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REVIEW

Factors accounting for asthma variability: achieving optimal symptom control for individual patients

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Abstract

Asthma is a variable disease, and various factors can lead to an increase (or decrease) in asthma symptoms and the level of asthma control. Pub Med was searched for recent articles dealing with asthma variability, environmental factors and co-morbid conditions that affect asthma control, and for publications which identified tools to facilitate patients' response to asthma variability. Variability in asthma symptoms may be a response to the individual's environment (e.g. seasonal variation, cigarette smoke, and air pollutants) or personal factors (e.g. inhaler technique, pregnancy, exercise). Co-morbid diseases such as allergic rhinitis may also impact significantly on asthma variability and control. Documenting asthma variability and assessing both adherence and possible triggers over time may allow patients and physicians to develop treatment programmes that anticipate, rather than follow, changes in the level of asthma symptoms. Personalised asthma control plans which take into account factors affecting symptom variability may enable patients to modify medication and their environment prophylactically in anticipation of a known trigger or at the first sign of an asthma exacerbation.

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See Appendix A at www.thepcrj.org

Background

Asthma imposes a significant clinical, social, and economic burden. In 2003, approximately 3% of adults and 6% of children in the US had an asthma attack.[1] Although the overall rate of asthma mortality is decreasing in the US,[2] the risk of death in patients even with mild asthma is a continued problem.

Asthma diagnostic and management guidelines recommend a stepwise approach to treatment, indicating that the lowest effective doses of medication should always

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Table 1. Classification of asthma severity by clinical features before treatment and recommended treatment options[3,4]

Classification	Symptoms and lung function	Recommended treatment options All levels: inhaled rapid-acting β2-agonist for symptom relief* (not more than 3–4 times daily)
Intermittent†	Symptoms less than once a week Brief exacerbations Nocturnal symptoms ≤2x/month FEV_1 or PEF ≥80% predicted PEF or FEV_1 variability <20%	Controller: None necessary
Mild persistent	Symptoms >once/week but <once/day Exacerbations may affect activity and sleep Nocturnal symptoms >2x/month FEV_1 or PEF ≥80% predicted PEF or FEV_1 variability 20–30%	Preferred controller: Low-dose inhaled corticosteroid Alternatives: Sustained-release theophylline *or* Cromone *or* Leukotriene modifier
Moderate persistent	Symptoms daily Exacerbations may affect activity and sleep Nocturnal symptoms >1/week Daily use of inhaled short-acting β2-agonist FEV_1 or PEF 60–80% predicted PEF or FEV_1 variability >30%	Preferred controller: Low-to-medium dose inhaled corticosteroid plus long-acting β2-agonist Alternatives: Medium-dose inhaled corticosteroid plus sustained release theophylline, *or* Medium-dose inhaled corticosteroid plus long-acting oral β2-agonist, *or* High-dose inhaled corticosteroid, *or* Medium-dose inhaled corticosteroid plus leukotriene modifier
Severe persistent	Symptoms daily Frequent exacerbations Frequent nocturnal asthma symptoms Limitation of physical activities FEV_1 or PEF <60% predicted PEF or FEV_1 variability >30%	Preferred controller: High-dose inhaled corticosteroid plus long-acting inhaled β2-agonist, plus one or more of the following, if needed: Sustained-release theophylline Leukotriene modifier Long-acting oral β2-agonist Oral corticosteroid Anti-IgE‡

FEV_1 = forced expiratory volume in 1 second; PEF = peak expiratory flow; IgE = immunoglobulin E.

*Other options for reliever medications are (in increasing order of cost): inhaled anticholinergic, short-acting oral β2-agonist, and short-acting theophylline.

†Patients with intermittent asthma but severe exacerbations should be treated as having moderate-persistent asthma.

‡Current evidence supports use in patients ≥12 years only.

be used. This approach is currently based on four asthma severity categories: intermittent, mild persistent, moderate persistent, and severe persistent[3,4] (see Table 1). The recommended first-line treatment for persistent asthma is an inhaled corticosteroid (ICS), with the addition of a long-acting β2-agonist (LABA) for continuous symptoms which are not responsive to ICS treatment alone. Full details of all recommended medications are provided in Table 1.

The goals of asthma therapy, as defined by the National Asthma Education and Prevention Program (NAEPP), are outlined in Table 2. Despite the availability of effective medications and treatment strategies, many patients continue to report hospitalisations, missed school or work days, and suboptimal pharmacotherapy.[5] One reason for this may be fluctuations in patients' asthma symptoms – i.e. fluctuating levels of asthma "control". This was illustrated by Calhoun and colleagues,[6] who demonstrated that out of 85 patients with moderate or severe persistent asthma at baseline, approximately 70% experienced one or more changes in morning peak expiratory flow (PEF) that were

Table 2. National asthma education and prevention programme goals of asthma therapy[4]

- Prevent chronic symptoms (e.g. no sleep disruption or missed days from school or work)
- Maintain (near) "normal" pulmonary function
- Maintain "normal" activity levels (including exercise and other physical activity)
- Prevent recurrent exacerbations of asthma and minimise the need for emergency department visits or hospitalisations
- Provide optimal pharmacotherapy with minimal or no adverse effects
- Meet patient and family expectations of – and satisfaction with – asthma care

consistent with a change in severity level. Moreover, nearly half experienced five or more such changes during the 12-week study periods (see Figure 1).[6]

In addition to day-to-day and day-to-night changes in asthma symptoms, various factors are known to aggravate the disease. Exposure to these intrinsic and extrinsic factors makes it appear as though patients are shifting from one level of severity classification to another over time (e.g. mild persistent to moderate persistent), and this can trigger periodic exacerbations or "attacks".

Treatment regimens often do not take such variations into account and may lead to over- or undertreatment during periods of good or poor control, respectively. The 2007 NAEPP guidelines[4] define control based on impairment and risk; symptom frequency, missed activity days, and occurrence of exacerbations requiring medical attention.[7,8] Current guidelines recommend that physicians react to changes in the frequency and intensity of symptoms by adjusting therapy over time to improve asthma symptoms and minimise the occurrence of exacerbations.[4] However, in practice, it is preferable to be proactive, aiming to increase medication in order to maintain asthma control upon exposure to precipitating factors such as the onset of the allergy season or exposure to smoke or air pollution. Modifying asthma control plans to include a patient's known or suspected causes of exacerbations (e.g. seasonal allergies) would provide the patient with the means to initiate rapid and pre-agreed changes in medication at the first signs of asthma worsening, and prophylactically to increase controller medications upon anticipated exposure to their individual triggers.[9-12] It is therefore important to understand which factors can affect asthma variability in order to ensure that patients receive optimal treatment at all times.

Factors affecting asthma variability

Environmental factors

In the US, the incidence of hospitalisations or emergency department visits for asthma varies seasonally, peaking in the autumn and reaching a low point during the summer (see Figure 2).[13] This seasonal pattern also varies with age: children and young adults show an autumnal peak in asthma morbidity and a summer peak in mortality,[13,14] whereas those aged 65 years or older have greater asthma morbidity and mortality in the winter.[14] Possible determinants of seasonal

Figure 1. Percentage of patients experiencing changes in asthma severity on the basis of per cent predicted morning peak expiratory flow (analysis from two 12-week studies).[6]

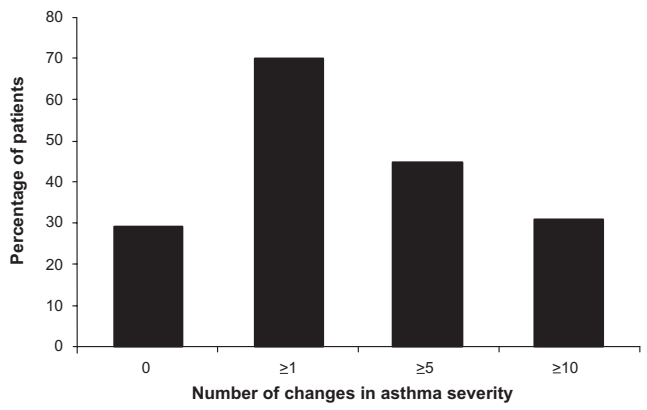
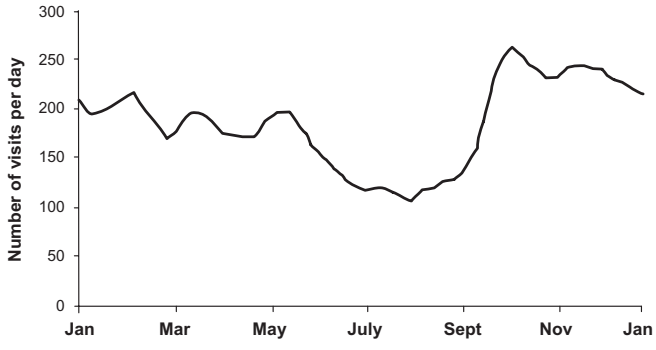


Figure 2. Seasonal fluctuations in the weekly average number of emergency department visits by asthma patients over a 10-year period (1991–2000) in 11 New York City municipal hospitals.[13]



fluctuations include increased exposure to allergens such as pollens, house-dust mites,[15] and mould spores[16] in the younger population, and influenza or other respiratory tract infections in the older population. Recognising each patient's unique seasonal patterns has practical implications for patient care, including the need to consider a pre-allergy season office visit, closer monitoring at home, and increased medication for patients entering a season of higher risk.[17,18]

Cigarette smoke, including second-hand smoke, is one of the most common asthma triggers[19,20] and can lead to increased bronchodilator use in children.[21] Indoor air pollutants (e.g. cockroaches, mould, and house-dust mites) can worsen a patient's asthma,[4] and outdoor air pollutants – including ozone and particulate matter – affect asthma symptoms in children.[22,23] Inhalation of toxic vapours from industrial fumes, bleach, sulphur, or smoke from fire or tobacco was closely associated with rapid onset of fatal or near-fatal acute exacerbations (defined as a respiratory crisis developing in two hours or less).[24]

Viral upper respiratory tract infections (URTIs), in particular infection with human rhinovirus, are linked to a substantial proportion of asthma exacerbations. A study of emergency hospitalisations for asthma among 106 children with asthma, admitted 136 times over a 12-month period, found that URTIs were the trigger in 63% of episodes.[25] Knowing that an URTI often triggers bronchospasm in an individual makes it possible to increase medications at the onset of URTI symptoms.

Individual factors

Inhaler technique

The large number of inhalers currently available has made choosing and using the most appropriate delivery device confusing for both patients and physicians. Poor inhaler technique for both metered-dose and dry powder inhalers is often observed in asthma patients and is associated with an increased risk of death.[26] Although appropriate training can enable patients to use inhalers effectively, regular reinforcement of good inhaler technique is recommended to maintain this standard.[3,4]

Co-morbid conditions

Personal characteristics can also lead to changes in lung function. There is a strong relationship between allergic rhinitis (AR) and asthma – 75-80% of patients with asthma are believed to have AR.[27] The nose and the bronchi are parts of a common airway with similar allergic inflammatory mechanisms, mediators, and lining cells, suggesting that asthma and AR may reflect manifestation of the same inflammatory process in different end organs (the lung and the nose).[27] While the conditions may reflect a parallel process affected by the same triggers, there is some evidence that AR and asthma severity do not occur in parallel[28] and that controlling AR may improve the control of asthma.[27]

In healthy individuals, lung function exhibits a circadian rhythm, reaching a maximum in the afternoon and a minimum in the early morning.[29] In nocturnal asthma, there is an exaggeration of this normal variation, which is associated with changes in lung function of more than 15% and which can be aggravated by gastro-oesophageal reflux disease (GORD) or obesity.[29]

Asthma often coexists with GORD, but the association is not always clear. Some patients can link increase in asthma symptoms to periods of reflux. Others report no apparent association. Review of the existing literature fails to clarify the direction of causality if indeed causality rather than just association is present.[30] However, in patients with difficult-to-control asthma or nocturnal asthma, a few simple questions (see Appendix A, available online at www.thepcrj.org) can identify the need for further evaluation or a therapeutic trial of GORD medication.[31] Even with symptoms suggesting a link, it is difficult to predict which patients will show improvements in their asthma after treatment for GORD.[30]

Obesity is well known as a risk factor for hypertension, diabetes, and atherosclerosis, and increasing evidence indicates that it may also be a risk factor for asthma.[32] Potential mechanisms affecting asthma in obesity include disease-related changes in lung volume, systemic inflammation, and other adipocyte-derived factors that might promote airway narrowing.[32] Such factors associated with obesity can lead to variability in peak expiratory flow (PEF); these PEF variations can decrease after weight loss.[33]

Women may experience premenstrual or peri-menstrual worsening of asthma symptoms.[34,35] The frequency of increased symptoms and decline in lung function (PEF) has been estimated to be as high as 30-40% in women attending specialty clinics or visiting emergency departments.[36,37] Diagnosis requires careful recording of daily symptoms and PEF levels. The aetiology remains unknown but has been hypothesised to be related to normal fluctuations in hormone levels that may be associated with changes in beta-adrenergic receptor responsiveness, airway hyper-reactivity and increased airway oedema.[35] However, the association may be more complex since women with asthma are at increased risk of irregular menses and therefore perhaps greater variations in sex hormones.[38] Some association with sex hormones is also suggested by the course of asthma during pregnancy – when about one third of women's asthma improves, one third remains the same, and one third declines, without a direct relationship to pre-pregnancy levels of control or severity.[37]

Patients with asthma are more likely to report co-morbid diabetes than the general population.[39] When these two conditions coexist, treatment of one can often exacerbate the other. Although ICS have been shown to have no effect on

the risk of developing diabetes, oral corticosteroids can increase susceptibility to, and the control of, diabetes.[40] Consequently, it is important to obtain good asthma control (by inhaled treatment) in patients with diabetes, thereby preventing asthma exacerbations which might necessitate treatment with oral corticosteroids.

Exercise and other non-allergy triggers

Asthma symptoms can also be triggered by exercise. Exercise-induced bronchoconstriction is estimated to occur in 50-60% of patients with asthma.[41] In addition, some patients experience increased asthma symptoms in response to ingestion of aspirin, nonsteroidal anti-inflammatory drugs, or beta blockers.[42,43] Psychosocial variables, such as mood and stress, have also been noted to influence asthma symptoms in some patients.[44]

Managing asthma variability

In patients treated with appropriate levels of medication (i.e. low-to-moderate doses of ICS alone or a combination of ICS and LABA), total or well-controlled asthma is achievable in most patients,[45] and this is a key objective of asthma therapy.[3,4] However, through development of the US federally-funded Asthma APGAR (Activities, Persistence, triGGers, Asthma medications, and Response to therapy) model,[46] it is apparent that a step down in asthma therapy seldom occurs when primary care physicians see patients for return visits. Furthermore, patients may initiate their own step-down or may discontinue therapy inappropriately; such non-adherence may contribute to the high rates of asthma-related emergency department visits.[47]

In patients who adhere to prescribed doses, treatment regimens that are not periodically re-evaluated may not adequately address asthma variability. Moreover, when asthma is managed strictly according to "severity", short-term variability in asthma symptoms and lung function may not be taken into account, and changes in prescribed medication may lag behind changes in symptom frequency and intensity. Therefore, short-term fluctuations in asthma should be taken into account when developing asthma control plans. Personalised control plans allow patients to manage their asthma within pre-defined agreed limits and, when tailored to patients' triggers and symptom patterns, should aim to guide patients so that they respond appropriately and promptly to signs of asthma worsening and can increase their medication prophylactically in anticipation of trigger exposure.[9-11,17,18]

Ensuring adequate knowledge of medication and delivery devices

Personalised action plans that ask patients to participate in self-management are based on the patient's knowledge of the purpose, time of onset, and duration of action of their medications.[9-11,17,18,48] It is not uncommon for patients in the emergency department to be confused about which inhaler is the "rescue" inhaler (short-acting β2-agonist) and which is the "controller" (ICS or combination ICS and LABA). The use of coloured stickers – red for rescue and green or yellow for controller medications – can help patients to remember. However, knowing which medication is which does not help if the patient does not know how to use their inhaler properly.

Early in the series of asthma visits, patients should be made aware of the type of medications they receive and how and when they should be used. This should be reinforced during regular physician visits by asking the patient to bring all medications and inhalers to each visit and to describe the purpose of each medication or inhaler they brought with them. Patients should understand that reliever medications (e.g. rapid-acting β2-agonists) should be used for acute attacks or sudden increases or onset of symptoms and that their controller medications (e.g. ICS, LABAs, leukotriene modifiers) are essential to control underlying disease, even though the effects of the controller may not be felt immediately.

Identify patterns of symptoms and their triggers

Developing a personalised asthma control plan that takes into account variations in a patient's asthma requires the patient to recognise triggers and seasonal patterns.[9-11,17,18] While daily symptom and trigger diaries are often impractical, notes on a calendar kept on the refrigerator can be helpful since possible triggers or times of worsening can be listed directly on the date of occurrence. These should be reviewed at regular physician visits. It is easier to identify potential asthma triggers if information is collected regularly rather than by trying to reconstruct patterns weeks or months later. Many patients fail to identify variations in the level of asthma symptoms as being important and do not report them during visits unless questioned specifically. A checklist, such as that shown in Table 3, can be provided to aid record-keeping. It is important to obtain a full profile of the factors affecting a patient's day-to-day asthma control, including allergen exposure and seasonal variations with increased symptoms,[8] to allow intensive management at such times, and thereby maximise the efficacy of his/her asthma management.

Identify individual factors that affect asthma variability

Co-morbid conditions such as obesity, GORD, and AR are often ignored by the patient or managed with over-the-counter drugs. If physicians do not ask about symptoms such as recurrent heartburn or nasal congestion or rhinorrhea, they may never learn of these co-morbid conditions since patients or caregivers may not link the non-lung symptoms with asthma control. Conditions to explore are listed in Table 3. Effective treatment of AR[49] can significantly reduce emergency department visits and asthma-related hospitalisations.[50]

Table 3. Checklist for factors to consider when assessing reasons for poor control

Checklist for factors influencing the patient's asthma control		
Technique	Does not understand the role of each medication in disease control (rapid relief versus preventive)	
	Is not using the drug devices properly (pMDI, DPI, nebuliser)	
	Cannot determine peak flow, if applicable (cannot use or does not own a peak flow meter)	
Environmental triggers	Cigarette smoke (passive)	
	Pets (animal dander)	
	Viral respiratory tract infection (e.g. human rhinovirus)	
	Seasonal allergens (e.g. pollen)	
	House-dust mites	
	Mould spores	
	Indoor pollutants (e.g. particulate matter, nitrogen dioxide)	
	Outdoor pollutants (e.g. ozone, particulate matter, industrial fumes)	
Individual factors	Allergic rhinitis	
	Circadian rhythm	
	Gastro-oesophageal reflux disease (nocturnal and recumbent symptoms with mechanical and "acid" irritation)	
	Obesity	
	Menstrual cycle (worsening of asthma during premenstrual phase)	
	Pregnancy	
	Exercise	
	Drugs (e.g. aspirin and other nonsteroidal anti-inflammatory drugs, beta-blockers)	
	Psychosocial variables (e.g. mood and stress)	

pMDI = pressurised metered-dose inhaler, DPI = dry-powder inhaler.

Treating GORD in both adults and children with concomitant asthma can result in improved lung function and/or a significant reduction in the need for asthma medications. However, not all patients improve with even very aggressive GORD therapy and it is difficult to predict which patients will benefit.[30] In some patients controlling asthma may actually improve GORD rather than vice versa.[30] Weight loss has been shown to improve lung function in obese women[51] but data is not available for children or men.

During pregnancy, lack of asthma control can result in preterm birth, intrauterine growth restriction, perinatal mortality, and small-for-gestational-age infants.[52] It is important to treat asthma with the safest and best available therapy to reduce foetal exposure to the potential hypoxia and stress of uncontrolled maternal asthma. Both ICS or β2-agonist therapy can be used, as they do not increase perinatal risks and effectively control asthma for most women.[53,54]

In patients who experience exercise-induced bronchoconstriction (EIB), prophylactic symptom control, usually with short-acting β2-agonists, can reduce the risk of an exacerbation.[41] People with daily EIB should be considered for long-term controller therapy rather than daily or multiple daily doses of a rescue medication use prophylactically.

Develop an individualised asthma control plan

An example of an asthma control plan is outlined in Figure 3, and this can be tailored to the individual patient. In addition to the items found in many asthma control plans, space is provided to note individualised factors affecting the patient's asthma and what action should be taken if these are, or are about to be, encountered (Table 4). For example, if the patient has AR that aggravates his/her asthma, the asthma control plan should specify AR under "Things that make your asthma worse" and should indicate the physician-recommended treatment (under "Treat other diseases that make your asthma worse").

By taking a more personalised approach that allows the patient to set goals and help determine appropriate actions, this plan aims to maximise asthma control using the lowest effective dose of medication. Development and implementation of the plan should be a joint effort between the patient and his/her physician and should be reviewed at regular intervals. By involving patients and ensuring that they

Figure 3. Example of a personalised asthma control plan

Asthma control plan	For:		
Doctor's name:	Friend's name:		Date:
Doctor's phone no.:	Friend's phone no.:		Initial/revised plan
Things that make your asthma worse: Activities:			
Triggers:			
Diseases:			
Medications:			
GREEN ZONE – OK!	**Use these medicine(s) daily and, when possible, avoid triggers to keep asthma under control** Take actions indicated below for activities, diseases, and unavoidable triggers		
This is how you should feel every day	Medicine	How much	When
Good breathing			
No cough, wheezing, or shortness of breath			
Normal sleep			
Can work/play			
AND (if a peak flow meter is used) peak flow is more than 80% of my best: My best:	80%:		
Before exercise or sports you should:			
If you come into contact with any of your triggers you should:			
Treat other diseases that make your asthma worse:			
Disease:	Medication:		
YELLOW ZONE – Caution	**Use these medicines to stop yourself from getting worse AND continue to take your green zone medications**		
Your asthma is getting worse	Medicine	How much	When
Cough or wheeze			
Tight chest			
Wake up at night due to asthma			
Can do some, but not all, usual activities			
Peak flow is between: and (50–80% of my personal best)			
If you do not return to the green zone after 1 hour you should: Call your doctor (tel:) Take: _____ AND _____ For: (relief medication) (steroid)			
If you return to the green zone after one hour you should:			
RED ZONE – Danger	**Call your doctor immediately or ask someone to take you to the emergency room immediately**		
Call your doctor right away	Medicine	How much	When
Medicine is NOT helping			
Breathing is difficult			
Lips or fingernails turn blue/grey			
Hard to walk and/or talk			
Ribs or neck muscles show when breathing	**Call your family doctor NOW (tel:)** If you are unable to reach your doctor within 15 minutes and you are still in the red zone: Go to the hospital or dial 911 for an ambulance		
Repeated wheeze at rest			
OR peak flow is below: (less than 50% of my best)	**If you have trouble walking/talking or your lips/fingernails turn blue you should go to the hospital right away!** Take _____ of your quick-relief medication		

Table 4. Control measures for triggers[4,41]

Trigger	Control measures: instructions to patients
Allergens	Essential. Keep mattress and pillow in an airtight (allergen-impermeable) cover. Wash bed covers, clothes, and stuffed toys once a week in hot water (≥130 °F) Desirable. Reduce humidity to less than 50%. Remove carpets from bedroom. Avoid sleeping or lying on upholstered furniture. If you must vacuum, use a dust mask
House-dust mites	
Animals	If possible, remove the animal from the home. If the pet must be indoors, keep it outside the patient's bedroom. Choose a pet without fur or feathers. Do not visit homes with pets, or take appropriate asthma medicine before going. Do not buy or use products made with feathers or kapok. Use a vacuum cleaner with a HEPA filter. Wash hands and clothes after contact with pets
Cockroaches	Use insect sprays and cockroach traps. Do not leave garbage exposed
Pollens	Stay indoors at midday and in the afternoon when pollen counts are highest. Keep windows closed in cars and at home. Use air conditioning if possible. Keep pets indoors or outdoors and do not allow them to go in and out of the home. If you must mow the lawn, use a pollen filter mask
Mould	Avoid sources of moulds (wet leaves, garden debris, dried wood). Avoid standing water or areas of poor drainage. Consider reducing humidity to less than 50%
Tobacco smoke	Stop smoking. Reduce exposure to other sources of tobacco smoke, such as smoke from day-care providers, visitors to the home, and co-workers
Rhinitis	Use intranasal corticosteroids and antihistamines as prescribed
Sinusitis	Use medical measures to promote drainage and decrease congestion
Gastro-oesophageal reflux	Do not eat within 3 hours of bedtime. Avoid alcohol or chocolate in the evening. Elevate the head of bed by six to eight inches. Take appropriate medication as directed
Sulfite sensitivity	Avoid eating shrimp, dried fruit, or processed potatoes. Do not drink beer or wine
Medication interactions	Do not use beta-blockers (including ophthalmologic preparations) Aspirin and other nonsteroidal anti-inflammatory drugs can cause severe and even fatal episodes for patients with severe persistent asthma, nasal polyps, or a history of aspirin sensitivity. Safe alternatives usually include acetaminophen and salsalate
Occupational exposures	Avoidance, good ventilation, respiratory protection, and a tobacco smoke-free environment are the most effective measures
Viral respiratory tract infections	Patients with persistent asthma should receive annual influenza vaccinations. Wash hands often when around those with respiratory tract infections

understand the rationale behind changes in dose or medication, they are more likely to adhere to treatment regimens – for example, the most frequently cited reasons for non-adherence to ICS treatment are patients' beliefs that ICS are unnecessary during asymptomatic periods and their concerns about adverse effects.[55] Addressing these beliefs while developing an action plan could enhance patient understanding and might help modify fears.

The importance of having good patient-physician interaction in modern asthma management should not be overlooked. Improved physician communication is strongly correlated with greater satisfaction with the care received.[56] Furthermore, direct clinician-to-patient feedback has been shown to improve adherence,[57] and regular medical review can have a significant impact on patient outcomes in asthma.[58] The individualised management plan can be used as the basis for regular asthma follow-up visits. Each visit should include a review of current medications, inhaler technique, any new triggers noted, and whether the use of the management plan has controlled symptoms. Regular review of management plans helps patients to understand their important role in asthma management and control.[10]

A systematic review on the use of personalised asthma action plans has been published recently.[59] Few studies have been published that have used control-based action plans or control scores as a routine part of primary care asthma

management. Such studies are in progress and soon data should be available to confirm whether or not the suggestions outlined in this review (drawn from the management of other chronic diseases) can be used with validated asthma control scores in order to improve asthma care and patient outcomes.[60-69]

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Appendix A. Reflux disease questionnaire for diagnosis of gastro-oesophageal reflux disease[22]

For each statement, the respondent is asked to grade each of the following symptoms based on a scale of:

0	Did not have	**1**	Less than 1 day a week	**2**	1 day a week
3	2 to 3 days a week	**4**	4 to 6 days a week	**5**	Daily

Thinking about your symptoms over the last 4 weeks, how often did you have the following:

a) A burning feeling behind your breastbone ☐
b) Pain behind your breastbone ☐
c) A burning feeling in the centre of the upper stomach ☐
d) A pain in the centre of the upper stomach ☐
e) An acid taste in your mouth ☐
f) Unpleasant movement of material upwards from the stomach ☐

For each statement, the respondent is asked to grade each of the following symptoms based on a scale of:

0	Did not have	**1**	Very mild	**2**	Mild
3	Moderate	**4**	Moderately severe	**5**	Severe

Thinking about symptoms over the last 4 weeks, how would you rate the following?

a) A burning feeling behind your breastbone ☐
b) Pain behind your breastbone ☐
c) A burning feeling in the centre of the upper stomach ☐
d) A pain in the centre of the upper stomach ☐
e) An acid taste in your mouth ☐
f) Unpleasant movement of material upwards from the stomach ☐