is needed. Stepping down should not be attempted at the beginning of the school year.4

**Stepping down from regular inhaled corticosteroid**
For children already taking the lowest available dose, options are stop preventer treatment entirely, or switch to montelukast. Few studies have compared different options for stepping down.

Children may be at higher risk of a flare-up or loss of asthma control after stopping low-dose inhaled corticosteroid treatment.8, 7, 5

**Stepping down from regular inhaled corticosteroid plus long-acting beta-2 agonist**
Options for stepping down from regular treatment with a combination inhaled corticosteroid and long-acting beta2 agonist are to reduce the inhaled corticosteroid dose or switch to inhaled corticosteroid only (i.e. discontinue the long-acting beta2 agonist).

There is insufficient evidence from randomised trials on which to base recommendations on whether and how to discontinue long-acting beta2 agonist treatment in children once good asthma control has been achieved with the combination of inhaled corticosteroid and long-acting beta2 agonist.9

In a study of children aged 4–11 years whose asthma was well controlled while using a combination of inhaled corticosteroid and long-acting beta2-agonist, stepping down to inhaled corticosteroid monotherapy was associated with a higher rate of flare-ups than continuing on combination therapy.10

In a study of children aged 5–15 years with well-controlled asthma, halving the inhaled corticosteroid component and discontinuing the long-acting beta2 agonist had equivalent outcomes for asthma symptoms and lung function.2

In a study of children with asthma well controlled on twice-daily fluticasone propionate, switching to montelukast was associated with a higher rate of treatment failure and poorer asthma control than halving the fluticasone dose and adding salmeterol.6

**Stepping down from montelukast**
In children taking montelukast, treatment can be stopped abruptly.

Asthma control should be monitored and the child’s written asthma action plan updated to ensure parents/carers know how to manage symptoms.

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**Inhaled corticosteroids for children: adverse effects**

**Local adverse effects**

Hoarseness and pharyngeal candidiasis are not commonly reported among preschool children or school-aged children talking inhaled corticosteroids.11, 1, 12

Topical effects can be reduced by use of spacer devices (which reduce oropharyngeal deposition), and by mouth-rinsing and spitting after use.1 Immediate quick mouth-rinsing removes more residual medicine in the mouth than delayed rinsing.13

There is limited evidence that inhaled asthma medication can affect dental health.1, 14 Mouth rinsing might reduce this risk.
Systemic adverse effects

Systemic effects of inhaled corticosteroids in children depend on the dose, but clinically significant adverse effects are uncommon.1 The use of spacers and mouth rinsing will not reduce systemic effects, but the use of a spacer may increase efficacy so that a lower dose is required.

Growth

Short-term suppression of linear growth has been demonstrated in children taking inhaled corticosteroids.15,16 The effect seems to be maximal during the first year of therapy and only one study has reported an effect in subsequent years of treatment.16 A Cochrane systematic review concluded that regular use of inhaled corticosteroid at low or medium daily doses is associated with a mean reduction of 0.48 cm per year in linear growth velocity and 0.61 cm less gain in height during 1 year of treatment in children with mild to moderate persistent asthma.16

One study of patients who participated in a clinical trial of inhaled corticosteroids as children, reported a reduction in adult height of approximately 1 cm,15,17,18,19 whereas several studies have reported that children taking inhaled corticosteroids attained normal adult height.20,21

The effect is dose-dependent18,19 and may be more likely in children who begin inhaled corticosteroid treatment before age 10.17 Other factors affect growth in children with asthma. Uncontrolled asthma itself reduces growth and final adult height.21 One study found that inhaled corticosteroid equivalent to budesonide 400 microg/day affected growth less than low socioeconomic status.22

Bone density

Inhaled corticosteroids have not been associated with effects on bone density or fractures in children.1 However, data from a recent study in Australia suggested asthma itself is associated with increased incidence of fractures in children, independent of medication.23 Given that the total dose of corticosteroids (both inhaled corticosteroids and oral corticosteroids) influences bone health, the aim of asthma management is to maintain symptom control using the lowest inhaled corticosteroid dose required, and to avoid repeated courses of oral corticosteroids.

Adrenal suppression

Biochemical testing in a research setting suggests that hypothalamic–pituitary–adrenal axis suppression may occur in up to two-thirds of children treated with inhaled corticosteroids, and may occur at even low doses.24 The risk is higher among children receiving concomitant intranasal steroids and those with lower body mass index,24 and is influenced by genetics.25

Clinical adrenal insufficiency in children taking inhaled corticosteroids is rare but has been reported,26,27,28 including cases in Australia.28 Most cases have involved children given more than 500 microg per day fluticasone propionate.26

Adrenal suppression is associated with hypoglycaemia, hypotension, weakness, failure to grow, and is potentially fatal. Hypothalamic–pituitary–adrenal axis suppression may not be detected until adrenal crisis is precipitated by physical stress.29

Written information (e.g. a steroid alert card) can be prepared for children receiving long-term high-dose inhaled corticosteroids. Parents/carers can be instructed to present the card if the child ever needs to go to the emergency department (for any reason) or be admitted to hospital. A steroid alert card should state that child has asthma and the inhaled corticosteroid dose. A medical alert bracelet could also be considered.

There are no nationally accepted protocols for routine assessment of adrenal function in primary care because it has not yet been possible to identify precisely which children should be tested, to interpret test results reliably, to identify the appropriate interval for retesting, and because a clinical benefit has not been clearly demonstrated.

Regular monitoring of height might help detect adrenal suppression, based on the findings of a study in which a reduction in linear growth velocity occurred before adrenal suppression.30

<table>
<thead>
<tr>
<th>Inhaled corticosteroid</th>
<th>Daily dose (microg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Beclometasone dipropionate †</td>
<td>100–200</td>
</tr>
<tr>
<td>Budesonide</td>
<td>200–400</td>
</tr>
</tbody>
</table>
### Approaches to assessment and monitoring of asthma control in children

Assessment of asthma control in children is based mainly on:
- recent asthma symptom control (assessed by the frequency and severity of symptoms between flare-ups)
- the degree to which asthma symptoms affect daily activities such as interference with physical activity or missed school days
- the frequency of flare-ups
- spirometry in children who are able to perform the test reliably.

#### Standardised questionnaires

Questionnaire-based instruments have been validated for assessing asthma control in children:

- **Test for Respiratory and Asthma Control in Kids (TRACK)** for children less than 5 years old – consists of five questions about frequency of respiratory symptoms (wheeze, cough, shortness of breath), activity limitation, and night-time awakenings in the past 4 weeks, rescue medication use in the past 3 months, and oral corticosteroid use in the previous year. A lower score indicates worse asthma control.

- **Childhood Asthma Control Test (C-ACT)** for children aged 4–11 years – consists of seven items: three for the parent/carer (about the child’s symptoms over the previous 4 weeks) and four for the child. A lower score indicates worse asthma control. **Note:** C-ACT is intended for US use.

#### Lung function tests

Frequent spirometry to guide asthma treatment in children has not been shown to achieve superior outcomes to symptom-based treatment. Current evidence does not support use of home spirometers to guide asthma treatment in children. However, low FEV$_1$ predicts clinically significant flare-ups, so spirometry should be performed at asthma reviews for children who are old enough to do the test.

The quality and utility of spirometry depends on the skill, clinical expertise and experience of the person doing and interpreting spirometry.

The results of one study in children aged 6–16 years with moderate atopic asthma suggest that asthma treatment guided by airway hyperresponsiveness (measured by bronchial provocation testing) may have a benefit over symptom-guided treatment in improving lung, but this effect was lost after 3–7 years of usual care. Repeated bronchial provocation testing is not feasible in clinical practice.

#### Measures of airway inflammation

Measures of airway inflammation (e.g. sputum eosinophil count, exhaled nitric oxide measurement) are not recommended in primary care to guide treatment decisions, but are increasingly used in specialist clinics.
Asthma treatment guided by sputum eosinophil count has been shown to reduce the frequency of flare-ups in adults with asthma, but there is insufficient evidence to ascertain its value for children.\(^3\)

Exhaled nitric oxide measurement may be useful in guiding asthma management in some children. In children not taking inhaled corticosteroid, a high nitric oxide level probably predicts a good short-term response to inhaled corticosteroid treatment,\(^4\) but it does not distinguish between asthma and eosinophilic bronchitis and is often high in children with atopy. There is insufficient evidence to ascertain whether a low exhaled nitric oxide level predicts successful withdrawal from inhaled corticosteroids without asthma relapse,\(^5\) or safety of treating asthma without inhaled corticosteroids.

A Cochrane review\(^6\) found that exhaled nitric oxide-guided management was significantly better than other approaches to adjusting medicines for reducing the number of children with flare-ups and the number of children who needed oral corticosteroids, but did not reduce the frequency of flare-ups or the rate of flare-ups requiring hospitalisation, improve lung function or symptoms scores, or reduce inhaled corticosteroid doses. The authors concluded that it could not be recommended for all children but may be beneficial for a subset not yet defined.\(^7\)

**Towards personalised asthma care**

Emerging understanding of asthma phenotypes and of genetic factors that predict therapeutic response to preventer options is leading to the possibility of personalised, genomics-based treatment for asthma in children.\(^8\) In the near future, individual tailored therapy may replace the standardised step model based on population data.

**Classification of recent asthma symptom control in children**

Ongoing review of asthma involves both assessing recent asthma symptom control and assessing risks for poor asthma outcomes such as flare-ups and adverse effects of medicines.

Recent asthma symptom control is assessed according to the frequency of asthma symptoms over the previous 4 weeks.

<table>
<thead>
<tr>
<th>Good control</th>
<th>Partial control</th>
<th>Poor control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any of:</td>
<td>Any of:</td>
<td>Either of:</td>
</tr>
<tr>
<td>- Daytime symptoms(\dagger) ≤ 2 days per week (lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)</td>
<td>- Daytime symptoms(\dagger) &gt; 2 days per week (lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)</td>
<td>- Daytime symptoms(\dagger) &gt; 2 days per week (lasting from minutes to hours or recurring, and partially or fully relieved by SABA reliever)</td>
</tr>
<tr>
<td>- No limitation of activities(\dagger)</td>
<td>- Any limitation of activities(\ast)</td>
<td>- ≥ 3 features of partial control within the same week</td>
</tr>
<tr>
<td>- No symptoms(\ast) during night or when wakes up</td>
<td>- Any symptoms during night or when wakes up(\dagger)</td>
<td>- Need for SABA reliever# ≤ 2 days per week</td>
</tr>
<tr>
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<td>- Need for SABA reliever# &gt; 2 days per week</td>
<td>- Need for SABA reliever# &gt; 2 days per week</td>
</tr>
</tbody>
</table>

SABA: short-acting beta\(2\) agonist

\(\dagger\) e.g. wheezing or breathing problems

\(\dagger\) child is fully active; runs and plays without symptoms

\(\ast\) including no coughing during sleep

\# not including doses taken prophylactically before exercise. (Record this separately and take into account when assessing management.)

\(\ast\) e.g. wheeze or breathlessness during exercise, vigorous play or laughing

\(\dagger\) e.g. waking with symptoms of wheezing or breathing problems

**Notes:**

Recent asthma control is based on symptoms over the previous 4 weeks. Each child’s risk factors for future asthma outcomes should
also be assessed and taken into account in management.

Validated questionnaires can be used for assessing recent symptom control:
- Test for Respiratory and Asthma Control in Kids (TRACK) for children < 5 years
- Childhood Asthma Control Test (C-ACT) for children aged 4–11 years

**Table. Risk factors for life-threatening asthma flare-ups in children**

**Asthma-related factors**
- Poor asthma control
- Admission to hospital in preceding 12 months
- History of intubation for acute asthma
- Over-use of short-acting beta2 agonist reliever
- Abnormal spirometry findings
- Reversible expiratory airflow limitation on spirometry despite treatment
- Poor adherence to preventer
- Incorrect inhaler technique for preventer
- Poor adherence to asthma action plan
- Exposure to clinically relevant allergens
- Exposure to tobacco smoke

**Other clinical factors**
- Allergies to foods, insects, medicines
- Obesity

**Family-related factors**
- Frequent failure to attend consultations/lack of follow-up after an acute flare-up
- Significant parental psychological or socioeconomic problems
- Parent/carer unequipped to manage asthma emergency

References


35. Abramson MJ, Schattner RL, Holton C et al. Spirometry and regular follow-up do not improve quality of life in children or


Managing flare-ups in children aged 6 years and over

See also: Managing acute asthma in adults and children

Recommendations

Ensure all children with asthma have a short-acting inhaled bronchodilator (reliever) inhaler (and spacer, if needed) with them at all times. Educate parents/carers how and when to give reliever.

Note: The recommended dose for non-emergency bronchodilator in children aged 6–11 years is salbutamol 2–4 puffs (100 microg per puff) as needed, 1 puff at a time, via pressurised metered-dose inhaler plus spacer, and repeated 4 hours later, if needed.

- Advise parents/carers to get medical advice if reliever is needed again within 4 hours.
- Do not prescribe oral salbutamol. Inhalation is the recommended route for delivering relievers for all children and adults.

Table. Non-emergency use of bronchodilators (relievers) in children aged 6–11 years

<table>
<thead>
<tr>
<th>Option</th>
<th>Dose</th>
<th>Mode of delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salbutamol</td>
<td>2–4 puffs as needed (one at a time)</td>
<td>Pressurised metered-dose inhaler plus spacer</td>
</tr>
<tr>
<td>100 microg per actuation (puff)</td>
<td>Repeat if needed</td>
<td></td>
</tr>
<tr>
<td>Terbutaline</td>
<td>1–2 actuations</td>
<td>Dry-powder inhaler†</td>
</tr>
<tr>
<td>500 microg/actuation</td>
<td>Repeat if needed</td>
<td></td>
</tr>
</tbody>
</table>

Note: This table lists usual doses to be administered by parents/carers in the community to manage symptoms as needed. Higher during may be given during acute asthma, including emergencies.

† If able to use this type of inhaler correctly

- Do not prescribe oral salbutamol.

How this recommendation was developed

Consensus

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

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Asset ID: 28

Consider prescribing a short course of prednisolone for a child with acute asthma if beta2 agonist reliever is needed approximately every 4 hours over a period of 24 hours.

Note: the recommended dose is 1 mg/kg (maximum 50 mg) orally each morning for 3 days.

How this recommendation was developed

Adapted from existing guidance
If oral corticosteroids are needed to manage severe acute flare-ups, reassess regular medicine regimen (including adherence and inhaler technique) and consider specialist referral.

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

Do not start long-term oral corticosteroids except on the advice of a paediatric specialist (respiratory physician or paediatrician).

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 all children using a regular preventer (montelukast, inhaled corticosteroid, or combination of inhaled corticosteroid plus long-acting beta2 agonist) explain to children and parents that the child should keep taking it during asthma flare-ups, including acute asthma episodes that require treatment in an emergency department.

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

Do not routinely prescribe antibiotics for children with upper respiratory tract infections who experience acute wheeze or asthma associated with viral respiratory 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):
• Normansell et al. 2018
• Johnston et al. 2016
• Fonseca-Aten et al. 2006

More information

Short-acting beta-2 agonist relievers for children: 6 years and over
Inhaled short-acting beta<sub>2</sub> agonists is the major class of bronchodilators used for relief of symptoms in asthma.\textsuperscript{5} Children with well-controlled asthma need little or no reliever (on no more than 2 days per week). Increased use of short-acting beta<sub>2</sub> agonists for relief of asthma symptoms, especially daily use, indicates deterioration of asthma control.\textsuperscript{6,7}

Dispensing of 3 or more canisters in a year (average 1.6 puffs per day) is associated with increased risk of flare-ups.\textsuperscript{8} Dispensing 12 or more canisters in a year (average 6.6 puffs per day) is associated with increased risk of asthma death.\textsuperscript{2}

**Table. Definition of levels of recent asthma symptom control in children (regardless of current treatment regimen)**

<table>
<thead>
<tr>
<th>Good control</th>
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<td>• ≥ 3 features of partial control within the same week</td>
</tr>
<tr>
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<td>• Any symptoms during night or when wakes up\textsuperscript{††}</td>
<td></td>
</tr>
<tr>
<td>• Need for SABA reliever\textsuperscript{#} ≤ 2 days per week</td>
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SABA: short-acting beta<sub>2</sub> agonist

\textsuperscript{†} e.g. wheezing or breathing problems

\textsuperscript{‡} child is fully active; runs and plays without symptoms

\textsuperscript{§} including no coughing during sleep

\textsuperscript{#} not including doses taken prophylactically before exercise. (Record this separately and take into account when assessing management.)

\textsuperscript{*} e.g. wheeze or breathlessness during exercise, vigorous play or laughing

\textsuperscript{††} e.g. waking with symptoms of wheezing or breathing problems

**Notes:**

Recent asthma control is based on symptoms over the previous 4 weeks. Each child’s risk factors for future asthma outcomes should also be assessed and taken into account in management.

**Validated questionnaires can be used for assessing recent symptom control:**

- Test for Respiratory and Asthma Control in Kids (TRACK) for children < 5 years
- Childhood Asthma Control Test (C-ACT) for children aged 4–11 years

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</table>

Parent/carer-initiated oral corticosteroids for wheezing and asthma flare-ups

- See also: Managing acute asthma in clinical settings

- Oral corticosteroids are associated with adverse effects on behaviour and bone health. Frequent courses may affect the hypothalamus–pituitary–adrenal axis.

Children aged 1–5 years
Short courses of oral corticosteroids initiated by parents/carers in response to children’s wheezing, or at the first sign of a cold, are not effective in managing symptoms in preschool children.\textsuperscript{9, 10, 11} There is inconsistent evidence for the benefits of systemic corticosteroids in preschool children with acute viral-induced wheezing presenting to acute care services.\textsuperscript{11, 12, 13} Current evidence does not strongly support their use in this age group.\textsuperscript{14} The Thoracic Society of Australia and New Zealand position statement on the use of corticosteroids in children\textsuperscript{1} recommends that oral corticosteroid treatment in preschool children, particularly those with intermittent viral-induced wheezing, should be limited to children with wheeze severe enough to need admission to hospital.

**Children aged 6 years and over**

A Cochrane systematic review found that there was insufficient evidence supporting the use of parent-initiated courses of oral corticosteroids in school-aged children,\textsuperscript{15} although some clinical trials have reported benefits. In a clinical trial in children aged 6–14 years with a history of recurrent episodes of acute asthma, short courses of oral prednisolone (1 mg/kg a day), initiated by parents in response to an asthma flare-ups, reduced asthma symptoms and the number of missed school days.\textsuperscript{16} Another quasi-experimental study found that home initiation of corticosteroids reduced the rate of emergency department visits among school-aged children with moderate-to-severe persistent asthma, compared with rates pre-intervention.\textsuperscript{17}

The Thoracic Society of Australia and New Zealand position statement on the use of corticosteroids in children\textsuperscript{1} recommends a short course of systemic corticosteroid therapy for children with moderate-to-severe acute asthma or when there is an incomplete response to beta-agonists, and does not recommend against parent/carer-initiated courses.

**Back-to-school asthma care**

Each year during February, a few days after the school year starts, there is an annual increase in asthma flare-ups among children with asthma. Asthma flare-ups in children, including those resulting in emergency department presentations and hospitalisations, surge during the first month of the school year.\textsuperscript{18, 19, 20, 22} There are smaller increases at the beginning of the other school terms.\textsuperscript{23} These flare-ups may be due to changes in exposure to virus, allergens, pollution and/or stress during the early days after school return.\textsuperscript{24} Primary care health professionals can help parents/carers prepare for back-to-school flare-ups by:

- recommending a full asthma review at the end of the school holidays to check asthma control, adherence to preventer and inhaler technique
- ensuring that each child has an up-to-date written asthma action plan and the child and/or parents/carers understand how to follow it
- reminding parents/carers to get their child back into their asthma routine before the school year starts, including taking preventer medications every day, if prescribed

Go to: National Asthma Council Australia’s [Back to school checklist for kids with asthma](#)

**Increasing the inhaled corticosteroid dose to control flare-ups in children**

In children taking regular inhaled corticosteroid-containing preventers, there is conflicting evidence for whether, and by how much, the dose should be increased when symptoms worsen or at the onset of an acute flare-up. Overall, current evidence from highly controlled randomised controlled trials does not support increasing the dose of inhaled corticosteroid as part of a self-initiated action plan to manage flare-ups in children younger than 12 years.\textsuperscript{25} There is some evidence that high doses of inhaled steroids used pre-emptively might be effective in preventing severe acute asthma in children aged under 5 years, based on studies in children not taking regular inhaled corticosteroids.\textsuperscript{26} However, very high pre-emptive doses affect children’s growth\textsuperscript{27} and are not recommended.

Recent randomised controlled trials reported a lack of effect with a range of dose increases:

- A five-fold increase in the inhaled corticosteroid dose at early signs of worsening asthma did not reduce the rate of severe acute asthma in children aged 5–11 years with well-controlled asthma while taking maintenance inhaled corticosteroid treatment (with high adherence).\textsuperscript{28} This strategy was associated with a small reduction in linear growth.\textsuperscript{28}
- Dose increases of four or eight times usual inhaled corticosteroid maintenance dose at the onset of an acute flare-up in children aged 2–17 years did not reduce requirement for oral corticosteroids, compared with doubling the dose.\textsuperscript{29}

A Cochrane systematic review\textsuperscript{25} in children and adults reported that increasing the inhaled corticosteroid dose did not prevent severe flare-ups, regardless of how soon the increase was initiated after the onset of symptoms or the magnitude of the dose increase.
Oral corticosteroids may have adverse psychiatric effects in children, including aggression and hyperactivity. Effects in the general population include euphoria, hypomania, depression, disturbances of mood, cognition, sleep and behaviour. A short course of oral corticosteroid therapy (less than 2 weeks) is associated with little risk of long-term suppression of the hypothalamus–pituitary–adrenal axis. However, risk can accumulate if frequent courses (four or more per year) are given. Recurrent courses of oral corticosteroids may also affect bone mineral density, especially in boys.

Thunderstorm asthma
Certain types of thunderstorms in spring or early summer in regions with high grass pollen concentrations in the air can cause life-threatening allergic asthma flare-ups in individuals sensitised to rye grass, even if they have not had asthma before. Sensitisation to rye grass allergen is almost universal in patients who have reported flare-ups consistent with thunderstorm asthma in Australia. People with allergic rhinitis and allergy to ryegrass pollen (i.e. most people with springtime allergic rhinitis symptoms) are at risk of thunderstorm asthma if they live in, or are travelling to, a region with seasonal high grass pollen levels – even if they have never had asthma symptoms before. This includes people with undiagnosed asthma, no previous asthma, known asthma. Lack of inhaled corticosteroid preventer treatment has been identified as a risk factor. Epidemics of thunderstorm asthma can occur when such a storm travels across a region and triggers asthma in many susceptible individuals. Epidemic thunderstorm asthma events are uncommon, but when they occur can they make a high demand on ambulance and health services. Data from thunderstorm asthma epidemics suggest that the risk of asthma flare-ups being triggered by a thunderstorm is highest in adults who are sensitised to grass pollen and have seasonal allergic rhinitis (with or without known asthma). The worst outcomes are seen in people with poorly controlled asthma. Treatment with an inhaled corticosteroid asthma preventer was significantly protective in a well-conducted Australian case-control study. There is insufficient evidence to determine whether intranasal corticosteroids help protect against thunderstorm asthma. Intranasal corticosteroids reduce symptoms of allergic rhinitis and limited indirect evidence suggests they may protect against asthma flare-ups in people not taking inhaled corticosteroids. The effectiveness of specific allergen immunotherapy in protecting against thunderstorm asthma has not been evaluated in randomised clinical trials, but data from a small Australian open-label study suggest that short-term treatment with five-grass sublingual immunotherapy may have been protective in individuals.

Go to: National Asthma Council Australia’s Epidemic thunderstorm asthma information paper
Go to: ASCIA’s Pollen calendar
Go to: Vic Emergency’s Thunderstorm asthma forecast (Victoria only)

Administration of inhaled medicines in children: 6 years and over
Parents, carers and children need training to use inhaler devices correctly, including inhaler technique, and care and cleaning of inhalers and spacers. School-aged children (depending on the child’s age, ability, and with individualised training) can learn to use a range of inhaler types, including manually actuated pressurised metered-dose inhalers with spacers, breath-actuated pressurised metered-dose inhalers (e.g. Autohaler), and dry-powder inhalers (e.g. Accuhaler, Turbuhaler). A pressurised metered-dose inhaler and spacer is an appropriate first choice for most children. School-aged children are unlikely to use their inhaler device correctly without careful training and repeated checking.
Preparation of new spacers before first use

Spacers are made of plastic, antistatic polymer/polycarbonate polyurethane, or cardboard.

**Plastic spacers (e.g. Breath-A-Tech, Volumatic)**

Electrostatic surface charge on new spacers made of plastic (e.g. Breath-A-Tech, Volumatic) reduces the proportion of medicine available for delivery to the airway. This charge can be reduced by washing the plastic spacer in dishwashing liquid and allowing it to air dry or drip-dry without rinsing or wiping.48 Alternatively, priming the spacer by actuating the device several times into the spacer also overcomes the charge, but this wastes medicine. The optimal number of actuations for priming is not known and the findings of in vitro studies vary widely. One study (using older, CFC-based formulations of asthma medicines) reported that up to 40 actuations fired into a new plastic spacer overcame the effect of the electrostatic charge.49 Others have concluded that the electrostatic charge on plastic spacers does not reduce in vivo efficacy of bronchodilator therapy in children with asthma.50 The number of actuations necessary may be known when the results of recent studies become available.

When a new plastic spacer must be used immediately (e.g. for a person with asthma symptoms), patients, parents and carers should follow the manufacturer’s priming instructions. In hospitals and emergency departments, a new spacer that has not been pre-treated by washing can be primed using multiple (at least 10) puffs of salbutamol. (This is an arbitrary number of actuations in the absence of evidence that would enable a precise guideline.)

**Non-plastic spacers**

Disposable cardboard spacers (e.g. DispozABLE, LiteAire) and polyurethane/antistatic polymer spacers (e.g. Able A2A, AeroChamber Plus, La Petite E-Chamber, La Grande E-Chamber) do not require preparation before first use.48

**Note:** The term ‘priming’ is also used for the preparation process that is necessary for new pressurised metered-dose inhalers that have not been used for more than a week. This involves first actuating the inhaler into the air (away from the patient). Users should follow the manufacturer’s instructions for the particular brand of inhaler, which specify the number of actuations required.

Correct use of inhaler devices

Checking and correcting inhaler technique is essential to effective asthma management.

Most patients with asthma or COPD do not use their inhalers properly,51, 52, 53, 54 and most have not had their technique checked or corrected by a health professional.

Incorrect inhaler technique when using maintenance treatments increases the risk of severe flare-ups and hospitalisation for people with asthma or COPD.51, 52, 55, 56, 57, 58

Poor asthma symptom control is often due to incorrect inhaler technique.59, 60

Incorrect inhaler technique when using inhaled corticosteroids increases the risk of local side effects like dysphonia and oral thrush.

The steps for using an inhaler device correctly differ between brands. Checklists of correct steps for each inhaler type and how-to videos are available from the National Asthma Council website.

References


60. Hardwell, A., Barber, V., Hargadon, T., et al. Technique training does not improve the ability of most patients to use pressurised metered-dose inhalers (pMDIs). *Prim Care Respir J*. 2011; 20: 92-6. Available from: [http://www.nature.com/articles/pcrj201088](http://www.nature.com/articles/pcrj201088)
Managing difficult-to-treat and severe asthma in children aged 6 years and over

Recommendations

If asthma symptoms remain uncontrolled (persisting symptoms or flare-ups) despite maximal regular preventer treatment:

- assess adherence
- check inhaler technique
- review the diagnosis
- check that the dose and regimen is appropriate
- assess comorbidities (e.g. allergic rhinitis)
- check whether the child is exposed to environmental triggers (e.g. allergens, cigarette smoke).

Table. Reviewing and adjusting preventer treatment for children aged 6–11 years
Please view and print this figure separately: http://www.asthmahandbook.org.au/table/show/26

Figure. Stepped approach to adjusting asthma medication in children aged 6–11 years
Please view and print this figure separately: http://www.asthmahandbook.org.au/figure/show/120

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):
- Chung et al. 2014
- Bush et al. 2011
- Bush et al. 2010

Last reviewed version 2.0

If good asthma control is still not achieved after eliminating common reasons for treatment failure, offer referral to a paediatric respiratory physician or paediatrician.

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

Last reviewed version 2.0

Regular treatment with a theophylline is not recommended routinely for children.

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

Last reviewed version 2.0
Identify children with uncontrolled asthma who might benefit from monoclonal antibody therapy and offer referral for specialist assessment (after checking and correcting common causes of uncontrolled asthma such as incorrect inhaler technique and suboptimal adherence).

Notes:
Omalizumab is indicated as add-on treatment for uncontrolled severe allergic asthma in children ≥ 6 years.
Before becoming eligible for PBS subsidy for monoclonal antibody therapy treatment, patients must have been treated by the same specialist (paediatric respiratory physician, clinical immunologist, allergist or a paediatrician or general physician experienced in the management of patients with severe asthma, in consultation with a respiratory physician), for at least 6 months. Stringent criteria for starting and continuing therapy apply.

> Go to: National Asthma Council Australia's information paper for health professionals on Monoclonal antibody therapy for severe asthma

How this recommendation was developed
Adapted from existing guidance
Based on reliable clinical practice guideline(s) or position statement(s):
• National Asthma Council Australia 2018

Last reviewed version 2.0

More information

Definitions of severe and difficult-to-treat asthma
Although most people's asthma can be effectively treated with currently available medicines, a substantial subset of people have uncontrolled asthma (as indicated by persisting symptoms, low lung function and/or flare-ups) despite treatment. These patients are described as having difficult-to-treat asthma.
Some patients with difficult-to-treat asthma have severe asthma. Asthma severity is classified retrospectively according to the level of treatment needed to achieve or maintain good asthma control, rather than by the intensity or frequency of symptoms. International guidelines have been published for the assessment and management of patients with severe asthma. 'Severe asthma' (also called severe refractory asthma or 'severe treatment-resistant asthma') is defined as asthma for which good control is not achieved despite the highest level of recommended treatment, or asthma for which control can be maintained only with the highest level of recommended treatment. It is estimated that 5-10% of patients with asthma have severe asthma. Not all patients with difficult-to-treat asthma have severe asthma. 'Difficult-to-treat asthma' includes asthma that is uncontrolled due to adherence issues, inappropriate or incorrect use of medicines, environmental triggers or comorbidities. Patients whose asthma control improves rapidly with correction of such problems are not considered to have severe asthma.
Treatment-resistant asthma or severe refractory asthma can only be diagnosed after confirming the diagnosis, confirming good adherence to high-dose inhaled corticosteroid and correct inhaler technique, excluding alternative or overlapping diagnoses, identifying and minimising exposure to preventable triggers including allergens, irritants and medicines that cause bronchoconstriction, managing comorbidities, and closely monitoring for at least 6 months.
Omalizumab is a treatment option for some adults, adolescents and children with severe asthma.
The definition of severe asthma proposed by the World Health Organization (WHO) Consultation on Severe Asthma for global use is 'uncontrolled asthma which can result in risk of frequent severe exacerbations (or death) and/or adverse reactions to medications and/or chronic morbidity (including impaired lung function or reduced lung growth in children). The WHO definition of severe asthma includes a category called 'severe untreated asthma', a term recommended only for use in countries that lack access to standard asthma medications such as inhaled corticosteroids.
Patients with severe symptoms due to untreated asthma may be found, after starting regular treatment, to have mild asthma (i.e. asthma that is easily controlled with low-dose inhaled corticosteroids).

> Go to: European Respiratory Society and American Thoracic Society guidelines on definition, evaluation and treatment of severe asthma

Common reasons for poor response to preventer treatment
Apparent lack of response to asthma treatment is commonly due to one or more of the following:
• poor adherence (which may be due to lack of perceived need for the medication, concern about potential or actual side-effects, cost
of medicines, a busy lifestyle, misunderstanding of the purpose and effects of asthma medicines, or inability to follow the medical instructions)
- poor inhaler technique
- mishandling devices (e.g. failure to clean spacer, allowing mouthpiece of dry-powder inhalers to become blocked)
- incorrect dose or frequency
- empty inhaler
- expired medicines
- continued exposure to smoke or allergen triggers.

Failure to identify these causes before adjusting medicines could result in over-medication with preventers.

▶ See: Management challenges

Last reviewed version 2.0

**Classification of recent asthma symptom control in children**

Ongoing review of asthma involves both assessing recent asthma symptom control and assessing risks for poor asthma outcomes such as flare-ups and adverse effects of medicines.

Recent asthma symptom control is assessed according to the frequency of asthma symptoms over the previous 4 weeks.
Table. Definition of levels of recent asthma symptom control in children (regardless of current treatment regimen)

<table>
<thead>
<tr>
<th>Good control</th>
<th>Partial control</th>
<th>Poor control</th>
</tr>
</thead>
<tbody>
<tr>
<td>All of:</td>
<td>Any of:</td>
<td>Either of:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Daytime symptoms† ≤ 2 days per week (lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)</td>
<td>• Daytime symptoms† &gt;2 days per week (lasting only a few minutes and rapidly relieved by rapid-acting bronchodilator)</td>
<td>• Daytime symptoms† &gt;2 days per week (lasting from minutes to hours or recurring, and partially or fully relieved by SABA reliever)</td>
</tr>
<tr>
<td>• No limitation of activities‡</td>
<td>• Any limitation of activities*</td>
<td>• ≥3 features of partial control within the same week</td>
</tr>
<tr>
<td>• No symptoms§ during night or when wakes up</td>
<td>• Any symptoms during night or when wakes up††</td>
<td></td>
</tr>
<tr>
<td>• Need for SABA reliever# ≤ 2 days per week</td>
<td>• Need for SABA reliever# &gt;2 days per week</td>
<td></td>
</tr>
</tbody>
</table>

SABA: short-acting beta2 agonist
† e.g. wheezing or breathing problems
‡ child is fully active; runs and plays without symptoms
§ including no coughing during sleep
# not including doses taken prophylactically before exercise. (Record this separately and take into account when assessing management.)
* e.g. wheeze or breathlessness during exercise, vigorous play or laughing
†† e.g. waking with symptoms of wheezing or breathing problems

Notes:
Recent asthma control is based on symptoms over the previous 4 weeks. Each child’s risk factors for future asthma outcomes should also be assessed and taken into account in management.

Validated questionnaires can be used for assessing recent symptom control:
Test for Respiratory and Asthma Control in Kids (TRACK) for children < 5 years
Childhood Asthma Control Test (C-ACT) for children aged 4–11 years

Last reviewed version 2.0
Asset ID: 23

Table. Risk factors for life-threatening asthma flare-ups in children

Asthma-related factors
Poor asthma control
Admission to hospital in preceding 12 months
History of intubation for acute asthma
Over-use of short-acting beta2 agonist reliever
Abnormal spirometry findings
Reversible expiratory airflow limitation on spirometry despite treatment
Poor adherence to preventer
Incorrect inhaler technique for preventer
Poor adherence to asthma action plan
Exposure to clinically relevant allergens
Exposure to tobacco smoke
**Other clinical factors**
- Allergies to foods, insects, medicines
- Obesity

**Family-related factors**
- Frequent failure to attend consultations/lack of follow-up after an acute flare-up
- Significant parental psychological or socioeconomic problems
- Parent/carer unequipped to manage asthma emergency

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**Step-up options in children with asthma that is not controlled by low-dose inhaled corticosteroids**

In children whose asthma is inadequately controlled by low-dose inhaled corticosteroids alone (and adherence is good, inhaler technique is correct and diagnosis has been confirmed), treatment options include:

- increasing the inhaled corticosteroid dose
- adding montelukast
- switching to inhaled corticosteroid/long-acting beta2 agonist combination.

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**Table. Step-up options for children when good asthma control is not achieved with low-dose ICS**

<table>
<thead>
<tr>
<th>Option</th>
<th>TGA-registered indications for add-on therapy</th>
<th>PBS considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High-dose ICS</strong></td>
<td>N/A</td>
<td>Subsidised</td>
</tr>
<tr>
<td><strong>ICS plus montelukast</strong></td>
<td>2 years and over</td>
<td>2–5 years: not subsidised*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6–14 years: not subsidised unless for exercise-induced bronchoconstriction despite ICS treatment†</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 years and over: not subsidised‡</td>
</tr>
<tr>
<td><strong>ICS/long-acting beta2 agonist combination</strong></td>
<td>4 years and over for fluticasone propionate/salmeterol xinafoate</td>
<td>Subsidised</td>
</tr>
<tr>
<td></td>
<td>12 years and over for budesonide/formoterol fumarate dihydrate</td>
<td></td>
</tr>
</tbody>
</table>

* Advise parents about potential adverse psychiatric effects of montelukast

* Montelukast is not subsidised for use in combination with other preventers or for children who require inhaled corticosteroids.

† Montelukast is subsidised for prevention of exercise-induced asthma if asthma is otherwise well controlled while taking optimal-dose inhaled corticosteroids – it is not otherwise subsidised in combination with inhaled corticosteroids (or inhaled corticosteroid/long-acting beta2 agonist combinations).

‡ Montelukast is not subsidised for people aged over 15 years.

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In the majority of children with persistent asthma that requires preventive treatment, control can be achieved with one of these options.⁹
Few studies have been conducted in preschool-aged children. The preferred step-up option for children aged 6–12 years is controversial and guidelines differ in their recommendations.10

**Increasing inhaled corticosteroid dose versus adding a long-acting beta2 agonist**

In school-aged children with persistent asthma taking regular inhaled corticosteroid, the addition of a long-acting beta2 agonist does not reduce the rate of asthma flare-ups requiring systemic steroids compared with the same or higher doses of inhaled corticosteroid.11, 12 However, the long-acting beta2 agonist–inhaled corticosteroid was superior for improving lung function.11 Growth is reduced in children treated with higher-dose inhaled corticosteroid, compared with those taking same dose plus a long-acting beta2 agonist.11

Adolescents may benefit more from combination inhaled corticosteroid/long-acting beta2 agonist treatment than children under 12 years. In adolescents with persistent asthma that is not controlled by a low dose of inhaled corticosteroids, the combination of a long-acting beta2 agonist and an inhaled corticosteroid is modestly more effective in reducing the risk of flare-ups requiring oral corticosteroids than a higher dose of inhaled corticosteroids.13

**Adding montelukast versus adding a long-acting beta-2 agonist or increasing inhaled corticosteroid dose**

**Children aged 1–5 years**

In one study in children aged 5 years or less with persistent asthma/wheeze requiring preventer treatment, raised blood eosinophil levels and atopy predicted better short-term response to high-dose inhaled corticosteroid than to montelukast.14 However, routine eosinophil counts are currently not recommended to guide treatment in children.

In children aged 1–5 years with asthma/wheeze that is not adequately controlled by low-dose inhaled corticosteroid alone, adding montelukast is preferable to increasing the dose of inhaled corticosteroids when the safety profiles of these options are compared.15 Long-acting beta2 agonists are not recommended for this age group.

- Montelukast use has been associated with behavioural and/or neuropsychiatric adverse effects.

► Go to: [TGA alert](https://www.tga.gov.au/drugsafety/adverse-reactions/montelukast)

Note: Montelukast is TGA-approved for children aged 2 years and over.

**Children aged 6 years and over**

Among children 6 years and over with asthma that is not controlled by low-dose inhaled corticosteroids, the optimal regimen varies between individuals.16 In one study of children selected for high adherence with maintenance treatment, short-term responses varied between individuals: in some children the best response was achieved by adding a long-acting beta2 agonist, in others by adding montelukast, and in others by increasing the dose of inhaled corticosteroid.16

Note: The use of inhaled corticosteroids and long-acting beta2 agonists in separate inhalers is not recommended for either children or adults because of the potential for increased risk due to selective non-adherence to the inhaled corticosteroid.17

Overall, the addition of montelukast to an inhaled corticosteroid does not reduce the need for rescue oral corticosteroids or hospital admission, compared with the same or an increased dose of inhaled corticosteroids, in children aged 6 years and over or adolescents with mild-to-moderate asthma.18

For children aged 6–14 years with persistent asthma and exercise-induced bronchoconstriction, adding montelukast is more effective in protecting against exercise-induced bronchoconstriction than switching to a combination of inhaled corticosteroid and a long-acting beta2 agonist.19 The use of montelukast also avoids beta-receptor tolerance associated with long-acting beta2 agonists, so a short-acting beta2 agonist taken after exercise produces a greater bronchodilator response than it does in children taking regular long-acting beta2 agonist.19

A treatment trial of montelukast for 4–6 weeks is the best option when effects on exercise-induced symptoms and safety are also considered.15

- Montelukast use has been associated with behavioural and/or neuropsychiatric adverse effects.

► Go to: [TGA alert](https://www.tga.gov.au/drugsafety/adverse-reactions/montelukast)

See: [Investigation and management of exercise-induced bronchoconstriction](https://www.tga.gov.au/drugsafety/asthma/montelukast)

**Genetic influence on effect of long-acting beta2 agonists**

Clinical response to long-acting beta2 agonists partly depends on genetics. A beta2 receptor genotype (Arg16 polymorphism in the beta2 receptor gene) pre-disposes children with asthma to down-regulation of the beta2 receptor and increased susceptibility to flare-ups during regular treatment with regular long-acting beta2 agonists.20 However, routine genetic testing to tailor asthma therapy is not
Tiotropium for children aged 6 years and over

Tiotropium (5 microg administered via mist inhaler as two puffs once daily) is approved by TGA for use in children aged 6 years and older with moderate-to-severe asthma.

Tiotropium is subsidised by then PBS for children aged 6–17 years when used in combination with maintenance ICS+LABA treatment, for patients with severe asthma treated by, or in consultation with, a specialist (respiratory physician, paediatric respiratory physician, clinical immunologist, allergist, paediatrician or general physician experienced in severe asthma management), with frequent moderate exacerbations or ≥ one documented severe exacerbation that required systemic corticosteroids in the previous 12 months despite maintenance treatment with a medium-to-high dose of inhaled corticosteroid in combination with a long-acting beta2 agonist, and correct inhaler technique has been assessed, demonstrated and documented (see PBS for details).

Children aged 6–11

A systematic review of three randomised controlled trials reported that, in children aged 6–11 years with moderate-to-severe symptomatic asthma, tiotropium improved lung function, improved symptoms, and reduced the rate of flare-ups. Tiotropium was generally well tolerated.

Specific allergen immunotherapy (desensitisation)

- Specific allergen immunotherapy should not be started unless the patient has stable asthma, including spirometry-demonstrated forced expiratory volume in 1 second (FEV1) greater than 80% predicted for subcutaneous immunotherapy and greater than 70% predicted for sublingual immunotherapy. For patients with unstable asthma (e.g. frequent symptoms, marked variability in airflow measured by spirometry or peak flow monitor), the risks of treatment should be considered. These patients will need specialist supervision during treatment.

Options available in Australia

Two forms of specific allergen immunotherapy are available:

- sublingual immunotherapy
- subcutaneous immunotherapy.

Both forms of specific allergen immunotherapy require 3–5 years of treatment. Specific allergy immunotherapy can be repeated.

Although some specific allergen therapies can be prescribed by primary care health professionals, it is recommended that they are initiated under the care of an allergy specialist (allergist or clinical immunologist), where possible.

Commercial allergen preparations for immunotherapy are available in Australia for aeroallergens including house dust mite, pollens (e.g. grass, tree and weed pollens), animal dander and moulds.

Overview of efficacy

There is strong evidence that allergen immunotherapy is effective in the treatment of seasonal and perennial allergic rhinitis. There is less evidence supporting specific allergen immunotherapy in children than in adults. Specific allergen immunotherapy in children with seasonal allergic rhinoconjunctivitis might prevent development of asthma. Single-allergen specific allergen immunotherapy is effective in patients sensitised to one allergen and those sensitised to multiple allergens. In selected cases more than one allergen may be administered as separate extracts. There is weak evidence for the efficacy of allergen mixes.

A systematic review of studies directly comparing subcutaneous immunotherapy and sublingual immunotherapy in the treatment of allergic rhinoconjunctivitis and asthma found:

- low-grade evidence that subcutaneous immunotherapy is more effective than sublingual immunotherapy for reducing asthma symptoms and for reducing a combined measure of rhinitis symptoms and medication use
- moderate-grade evidence that subcutaneous immunotherapy is more effective than sublingual immunotherapy for reducing nasal and/or eye symptoms.

Sublingual immunotherapy is associated with a lower rate of severe adverse effects (anaphylaxis and death) than subcutaneous
Sublingual immunotherapy

Sublingual immunotherapy (self-administered at home) is effective for the treatment of allergic rhinitis in adults and children. The greatest benefits have been demonstrated in those with allergies to temperate grass pollens or house dust mite. Therapeutic Goods Administration (TGA)-approved indications for commercially available preparations vary according to age group.

The extract must be held under the tongue without swallowing for 2 minutes (liquid extracts) or 1 minute (tablets). Sublingual immunotherapy is generally well tolerated. Local adverse effects are common in children receiving sublingual immunotherapy. Systemic adverse reactions, such as anaphylaxis, are very rare. The majority of adverse events occur soon after beginning treatment.

TGA-approved indications

Asthma: *Acarizax* (house dust mite) is indicated for adults 18–65 years with house dust mite allergic asthma that is not well controlled by inhaled corticosteroids and is associated with mild-to-severe house dust mite allergic rhinitis. It is contraindicated in patients with FEV₁ <70% predicted after adequate treatment, and for patients who have experienced a severe flare-up within the previous 3 months.

Allergic rhinitis: Several commercial preparations of aeroallergens for sublingual immunotherapy in patients with allergic rhinitis are used in Australia, including:

- *Acarizax* (house dust mite) – indicated for adults 18–65 years with persistent moderate to severe house dust mite allergic rhinitis despite symptomatic treatment.
- *Actair* (house dust mite) – indicated for the treatment of house dust mite allergic rhinitis with or without conjunctivitis in adults and adolescents over 12 years diagnosed with house dust mite allergy.
- *Grazax* (Timothy grass *[Phleum pratense]* pollen extract) – indicated for adults, adolescents and children older than 5 years with allergic rhinitis induced by Timothy grass.
- *Oralair* tablets (mix of grass pollens) – indicated for adults and children over 5 years with grass pollen allergic rhinitis.

Various single allergens and/or multiple allergen mixes are available for use as advised by the treating allergist, available as liquid extracts. Age restrictions vary between products.

Note: PBS status as at October 2016: Treatment with sublingual immunotherapy specific allergen preparations is not subsidised by the PBS.

Subcutaneous immunotherapy

Subcutaneous immunotherapy involves injections in which the dose is gradually increased at regular intervals (usually weekly), or until a therapeutic/maintenance dose is reached. This can take approximately 3–6 months. Treatment is then continued for a further 3–5 years.

Subcutaneous immunotherapy is generally not suitable for younger children (e.g. less than 7 years) because they may not be able to tolerate frequent injections.

Several commercial preparations of aeroallergens for subcutaneous immunotherapy are available in Australia, including various single allergens and/or multiple allergen mixes for use as advised by the treating allergist. Age restrictions vary between products.

Subcutaneous immunotherapy is effective for the treatment of allergic rhinitis and asthma, particularly when single-allergen immunotherapy regimens are used. There is strong evidence that it reduces asthma symptoms, asthma medication usage, rhinitis/rhinoconjunctivitis symptoms, conjunctivitis symptoms, and rhinitis/rhinoconjunctivitis disease-specific quality of life, in comparison to placebo or usual care. There is also moderate evidence that subcutaneous immunotherapy reduces rhinitis/rhinoconjunctivitis medication usage.

Subcutaneous immunotherapy is associated with local adverse effects (e.g. injection-site swelling) and, less frequently, serious systemic adverse effects. The most common systemic reactions are respiratory symptoms. There have been few reports of anaphylaxis.

Note: PBS status as at March 2019: Treatment with subcutaneous specific allergen immunotherapy preparations is not subsidised by the PBS.

Last reviewed version 2.0
Oral corticosteroids for children: adverse effects

Oral corticosteroids may have adverse psychiatric effects in children, including aggression and hyperactivity. Effects in the general population include euphoria, hypomania, depression, disturbances of mood, cognition, sleep and behaviour.

A short course of oral corticosteroid therapy (less than 2 weeks) is associated with little risk of long-term suppression of the hypothalamus–pituitary–adrenal axis. However, risk can accumulate if frequent courses (four or more per year) are given.

Recurrent courses of oral corticosteroids may also affect bone mineral density, especially in boys.

Correct use of inhaler devices

Checking and correcting inhaler technique is essential to effective asthma management.

Most patients with asthma or COPD do not use their inhalers properly, and most have not had their technique checked or corrected by a health professional.

Incorrect inhaler technique when using maintenance treatments increases the risk of severe flare-ups and hospitalisation for people with asthma or COPD.

Poor asthma symptom control is often due to incorrect inhaler technique.

Incorrect inhaler technique when using inhaled corticosteroids increases the risk of local side effects like dysphonia and oral thrush.

The steps for using an inhaler device correctly differ between brands. Checklists of correct steps for each inhaler type and how-to videos are available from the National Asthma Council website.

References


46. Hardwell, A., Barber, V., Hargadon, T., et al. Technique training does not improve the ability of most patients to use pressurised metered-dose inhalers (pMDIs). Prim Care Respir J. 2011; 20: 92-6. Available from: http://www.nature.com/articles/prcjr201088
Administering inhaled medicines correctly in children

Recommendations

Check the child's inhaler technique at each asthma consultation or when dispensing inhaled asthma medicines:

- Have the child or parent demonstrate how the child uses the inhaler, while checking against a checklist of steps for that type of inhaler.
- Demonstrate correct technique using a placebo device and correct any specific errors identified.
- Have the child or parent repeat the demonstration to check they can now use the device correctly. If necessary, repeat instruction until the patient has all steps correct.
- Provide the checklist as a reminder, and write down or highlight any steps that were done incorrectly (e.g. on a sticker attached to their inhaler).

Note: Watch the child/parent use the inhaler – don’t just ask if they think they know how to use it properly.

Checklists of steps, and videos demonstrating correct technique, for various types of inhalers are available on National Asthma Council Australia’s website.

Go to: National Asthma Council Australia’s [How to use a puffer and spacer for kids](#) video
Go to: National Asthma Council Australia’s [Using your inhaler](#) webpage for information, patient resources and videos on inhaler technique
Go to: National Asthma Council Australia's information paper for health professionals on [inhaler technique for people with asthma or COPD](#)

How this recommendation was developed

Evidence-based recommendation
Based on literature search and formulated by multidisciplinary working group

Key evidence considered:
- The Inhaler Error Steering Committee 2013
- Basheti et al. 2008
- Basheti et al. 2017
- Crane et al. 2014
- Giraud et al. 2011
- Lavorini et al. 2014
- Newman et al. 2014

For children too young to use a mouthpiece (most children under 4 years), deliver inhaled medicines via a pressurised metered-dose inhaler and small-volume spacer with tightly fitting facemask.

Note: The child’s face should be washed after using inhaled corticosteroids.

How this recommendation was developed

Adapted from existing guidance
Based on reliable clinical practice guideline(s) or position statement(s):
- Brand et al. 2008

Last reviewed version 2.0
For children who are able to cooperate and understand how to seal their lips tightly around a spacer mouthpiece (usually those aged 4 years and over), deliver inhaled medicines via a pressurised metered-dose inhaler and small-volume spacer with a mouthpiece.

How this recommendation was developed

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

Last reviewed version 2.0

For children using spacers made of plastic (e.g. Breath-A-Tech, Volumatic), advise parents to wash the spacer before first use to reduce electrostatic charge. This should be done by disassembling if necessary, washing in warm water and dishwashing detergent, then allowing to air dry without rinsing or wiping before carefully reassembling.

If a new plastic spacer must be used immediately, it can be primed by firing multiple (at least 10) puffs of medicine into the spacer. (This is an arbitrary number of actuations in the absence of evidence that would enable a precise guideline.) Patients should follow the manufacturer’s instructions.

Notes:
Priming or washing spacers to reduce electrostatic charge before using for the first time is only necessary for plastic spacers (e.g. Breath-A-Tech, Volumatic). Priming or washing is not necessary for polyurethane/antistatic polymer spacers (e.g. Able A2A, AeroChamber Plus, La Petite E-Chamber, La Grande E-Chamber) or disposable cardboard spacers (e.g. DispozABLE, LiteAire).

Table. Types of spacers

<table>
<thead>
<tr>
<th>Name</th>
<th>Material</th>
<th>Cleaning necessary</th>
<th>Priming necessary before first use*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Able A2A</td>
<td>Antistatic polymer</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>AeroChamber Plus</td>
<td>Polycarbonate polyurethane</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Breath-A-Tech</td>
<td>Plastic</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>DispozABLE</td>
<td>Cardboard</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>La Grande E-Chamber</td>
<td>Polycarbonate polyurethane</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>LiteAire</td>
<td>Cardboard</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>La Petite E-Chamber</td>
<td>Polycarbonate polyurethane</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Volumatic</td>
<td>Plastic</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Washing: disassemble (if necessary), wash in warm water and dishwashing detergent, then allow to air dry without rinsing or wiping. Reassemble carefully.

Priming plastic spacers: wash and allow to dry (as above) before first use, to reduce static charge. If an unwashed plastic spacer needs to be used immediately, fire multiple (at least 10) actuations of medicine into the spacer, following manufacturer’s instructions. (This is an arbitrary number of actuations in the absence of evidence that would enable a precise guideline.)

Last reviewed version 2.0

Asset ID: 98

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):
For children using standard plastic spacers (e.g. Breath-A-Tech, Volumatic) or polyurethane/antistatic polymer spacers (e.g. Able A2A, AeroChamber Plus, La Petite E-Chamber, La Grande E-Chamber), advise patients and parents to clean the spacer monthly (but not more often) and after the resolution of any respiratory tract infection.

To clean a spacer:

- dismantle as per manufacturer’s instructions, if necessary
- wash parts in warm water with liquid dishwashing detergent
- allow to air dry without rinsing
- reassemble carefully, if necessary.

Notes:
Do not dry spacers with a cloth or paper towel. Wiping can increase the electrostatic charge on the inside of the spacer, which can reduce the available dose.
Spacers become cloudy after use – this is normal and does not affect their use.

<table>
<thead>
<tr>
<th>Table. Types of spacers</th>
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<tbody>
<tr>
<td>Name</td>
</tr>
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<td>Volumatic</td>
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Washing: disassemble (if necessary), wash in warm water and dishwashing detergent, then allow to air dry without rinsing or wiping. Reassemble carefully.

Priming plastic spacers: wash and allow to dry (as above) before first use, to reduce static charge. If an unwashed plastic spacer needs to be used immediately, fire multiple (at least 10) actuations of medicine into the spacer, following manufacturer’s instructions. (This is an arbitrary number of actuations in the absence of evidence that would enable a precise guideline.)

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available), with particular reference to the
When giving multiple puffs via a spacer, shake the inhaler, then fire one puff into the spacer and ask the child to take 4–6 breaths in and out of spacer after each puff.

Shake the inhaler again, and repeat.

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

Last reviewed version 2.0

For children taking inhaled corticosteroids, recommend:

- rinsing the mouth with water and spitting after inhaling the last dose, to minimise the amount of medicine deposited in the oropharynx
- using a spacer (if using a manually-actuated pressurised metered-dose inhaler).

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

Last reviewed version 2.0

Consider using a nebuliser only if a child cannot be taught to inhale medicine from a spacer.

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

Last reviewed version 2.0

More information

Administration of inhaled medicines in children: 6 years and over
Parents, carers and children need training to use inhaler devices correctly, including inhaler technique, and care and cleaning of inhalers and spacers.

School-aged children (depending on the child’s age, ability, and with individualised training) can learn to use a range of inhaler types, including manually actuated pressurised metered-dose inhalers with spacers, breath-actuated pressurised metered-dose inhalers (e.g. Autohaler), and dry-powder inhalers (e.g. Accuhaler, Turbuhaler).14, 15, 16, 17, 18

Table. Types of inhaler devices for delivering asthma and COPD medicines
Please view and print this figure separately: http://www.asthmahandbook.org.au/table/show/75

A pressurised metered-dose inhaler and spacer is an appropriate first choice for most children.16
School-aged children are unlikely to use their inhaler device correctly without careful training and repeated checking.19

Correct use of inhaler devices
Checking and correcting inhaler technique is essential to effective asthma management.
Most patients with asthma or COPD do not use their inhalers properly,1, 20,2, 21 and most have not had their technique checked or corrected by a health professional.
Incorrect inhaler technique when using maintenance treatments increases the risk of severe flare-ups and hospitalisation for people with asthma or COPD.1, 20, 22, 23, 24, 25
Poor asthma symptom control is often due to incorrect inhaler technique.26, 27
Incorrect inhaler technique when using inhaled corticosteroids increases the risk of local side effects like dysphonia and oral thrush.
The steps for using an inhaler device correctly differ between brands. Checklists of correct steps for each inhaler type and how-to videos are available from the National Asthma Council website.

References


27. Hardwell, A., Barber, V., Hargadon, T., et al. Technique training does not improve the ability of most patients to use pressurised metered-dose inhalers (pMDIs). Prim Care Respir J. 2011; 20: 92-6. Available from: http://www.nature.com/articles/prcj201088
Planning and conducting routine asthma review for children

Recommendations

As a general guide, review each child’s asthma:

- every 3–6 months when asthma is stable and well controlled
- 4 weeks after increasing the dose or number of medicines to regain control of partially or poorly controlled asthma
- 4–6 weeks after reducing dose of preventer or stepping down treatment
- within 4 weeks after a visit to the emergency department or a hospital stay due to acute asthma (in addition to early post-acute reassessment within 3 days of discharge).

Table. Definition of levels of recent asthma symptom control in children (regardless of current treatment regimen)

<table>
<thead>
<tr>
<th>Good control</th>
<th>Partial control</th>
<th>Poor control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All of:</strong></td>
<td><strong>Any of:</strong></td>
<td><strong>Either of:</strong></td>
</tr>
<tr>
<td>- Daytime symptoms† ≤2 days per week (lasting only a few minutes and rapidly</td>
<td>- Daytime symptoms† &gt;2 days per week (lasting only a few minutes and rapidly</td>
<td>- Daytime symptoms† &gt;2 days per week (lasting from minutes to hours or</td>
</tr>
<tr>
<td>relieved by rapid-acting bronchodilator)</td>
<td>relieved by rapid-acting bronchodilator)</td>
<td>recurring, and partially or fully relieved by SABA reliever)</td>
</tr>
<tr>
<td>- No limitation of activities‡</td>
<td>- Any limitation of activities*</td>
<td>- ≥3 features of partial control within the same week</td>
</tr>
<tr>
<td>- No symptoms§ during night or when wakes up</td>
<td>- Any symptoms during night or when wakes up††</td>
<td></td>
</tr>
<tr>
<td>- Need for SABA reliever# ≤2 days per week</td>
<td>- Need for SABA reliever# &gt;2 days per week</td>
<td></td>
</tr>
</tbody>
</table>

SABA: short-acting beta2 agonist

† e.g. wheezing or breathing problems
‡ child is fully active; runs and plays without symptoms
§ including no coughing during sleep
# not including doses taken prophylactically before exercise. (Record this separately and take into account when assessing management.)

* e.g. wheeze or breathlessness during exercise, vigorous play or laughing
†† e.g. waking with symptoms of wheezing or breathing problems

Notes:

Recent asthma control is based on symptoms over the previous 4 weeks. Each child’s risk factors for future asthma outcomes should also be assessed and taken into account in management.

Validated questionnaires can be used for assessing recent symptom control:

- Test for Respiratory and Asthma Control in Kids (TRACK) for children < 5 years
- Childhood Asthma Control Test (C-ACT) for children aged 4–11 years

Last reviewed version 2.0

Asset ID: 23
Arrange more frequent follow-up for children with any of the following risk factors:

- confirmed food allergy
- poor asthma control
- admission to hospital in preceding 12 months
- a history of intubation for acute asthma
- over-use of short-acting beta2 agonist reliever
- frequent failure to attend consultations
- abnormal spirometry findings
- reversible expiratory airflow limitation on spirometry despite treatment
- poor adherence to preventer
- poor inhaler technique for preventer
- poor adherence to asthma action plan
- significant parental psychological or socioeconomic problems
- carer unequipped to manage asthma emergency
- exposure to clinically relevant allergens
- exposure to tobacco smoke
- obesity.

- food allergy is risk factor for life-threatening asthma flare-ups

Notes:
Normal spirometry includes FEV1/FVC greater than lower limit of normal for age and FEV1 % predicted ≥80%.
Reversible expiratory airflow limitation in children is defined as an increase in FEV1 ≥12% from baseline 10–15 minutes after administration of bronchodilator.

At each asthma review, assess:

- recent asthma symptom control based on reported symptoms, limitation of daily activity and need for reliever medicine
- whether the child has any risk factors for poor asthma outcomes in future (e.g. persistent symptoms, over-use of short-acting beta2 agonist reliever, severe asthma, poor adherence, exposure to tobacco smoke, obesity, severe allergies such as food allergies or history of anaphylaxis, previous severe life-threatening acute asthma or hospital admission for asthma, history of sudden severe unpredictable asthma flare-ups, or significant psychosocial factors including socioeconomic deprivation)
- lung function using spirometry (for children old enough to perform the test)
- adherence to treatment
- inhaler technique
- whether the written asthma action plan is up to date
- modifiable environmental factors including exposure to tobacco smoke or significant airborne allergens
- whether parents or child have any concerns about the treatment (e.g. cost, potential side effects).

Notes:
Assessments can be made by asking the same questions at each visit, or using validated questionnaires.
If children are referred to a lung function laboratory for spirometry for the purpose of monitoring asthma treatment, they should keep taking their...
preventer as usual. Inhaled corticosteroid–long-acting beta2 agonist preventers should not be withheld before the test. (If referred for diagnostic spirometry, preventer should be withheld to ensure the test is accurate.)

**Table. Definition of levels of recent asthma symptom control in children (regardless of current treatment regimen)**

<table>
<thead>
<tr>
<th>Good control</th>
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<td>· Need for SABA reliever# ≤2 days per week</td>
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**Notes:**
Recent asthma control is based on symptoms over the previous 4 weeks. Each child’s risk factors for future asthma outcomes should also be assessed and taken into account in management.

Validated questionnaires can be used for assessing recent symptom control:
- **Test for Respiratory and Asthma Control in Kids (TRACK) for children < 5 years**
- **Childhood Asthma Control Test (C-ACT) for children aged 4–11 years**

*Last reviewed version 2.0*

**Asset ID: 23**

**Table. Sample questions for reviewing asthma in children**

**Recent symptom control**
- How often does child wheeze or become short of breath?
- Does child wake during the night due to wheezing or shortness of breath? (How many times per month?)
- How often does child need to take reliever inhaler? (How many days per week? How many times per day? How many puffs?)*
- How many weeks does child’s reliever inhaler last?
- Has child missed time from childcare, school and or sport due to asthma?

*Validated questionnaires are available for assessing recent symptom control:*
- **Test for Respiratory and Asthma Control in Kids (TRACK) for children < 5 years**
- **Childhood Asthma Control Test (C-ACT) for children aged 4–11 years**
Adherence to preventer treatment (if prescribed)

Does child take a preventer inhaler? (What dose is on the label? How many puffs per day have you been told to use?)

Many children miss some doses. In the last four weeks:

- how many days a week would your child have taken the preventer medication? None at all? One? Two? (etc).
- how many times a day would your child take it? Morning only? Evening only? Morning and evening? (or other)
- each time, how many puffs would they take? One? Two? (etc).

Do you find it easier to remember to give it in the mornings or evenings?

How often does child need new script for preventer medicine? (Note: number of doses per unit varies between brands)

Flare-ups

Has child had a flare-up since last visit?

What triggered it? (e.g. cold symptoms, allergies, stopping preventer)

How was the flare-up treated?

Has child ever been hospitalised for asthma or a wheezing episode?

When was the child’s last flare-up (and last flare-up before that one)? How were these flare-ups treated?

How many times has child visited GP/hospital emergency room for asthma symptoms in the last [specify time period, e.g. year/month/2 weeks]?

Allergies

Does child have allergic rhinitis (hay fever)?

Is child using other medicines for respiratory symptoms (e.g. oral or intranasal antihistamines, intranasal corticosteroids)?

Does the child have allergies (e.g. to foods or insect bites) or need an adrenaline injector (e.g. Epipen) for emergencies?

Does the child get skin rashes caused by allergies?

Inhaler technique

Can you show me how you use the inhaler?

When did you last wash the spacer? (How do you wash it?)

*Note: The use of more than 3 canisters per year (equivalent to use every day) is associated with doubling of the risk of severe flare-ups. 1


Last reviewed version 2.0
Asset ID: 29

How this recommendation was developed

Consensus

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

Last reviewed version 2.0

Validated checklists or questionnaires can be used to assess recent asthma symptom control at each visit, e.g:

- Test for Respiratory and Asthma Control in Kids (TRACK) – suitable for children under 5 years
- Childhood Asthma Control Test (C-ACT) – suitable for children aged 4–11 years
Pharmacists should record the number of times a non-prescription short-acting beta₂ agonist is dispensed for a child and ask parents how long puffer usually lasts, so that over-use can be identified and addressed (e.g. by counselling parents about risk of over-use of relievers, assessing asthma control and advising parents to visit their GP if poor control is identified, or alerting the child’s GP).

- Dispensing of 3 or more canisters in a year (average 1.6 puffs per day) is associated with increased risk of exacerbations.
- Dispensing 12 or more canisters in a year (average 6.6 puffs per day) is associated with increased risk of asthma death.

Notes:
Recent asthma symptom control can be assessed using validated checklists or questionnaires.
Recording short-acting beta₂ reliever dispensing is a regulatory requirement in some states.

For children taking inhaled corticosteroids long term, monitor linear growth. At least annually, measure height and weight, accurately measured and plotted on a percentile chart.

If treatment with high-dose inhaled corticosteroids is needed for 6 months or longer to control asthma or wheezing symptoms, or frequent courses of oral corticosteroids are needed:

- refer to a paediatric specialist (e.g. paediatric respiratory physician or paediatrician) for assessment, including screening for adrenal suppression
- provide specific written advice (steroid alert card) for other health professionals such as emergency services (e.g. that if child shows reduced consciousness, consider the possibility of adrenal insufficiency, check serum biochemistry, blood glucose level and serum cortisol urgently, and consider whether intramuscular hydrocortisone is indicated)
- warn parents that adrenal suppression is a possible side effect and advise them what to do if the child develops symptoms consistent with adrenal insufficiency, such as lethargy, vomiting, abdominal pain or seizures (e.g. go to the emergency department without delay, tell staff that the child is using regular high-dose medicine for asthma, and hand them the child’s steroid alert card)
- advise parents to consider having the child wear a medical alert bracelet.

Note:
Morning cortisol level is the standard screening test for adrenal suppression. If abnormal, it is followed up with a low-dose adrenocorticotropic hormone stimulation test. Referral to an endocrinologist is indicated if adrenal suppression is suspected or detected.

Table. Definitions of ICS dose levels in children

<table>
<thead>
<tr>
<th>Inhaled corticosteroid</th>
<th>Daily dose (microg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How this recommendation was developed
Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).
Last reviewed version 2.0
<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beclometasone dipropionate †</strong></td>
<td>100–200</td>
<td>&gt;200 (maximum 400)</td>
</tr>
<tr>
<td><strong>Budesonide</strong></td>
<td>200–400</td>
<td>&gt;400 (maximum 800)</td>
</tr>
<tr>
<td><strong>Ciclesonide ‡</strong></td>
<td>80–160</td>
<td>&gt;160 (maximum 320)</td>
</tr>
<tr>
<td><strong>Fluticasone propionate</strong></td>
<td>100–200</td>
<td>&gt;200 (maximum 500)</td>
</tr>
</tbody>
</table>

† Dose equivalents for Qvar (TGA-registered CFC-free formulation of beclometasone dipropionate)
‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

**Source**

Last reviewed version 2.0
Asset ID: 21

**Inhaled corticosteroids for children: adverse effects**

**Local adverse effects**
Hoarseness and pharyngeal candidiasis are not commonly reported among preschool children or school-aged children talking inhaled corticosteroids.14, 7, 15 Topical effects can be reduced by use of spacer devices (which reduce oropharyngeal deposition), and by mouth-rinsing and spitting after use.7 Immediate quick mouth-rinsing removes more residual medicine in the mouth than delayed rinsing.16

There is limited evidence that inhaled asthma medication can affect dental health.7, 17 Mouth rinsing might reduce this risk.

**Systemic adverse effects**
Systemic effects of inhaled corticosteroids in children depend on the dose, but clinically significant adverse effects are uncommon.7 The use of spacers and mouth rinsing will not reduce systemic effects, but the use of a spacer may increase efficacy so that a lower dose is required.

**Growth**
Short-term suppression of linear growth has been demonstrated in children taking inhaled corticosteroids.18,19 The effect seems to be
maximal during the first year of therapy and only one study has reported an effect in subsequent years of treatment. A Cochrane systematic review concluded that regular use of inhaled corticosteroid at low or medium daily doses is associated with a mean reduction of 0.48 cm per year in linear growth velocity and 0.61 cm less gain in height during 1 year of treatment in children with mild to moderate persistent asthma.

One study of patients who participated in a clinical trial of inhaled corticosteroids as children, reported a reduction in adult height of approximately 1 cm, whereas several studies have reported that children taking inhaled corticosteroids attained normal adult height.

The effect is dose-dependent and may be more likely in children who begin inhaled corticosteroid treatment before age 10. Other factors affect growth in children with asthma. Uncontrolled asthma itself reduces growth and final adult height. One study found that inhaled corticosteroid equivalent to budesonide 400 microg/day affected growth less than low socioeconomic status.

Bone density

Inhaled corticosteroids have not been associated with effects on bone density or fractures in children. However, data from a recent study in Australia suggested asthma itself is associated with increased incidence of fractures in children, independent of medication. Given that the total dose of corticosteroids (both inhaled corticosteroids and oral corticosteroids) influences bone health, the aim of asthma management is to maintain symptom control using the lowest inhaled corticosteroid dose required, and to avoid repeated courses of oral corticosteroids.

Adrenal suppression

Biochemical testing in a research setting suggests that hypothalamic–pituitary–adrenal axis suppression may occur in up to two-thirds of children treated with inhaled corticosteroids, and may occur at even low doses. The risk is higher among children receiving concomitant intranasal steroids and those with lower body mass index, and is influenced by genetics.

Clinical adrenal insufficiency in children taking inhaled corticosteroids is rare but has been reported, including cases in Australia. Most cases have involved children given more than 500 microg per day fluticasone propionate. Adrenal suppression is associated with hypoglycaemia, hypotension, weakness, failure to grow, and is potentially fatal. Hypothalamic–pituitary–adrenal axis suppression may not be detected until adrenal crisis is precipitated by physical stress.

Written information (e.g. a steroid alert card) can be prepared for children receiving long-term high-dose inhaled corticosteroids. Parents/carers can be instructed to present the card if the child ever needs to go to the emergency department (for any reason) or be admitted to hospital. A steroid alert card should state that child has asthma and the inhaled corticosteroid dose. A medical alert bracelet could also be considered.

There are no nationally accepted protocols for routine assessment of adrenal function in primary care because it has not yet been possible to identify precisely which children should be tested, to interpret test results reliably, to identify the appropriate interval for retesting, and because a clinical benefit has not been clearly demonstrated.

Regular monitoring of height might help detect adrenal suppression, based on the findings of a study in which a reduction in linear growth velocity occurred before adrenal suppression.

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‡ Ciclesonide is registered by the TGA for use in children aged 6 and over

Source
Approaches to assessment and monitoring of asthma control in children

Assessment of asthma control in children is based mainly on:

- recent asthma symptom control (assessed by the frequency and severity of symptoms between flare-ups)
- the degree to which asthma symptoms affect daily activities such as interference with physical activity or missed school days)
- the frequency of flare-ups
- spirometry in children who are able to perform the test reliably.

Standardised questionnaires

Questionnaire-based instruments have been validated for assessing asthma control in children:

- **Test for Respiratory and Asthma Control in Kids (TRACK)** for children less than 5 years old – consists of five questions about frequency of respiratory symptoms (wheeze, cough, shortness of breath), activity limitation, and night-time awakenings in the past 4 weeks, rescue medication use in the past 3 months, and oral corticosteroid use in the previous year. A lower score indicates worse asthma control.
- **Childhood Asthma Control Test (C-ACT)** for children aged 4–11 years – consists of seven items: three for the parent/carer (about the child’s symptoms over the previous 4 weeks) and four for the child. A lower score indicates worse asthma control. Note: C-ACT is intended for US use.

Lung function tests

Frequent spirometry to guide asthma treatment in children has not been shown to achieve superior outcomes to symptom-based treatment. However, low FEV<sub>1</sub> predicts clinically significant flare-ups, so spirometry should be performed at asthma reviews for children who are old enough to do the test.

The quality and utility of spirometry depends on the skill, clinical expertise and experience of the person doing and interpreting spirometry.

The results of one study in children aged 6–16 years with moderate atopic asthma suggest that asthma treatment guided by airway hyperresponsiveness (measured by bronchial provocation testing) may have a benefit over symptom-guided treatment in improving lung, but this effect was lost after 3–7 years of usual care. Repeated bronchial provocation testing is not feasible in clinical practice.

Measures of airway inflammation

Measures of airway inflammation (e.g. sputum eosinophil count, exhaled nitric oxide measurement) are not recommended in primary care to guide treatment decisions, but are increasingly used in specialist clinics.

Asthma treatment guided by sputum eosinophil count has been shown to reduce the frequency of flare-ups in adults with asthma, but there is insufficient evidence to ascertain its value for children.

Exhaled nitric oxide measurement may be useful in guiding asthma management in some children. In children not taking inhaled corticosteroid, a high nitric oxide level probably predicts a good short-term response to inhaled corticosteroid treatment, but it does not distinguish between asthma and eosinophilic bronchitis and is often high in children with atopy. There is insufficient evidence to ascertain whether a low exhaled nitric oxide level predicts successful withdrawal from inhaled corticosteroids without asthma relapse, or safety of treating asthma without inhaled corticosteroids.

A Cochrane review found that exhaled nitric oxide-guided management was significantly better than other approaches to adjusting medicines for reducing the number of children with flare-ups and the number of children who needed oral corticosteroids, but did not reduce the frequency of flare-ups or the rate of flare-ups requiring hospitalisation, improve lung function or symptoms scores, or reduce inhaled corticosteroid doses. The authors concluded that it could not be recommended for all children but may be beneficial for a subset not yet defined.

Towards personalised asthma care
Emerging understanding of asthma phenotypes and of genetic factors that predict therapeutic response to preventer options is leading to the possibility of personalised, genomics-based treatment for asthma in children. In the near future, individual tailored therapy may replace the standardised step model based on population data.

**Asthma triggers in children: respiratory tract infections**

Viral respiratory infections, such as the common cold, are a frequent cause of wheezing and asthma flare-ups in children, especially in preschool children.

The findings of observational cohort studies and limited randomised controlled trials show that influenza vaccination reduces the number, frequency and duration of asthma flare-ups in children, and lower the rate of emergency department visits and hospitalisation for asthma.

Although bacterial respiratory infections may also trigger wheezing, antibiotics are not routinely indicated for asthma flare-ups or wheezing, and should only be given if they would otherwise be indicated.

▶ See: Preventive care

**Asthma triggers in children: environmental allergens**

There is insufficient evidence on which to base recommendations for the reduction of exposure to environmental allergens in the treatment of wheezing in preschool children.

▶ See: Allergies and asthma
See: Asthma triggers

**Asthma triggers in children: tobacco smoke**

There is consistent, high-quality evidence that exposure to environmental tobacco smoke can both cause and worsen wheezing in preschool children.

The introduction of environmental tobacco controls has led to significant reduction in asthma hospitalisations among children.

▶ See: Smoking and asthma
See: Asthma triggers

**Written asthma action plans for children**

Every child with asthma should have their own written asthma action plan.

A systematic review found that the use of written asthma action plans significantly reduces the rate of visits to acute care facilities, the number of school days missed and night-time waking, and improves symptoms.

For children and adolescents, written asthma action plans that are based on symptoms appear to be more effective than action plans based on peak expiratory flow monitoring.

A written asthma action plan should include all the following:

- a list of the child's usual medicines (names of medicines, doses, when to take each dose) – including treatment for related conditions such as allergic rhinitis
- clear instructions on what to do in all the following situations:
  - when asthma is getting worse (e.g. when needing more reliever than usual, waking up with asthma, more symptoms than usual, asthma is interfering with usual activities)
  - when asthma symptoms get substantially worse (e.g. when needing reliever again within 3 hours, experiencing increasing difficulty breathing, waking often at night with asthma symptoms)
  - during an asthma emergency.
- instructions on when and how to get medical care (including contact telephone numbers)
- the name and contact details of the child's emergency contact person (e.g. parent)
- the name of the person writing the action plan, and the date it was issued.
Table. Checklist for reviewing a written asthma action plan

- Ask if the person (or parent) knows where their written asthma action plan is.
- Ask if they have used their written asthma action plan because of worsening asthma.
- Ask if the person (or parent) has had any problems using their written asthma action plan, or has any comments about whether they find it suitable and effective.
- Check that the medication recommendations are appropriate to the person's current treatment.
- Check that all action points are appropriate to the person's level of recent asthma symptom control.
- Check that the person (or parent) understands and is satisfied with the action points.
- If the written asthma action plan has been used because of worsening asthma more than once in the past 12 months: review the person's usual asthma treatment, adherence, inhaler technique, and exposure to avoidable trigger factors.
- Check that the contact details for medical care and acute care are up to date.

Templates for written asthma action plans

Templates are available from National Asthma Council Australia:
- National Asthma Council Australia colour-coded plan, available as a printed handout that folds to wallet size and as the Asthma Buddy mobile site
- Asthma Cycle of Care asthma action plan
- A plan designed for patients using budesonide/formoterol combination as maintenance and reliever therapy
- Remote Indigenous Australian Asthma Action Plan
- Every Day Asthma Action Plan (designed for remote Indigenous Australians who do not use written English – may also be useful for others for whom written English is inappropriate)
- Children's written asthma action plans.

Some written asthma action plans are available in community languages.

Software for developing electronic pictorial asthma action plans is available online.

Go to: National Asthma Council Australia's Asthma Action Plan Library
Download: Imperial College London's Electronic Asthma Action Plan

Asthma education programs for parents/carers and children

Asthma education for children and/or caregivers reduces the risk of emergency department visit for asthma, compared with usual care. However, the most effective components of education have not been clearly identified. There have been relatively few Australian controlled trials assessing education programs.

There is not enough evidence to tell whether asthma education programs in the child's home are more effective in helping control asthma than asthma education provided somewhere else or standard care, or to identify which types of education is more effective.

All age groups

A systematic review found that asthma education programs were associated with moderate improvement in lung function and with a small reduction in school absence, restriction of physical activity, and emergency department visits. The greatest effects were in children with more severe asthma.

Another systematic review found that educational programmes for the self-management of asthma in children and adolescents improved lung function, reduced the number of school days missed and the number of days with restricted activity, reduced the rate of visits to an emergency department, and possibly reduced the number of disturbed nights.

0-5 years

There is little evidence about the effects of education for parents of preschool-aged children with asthma or wheezing. Most studies have investigated the effects of asthma management education for older children and their parents. Limited evidence suggests that:
- education for parents of preschool children (e.g. written information and review by a health professional, small-group teaching by
nurses or education in the family’s home) may help improve asthma control.\textsuperscript{14} 

- education programs are more likely to be effective if they involve multiple sessions, each longer than 20 minutes’ duration.\textsuperscript{14}

Opportunistic asthma education

In addition to the types of structured or formal asthma education evaluated in research trials, all health professionals who work with children with asthma and their parents/carers can provide asthma education whenever the opportunity occurs.

Table. Childhood asthma education checklist

Please view and print this figure separately: http://www.asthmahandbook.org.au/table/show/30

Resources

Education resources are available from the National Asthma Council Australia, Asthma Australia, and the Asthma Foundation in your state or territory.

Go to: National Asthma Council Australia

Go to: Asthma Australia

Last reviewed version 2.0

Correct use of inhaler devices

Checking and correcting inhaler technique is essential to effective asthma management.

Most patients with asthma or COPD do not use their inhalers properly,\textsuperscript{52, 53, 54, 55} and most have not had their technique checked or corrected by a health professional.

Incorrect inhaler technique when using maintenance treatments increases the risk of severe flare-ups and hospitalisation for people with asthma or COPD.\textsuperscript{52, 53, 56, 57, 58, 59}

Poor asthma symptom control is often due to incorrect inhaler technique.\textsuperscript{60, 61}

Incorrect inhaler technique when using inhaled corticosteroids increases the risk of local side effects like dysphonia and oral thrush. The steps for using an inhaler device correctly differ between brands. Checklists of correct steps for each inhaler type and how-to videos are available from the National Asthma Council website.

Go to: National Asthma Council Australia’s Using your inhaler webpage for information, patient resources and videos on inhaler technique

Go to: National Asthma Council Australia’s information paper for health professionals on Inhaler technique for people with asthma or COPD

Go to: NPS MedicineWise information on Inhaler devices for respiratory medicines

Last reviewed version 2.0

Common reasons for poor response to preventer treatment

Apparent lack of response to asthma treatment is commonly due to one or more of the following:\textsuperscript{62}

- poor adherence (which may be due to lack of perceived need for the medication, concern about potential or actual side-effects, cost of medicines, a busy lifestyle, misunderstanding of the purpose and effects of asthma medicines, or inability to follow the medical instructions)
- poor inhaler technique
- mishandling devices (e.g. failure to clean spacer, allowing mouthpiece of dry-powder inhalers to become blocked)
- incorrect dose or frequency
- empty inhaler
- expired medicines
- continued exposure to smoke or allergen triggers.

Failure to identify these causes before adjusting medicines could result in over-medication with preventers.

See: Management challenges

Last reviewed version 2.0

References


61. Hardwell, A., Barber, V., Hargadon, T., et al. Technique training does not improve the ability of most patients to use pressurised metered-dose inhalers (pMDIs). Prim Care Respir J. 2011; 20: 92-6. Available from: http://www.nature.com/articles/pcrj201088

Managing triggers in children

Recommendations

Advise parents/carers to ensure that children are not exposed to tobacco smoke and to ensure that the home and car are smoke-free zones. Explain that smoking outdoors near children still exposes children to smoke.

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

Last reviewed version 2.0

All health professionals should advise parents and household members about smoking cessation options and support them to quit smoking.

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

- RACGP 2014

Last reviewed version 2.0

Identify aeroallergens to which the child is sensitised and reduce exposure to allergic triggers, where avoidance is feasible and has been shown to be effective and cost-effective.

Table. Summary of asthma triggers

Please view and print this figure separately: http://www.asthmahandbook.org.au/table/show/52

See: Considering allergen avoidance where feasible

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

Last reviewed version 2.0

More information

Back-to-school asthma care

Each year during February, a few days after the school year starts, there is an annual increase in asthma flare-ups among children with asthma.

Asthma flare-ups in children, including those resulting in emergency department presentations and hospitalisations, surge during the first month of the school year. There are smaller increases at the beginning of the other school terms. These flare-ups may be due to changes in exposure to virus, allergens, pollution and/or stress during the early days after school return.
Primary care health professionals can help parents/carers prepare for back-to-school flare-ups by:

- recommending a full asthma review at the end of the school holidays to check asthma control, adherence to preventer and inhaler technique
- ensuring that each child has an up-to-date written asthma action plan and the child and/or parents/carers understand how to follow it
- reminding parents/carers to get their child back into their asthma routine before the school year starts, including taking preventer medications every day, if prescribed

Go to: National Asthma Council Australia’s Back to school checklist for kids with asthma

Last reviewed version 2.0

Thunderstorm asthma

Certain types of thunderstorms in spring or early summer in regions with high grass pollen concentrations in the air can cause life-threatening allergic asthma flare-ups in individuals sensitised to rye grass, even if they have not had asthma before.9, 10, 11, 12, 13 Sensitisation to rye grass allergen is almost universal in patients who have reported flare-ups consistent with thunderstorm asthma in Australia.

People with allergic rhinitis and allergy to ryegrass pollen (i.e. most people with springtime allergic rhinitis symptoms) are at risk of thunderstorm asthma if they live in, or are travelling to, a region with seasonal high grass pollen levels – even if they have never had asthma symptoms before. This includes people with undiagnosed asthma, no previous asthma, known asthma.9, 10 Lack of inhaled corticosteroid preventer treatment has been identified as a risk factor.9

Epidemics of thunderstorm asthma can occur when such a storm travels across a region and triggers asthma in many susceptible individuals. Epidemic thunderstorm asthma events are uncommon, but when they occur can they make a high demand on ambulance and health services.14, 13, 15

Data from thunderstorm asthma epidemics suggest that the risk of asthma flare-ups being triggered by a thunderstorm is highest in adults who are sensitised to grass pollen and have seasonal allergic rhinitis (with or without known asthma).9 The worst outcomes are seen in people with poorly controlled asthma.14 Treatment with an inhaled corticosteroid asthma preventer was significantly protective in a well-conducted Australian case-control study.10

There is insufficient evidence to determine whether intranasal corticosteroids help protect against thunderstorm asthma. Intranasal corticosteroids reduce symptoms of allergic rhinitis and limited indirect evidence suggests they may protect against asthma flare-ups in people not taking inhaled corticosteroids.16

The effectiveness of specific allergen immunotherapy in protecting against thunderstorm asthma has not been evaluated in randomised clinical trials, but data from a small Australian open-label study suggest that short-term treatment with five-grass sublingual immunotherapy may have been protective in individuals.17

Go to: National Asthma Council Australia’s Epidemic thunderstorm asthma information paper
Go to: ASCIA’s Pollen calendar
Go to: Vic Emergency’s Thunderstorm asthma forecast (Victoria only)

Last reviewed version 2.0

Asthma triggers in children: respiratory tract infections

Viral respiratory infections, such as the common cold, are a frequent cause of wheezing and asthma flare-ups in children, especially in preschool children.

The findings of observational cohort studies and limited randomised controlled trials show that influenza vaccination reduces the number, frequency and duration of asthma flare-ups in children, and lower the rate of emergency department visits and hospitalisation for asthma.18

Although bacterial respiratory infections may also trigger wheezing, antibiotics are not routinely indicated for asthma flare-ups or wheezing, and should only be given if they would otherwise be indicated.

See: Preventive care

Last reviewed version 2.0

Asthma triggers in children: environmental allergens

There is insufficient evidence on which to base recommendations for the reduction of exposure to environmental allergens in the
The Introduction of environmental tobacco controls has led to significant reduction in asthma hospitalisations among children.19, 20

There is consistent, high-quality evidence that exposure to environmental tobacco smoke can both cause and worsen wheezing in preschool children.19

Asthma triggers in children: tobacco smoke

There is consistent, high-quality evidence that exposure to environmental tobacco smoke can both cause and worsen wheezing in preschool children.19

See: Smoking and asthma
See: Asthma triggers

References


Providing asthma management education for parents and children

Recommendations

Provide parents (and children, if old enough) with asthma education that includes information about asthma symptoms and signs, asthma medicines, and how to take inhaled medicines correctly.

Table. Childhood asthma education checklist

Please view and print this figure separately: http://www.asthmahandbook.org.au/table/show/30

How this recommendation was developed

Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).
Last reviewed version 2.0

Provide a written asthma action plan for all children with asthma, and train parents (and older children) how to follow it.

Go to: National Asthma Council Australia's Asthma Action Plan Library

How this recommendation was developed

Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).
Last reviewed version 2.0

Review the child’s written asthma action plan at least yearly and whenever asthma control status changes significantly or medicines are changed or stopped.

Table. Checklist for reviewing a written asthma action plan

- Ask if the person (or parent) knows where their written asthma action plan is.
- Ask if they have used their written asthma action plan because of worsening asthma.
- Ask if the person (or parent) has had any problems using their written asthma action plan, or has any comments about whether they find it suitable and effective.
- Check that the medication recommendations are appropriate to the person’s current treatment.
- Check that all action points are appropriate to the person’s level of recent asthma symptom control.
- Check that the person (or parent) understands and is satisfied with the action points.
- If the written asthma action plan has been used because of worsening asthma more than once in the past 12 months: review the person's usual asthma treatment, adherence, inhaler technique, and exposure to avoidable trigger factors.
- Check that the contact details for medical care and acute care are up to date.

Asset ID: 43

How this recommendation was developed

Consensus
Based on clinical experience and expert opinion (informed by evidence, where available).
Provide parents of wheezing preschool children with education that includes information on:

- causes of wheeze
- when wheezing is clinically significant (i.e. when accompanied by increased work of breathing or severe enough to interrupt eating, play, physical activity or sleep)
- effective treatment options
- how to recognise worsening asthma symptoms (a flare-up).

**How this recommendation was developed**

Consensus

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

*Last reviewed version 2.0*

Provide training for children and parents on how to use inhaler devices correctly, including inhaler technique and the care and cleaning of devices and spacers. Review technique each time asthma medicines are dispensed or prescribed.

➤ See: [Inhaler devices and technique](#)

**How this recommendation was developed**

Consensus

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

*Last reviewed version 2.0*

Advise parents that inhaled medications might affect dental health. Advise rinsing and spitting after taking inhaled medicines to minimise local absorption and the risk of oropharyngeal candidiasis ('thrush') with inhaled corticosteroids, and possibly reduce the risk of dental caries with inhaled beta2 agonists.

**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
- National Asthma Council Australia 2018

*Last reviewed version 2.0*

Advise parents to ensure children have adequate exposure to sunlight to maintain healthy vitamin D levels, while avoiding excess exposure to UV radiation.

Note: Parents can use the Sunsmart app to determine safe exposure times in their region for different times of year.

➤ Go to: Cancer Council Victoria’s and the Victorian Health Promotion Foundation (VicHealth)’s Sunsmart initiative

Go to: [Australian and New Zealand Bone and Mineral Society, the Australasian College of Dermatologists, Cancer Council Australia, Endocrine Society of Australia and Osteoporosis Australia](#) position statement on sun exposure and vitamin D

**How this recommendation was developed**

Adapted from existing guidance

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

- Cancer Council Australia
- Paxton et al. 2013

*Last reviewed version 2.0*
**Written asthma action plans for children**

Every child with asthma should have their own written asthma action plan.

A systematic review found that the use of written asthma action plans significantly reduces the rate of visits to acute care facilities, the number of school days missed and night-time waking, and improves symptoms.5

For children and adolescents, written asthma action plans that are based on symptoms appear to be more effective than action plans based on peak expiratory flow monitoring.5

A written asthma action plan should include all the following:

- a list of the child’s usual medicines (names of medicines, doses, when to take each dose) – including treatment for related conditions such as allergic rhinitis
- clear instructions on what to do in all the following situations:
  - when asthma is getting worse (e.g. when needing more reliever than usual, waking up with asthma, more symptoms than usual, asthma is interfering with usual activities)
  - when asthma symptoms get substantially worse (e.g. when needing reliever again within 3 hours, experiencing increasing difficulty breathing, waking often at night with asthma symptoms)
  - during an asthma emergency.
- instructions on when and how to get medical care (including contact telephone numbers)
- the name and contact details of the child’s emergency contact person (e.g. parent)
- the name of the person writing the action plan, and the date it was issued.

**Table. Checklist for reviewing a written asthma action plan**

- Ask if the person (or parent) knows where their written asthma action plan is.
- Ask if they have used their written asthma action plan because of worsening asthma.
- Ask if the person (or parent) has had any problems using their written asthma action plan, or has any comments about whether they find it suitable and effective.
- Check that the medication recommendations are appropriate to the person’s current treatment.
- Check that all action points are appropriate to the person’s level of recent asthma symptom control.
- Check that the person (or parent) understands and is satisfied with the action points.
- If the written asthma action plan has been used because of worsening asthma more than once in the past 12 months: review the person’s usual asthma treatment, adherence, inhaler technique, and exposure to avoidable trigger factors.
- Check that the contact details for medical care and acute care are up to date.

Asset ID: 43

**Templates for written asthma action plans**

Templates are available from National Asthma Council Australia:

- National Asthma Council Australia colour-coded plan, available as a printed handout that folds to wallet size and as the Asthma Buddy mobile site
- Asthma Cycle of Care asthma action plan
- A plan designed for patients using budesonide/formoterol combination as maintenance and reliever therapy
- Remote Indigenous Australian Asthma Action Plan
- Every Day Asthma Action Plan (designed for remote Indigenous Australians who do not use written English – may also be useful for others for whom written English is inappropriate)
- Children’s written asthma action plans.

Some written asthma action plans are available in community languages.

Software for developing electronic pictorial asthma action plans6,7 is available online.

> Go to: National Asthma Council Australia’s [Asthma Action Plan Library](#)

Download: Imperial College London’s [Electronic Asthma Action Plan](#)
Asthma education programs for parents/carers and children

Asthma education for children and/or caregivers reduces the risk of emergency department visit for asthma, compared with usual care.\(^8\) However, the most effective components of education have not been clearly identified.\(^8,\,9\) There have been relatively few Australian controlled trials assessing education programs.\(^9\)

There is not enough evidence to tell whether asthma education programs in the child's home are more effective in helping control asthma than asthma education provided somewhere else or standard care,\(^9\) or to identify which types of education is more effective.

All age groups

A systematic review\(^10\) found that asthma education programs were associated with moderate improvement in lung function and with a small reduction in school absence, restriction of physical activity, and emergency department visits. The greatest effects were in children with more severe asthma.\(^10\)

Another systematic review found that educational programmes for the self-management of asthma in children and adolescents improved lung function, reduced the number of school days missed and the number of days with restricted activity, reduced the rate of visits to an emergency department, and possibly reduced the number of disturbed nights.\(^11\)

0-5 years

There is little evidence about the effects of education for parents of preschool-aged children with asthma or wheezing. Most studies have investigated the effects of asthma management education for older children and their parents.\(^12\) Limited evidence suggests that:

- education for parents of preschool children (e.g. written information and review by a health professional, small-group teaching by nurses or education in the family's home) may help improve asthma control\(^12\)
- education programs are more likely to be effective if they involve multiple sessions, each longer than 20 minutes' duration.\(^12\)

Opportunistic asthma education

In addition to the types of structured or formal asthma education evaluated in research trials, all health professionals who work with children with asthma and their parents/carers can provide asthma education whenever the opportunity occurs.

Table. Childhood asthma education checklist

Please view and print this figure separately: http://www.asthmahandbook.org.au/table/show/30

Resources

Education resources are available from the National Asthma Council Australia, Asthma Australia, and the Asthma Foundation in your state or territory.

Go to: National Asthma Council Australia
Go to: Asthma Australia

Back-to-school asthma care

Each year during February, a few days after the school year starts, there is an annual increase in asthma flare-ups among children with asthma.

Asthma flare-ups in children, including those resulting in emergency department presentations and hospitalisations, surge during the first month of the school year.\(^13,\,14,\,15,\,17\) There are smaller increases at the beginning of the other school terms.\(^18\) These flare-ups may be due to changes in exposure to virus, allergens, pollution and/or stress during the early days after school return.\(^19\)

Primary care health professionals can help parents/carers prepare for back-to-school flare-ups by:

- recommending a full asthma review at the end of the school holidays to check asthma control, adherence to preventer and inhaler technique
- ensuring that each child has an up-to-date written asthma action plan and the child and/or parents/carers understand how to follow it
- reminding parents/carers to get their child back into their asthma routine before the school year starts, including taking preventer medications every day, if prescribed

Go to: National Asthma Council Australia's Back to school checklist for kids with asthma
Increasing the inhaled corticosteroid dose to control flare-ups in children

In children taking regular inhaled corticosteroid-containing preventers, there is conflicting evidence for whether, and by how much, the dose should be increased when symptoms worsen or at the onset of an acute flare-up.

Overall, current evidence from highly controlled randomised controlled trials does not support increasing the dose of inhaled corticosteroid as part of a self-initiated action plan to manage flare-ups in children younger than 12 years. There is some evidence that high doses of inhaled steroids used pre-emptively might be effective in preventing severe acute asthma in children aged under 5 years, based on studies in children not taking regular inhaled corticosteroids. However, very high pre-emptive doses affect children's growth and are not recommended.

Recent randomised controlled trials reported a lack of effect with a range of dose increases:

- A five-fold increase in the inhaled corticosteroid dose at early signs of worsening asthma did not reduce the rate of severe acute asthma in children aged 5–11 years with well-controlled asthma while taking maintenance inhaled corticosteroid treatment (with high adherence). This strategy was associated with a small reduction in linear growth.
- Dose increases of four or eight times usual inhaled corticosteroid maintenance dose at the onset of an acute flare-up in children aged 2–17 years did not reduce requirement for oral corticosteroids, compared with doubling the dose.

A Cochrane systematic review in children and adults reported that increasing the inhaled corticosteroid dose did not prevent severe flare-ups, regardless of how soon the increase was initiated after the onset of symptoms or the magnitude of the dose increase (doubling versus quadrupling). The results did not differ between children under 15 and adults or older adolescents. However, there were too few studies in children to make firm conclusions.

Parent/carer-initiated oral corticosteroids for wheezing and asthma flare-ups

▶ See also: Managing acute asthma in clinical settings

- Oral corticosteroids are associated with adverse effects on behaviour and bone health. Frequent courses may affect the hypothalamus–pituitary–adrenal axis.

Children aged 1–5 years

Short courses of oral corticosteroids initiated by parents/carers in response to children's wheezing, or at the first sign of a cold, are not effective in managing symptoms in preschool children. There is inconsistent evidence for the benefits of systemic corticosteroids in preschool children with acute viral-induced wheezing presenting to acute care services. Current evidence does not strongly support their use in this age group.

The Thoracic Society of Australia and New Zealand position statement on the use of corticosteroids in children recommends that oral corticosteroid treatment in preschool children, particularly those with intermittent viral-induced wheezing, should be limited to children with wheeze severe enough to need admission to hospital.

Children aged 6 years and over

A Cochrane systematic review found that there was insufficient evidence supporting the use of parent-initiated courses of oral corticosteroids in school-aged children, although some clinical trials have reported benefits.

In a clinical trial in children aged 6–14 years with a history of recurrent episodes of acute asthma, short courses of oral prednisolone (1 mg/kg a day), initiated by parents in response to an asthma flare-ups, reduced asthma symptoms and the number of missed school days. Another quasi-experimental study found that home initiation of corticosteroids reduced the rate of emergency department visits among school-aged children with moderate-to-severe persistent asthma, compared with rates pre-intervention.

The Thoracic Society of Australia and New Zealand position statement on the use of corticosteroids in children recommends a short course of systemic corticosteroid therapy for children with moderate-to-severe acute asthma or when there is an incomplete response to beta-agonists, and does not recommend against parent/carer-initiated courses.

Correct use of inhaler devices

Checking and correcting inhaler technique is essential to effective asthma management.

Most patients with asthma or COPD do not use their inhalers properly, and most have not had their technique checked or...
Incorrect inhaler technique when using maintenance treatments increases the risk of severe flare-ups and hospitalisation for people with asthma or COPD.34, 35, 38, 39, 40, 41

Poor asthma symptom control is often due to incorrect inhaler technique.42, 43 Incorrect inhaler technique when using inhaled corticosteroids increases the risk of local side effects like dysphonia and oral thrush. The steps for using an inhaler device correctly differ between brands. Checklists of correct steps for each inhaler type and how-to videos are available from the National Asthma Council website.

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Go to: National Asthma Council Australia’s information paper for health professionals on Inhaler technique for people with asthma or COPD
Go to: NPS MedicineWise information on Inhaler devices for respiratory medicines

Last reviewed version 2.0

References


43. Hardwell, A., Barber, V., Hargadon, T., et al. Technique training does not improve the ability of most patients to use pressurised metered-dose inhalers (pMDIs). Prim Care Respir J. 2011; 20: 92-6. Available from: http://www.nature.com/articles/pcrj201088