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International Consensus Report on Diagnosis and Treatment of Asthma

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Preface

Claude Lenfant, Director

Asthma is a chronic lung disease that affects people of all ages; it can be severe and is sometimes fatal. Data from many countries suggest that both asthma morbidity and mortality are increasing, although the reasons for this are not clear. Asthma prevalence has been reported to be increasing in the United States, the United Kingdom, New Zealand, and Australia; asthma mortality rates and mortality trends vary widely but appear to be increasing in many countries where data are available. Increases in asthma morbidity and mortality are of international concern because they are occurring at a time when scientific advances have improved the understanding of asthma and provided new therapies.

Medical communities in several countries have responded to this concern by convening panels of asthma specialists to develop guidelines on asthma detection and treatment and to disseminate the panel reports through their respective societies and medical journals. The National Heart, Lung, and Blood Institute of the United States Public Health Service thought it would be important to the international community of asthma patients and health care providers to discuss differences and similarities among the various documents. Therefore, a working group of eighteen physicians and scientists representing eleven nationalities was established for two purposes: (1) to explore the possibility of developing an international consensus statement on the diagnosis and management of asthma and (2) to identify areas for scientific study to help resolve differences and uncertainties in our understanding of asthma and its treatment.

Members of the International Asthma Project met three times over a six month period and prepared a report that was also reviewed by twelve consultants from eight countries.

This document is an international consensus statement that presents a general approach to asthma management. Reference to individual country documents is encouraged for more detailed discussion of treatment protocols and issues pertinent to the respective countries.

The document is intended for use by asthma specialists and medical opinion leaders to provide insights on internationally recognized modalities for asthma treatment. It is hoped that the report will assist these specialists in their dissemination of the best possible care for asthma patients.

I would like to acknowledge the support provided by Glaxo and Allen and Hanburys as their generous contribution assured that the participants could meet together to discuss issues and to reach consensus in a constructive and timely manner. However, the National Heart, Lung, and Blood Institute and the participants are solely responsible for the statements and conclusions that are presented in this document.

On behalf of the National Heart, Lung, and Blood Institute, I would like to acknowledge the superb and timely work of the project participants and the leadership of the project chair, Dr. Albert L. Sheffer. It was a privilege to bring together physicians and scientists from a wide variety of specialities and nationalities and to then discover a group whose members shared a remarkable spirit of collaboration as well as commitment to basic principles of asthma care.

Executive summary

Asthma is a chronic, persistent inflammatory disease of the airways characterized by exacerbations of coughing, wheezing, chest tightness, and difficult breathing that are usually reversible, but that can be severe and sometimes fatal. The major factors contributing to asthma morbidity and mortality are under-diagnosis and inappropriate treatment. Most exacerbations reflect a treatment failure because they can be prevented if treatment of the disease is comprehensive and ongoing.

The goals of asthma therapy are to improve the patient's quality of life by achieving and maintaining control of symptoms, preventing exacerbations, attaining normal lung function, maintaining normal activity levels, including exercise, and avoiding adverse effects from asthma medications.

Recent studies have revealed that inflammation is a critical feature in the pathogenesis of asthma, and therefore asthma therapy is predicated on medications to reverse and prevent this abnormality. Anti-inflammatory medications such as inhaled corticosteroids, sodium cromoglycate, and nedocromil are the primary therapy for the chronic care of all but mild, intermittent asthma. Further, early introduction or an increase in the dose of corticosteroids is an important component of treating severe exacerbations in order to

speed resolution of the exacerbation and prevent recurrence.

A six-part asthma management programmeme is recommended for effective treatment:

1. *Educate patients to develop a partnership in asthma management.*
Open communication, joint development of a treatment plan by the clinician and patient (guided self-management strategies), and encouragement of the family's efforts to improve asthma management will help patients gain the motivation, skill, and confidence to control their asthma.

2. *Assess and monitor asthma severity with objective measures of lung function.*
Spirometry is recommended for the initial and scheduled periodic assessment of all asthma patients. A period of home peak flow monitoring may be useful for the initial assessment. Spirometry or peak expiratory flow monitoring is essential in hospital-based management of exacerbations. Home peak expiratory flow monitoring should be considered for patients who take medications daily.

3. *Avoid or control asthma triggers.*
Environmental control measures are an important prevention strategy: Appropriate avoidance of triggers may reduce symptoms, the need for medication, and levels of nonspecific airway hyperresponsiveness. The role of specific immunotherapy in asthma management is under continual investigation. Currently available asthma management strategies with patient education, avoidance measures, and pharmacological treatment usually provide good control of asthma. Immunotherapy may be considered when avoiding allergens is not possible, when appropriate medications fail to control symptoms, and where an effective specific immunotherapy is available.

4. *Establish medication plans for chronic management.*
Because asthma is a dynamic as well as a chronic condition, medication plans need to accommodate variability among patients as well as within individual patients over time. A step-wise approach to pharmacological therapy, in which the number and frequency of medications are increased with increasing classification of asthma severity, permits this flexibility. Once control of asthma is sustained for several weeks or months, a reduction in therapy-a step down-can be carefully considered and is needed to identify the minimum therapy required to maintain control. The four steps to achieve and maintain control of asthma emphasize that anything more than mild occasional asthma requires daily therapy with anti-inflammatory agents and that patients should not rely on frequent use of bronchodilator agents to control their asthma. Figure 3 a Six-part asthma management programme summarizes the treatment recommended in the step-wise approach.

A colour-coded asthma zone management system for patients has been developed to help patients understand and monitor the variable nature of this chronic disease and take appropriate actions to maintain control of asthma. The first (Green Zone) reflects therapy required to achieve the goals of therapy, *i.e.*, maintain control of symptoms and prevent exacerbations. The step-wise approach described above is used to identify the minimum amount of medication required to maintain control of the patient's asthma. The second (Yellow Zone) reflects a deterioration in asthma control and indicates a need to temporarily increase treatment as well as a need to review the Green Zone plan. The third (Red Zone) signals a medical alert, and immediate steps to manage the exacerbation are required, with subsequent adjustment of the Green Zone plan. Written plans for each zone are essential to improve patient adherence.

5. *Establish plans for managing exacerbations.*
Exacerbations usually reflect either a failure of chronic management or exposure to a noxious agent. Severe exacerbations often reflect inadequate action at the onset of the exacerbation. Therapy for exacerbations emphasizes the early introduction of corticosteroids as well as frequent administration of inhaled $beta_2$-agonists. Patients need a written plan for recognizing signs that asthma is worsening, for when, how, and for how long to increase treatment, and for reaching medical care.

6. *Provide regular follow-up care.*
Patients need regular supervision and support by a clinician who is knowledgeable about asthma. Continual monitoring is essential to assure that therapeutic goals are met.

The following report elaborates upon each of these six parts of effective asthma management. It provides more detailed recommendations and documentation from the scientific literature.

Definition, diagnosis, and classification

Definition

Few aspects of asthma generate more discussion and disagreement than its definition. Previous attempts to define asthma in terms of airflow obstruction, its reversibility, and bronchial hyperresponsiveness have fallen short because of a lack of understanding of the disease mechanism(s) [1, 2].

Clinicians have long recognized an association of sputum and blood eosinophilia with asthma, and the presence of widespread airway inflammation as a prominent feature of death from asthma; but until recently there has been difficulty relating these pathological features to clinical and physiological indices of the disease. The application of fiberoptic bronchoscopy to obtain mucosal lavage and biopsy samples has provided an opportunity to study the local inflammatory events of adult [3] and childhood [4] asthma. In allergic [5], late onset [6], and toluene diisocyanate (TDI) occupational asthma [7], there is ample evidence for mast cells and eosinophils being effector cells through their capacity to secrete a range of inflammatory mediators. T-lymphocytes and macrophages are important in orchestrating this immune reaction through the elaboration of specific cytokinins, and neural mechanisms serve to amplify the inflammatory response. Although there is no direct measure of airway inflammation that can be used routinely, the degree of airway narrowing and its variability assessed by peak expiratory flow (PEF) monitoring may be used as functional correlates.

Longitudinal studies in asthma, particularly of patients with poorly controlled disease, have demonstrated the progressive acquisition of a "fixed" element to the airways obstruction superimposed on the reversible component [8]. The presence of a bronchodilator-insensitive increased peripheral airflow resistance in asthma might have a similar mechanism [9]. Organization of the inflammatory exudate and deposition of interstitial collagen provides one explanation for these findings [10].

These different perspectives of asthma can be drawn together into an operational definition:

Asthma is a chronic inflammatory disorder of the airways in which many cells play a role, including mast cells and eosinophils. In susceptible individuals this inflammation causes symptoms which are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment, and causes an associated increase in airway responsiveness to a variety of stimuli.

Diagnosis

Although the diagnosis of asthma can be elusive, the clinical history usually provides the necessary clues. The most common symptoms-wheezing, breathlessness, chest tightness, cough, and sputum, in themselves are not diagnostic. What is important is a history of recurrent exacerbations (or attacks) often provoked by exogenous factors such as allergens, irritants, exercise, and virus infections. Nocturnal (including early morning) asthma symptoms are particularly characteristic.

Because asthma symptoms are characteristically episodic, the physical examination may be completely normal. The examination may also be normal when the patient is symptomatic. Further, asthma patients frequently have poor recognition of symptoms and poor perception of the severity of their disease [11]. Thus, objective measures of airflow obstruction and its variability are critical in establishing a diagnosis.

Demonstrating allergen-specific IgE by skin testing and/or demonstrating specific IgE antibodies in the serum can help categorize asthma, but these tests have low diagnostic precision since more than 30 percent of the population is atopic. However, these tests are of particular value when attempting to confirm a single causative allergen for the purposes of undertaking avoidance strategies for the asthma therapy. Deliberate provocation of the airways with a suspected sensitizing agent may be helpful in establishing causation, especially in the occupational setting, but it is not recommended for routine use largely on the grounds of safety. Evidence for airway inflammation may be sought by examining spontaneously produced or hypertonic saline-induced sputum for eosinophils and metachromatic staining cells [12, 13]. Direct investigative methods, which include fiberoptic bronchoscopy with brushings, lavage, and mucosal biopsies, can be useful in children and adults but should only be used in exceptional circumstances such as research protocols [14].

Classification

Asthma may be described either in aetiological terms or in accordance with the clinical pattern and severity of airflow obstruction. This classification may help the clinician in the diagnosis and treatment of the disease and give an indication of prognosis.

Classification based on aetiology

From mechanistic and therapeutic standpoints, it is appropriate to differentiate those factors that induce inflammation with associated airway narrowing and hyperresponsiveness (inducers) from those that precipitate acute constriction in susceptible individuals (inciters). There have been many attempts to classify asthma according to aetiology, particularly with regard to environmental sensitizing agents. Such a classification is severely hampered by the existence of a group of patients in whom no environmental cause can be identified, and these have traditionally been described

as having intrinsic (cryptogenic) asthma. Conversely, patients with extrinsic asthma include those whose symptoms are associated with atopy, a genetic predisposition for directing an IgE mast cell and eosinophil response to common environmental allergens. Sensitization of the airways to a single agent involving IgE or non-IgE mechanisms underlies occupational asthma. The recent associations found between serum IgE and indices of asthma in all age groups-including individuals who are "not atopic" [15] -raises the possibility that all forms of this disease relate to a mucosal inflammatory response to environmental or endogenous antigens [16].

Asthma in infancy and early childhood is particularly difficult to categorize because under the age of 5 years it is recognized on purely clinical grounds [17]. Clinicians are being discouraged from using such terms as wheezy bronchitis, wheezy baby syndrome, or recurrent bronchiolitis; the clinician should make the appropriate diagnosis and use the correct term of asthma in order to encourage the implementation of anti-asthma strategies [17, 18].

Classification based on severity and pattern of airflow obstruction

When decisions have to be made about treatment, the pattern and severity of airflow obstruction are important. A classification of a patient's asthma based on disease severity over the preceding year [19] has been shown to relate to pathological indices of airway inflammation [20]. Other classifications describe asthma in terms of patterns of airflow obstruction monitored by PEF recording [21]. Descriptions of levels of disease severity based on a combination of such clinical criteria as symptoms and treatment requirements as well as objective measurements differ little among countries that have developed asthma management guidelines (see Resources). A modified classification scheme is presented in Figure 1; studies to validate this scheme will be important. These descriptions of asthma severity are useful because asthma therapy has a stepwise approach in which the level of therapy is increased as the severity of the disease increases (see Six-part asthma management programme).

Figure 1. – Classification of Asthma Severity*

Asthma Severity	Clinical Features Before Treatment	Lung function	Regular Medication Usually Required to Maintain Control
Mild	• Intermittent, brief symptoms <1–2 times a week • Nocturnal asthma symptoms <2 times a month • Asymptomatic between exacerbations	• PEF >80% predicted at baseline • PEF variability <20% • PEF normal after bronchodilator	• Intermittent inhaled short acting beta$_2$-agonist (taken as needed) only
Moderate	• Exacerbations >1–2 times a week • Nocturnal asthma symptoms >2 times a month • Symptoms requiring inhaled beta$_2$-agonist almost daily	• PEF 60–80% predicted at baseline • PEF variability 20–30% • PEF normal after bronchodilator	• Daily inhaled anti-inflammatory agent • Possibly a daily long acting bronchodilator, especially for nocturnal symptoms
Severe	• Frequent exacerbations • Continuous symptoms • Frequent nocturnal asthma symptoms • Physical activities limited by asthma • Hospitalization for asthma in previous year† • Previous life-threatening exacerbation†	• PEF <60% predicted at baseline • PEF variability >30% • PEF below normal despite optimal therapy	• Daily inhaled anti-inflammatory agent at high doses • Daily long acting bronchodilator, especially for nocturnal symptoms • Frequent use of systemic corticosteroids

*Note:
The characteristics noted in this table are general, and the characteristics may overlap because asthma is highly variable. Furthermore, an individual's classification may change over time. One or more features may be present to be assigned a grade of severity. An individual should usually be assigned to the most severe grade in which any feature occurs. Once the minimum medication required to maintain control of asthma has been identified, then this medication requirement reflects the overall severity of the condition.
†The potential severity-related to a patient's past history (for example, a previous life-threatening exacerbation or a hospitalization for asthma in the previous year) as well as present status should be considered at all times.

The severity of an exacerbation of acute severe asthma is often underestimated by patients, their relatives, and their physicians. This is largely because of failure to use objective measurements of assessment. If acute severe asthma is not recognized and not treated appropriately such exacerbations can be fatal. It is important to recognize that it is possible for any patient with asthma, however mild on a chronic basis, to have an acutely severe asthma exacerbation. However, factors have been identified that are associated with a higher risk of asthma mortality. These include a previous history of acute life-threatening attacks, hospitalization within the previous year, psychosocial problems, a history of intubation for asthma, recent reductions or cessation of corticosteroids, and noncompliance with recommended medical therapy [22, 23]. Populations who are low income, medically underserved, live in the inner city, or who have cultural differences are at especially high risk [24]. Deaths usually occur because of failure to appreciate the severity of the exacerbation and to initiate appropriate emergency treatment that includes the early introduction of corticosteroids.

References

1. American Thoracic Society. – Chronic bronchitis, asthma, and pulmonary emphysema. *Am Rev Respir Dis*, 1987; 136: 224–225.
2. Ciba Foundation Study Group No. 38. – The identification of asthma. Edinburgh & London, Churchill Livingston, 1971.
3. Beasley R, Roche WR, Roberts JA, Holgate ST. – Cellular events in the bronchi in mild asthma and after bronchial provocation. *Am Rev Respir Dis*, 1989; 139: 806–817.
4. Cutz E, Levison H, Cooper DM. – Ultrastructure of airways in children with asthma. *Histopathology*, 1978; 2: 407–421.
5. Djukanovic R, Wilson J, Britten K, Wilson S, Walls A, Roche W, Howarth P, Holgate ST. – Quantitation of mast cells and eosinophils in the bronchial mucosa of symptomatic atopic asthmatics and healthy control subjects using immunohistochemistry. *Am Rev Respir Dis*, 1990; 142: 863–871.
6. Foresi A, Bertorelli G, Pesci A, Chetta A, Olivieri D. – Inflammatory markers in bronchoalveolar lavage and in bronchial biopsy in asthma during remission. *Chest*, 1990; 98: 528–535.
7. Paggiaro P, Bacci E, Paoletti P, Bernard P, Dente DL, Marchetti G, Talini D, Menconi DGF, Giuntlini C. – Bronchoalveolar lavage and morphology of the airways after cessation of exposure in asthmatic subjects sensitized to toluene diisocyanate. *Chest*, 1990; 98: 536–542.
8. Peak JK, Woolcock AJ, Cullen K. – Rate of decline of lung function in subjects with asthma. *Eur J Respir Dis*, 1987; 70: 171–179.
9. Wagner EM, Liu MC, Weinmann GG, Permutt S, Bleecker ER. – Peripheral lung resistance in normal and asthmatic subjects. *Am Rev Respir Dis*, 1990; 141: 584–588.
10. Roche WR, Beasley R, Williams JH, Holgate ST. – Epithelial fibrosis in the bronchi of asthmatics. *Lancet*, 1989; 1: 520–524.
11. Rubinfield AR, Pain MCF. – Perception of asthma. *Lancet*, 1976; 1: 882–884.
12. Gibson PG, Girgis-Gabardo A, Morris MM, Mattoli S, Kay JM, Dolovich J, Denburg J, Hargreave FE. – Cellular characteristics of sputum from patients with asthma and chronic bronchitis. *Thorax*, 1989; 44: 693–699.
13. Pin I, Gibson PG, Kolendowicz R, Girgis-Gabardo A, Denburg JA, Hargreave FE, Dolovich J. – Use of induced sputum cell counts to investigate airway inflammation in asthma. *Thorax*, 1992; 47: 25–29.
14. Workshop summary and guidelines: investigative use of bronchoscopy, lavage, and bronchial biopsies in asthma and other airways disease. *J Allergy and Clin Immunol*, 1991; 88: 808–814.
15. Burrows B, Martinez FD, Halonen M, Barbee RA, Cline MG. – Association of asthma with serum IgE levels and skin test reactivity to allergens. *New Engl J Med*, 1989; 320: 271–277.
16. Sears MR, Burrows B, Flannery EM *et al.* – Relation between airway responsiveness and serum IgE in children with asthma and in apparently normal children. *N Engl J Med*, 1991; 325: 1067–1071.
17. Warner JO, Gotz M, Landau LI, Levison H, Milner AD, Pederson S, Silverman M. – Management of asthma: a consensus statement. *Arch Dis Child*, 1989; 64: 1065–1079.
18. Wilson NM. – Wheezy bronchitis revisited. *Arch Dis Child*, 1989; 64: 1194–1199.
19. Aas K. – Heterogeneity of bronchial asthma. *Allergy*, 1981; 36: 3–14.
20. Bousquet J, Chanez P, Lacoste JY, *et al.* – Eosinophilic inflammation in asthma. *New Engl J Med*, 1990; 323: 1033–1039.
21. Turner-Warwick M. – On observing patterns of airflow obstruction in chronic asthma. *Br J Dis Chest*, 1977; 71: 73–86.
22. Rea HH, Scragg R, Jackson R, *et al.* – A case-control study of deaths from asthma. *Thorax*, 1986; 41: 833–839.
23. Strunk RC. – Identification of the fatality-prone subject with asthma. *J Allergy Clin Immunol*, 1989; 83: 477–485.
24. Weiss KB, Wagener DK. – Changing patterns of asthma mortality-Identifying target populations at high risk. *JAMA*, 1990; 264: 1683–1687.

The six-part asthma management programme

The goals for successful asthma management are to:
- Achieve and maintain control of symptoms
- Prevent asthma exacerbations
- Maintain pulmonary function as close to normal levels as possible
- Maintain normal activity levels, including exercise
- Avoid adverse effects from asthma medications
- Prevent development of irreversible airway obstruction
- Prevent asthma mortality.

Asthma is a chronic condition with acute exacerbations (or attacks). However, the occurrence of frequent exacerbations during chronic treatment is considered a failure of the overall treatment and an indication to adjust the management plan. The increased appreciation of the importance of inflammation in the pathogenesis of asthma has led to emphasis on the use of medication with anti-inflammatory activity for the chronic treatment of asthma in both adults and children. Prevention of exacerbations is an important principle of therapy and includes avoidance or control of asthma triggers, such as known allergens.

Asthma management has six interrelated parts:
1. Educate patients to develop a partnership in asthma management
2. Assess and monitor asthma severity with objective measures of lung function
3. Avoid or control asthma triggers
4. Establish medication plans for chronic management
5. Establish plans for managing exacerbations
6. Provide regular follow-up care.

This chapter presents general guidelines for each of these six parts of asthma management. Specific protocols are available in the respective country documents of the International Asthma Project participants (see Resources).

Part 1. Educate patients to develop a partnership in asthma management

The aim of patient education-which is a continual process, is to provide the asthma patient and the patient's family with suitable information and training so that the patient can keep well and adjust treatment according to a medication plan developed with the clinician. This goal of guided self-management (or co-management) should be made apparent to the patient from the outset. The emphasis must be on the development of an ongoing partnership among the health professional the patient, and the patient's family.

Successful education involves the exchange of information between doctor and patient and behaviour change for the patient. This is most likely to occur if the patient is encouraged to discuss expectations and concerns early in each visit. The partnership relationship should involve a continual assessment of the patient's wants and needs, and the patient should have the opportunity at each visit to ask questions.

The responsibility for education lies with the physician, but it may effectively be shared with other health professionals. Both patient and physician must accept that the condition is likely to be chronic and that regular consultations will be required.

Individualizing education in a step-wise manner

Information improves knowledge and satisfaction (and possibly confidence) but does not by itself lead to behaviour change and a reduction in morbidity [1, 2]. Patients also need to develop the skill and confidence to follow the clinician's medical advice in their home environments. The information required by individual patients varies, and each patient's ability or willingness to take responsibility similarly differs. Thus, all individuals require certain core information and skills, but most education must be personalized and given to the patient in a number of steps. Social and psychological support may also be required to maintain positive behavioural change. Further, the patient's understanding of the information and management skills should be assessed periodically so that educational steps may be repeated or added as appropriate.

Initial consultation: In early consultation the asthma patient needs information about the diagnosis and simple information about the types of treatment available and the rationale for the specific therapeutic interventions being recommended. For example, different inhaler devices should be demonstrated, and patients should take part in a decision as to which is most suitable for them. It may be useful to use a criterion based performance checklist for training patients in inhaler techniques. Patients should be advised to avoid cigarette smoke as well as to avoid allergens, occupational sensitizing agents, and drugs known to induce asthma in an individual. The consequences of ongoing exposure to such chronic irritants and allergens even when the exposure does not always lead to an exacerbation should be explained. Advising patients to avoid such day-to-day triggers as exercise and cold air generally imposes inappropriate restrictions, and it is often preferable to adjust treatment to prevent exacerbations precipitated by exposure to these [3].

Patients should be given adequate opportunity to express their expectations of both the asthma and its treatment. A frank appraisal should be made of how far their expectations may or may not be met, and agreement should be made about specific goals for therapy. In many cases, it is up to the physician to raise the patients' level of expectations. For most patients it is reasonable for them to expect:

- Freedom from symptoms day and night
- No restriction to activities, including sports
- Best possible pulmonary function (*e.g.*, peak expiratory flow).

At the initial consultation, verbal information should be supplemented by the provision of written information about asthma and its treatment. The patient and the patient's family should be encouraged to make note of any questions that arise from reading this information or as a result of the consultation. Patients should understand that time will be set aside for further information and for answering questions during each subsequent consultation.

During this initial visit, or a follow-up consultation if necessary, the concept of peak expiratory flow (PEF) monitoring should be considered as appropriate to the patient's age, ability, and clinical assessment. The patient should receive training in how to measure and record PEF. The technique of rapid exhalation required for peak flow meter use is very different from the slow breathing required for using metered dose inhalers; this may be confusing to patients and thus requires careful instruction. When patients are taught how to record and interpret their PEF, it is helpful to explain that in addition to the absolute value of peak expiratory flow, its variability is important. The patient should understand that such monitoring is undertaken to check on the effectiveness of therapy and to give early warning of potential deterioration. It may be helpful to stress that PEF monitoring is not done merely for the physician's record, but rather it provides critical information for making decisions about treatment and thus PEF monitoring is a tool for patients to help themselves.

Verbal and written instructions should be provided to patients on indications that suggest their asthma control is deteriorating, with particular emphasis on the significance and importance of a reduction in PEF or PEF variability (including the difference between morning and evening PEF measurements), nocturnal symptoms, and an increased need for bronchodilator agents. The patient needs to understand the difference between treatments that rapidly relieve symptoms and those that suppress or reduce the underlying airway inflammation.

The three zone "Green-Yellow-Red Zone System" for guided self-management of asthma (see Establish medication plan for chronic management) is explained as a programme for using PEF and symptom monitoring to give indications on when to start, add, or stop medications.

A written management plan should be given to the patient. Sample written guidelines are available from the individual country documents listed in Resources. Three samples are presented in Appendix. Written guidelines need to reflect the health care system and cultural needs of the respective country, and they must be tailored to meet the specific needs of individual patients. In general, however, written guidelines should include the following information:

- Specific instructions about medication plans for chronic (maintenance) therapy, including criteria for recognizing when long-term treatment is less than optimal.
- Instructions about how to recognize signs of deteriorating control of asthma, including use of PEF measurements.
- List of steps to take in managing acute episodes, including criteria for initiating or modifying medications,
- Criteria for seeking emergency care.

A daily diary of symptoms and medication use, to be kept by the patient for at least 2 weeks prior to a follow-up consultation, can be of value in identifying problems in medication use and adherence. Recording of PEF measurements adjacent to this symptom and medication information may also be useful.

Follow-up consultation: At the follow-up consultation, the patient's questions are first discussed, and any problems with asthma and its initial treatment are reviewed. Follow-up consultations at regular intervals should include checking the patient's inhaler technique and adherence to the medication plan and environmental control recommendations.

Home PEF recordings and symptoms, as revealed in the patient diary, are also reviewed regularly. From such discussion will evolve the individualization of the guided self-management plan (*e.g.*, "Green-Yellow-Red Zone System") whereby the patient adjusts therapy or seeks medical attention in a predetermined manner in response to particular signs, symptoms, or measurements [4, 5]. Furthermore, review of home PEF and symptom monitoring is necessary to assure that the goals for therapy are met. Appropriate adjustments in therapy can then be considered.

Other sources of education and support

Asthma patients and their families should be informed of any local asthma societies, self-help and support groups, or asthma helplines. Educational messages can be reinforced if given by more than one route, and patients may benefit from the loan of additional books, audiotapes, and videos [6, 7]. (See Resources, for available patient materials). Further, health education programmes for groups of patients have been shown to be helpful in increasing the patient's management skills and in reducing morbidity and use of emergency health care services [8, 9, 10]. Cultural differences between the patient and clinician may impede communication and should be identified. Appropriate information and instructional materials should be available.

Longer term supervision and problems

During long-term follow-up it is important to provide supervision, reassurance, and praise to the patient for the patient's efforts in guided self-management. It is also important to be alert for signs of complacency or the development of bad habits because these may indicate a failure in the patient/physician partnership that can lead to poor adherence to the medication plan [11]. The reasons for poor adherence include drug and non-drug factors:

- Drug factors:
  - Problems with inhaler devices
  - Awkward regimens
  - Real or imagined side effects
  - Fear of corticosteroids
  - Overreliance on bronchodilators
  - Dislike of medications
  - Cost of medications.
- Non-drug factors:
  - Cost and availability of medical care
  - Underestimation of the severity of the disease
  - Forgetfulness
  - Complacency
  - Rebellion/anger
  - Misunderstanding
  - Attitudes towards ill health
  - Cultural factors
  - Stigmatization.

At each consultation, medication technique and the regularity of use of medication should be assessed by asking, for example:

- "How do you feel about taking your medicine?"
- "How often do you remember to take the medicine?"
- "So that we can plan the future treatment, can you tell me how often you actually take the medicine?"
- "Show me how you use your inhaler."

If underuse of medication is suspected, it is essential that the reasons for this are explored. Open-ended questions asked at the correct time may sometimes reveal unspoken concerns or fears:

- "Some people think that steroids are harmful; what do you think?"
- "What problems do you have taking these medicines?"
- "What do you like least about the medicines?"
- "What do you expect from your asthma treatment?"

Information both verbal and written may be given to correct any misconceptions. Adherence to therapy closely reflects patient satisfaction with the communication aspects of consultation and thus indicates the relative success of the patient/physician partnership [12].

Special situations

Individualization of asthma therapy and the use of written guided self-management plans enable patients to cope with most situations, but trips away from home may require special planning. Particularly helpful may be a pre-holiday or pre-travel check with their physician or nurse during which they can get advice about taking along a sufficient quantity of routine and emergency medication, keeping the medication available during travel, remembering to take medication despite the different routine of a holiday, and checking in advance on how to find local medical attention if it should become necessary.

References

1. Jenkinson D, Davison J, Jones, Hawtin P. – Comparison of effects of a self management booklet and audio cassette for patients with asthma. *Br Med J*, 1988; 297: 267–270.
2. Hilton S, Sibbald B, Anderson HR, Freeling P. – Controlled evaluation of the effects of patient education on asthma morbidity in general practice. *Lancet*, 1986; 26–29.
3. British Thoracic Society, Research Unit of Royal College of Physicians, Kings Fund Centre, National Asthma Campaign: Guidelines for management of asthma in adults: I: chronic persistent asthma. *Br Med J*, 1990; 301: 651–653.
4. Beasley R, Cushley M, Holgate ST. – A self management plan in the treatment of adult asthma. *Thorax*, 1989; 44: 200–204.
5. Charlton I, Charlton G, Broomfield J, Muller MA. – Evaluation of peak flow and symptoms and self management plans for control of asthma in general practice. *Br Med J*, 1990; 301: 1355–1359.
6. Partridge MR. – Asthma education: more reading or more viewing? *JR Soc Med*, 1986; 79: 326–328.
7. Mulloy EMT, Albazzaz MK, Warley ARH, Harvey JE. – Video education for patients who use inhalers. *Thorax*, 1987; 42: 719–720.
8. Wilson-Pessano SR, Mellins RB. – Workshop on asthma self management: summary of workshop discussion. *J Allergy Clin Immunol*, 1987; 80: 487–514.
9. Evans D, Mellins RB. – Educational programmes for children with asthma. *Paediatrician*, 1991; 18: 317–323.
10. Mayo PH, Richman J, Harris HW. – Results of a programme to reduce admissions for adult asthma. *Ann Intern Med*, 1990; 112: 864–871.
11. Eraker SA, Kirscht JP, Becker MH. – Understanding and improving patient compliance. *Ann Internal Med*, 1984; 100: 258–268.
12. Korsch BM, Negreve VF. – Doctor patient communication. *Scientific American*, 1972; 227: 66–72.

Part 2. Assess and monitor severity with objective measures of lung function

Asthma severity can be judged by symptoms, medication requirements, and objective measures of lung function. This section discusses the latter. Pulmonary function studies are essential for diagnosing and assessing the severity of asthma in patients over 5 years old. They provide an indirect assessment of airway hyperresponsiveness, which may correlate with the degree of airway inflammation. Objective measurement of airflow obstruction in patients with asthma is desirable because subjective assessment of such symptoms as dyspnoea and wheezing by physicians and patients may be inaccurate [1]. Poor perception of the severity of asthma on the part of the patient and physician may be

a major factor causing delay in treatment and thus may contribute to increased morbidity and mortality from asthma exacerbations [2]. Patients who have access to peak expiratory flow (PEF) information may use their medication less frequently and more appropriately. Objective measurements of lung function for monitoring asthma are analogous to measurements in other chronic disease situations, for example, measuring blood pressure with a sphygmomanometer for hypertension, or measuring blood glucose with reagent strips or digital read-out meters for diabetes.

Spirometry

Spirometry is recommended in the initial assessment of most patients with suspected asthma and periodically in selected patients to confirm home PEF measurements. Subsequent measurement of PEF may be sufficient in most cases as the minimum objective parameter to follow in assessing symptoms and making therapeutic recommendations, when such recommendations depend on the severity of airflow obstruction. For individual cases with complex questions related to their pulmonary function, periodic assessment in a specialized pulmonary testing facility should be considered.

Some lung volumes and flow can be measured with spirometers [3, 4]. Vital capacity (VC) is the maximum volume of air that can be inhaled or exhaled from the lung. Vital capacity may be affected by parenchymal diseases, by chest wall diseases, by voluntary effort, and by significant airway diseases. To determine whether the reduction in vital capacity is due to restriction or airway obstruction, measurements of flow are obtained. The most common indices of forced expiratory flow are FEV_1, the maximum volume of air expired in 1 second from full inspiration, and PEF, the maximum flow rate that can be generated during a forced expiratory manoeuvre. The FEV_1 is the single best measure for assessing severity of airflow obstruction, although the PEF is a simple, reproducible measure of airway obstruction that correlates quite well with the FEV_1 [5]. The FEV_1/VC ratio provides an early and sensitive indication of airflow obstruction. The FEV_1/VC ratio is increasingly used as a measure for diagnosis because it distinguishes between restrictive and obstructive disease.

Peak expiratory flow monitoring

When treating asthmatic patients, it is often desirable to make frequent objective assessments of peak expiratory flow (PEF), usually more than once a day. Daily, or circadian, variations in PEF reflect the severity of asthma. The office spirometer is too cumbersome and inconvenient for such frequent assessment and in many cases, it is more convenient to obtain PEF measurements with simple inexpensive peak flow meters.

PEF monitoring is an important clinical tool in the office, emergency department, and hospital as well as in the home. It is valuable to assess severity; assess degree of circadian variation in lung function, which correlates with the degree of airway hyperresponsiveness [8]; monitor response to therapy during an acute exacerbation; detect asymptomatic deterioration of lung function in the home and office and intervene before it becomes more serious; monitor response to chronic therapy and provide objective justification for therapy to the patient; and to identify triggers (*e.g.*, exercise) and/or inducers (*e.g.*, occupational sensitizes) [5]. It is recommended that physicians consider using home PEF monitoring in patients over 5–7 years old (*i.e.*, able to provide a consistent effort) who are taking daily medications (*i.e.*, who have moderate to severe asthma).

Measurement of PEF. Most adults, as well as children as young as 5 years of age, usually can perform a PEF measurement. The effort required to produce the measurement is a short maximal blast of air. Because PEF measurement is effort dependent, patients need to be coached initially to give their best effort. For both spirometry and PEF measurements, it is important to use correct techniques as well as equipment that meets established standards [3–5].

Ideally, PEF measurements should be taken twice daily, immediately upon arising and 10–12 hours later, before and after using a bronchodilator if a bronchodilator is needed. If PEF measurements are taken only once daily, they should be done at the same time each day and consistently either before or after using a bronchodilator, if a bronchodilator is needed. A few patients will not comply, or their asthma will become extremely stable, and they may prefer to perform PEF measurements intermittently. Although this method loses the benefit of detecting early deterioration in lung function, it still provides important information about variability. If PEF is being measured only two or three times a week, it is best to do both a morning and an evening reading on the same day and consistently either before or after bronchodilator, if a bronchodilator is taken, so that any variation greater than 15 percent (which indicates worsening of asthma) can be detected.

Interpreting the PEF measurement. Predicted values of PEF are corrected for height and age, and normal limits of diurnal (or circadian) variability are available in the literature [6–8]. However, in many patients, PEF values are consistently higher or lower than the average predicted values. It is recommended that PEF objectives for therapy be based on each patient's personal best and daily variability rather than using a percent of normal predicted value, particularly for patients with chronically impaired lung function.

It is important to establish personal best values and minimum circadian variability when the patient is under effective treatment. During a monitoring period of 2 to 3 weeks, the patient should record PEF measurements at least twice a day. If the patient takes a bronchodilator, then PEF should be measured before and after using the bronchodilator. The personal best is the highest PEF measurement achieved when the patient's asthma is in control. If the patient's highest

value during the monitoring period is less than 80 percent of predicted value after adequate bronchodilator, and/or daily variability is more than 15 percent again after adequate bronchodilator, more aggressive therapy and continued daily monitoring are indicated. A course of oral steroids may be needed to establish personal best and minimum PEF daily variability.

The day-to-day variability of PEF provides a reasonable index of asthma stability and/ or severity. The variability should be calculated from at least two values (morning and night) before and after bronchodilators (if the patient is using bronchodilators) [8]. The variability of PEF may be calculated from the formula [5, 9]:

$$\text{Daily Variability} = \frac{\text{Highest PEF - Lowest PEF}}{\text{Highest PEF}} \times 100$$

Using PEF measurements to manage asthma. To help patients manage their asthma at home, a system of three colour-coded PEF zones has been suggested which correlates PEF measurements and variability with appropriate levels of medication to control asthma. The specific zones are established as a function of the individual's personal best or predicted value, whichever is highest, and/or daily variability. The emphasis is not on an isolated reading but rather on the variability from the patient's personal best or from one reading to the next. A suggested plan for use of the zone system for asthma management is presented in Establish medication plans for chronic management.

Supervision of home PEF monitoring. Several elements appear to be essential for the successful integration of home peak expiratory flow monitoring into the treatment plan. The following guidelines should be used:

• Educate the patient and family about the purpose and technique of home monitoring. Education should include:
- How and when to use the peak flow meter
- How to record PEF measurements in a diary
- How to interpret the measurements
- How to respond to change
- What information to communicate to the clinician (including emergency department clinicians).

• Explain how the clinician uses the home PEF data to choose and evaluate treatment. The clinician should review the data regularly by telephone or during office visits.

Reversibility of airway obstruction

If airway narrowing improves more than 15 percent in FEV_1 or PEF either spontaneously or after using a bronchodilator, this improvement is assumed as bronchodilator reversibility and is suggestive of asthma. In some patients with severe airway obstruction, resistance to bronchodilators is seen, and corticosteroids may be necessary to restore bronchodilation.

Airway hyperresponsiveness

Airway hyperresponsiveness is the airway constrictive response to a variety of chemical, physical or pharmacologic stimuli [10]. It is a feature of symptomatic asthma. However, it can be present in asymptomatic people and in others with chronic airflow limitation associated with conditions of other pathogenesis, *e.g.*, cigarette smoking, chronic bronchitis, and cystic fibrosis. Further, airway hyperresponsiveness can be absent in people with past asthma or symptomatic people with asthma where the stimulus for airway constriction is excessively strong (*e.g.*, a reaction to an allergen or chemical sensitizer) [11] or in people with occupational asthma who have not been exposed to the sensitizing agent for a long time [12]. In spite of these discrepancies, measurement is useful to exclude or confirm asthma when there is a suggestive history but spirometry is normal. While there is a general positive relationship between the degree of airway hyperresponsiveness and the severity of the patient's asthma, there is considerable overlap [13, 14]. Therefore, the degree of airway hyperresponsiveness cannot be used to indicate the degree of treatment. Changes in responsiveness are an indirect indicator of changes in asthmatic airway inflammation. While serial measurements of responsiveness are useful in certain situations as an additional criterion to follow the effect of treatment (*e.g.*, occupational asthma and research), their value for general use for this purpose requires investigation and is not currently recommended [15].

Measuring arterial blood gases

Arterial blood gas measurement provides important information for assessing the severity of any exacerbation. Although not necessary for all patients, such measures should be considered for patients in the emergency department, particularly if there is severe asthma exacerbation (*e.g.*, with FEV_1 or PEF <40 percent predicted), a decreased oxygen saturation and/ or a failure of the PEF to respond to initial treatment. However, treatment, and particularly oxygen treatment, should not be delayed because of the time necessary to obtain blood gases.

Gas exchange abnormalities, particularly arterial hypoxaemia, are common in asthma patients during a severe exacerbation. Ventilation-perfusion mismatching is the principal mechanism underlying abnormal gas exchange during asthma exacerbations [16]. The degree of ventilation-perfusion mismatching is correlated poorly with clinical findings and indices of airflow obstruction (FEV_1 or FEF_{25-75}), and there is often a delay in a patient's improvement during an exacerbation in ventilation-perfusion mismatching compared with both symptoms and spirometric indices [17]. Pulse oximetry provides measurement of oxygen saturation that can help monitor a patient's response to acute therapy. The more extensive information obtained through blood gas determinations may be important, particularly if the

pulse oximetry is normal in the presence of other indications of a severe exacerbation a situation that can arise because cardiac output may be inordinately elevated during a severe asthma exacerbation and the degree of hypoxaemia may not accurately reflect the underlying degree of ventilation-perfusion mismatch.

References

1. McFadden ER, Kiser R, DeGroot WJ. – Acute bronchial asthma: relationship between clinical and physiological manifestations. *New Engl J Med*, 1973; 288: 221.
2. Sears MR. – Increasing asthma mortality-fact or artifact? *J All Clin Immunol*, 1988; 82: 957–960.
3. Quanjer PH. – Standardized lung function testing. *Bull Eur Physiopath Respir*, 1983; 19 (Suppl): 7–28.
4. American Thoracic Society. – Standardization of spirometry 1987 update. *Am Rev Respir Dis*, 1987; 130: 1296–2009.
5. Lebowitz MJ. – The use of peak expiratory flow rate measurements in respiratory diseases. *Ped Pneumol*, 1991; 11: 166–174.
6. Godfrey S, Kamburoff PL, Nairn JR *et al.* – Spirometry, lung volumes and airway resistance in normal children aged 5 to 18 years. *Br J Dis Chest*, 1970; 64: 15–24.
7. Gregg I, Nunn AJ. – Peak expiratory flow in normal subjects. *Br Med J*, 1973; iii: 282–284.
8. Ryan G, Latimer KM, Dolovich J, Hargreave FE. – Bronchial responsiveness to histamine: relationship to diurnal variation of peak flow rate, improvement after bronchodilator therapy. *Thorax*, 1982; 37: 423–429.
9. Quackenboss JJ, Lebowitz MD, Krzyzanowski M. – The normal range of diurnal changes in peak expiratory flow rates: Relationship to symptoms and respiratory diseases. *Am Rev Respir Dis*, 1991; 143: 323–330.
10. Boushey HA, Holtzman MJ, Sheller JR, Nadel JA. – Bronchial hyperactivity. *Am Rev Respir Dis*, 1980; 12: 389–414.
11. Pauwels R, Joos G, van der Straeten M. – Bronchial hyperresponsiveness is not bronchial hyperresponsiveness is not bronchial asthma. *Clin Allergy*, 1988; 118: 317–321.
12. Mapp CE, Del Vecchio L, Boschetto P, De Marzo N, Fabbri LM. – Toluene diisocyanate-induced asthma without airway hyperresponsiveness. *Eur J Respir Dis*, 1986; 68: 89–95.
13. Josephs LK, Gregg I, Mullee KA, Holgate ST. – Nonspecific bronchial reactivity and its relationship to the clinical expression of asthma. A longitudinal study. *Am Rev Respir Dis*, 1989; 140: 350–357.
14. Pattermore P, Asher MI, Harrison AC, Mitchell EA, Rea HH, Stewart AW. – The interrelationship among bronchial hyperresponsiveness, the diagnosis of asthma, and asthma symptoms. *Amer Rev Respir Dis*, 1990; 142: 549–554.
15. Cockcroft DW, Hargreave FE. – Airway hyperresponsiveness: Relevance of random population data to clinical usefulness. *Am Rev Respir Dis*, 1990; 142: 1497–1500.
16. Wagner PD, Rodriguez-Roisin R. – Clinical advances in pulmonary gas exchange (State of the art/Conference report). *Am Rev Respir Dis*, 1991; 143: 883–888.
17. Roca J, Ramis LI, Rodriguez-Roisin R, Ballester E, Montserrat JM, Wagner PD. – Serial relationships between ventilation-perfusion inequality and spirometry in acute severe asthma requiring hospitalization. *Am Rev Respir Dis*, 1988; 137: 605–612.

Part 3. Avoid or control asthma triggers

The identification and control of triggers-factors that either induce airway inflammation (inducers) or those that precipitate acute obstruction (inciters), or both, are important steps in the management of asthma. Avoidance or control of triggers can reduce symptoms and may, in the long term, decrease airway inflammation and hyperresponsiveness. Inducer-triggers include allergens, chemical irritants, pharmacological agents, and viral infections, and inciter-triggers include such physical changes as exercise, cold air, and extreme emotional expression. Patients should be encouraged to identify their specific triggers. This section focuses on controlling exposure to allergens, irritants, and pharmacological agents. See Special Considerations, for discussion of controlling exercise as a trigger in order to allow full participation in physical activities.

Environmental control measures

In most countries, the outdoor and indoor allergic and non-allergic environments have changed within the past 30 years and may have increased the risk for allergic diseases and asthma [1]. In industrialized countries, because a majority of the time is spent indoors, the indoor environment is an important area of exposure to allergens and irritants. In temperate climate zones, energy saving measures may have led to "tight" houses with very low natural ventilation and thus an increase in indoor pollutants and house-dust mites [2, 3]. Environmental control measures should be applied as much as possible because they can help the patient and reduce the need for pharmacological treatment.

Aeroallergen avoidance: In allergic patients with asthma, environmental allergens are a major cause of airway responsiveness [4]. The occurrence of airway symptoms is closely related to the amount of environmental allergens [5]. Thus, environmental control to reduce exposure to indoor and outdoor allergen is of importance even though it is rarely possible to achieve completely.

One of the best examples of the relation of allergen avoidance and control of asthma comes from studies that show an improvement in asthma symptom and/or a reduction in airway hyperresponsiveness after exposure to house-dust mite was reduced [6]. Suggested house dust control measures that are currently being investigated are listed in Figure 2. It appears that adults and children with less severe asthma benefit from dust mite avoidance measures, although patients with an irreversible component of airways obstruction do not.

Removal of animal allergen from the patients' environment is also important, although it may take several weeks or months after the antigen has been removed for the full benefits to be perceived [7]. All warm-blooded pets, including small rodents and birds, produce dander, urine, and saliva that can cause allergic reaction.

If a cat is present and cannot be removed, washing it weekly appears to reduce the allergen load [8].

Although such common allergens as outdoor pollens and molds are impossible to avoid completely, exposure may be reduced by using air conditioners and by closing windows and doors during peak pollen and mold seasons [9].

A large number of substances have been identified as occupational allergens and irritants that can cause asthma, and levels above which the sensitization occurs frequently have been proposed for many chemicals (see Special Considerations). However, once a patient has been sensitized, the level of sensitizer necessary to induce symptoms may be extremely low. Attempts to reduce occupational exposure have been successful especially in industrial settings, and some potent sensitizers such as soy castor bean have been replaced by less allergenic substances [10].

Figure 2. – House-Dust Mite Control Measures*

Encase the mattress in an allergen nonpermeable cover.
Either encase the pillow or wash it weekly.
Wash the bedding weekly in water of 130°F or 55°C.
Avoid sleeping or lying on furniture upholstered with fabric.
Remove carpets that are laid on concrete.
Reduce indoor humidity to less than 50%
Remove carpets from the bedroom.
Use chemical agents (ascaricides) to kill mites or to alter the mite antigens in the house.

**These are suggested measures to reduce allergic patients' exposure to house-dust mites. The relative efficacy of these measures in improving control of asthma is currently being investigated.*

Food avoidance. Food allergy is a rare trigger of asthma and occurs primarily in young children [11]. However, food avoidance should not be recommended before a positive double-blind food challenge has been made [11, 12].

Sulphites (common food and drug preservatives found in such foods as processed potatoes, shrimp, dried fruits, beer, and wine) have often been implicated in causing severe asthma exacerbations and occasional deaths. They should be avoided by sensitive patients [13]. Proof for the involvement of other dietary substances, including the yellow-dye tartrazine, benzoate, and monosodium glutamate is difficult to ascertain. If suspected, they should be avoided. Confirmation of their relevance requires double-blind challenge.

Control of air pollution. Avoiding indoor irritants such as tobacco smoke, wood smoke, household sprays, volatile organic compounds (*e.g.*, cooking oils and polishes), and air pollutants is important because these components may worsen asthma [14, 15].

Drugs. Some medications can aggravate asthma. Aspirin and other nonsteroidal anti-inflammatory agents can cause severe exacerbations and should be avoided in sensitive patients [16, 17]. Beta-blocker drugs administered orally or by eye drops may exacerbate bronchospasm and should in general be avoided by asthma patients [18]. If beta blockers are used, they should be started under close medical supervision. Radiocontrast media can elicit bronchospasm, and a premedication with oral corticosteroid and H_1 blockers is advised for sensitive patients [19].

Specific immunotherapy

The role of specific immunotherapy in asthma management is under continual investigation. Currently available asthma management strategies with patient education, avoidance measures, and pharmacological treatment usually provide good control of asthma. Specific immunotherapy may be considered when avoiding allergens is not possible and when appropriate medication fails to control asthma symptoms. The efficacy of specific immunotherapy in asthma was contested some years ago because although allergen injections using well-defined and potent extracts had more effective results for many patients, it also resulted in a greater number of severe systemic reactions. It is therefore essential to consider several factors in order to appreciate the respective values of allergen avoidance and specific immunotherapy in comparison with other available therapeutic methods [20–22].

- Potential severity of the allergy to be treated
- Efficacy of available immunotherapy
- Cost and duration of each type of treatment
- Risk incurred by the patient due to the allergic disease and the treatments.

To minimize risk and improve efficacy, the following suggestions are made:

- Specific immunotherapy needs to be prescribed by specialists and administered by physicians trained to manage systemic reactions if anaphylaxis occurs;
- Patients with multiple allergen sensitivities and/or nonallergic triggers may not benefit from specific immunotherapy;

• Specific immunotherapy is more effective in children and young adults than later in life;
• It is essential for safety reasons that the patient should be asymptomatic at the time of the injections because lethal adverse reactions are more often found in asthma patients with severe airway obstruction; and
• FEV_1 with pharmacological treatment should reach at least 70 percent of the predicted value, for both efficacy and safety reasons.

Controlled studies show that with appropriately selected extract and safe administration of doses, *specific immunotherapy with grass pollen* is effective in asthma management [22]. However, systemic side reactions may occur in from 5 to 20 percent of patients with highly effective standardized extracts. These conclusions are at present restricted to grass pollen allergy because conflicting results have been produced in studies of ragweed pollen asthma and polysensitized patients. The duration of specific immunotherapy is still a matter of debate. After a 3-year specific immunotherapy course, the effect of the treatment may last for several years.

Extracts of house-dust should not be used in immunotherapy. In contrast, *house-dust mite specific immunotherapy* in asthma has been assessed in many controlled studies [20, 21]. Standardized extracts are effective but cause 5 to 30 percent of patients to experience systemic reactions. With other extracts the results are more disparate. The duration of specific immunotherapy with dust mite extracts is still a subject of debate.

Although it has been recommended that allergen avoidance is preferred over *specific immunotherapy in animal dander allergy,* such immunotherapy may be considered [20, 21].

Molds are major allergens in asthma, but they often induce polysensitization, and most extracts are not yet standardized. *Specific immunotherapy using standardized extracts of Alternaria* has been shown to be effective [23]. However, specific immunotherapy with other mold species, or with extracts of unknown quality, is not recommended.

Immunotherapy with other extracts or other routes

Although specific immunotherapy may be administered by oral or sublingual routes, there are no convincing controlled studies to show their effectiveness in asthma. Specific immunotherapy with extracts of undefined allergens (bacteria, foods, Candida albicans, insect dusts) should no longer be used.

References

1. Korsgaard J. – Preventive measures in house-dust allergy. *Am Rev Respir Dis*, 1982; 125: 80–84.
2. Korsgaard J. – Changes in indoor climate after tightening of apartments. *Envir Intern*, 1983; 9: 97–101.
3. Wickman M, Nordvall S, Pershagen G *et al.* – House dust mite sensitization in children and residential characteristics in a temperate region. *J Allergy Clin Immunol*, 1991; 88: 89–95.
4. International Workshop on Mite Allergens and Asthma. *J Allergy Clin Immunol*, 1989; 83: 416.
5. Sporik R, Holgate ST, Platts-Mills TAE, Cogswell JJ. – Exposure to house-dust mite allergen and the development of asthma in childhood: a prospective study. *N Engl J Med*, 1990; 323: 502–507.
6. Godfrey K. – House-dust mite avoidance-the way forward. *Clin Exp Allergy*, 1991; 21: 1–2.
7. Wood RA, Chapman MD, Adkinson NF Jr, Eggleston PA. – The effect of cat removal on allergen content in household-dust samples. *J Allergy Clin Immunol*, 1989; 83: 730–734.
8. De Blay F. – Airbourne cat allergen (fel-d-I) environmental control with the cat in situ. *Am Rev Respir Dis*, 1991; 143: 1334.
9. Solomon LOR, Burge HA, Bloise JR. – Exclusion of particulate allergens by window air conditioners. *J Allergy Clin Immunol*, 1980; 65: 305–308.
10. Bernstein DI, Bernstein IL. – Occupational asthma. In Middleton E Jr, Reed CE, Ellis EF, *et al.* (eds): Allergy, Principles and Practice, ed 3, St Louis, Mosby Co, 1988; pp. 1197–1219.
11. Metcalfe DD, Sampson HA. – Workshop on experimental methodology for clinical studies of adverse reactions to foods and food additives. *J Allergy Clin Immunol*, 1990; 86: 421–442.
12. Onorato J, Merland N, Terral C, Michel FB, Bousquet J. – Double-blind food challenge in asthma. *J Allergy Clin Immunol*, 1986; 78: 1139–1146.
13. Bush RK, Taylor SL, Busse W. – A critical evaluation of clinical trials in reactions to sulphites. *J Allergy Clin Immunol*, 1986; 78: 191–202.
14. Hackney JD, Linn WS. – Environmental factors and asthma: air pollution and weather. *In*: Weiss EB Segal MS, Stein M (eds): Bronchial Asthma, Mechanisms and Therapeutics, ed 2, Boston, Toronto, Little, Brown and Co, 1985; pp. 445–452.
15. Fielding JE, Phenow KJ. – Health effects of involuntary smoking. *N Engl J Med*, 1988; 319: 1452–1460.
16. Stevenson DD, Simon RA. – Aspirin sensitivity: respiratory and cutaneous manifestations. *In*: Middleton E Jr, Reed CE, Ellis EF *et al.* (eds): Allergy, Principles and Practice, ed 3, St Louis, Mosby Co, 1988.
17. Szczeklik A, Gryglewski RJ, Czerningwska-Myski G. – Clinical patterns of hypersensitivity to nonsteroidal anti-inflammatory drugs and their pathogenesis. *J Allergy Clin Immunol*, 1977; 60: 276–282.
18. Meeker DP, Wiedemann HP. – Drug-induced bronchospasm. *Clin Chest Medicine*, 1990; 11: 163–177.
19. Enfmeyer JE, Siegle RL, Lieberman P. – Anaphylactoid reactions to radiocontrast material. *J Allergy Clin Immunol*, 1985; 75: 401–410.
20. Thompson RA, Bousquet J, Cohen S, *et al.* – Current status of allergen immunotherapy (hyposensitization) (shortened version of a WHO/IUIS report). *Lancet*, 1989; 1: 259–262.
21. Immunotherapy Subcommittee of the European Academy of Allergology and Clinical Immunology: Immunotherapy (Position Paper). *Allergy*, 1988; 43 (suppl 6): 1–33.
22. Bousquet J, Hejjaoue A, Michel FB. – Specific immunotherapy in asthma. *J Allergy Clin Immunol*, 1990; 86: 292–306.
23. Horst M, Hejjaoui A, Horst V, Michel FB, Bousquet J. – Double-blind, placebo-controlled rush immunotherapy with a standardized *Alternaria* extract. *J Allergy Clin Immunol*, 1990; 85: 460–472.

Part 4. Establish medication plans for chronic management

In establishing the medication plan, there are three considerations:
- The medications
- A step-wise approach to pharmacological therapy
- An asthma management zone system for patients.

The medications

Medications for pharmacological therapy, which is used to reverse and prevent airflow obstruction, include anti-inflammatory agents and bronchodilators. Anti-inflammatory agents may interrupt the development of bronchial inflammation and have a prophylactic and suppressive action. Bronchodilators act principally to dilate the airways by relaxing bronchial smooth muscle. Although bronchodilators reverse and/or inhibit bronchoconstriction and related symptoms of acute asthma, they do not reverse bronchial inflammation and hyperresponsiveness.

Route of administration. Asthma is a disease of the airways, and therefore, treatment *via* inhalation is generally preferable to systemic or oral treatment. Aerosolized medications that are used to treat asthma are available as metered-dose inhalers (MDIs) and/or dry powder inhalers [1]. The advantage of delivering drugs directly into the airways is that high concentrations of drug can be delivered more effectively to the airways, and systemic side effects are usually avoided. The major disadvantage of this mode of drug delivery is that training and skill are required to coordinate activation of the drug through inhalation. Patients should be instructed in the use of a metered-dose inhaler or alternative device and their technique should be checked regularly (see Educate Patients To Develop a Partnership in Asthma Management).

For the patient who has difficulty using a metered-dose inhaler, a spacer improves delivery of the bronchodilator [2]. The spacer device allows discharge of the drug in the MDI into a chamber where particles of medications are held in suspension for 3 to 5 seconds. During this time, the patient can inhale the drug. Spacers eliminate the rapid initial particle velocity, reducing the irritant properties of the aerosol and the tendency to cough. They also reduce deposition in the mouth and oropharynx, decreasing cough as well as the possibility of oral candidiasis when used to deliver steroids. Further, the use of spacers for the delivery of inhaled steroids has been shown to decrease the systemic bio-availability of steroids and the risk of systemic side effects [3, 4]. Some (although not all) investigations suggest that high doses of $beta_2$-agonists administered from metered-dose inhalers using spacer devices achieve bronchodilation equivalent to that effected by nebulization in treating severe exacerbations [5].

Dry powder inhalers do not utilize freon propellants. These devices have similar potency to standard metered-dose inhalers. Dry powder inhalers require an inhalation technique that is different from the MDI technique and are generally easier to use.

Nebulized or "wet" aerosols generated by an air compressor are particularly useful for children under 5 years of age and in the treatment of acute severe asthma in which respiratory insufficiency could impair inhalation from a metered-dose inhaler or dry powder inhaler.

Special considerations for children. Metered-dose inhalers are often difficult for children to use correctly, and therefore can be recommended only when the prescription is accompanied by thorough and repeated instruction. The use of spacer devices allows children as young as 2 to 3 years of age to use the MDI after careful training. A device that combines a face mask with a spacer may also decrease the age at which MDIs can be used, although data evaluating this device are limited. A good inspiratory effort is required for the dry powder systems; the lower age limit for the devices will vary. In general, they are most suitable for children over 5 years old. During acute exacerbations, young children may have particular difficulty using the MDI, with or without a spacer device. Under such circumstances, nebulizers are appropriate. Nebulizers are of value to children under 2 years of age, older children who have difficulty with the MDI or dry powder techniques, and those prone to severe exacerbations. There are few controlled studies of nebulizer treatment in this age group; thus knowledge of dose requirements is limited [6].

Anti-inflammatory agents

- **Corticosteroids** are currently the most effective anti-inflammatory drugs for the treatment of asthma. The exact mechanisms of action of corticosteroids in asthma are not fully understood. While many mechanisms of action have been proposed, important ones are: interference with arachidonic acid metabolism and the synthesis of leukotrienes and prostaglandins; reduction in microvascular leakage; inhibition of cytokine production; prevention of the directed migration and activation of inflammatory cells; and increased responsiveness of beta receptors of the airway smooth muscle.

Corticosteroids may be administered parenterally, orally, or as aerosols. Early treatment of severe acute exacerbations of asthma with oral corticosteroids prevents progression of the asthma exacerbation, decreases the need for emergency department visits or hospitalizations, and reduces the morbidity of the illness. High-dose short-term systemic therapy may be needed to treat severe acute exacerbations of asthma.

Inhaled corticosteroids are safe and effective for the chronic treatment of asthma, administered long term in lower doses or in high doses for short periods [7, 8, 9]. Long-term high-dose regimens of inhaled corticosteroids are useful for the treatment of severe chronic asthma. Although the clinical relevance of side effects of long-term high doses has not yet been established, some recent studies suggest that doses above 1 milligram a day beclomethasone dipropionate (BDP) or equivalent may be associated with increased systemic absorption. Systemic effects may be observed at lower

doses in children [10], post menopausal women, and individuals with Addison's disease, and individual metabolism of drugs may alter the profile of systemic reaction [11]. However, long-term corticosteroids reduce the need for the chronic use of oral corticosteroids in a dose dependent manner and have significantly fewer systemic adverse effects. Local adverse effects from inhaled corticosteroids include oropharyngeal candidiasis, dysphonia, and occasional coughing from upper airway irritation, but these effects may often be prevented by using spacer devices [12]. Mouth washing after inhalation may also prevent oral candidiasis.

Chronic oral corticosteroid treatment should not be used unless other forms of therapy, including high doses of inhaled steroids, have failed to mitigate the patient's asthma. They should also be continued only if shown to reduce chronic symptoms substantially or reduce the frequency of severe exacerbations. Long-term oral corticosteroid therapy in severe asthma is limited by the risk of significant adverse effects. Although it is rare, adrenal failure may occur when a patient is withdrawn from long-term suppressive doses of systemic corticosteroids. Such withdrawal should be observed for clinical evidence of adrenal insufficiency.

Fatal varicella has been reported among patients who are exposed to chicken pox while taking systemic corticosteroids, even short bursts. If a patient is exposed to varicella, the following actions should be considered: discontinue the systemic corticosteroid, give the patient zoster immunoglobulin, and consider acyclovir therapy if the patient develops progressive varicella [13].

• **Sodium cromoglycate (cromolyn sodium)** is a non-steroid, topical, anti-inflammatory drug for the treatment of asthma [14]. The exact mechanisms of action of sodium cromoglycate are not fully understood, although sodium cromoglycate will partly inhibit the IgE mediated release from human mast cells in a dose dependent way [15], and has a cell-selective and mediator selective suppressive effect on other inflammatory cells (macrophages, eosinophils, neutrophils, monocytes [16]). Administered prophylactically, sodium cromoglycate inhibits early- and late-phase allergen-induced airway narrowing and acute airway narrowing after exposure to exercise, cold dry air, and sulphur dioxide. There is insufficient knowledge about the mode of action of sodium cromoglycate to predict those patients who will achieve a beneficial response; any patient may benefit, although some consider it most efficacious in mild allergic asthma [17]. A 4- to 6-week trial of sodium cromoglycate therapy may be required to determine efficacy in individual patients. As a rule, sodium cromoglycate produces only minimal side effects, such as occasional coughing upon inhalation of the powder formulation.

• **Nedocromil sodium** is a novel anti-inflammatory pyranoquinaline which, when administered by inhalation, is 4–10 times more potent than sodium cromoglycate in preventing some forms of acute bronchoconstriction in *in vitro* and *in vivo* studies in animal and human models of asthma [18, 19] although therapeutic comparisons have not been reported [20]. Clinical trials in adult patients with asthma show that long-term therapy with nedocromil sodium reduces nonspecific airway responsiveness in nonatopic asthmatics [21] and improves symptoms and lung function [22] commensurate with its proposed anti-inflammatory properties [21]. Thus, as with sodium cromoglycate, this drug may be used as a maintenance therapy early in the course of the disease. Clinical trials are required to establish the role of nedocromil in childhood asthma. Treatment with nedocromil sodium is not associated with any significant adverse effects.

Bronchodilators

• **Beta$_2$-agonists (adrenergic agonists)** relax airway smooth muscle and enhance mucociliary clearance, decrease vascular permeability, and may modulate mediator release from mast cells and basophils [23, 24]. Most of the currently available beta$_2$-agonists have limited duration of action (4 to 6 hours).

Newer long acting inhaled beta$_2$-agonists-formoterol and salmeterol-have a duration of action lasting more than 12 hours. Long acting inhaled beta$_2$-agonists inhibit allergen-induced early and late asthmatic responses and the increase in histamine-induced airway responsiveness. However, measurements in blood and induced-sputum show that the inflammatory cell response is not reduced [25, 26].

Aerosol or inhaled therapy with beta$_2$-agonists is comparable to, or better than, oral therapy in producing bronchodilation and causes fewer systemic adverse effects such as cardiovascular stimulation, skeletal muscle tremor, and hypokalaemia.

Short acting inhaled beta$_2$-agonists are the medication of choice for treatment of acute exacerbations of asthma [27] and for the pretreatment of exercise-induced asthma. Short acting inhaled beta$_2$-agonists are used intermittently to control episodic bronchoconstriction. Although short acting inhaled beta$_2$-agonists are commonly used chronically, regularly scheduled (as opposed to taken as needed) therapy with specific inhaled beta$_2$-agonists has recently been associated with diminished control of asthma [28, 29]. Further studies are required, but it is recommended that regularly scheduled short acting inhaled beta$_2$-agonist treatment should be kept to a minimum. Because well-controlled asthma requires minimal use of short acting inhaled beta$_2$-agonist, an increased use is indication of deteriorating control.

Frequent or regularly scheduled use of short acting inhaled beta$_2$-agonist for chronic management of asthma does not adequately control asthma symptoms, peak flow variability, or airway hyperresponsiveness [7, 8]. It is considered important to treat anything more than mild occasional asthma with an anti-inflammatory medication, with short acting inhaled beta$_2$-agonists used on an as-needed basis. An increased use-or even a daily use-of the short-acting inhaled beta$_2$-agonist is a warning of deterioration of the disease and indicates the need to institute or to intensify the regular anti-inflammatory therapy. Similarly, failure to achieve a quick and sustained response to beta$_2$-agonist treatment during an

exacerbation mandates medical attention and may indicate the need for short-term oral corticosteroids.

The position of long acting beta$_2$-agonists in asthma therapy has not been clearly defined; further clinical trials are necessary. Preliminary studies suggest that it is not appropriate to use long acting beta$_2$-agonists on an as-needed basis for acute symptomatic relief. Some asthma specialists indicate that long acting inhaled beta$_2$-agonists may be considered when standard introductory doses of inhaled corticosteroids fail to achieve control of asthma, especially nocturnal symptoms, and before raising the dose of inhaled corticosteroids [30]. However, other asthma specialists prefer to introduce long acting inhaled beta$_2$-agonists after a trial of higher doses of corticosteroids continues to reveal symptoms or a need for short acting inhaled beta$_2$-agonists three to four times a day or more. Further studies are necessary to establish the position of long acting beta$_2$-agonists in asthma therapy.

• **Methylxanthines.** Theophylline, the principal methylxanthine used in asthma therapy, is a bronchodilator that may also have extrapulmonary effects [31]. The precise mechanism of action of theophylline is not clear. When given as a sustained-release preparation, it has a long duration of action and is thus useful in the control of nocturnal symptoms [32]. Theophylline has the potential for significant adverse effects, but these can generally be avoided by appropriate dosing and monitoring. Although individual patient needs will vary, a general approach is to aim for a steady state serum concentration for theophylline of between 5 and 15 micrograms per millilitre during chronic theophylline treatment although toxic effects may occur at lower doses. Monitoring of serum concentrations should be conducted when theophylline therapy is started and at regular intervals of 6 to 12 months thereafter. Monitoring is also required when a patient develops an adverse effect on the usual dose, when expected therapeutic aims are not achieved, and when conditions known to alter theophylline metabolism exist (*e.g.*, febrile illness, pregnancy, liver disease, congestive heart failure, and the use of certain drugs, including cimetidine, quinalone, and macrolides).

The signs and symptoms of theophylline intoxication involve many different organ systems. Gastrointestinal symptoms, nausea, and vomiting are the most common early events. However, theophylline intoxication in children and adults can result in seizures and even death [33] and these events may not be preceded by evidence of central nervous system stimulation. Cardiopulmonary effects include tachycardia, arrhythmias, and, occasionally, stimulation of the respiratory centre.

Because of the risk of adverse effects and the difficulty of monitoring therapy, theophylline is regarded in some countries as a therapy that should be reserved for use after inhaled steroids and inhaled beta$_2$-agonists fail to achieve therapeutic goals. In other countries, theophylline is recommended earlier in the course of regularly scheduled therapy because it is a bronchodilator especially useful for the control of nocturnal symptoms.

• **Anticholinergics.** Inhaled anticholinergic agents (ipratropium bromide) block postganglionic efferent vagal pathways [34]. When inhaled, these agents produce bronchodilation by reducing intrinsic vagal tone to the airways. They also block reflex bronchoconstriction caused by inhaled irritants. They do not diminish the early and late allergic reaction or the reactions after exercise. In asthma, inhaled anticholinergics are less potent bronchodilators than inhaled beta$_2$-agonists and in general have a slower onset of action. Some reports show that ipratropium bromide has an additive effect when nebulized together with a beta$_2$-agonist for exacerbations of asthma [35].

Ipratropium bromide's benefits in the chronic management of asthma have not been established, although in several countries it is recognized as an alternative bronchodilator for patients who experience such adverse effects as tachycardia and tremor from beta$_2$-agonist.

Other medications. Ketotifen and potent antihistamines (H_1-antagonists) have inconsistently been shown to decrease asthma symptoms in seasonal and mild perennial asthma [36]. However, these drugs in general are of limited efficacy in asthma therapy.

Therapeutic regimens to reduce oral corticosteroid dependence such as troleandomycin, gold, methotrexate, and other immunosuppressive treatment are still experimental and should be used only in selected patients under the supervision of an asthma specialist.

There is anecdotal evidence that some patients have benefited from the use of ionizers, acupuncture, homeopathy, and other complementary treatment, but controlled clinical trials have so far been disappointing. It is strongly recommended that conventional treatment be continued if these treatments are tried.

A step-wise approach to pharmacological therapy

The selection of pharmacological treatment options is made on the basis of asthma severity and the patient's current treatment. Because asthma is a dynamic as well as chronic condition, medication plans need to accommodate variability among patients as well as within individual patients over time. An approach to pharmacologic therapy that correlates with classification of asthma severity permits this flexibility. Figure 1 in Definition, diagnosis, and classification is a classification that assesses the level of asthma severity based on clinical features, lung function, and medication requirements.

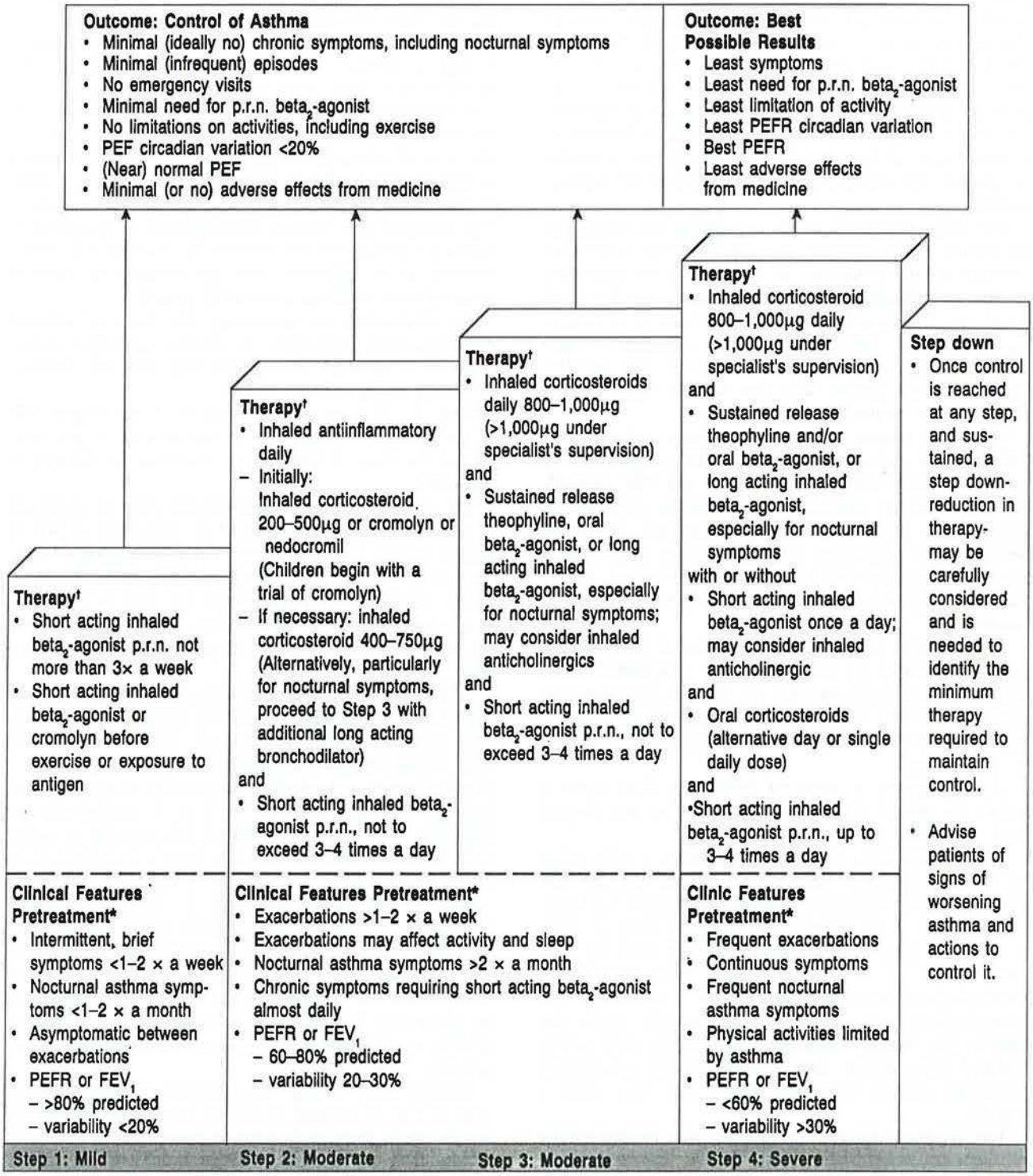
Four steps to achieve and maintain control of asthma. Control of asthma is defined as:

• Minimal (ideally no) chronic symptoms, including nocturnal symptoms
• Minimal (infrequent) exacerbations
• Minimal need for p.r.n. beta$_2$-agonist, ideally none
• No limitations on activities, including exercise
• PEF circadian variation <20 percent
• (Near) normal PEF
• Minimal (or no) adverse effects from medicine.

Figure 3. – Chronic Management of Asthma: Stepwise Approach to Asthma Therapy

Step-up: Progression to the next higher step is indicated when control cannot be achieved at the current step and there is assurance that medication is used correctly. If PEFR ≤60% predicted or personal best, consider a burst of oral corticosteroids and then proceed.

Step-down: Reduction in therapy is considered when the outcome for therapy has been achieved and sustained for several weeks or even months at the current step. Reduction in therapy is also needed to identify the minimum therapy required to maintain control.



* One or more features may be present to be assigned a grade of severity; an individual should usually be assigned the most severe grade in which any feature occurs. † **All therapy must include patient education about prevention (including environmental control where appropriate) as well as control of symptoms.**

Figure 3 illustrates a step-wise approach to therapy in which the number and frequency of medications are increased with increasing asthma severity [1–9]. Progression to the next step is indicated when control cannot be achieved at the current step and there is assurance the patient is using medication correctly. The aim is to accomplish the goals of therapy with the least possible medication. Thus, clinicians must judge whether to increase treatment in a gradual step-up manner, or to give maximum treatment at the onset, which may include a burst or cycle of oral corticosteroids, in order to achieve control of the patient's asthma. In either case, once control is sustained for several weeks or months, a reduction in therapy by a step down can be carefully considered and is needed to identify the minimum therapy required to maintain control.

The steps suggested in the following discussion are guidelines only; specific medication plans should be tailored by the physician in recognition of individual patient circumstances. For specific protocols for treatment, see the reports listed in Resources. It is recommended that an asthma specialist be consulted if there are questions about appropriate steps for specific patients, if the patient does not respond optimally, or if the patient requires step 3 or 4 care.

• **Step 1.** A patient has mild, intermittent asthma if the patient has a pretreatment baseline PEF greater than 80 percent of predicted or personal best and PEF variability less than 20 percent; if the patient experiences intermittent, brief exacerbations (episodes of cough, wheezing, or dyspnoea) less than one to two times a week; is asymptomatic between exacerbations; and/or has nocturnal asthma symptoms less than two times a month.

This requires only short acting inhaled $beta_2$-agonist taken as needed to relieve asthma symptoms. Short acting inhaled $beta_2$-agonist, or sodium cromoglycate prior to exercise or sodium cromoglycate prior to exposure to known antigen may be taken prophylactically if appropriate.

If $beta_2$-agonist is required more than three times a week, the patient should be moved to the next step of care, regardless of PEF measurements.

• **Step 2.** Moderate asthma encompasses a wide range of asthma severity; thus, two steps of therapy are associated with moderate asthma. A patient has moderate asthma if the patient's pretreatment baseline PEF is 60 to 80 percent predicted or personal best and PEF variability is 20–30 percent; if the patient experiences exacerbations more than two times a week and the exacerbations may affect sleep and activity levels; the patient has chronic symptoms that require short acting inhaled $beta_2$-agonist almost daily; and/or experiences nocturnal asthma symptoms more than two times a month.

The primary therapy is inhaled anti-inflammatory medication taken on a daily basis, either inhaled corticosteroids or sodium cromoglycate or nedocromil. Children are usually given an initial trial (4–6 weeks) of sodium cromoglycate. The suggested introductory dose of inhaled corticosteroids is 200 to 500 micrograms per day of beclomethasone dipropionate (BDP) or equivalent. (Doses cited here are illustrative and refer to BDP. In the absence of complete data, the same dosage guidelines may be applied to the other formulations - budesonide, flunisolide, and triamcinolone. However, the relative anti-inflammatory, steroid-suppressive effects of these three distinct formulations has not been established).

Inhaled short acting $beta_2$-agonist should be available to take as needed to relieve symptoms, but should not be taken more than three to four times a day.

If symptoms persist and the clinician is satisfied that the patient is using the inhaled medications correctly, the dose of inhaled corticosteroids should be increased to 400 or 500 to 750 or 800 micrograms per day BDP or equivalent. If the patient's anti-inflammatory therapy was initiated with sodium cromoglycate or nedocromil, inhaled corticosteroids should be introduced either instead of or together with nedocromil or sodium cromoglycate to allow an overlap period.

An alternative to increasing the dose of inhaled corticosteroids, especially to control nocturnal symptoms, is to proceed to the next step with the addition of a long acting bronchodilator.

• **Step 3.** If a patient's asthma is at the higher end of the moderate range and/or the asthma is not controlled by Step 2 therapy, an increase in therapy is necessary.

The dose of inhaled corticosteroids may be increased to 800–1,000 micrograms BDP or equivalent a day. A spacer device with the inhaler is recommended to reduce oropharyngeal side effects and systemic absorption. Doses over 1,000 micrograms per day may be necessary to achieve control of the patient's asthma, but should be administered under the supervision of an asthma specialist.

Additional, long acting bronchodilators may also be considered, particularly to control nocturnal symptoms. Oral sustained-release theophylline, oral $beta_2$-agonist, or long acting inhaled $beta_2$-agonist may be added. Theophylline serum concentrations should be monitored, with a general therapeutic range of 5 to 15 micrograms per millilitre. A long acting inhaled $beta_2$-agonist is available in some countries and may have a complementary effect to low-dose inhaled corticosteroids, although sufficient data are not available to establish the place of long-acting inhaled $beta_2$-agonist in asthma therapy. The role of anticholinergics (ipratropium bromide) in chronic therapy is not well established, but an introduction of anticholinergics may be considered as an alternative for patients who experience such adverse effects as tachycardia or tremor from inhaled $beta_2$-agonists.

Inhaled short acting $beta_2$-agonists should be available to take as needed to relieve symptoms, but should not be taken more than three to four times a day.

• **Step 4.** A patient has severe asthma if the patient has a pretreatment baseline PEF less than 60 percent of predicted or personal best and PEF variability greater than 30 percent; experiences highly variable, continuous

symptoms and frequent nocturnal symptoms; has limited activities and experiences severe exacerbations in spite of medication. Control of asthma as defined earlier may not be possible. In this more severe asthma, the goal of therapy becomes achieving best possible results: the least symptoms, the least need for $beta_2$-agonist, the best flow rates, the least circadian variation, and the least side effects from medication.

Therapy usually requires multiple daily medications. Primary therapy includes inhaled corticosteroids at higher doses (800–1,000 micrograms per day or more BDP or equivalent). Doses over 1,000 micrograms a day may be necessary to achieve control of the patient's asthma, but should be administered under the supervision of an asthma specialist.

If necessary, an additional bronchodilator is recommended, such as an oral sustained-release theophylline or oral $beta_2$-agonist and/or a long acting inhaled $beta_2$-agonist-especially for nocturnal symptoms. An inhaled short-acting $beta_2$-agonist regularly scheduled once a day, usually upon arising, may also be considered. A trial of inhaled ipratropium may be considered, particularly for those patients who experience adverse effects from $beta_2$-agonist.

Inhaled short acting $beta_2$-agonist should be available as needed up to three to four times a day to relieve symptoms.

Oral corticosteroids, if needed long term, should be used in the lowest possible dose (alternate or single daily dose after a 3–7 day burst). Persistent trials of high doses of inhaled corticosteroids (up to a maximum of 2 milligrams per day) administered with a spacer device should be made in an attempt to reduce oral corticosteroids. When patients are transferred from oral corticosteroids to high dose inhaled corticosteroids, they should be monitored closely for evidence of adrenal insufficiency.

It is to be noted that difficult to manage asthma may herald a life threatening underlying disorder such as Churg Strauss or other forms of systemic vasculitis.

However, the complexity of a multiple daily medication regimen is often a factor in patient nonadherence, and this in turn complicates control of the asthma. Patients with severe asthma may require particularly intensive patient education and referral to appropriate sources of support.

Special considerations for children. For children under 5 years of age, the PEF is either not attainable or too dependent on fluctuating levels of attention and effort to be reliable. For younger children, the history, which should include assessment of the child's quality of life, and physical examination, although imperfect, are essential elements in decision making. This can be enhanced by symptom reports kept by the parent on a patient diary card.

Under-diagnosis of asthma is a frequent problem, and it occurs most often in young children whose primary symptom is cough or who wheeze only when they have respiratory infections and are dismissed as having bronchitis or pneumonia even though the signs and symptoms are most compatible with a diagnosis of asthma.

Viral upper respiratory infections are a common asthma trigger among children. Although there is no specific therapy, patients and parents need to be vigilant in adhering to the regular asthma medication treatment plans and in being alert for early signs of an exacerbation so that asthma medication may be started or increased immediately. For those individuals who deteriorate rapidly every time they have a viral respiratory infection, it may be appropriate to institute a short course of oral corticosteroid therapy at the earliest sign of viral respiratory infection [10].

Recommended doses of medication for children differ from doses for adults. Specific dose recommendations are available in the respective country documents (see Resources).

There is potential for concern about systemic absorption of high doses of inhaled corticosteroids and its possible effect on linear growth as discussed in the previous section. Thus, when inhaled corticosteroids are added to treatment with sodium cromoglycate or nedocromil in order to achieve control of asthma, an appropriate step-down to consider is to gradually reduce the inhaled corticosteroids and maintain control with the sodium cromoglycate or nedocromil. The inhaled corticosteroids may need to be reinitiated for seasonal asthma.

An asthma management zone system for patients

An asthma management zone system has been developed to help patients understand the chronic and variable nature of asthma and to help them monitor the disease, identify the earliest possible signs that the day-to-day control of asthma is deteriorating, and act quickly to regain control. The patient may initiate actions appropriate to each zone, according to a prearranged plan made with the physician. The zones have been adapted to a traffic light system to make it easier for patients to use and remember [1, 2, 3]. The zones suggested in the following discussion are guidelines only; specific zones should be tailored by the physician in recognition of individual patient circumstances, especially since patterns of exercerbations vary markedly between patients but often exacerbations in a particular patient follow a similar pattern. Furthermore, whereas the zones discussed below are presented as percentages of predicted PEF in order to accommodate variations in patient size and age, patient understanding of the zones will be improved if the patient's written treatment plan indicates the actual PEF values that correspond with the percent range.

• **Green Zone.** Green indicates all clear. Asthma is under control. PEF is usually 80 to 100 percent of predicted or personal best and usually less than 20 percent variability. In this zone, there is no interruption of activities or sleep, and there are minimal (ideally no) symptoms. The specific medication to maintain this control of asthma in the Green Zone depends on the

level of asthma severity. A step-wise approach to asthma therapy, discussed earlier, is used to identify the minimum medication required to maintain control; generally, the number and frequency of medications are increased with increasing severity of asthma.

• **Yellow Zone.** Yellow signals caution. A PEF 50 to 80 percent of predicted or personal best and 20 to 30 percent variability, and/or occurrence of asthma symptoms (nocturnal symptoms, decreased activity, coughing, wheezing, chest tightness with activity or at rest) while the Yellow Zone indicates one of three things:

– An acute exacerbation may be present for which a temporary increase in medication, especially inhaled beta$_2$-agonists and possibly oral corticosteroids, is indicated (see the section following on Managing Exacerbations). The medication plan developed with the physician.

– A deterioration of asthma may be characterized by a gradual reduction in PEF that fails to have a sustained response to inhaled beta$_2$-agonist, greater intolerance of daily activities or exercise, or the development of nocturnal symptoms. This indicates the need for further treatment to be arranged with the physician. A short burst of oral corticosteriods (30 to 60 milligrams daily, in single or divided doses) until PEF returns to Green Zone is recommended. Oral corticosteroids should then be ceased; often this is accomplished by gradually tapered doses. Alternatively, in selected cases (*e.g.*, patients already on inhaled corticosteroids), the regular dose of inhaled corticosteroids may be doubled for one week or until PEF and symptoms improve.

– Frequent fluctuations into the Yellow Zone may indicate that the asthma in not sufficiently under control and the Green Zone therapy needs to be increased.

• **Red Zone.** Red signals a medical alert. PEF is below 50 percent of predicted or personal best. Asthma symptoms are present at rest or interfere with activity. An inhaled beta$_2$-agonist should be taken immediately. If PEF remains below 50 percent despite the bronchodilator, immediate medical attention is required, preferably in a hospital based emergency department.

Therapy for the Red Zone emphasizes adequate dosage of inhaled beta$_2$-agonist, which may require its frequent administration, and the early introduction of corticosteroids. Oxygen is also administered if the patient is hypoxaemic. Specific recommendations are presented in the section on Managing Exacerbations that follows.

If the PEF improves after initial bronchodilator treatment, the Yellow Zone actions should be followed. Entry into the Red Zone may reflect a failure of the Green Zone therapy. After the exacerbation is controlled, the Green Zone therapy and patient adherence (to the medication plan and environmental control measures) should be reviewed and adjusted accordingly.

Part 5. Establish plans for managing exacerbations

Exacerbations of asthma ("asthma attacks") are episodes of progressively worsening shortness of breath, cough, wheezing, or chest tightness, or some combination of these symptoms. Respiratory distress is common. Exacerbations are characterized by decreases in expiratory airflow that can be quantified by measurement of lung function (PEF or FEV_1 [1], and, as discussed earlier, these objective measures are more reliable indicators of the severity of airflow obstruction than the degree of symptoms.

Exacerbations usually reflect either a failure of long-term management or exposure to a noxious agent. The severity of asthma exacerbations may range from mild to life threatening. Deterioration usually progresses over hours or days, but may occasionally occur precipitously over some minutes. Morbidity and mortality are most often associated with underassessment of the exacerbation's severity, inadequate action at the onset of the exacerbation, and undertreatment of the exacerbation.

Treatment of exacerbations depends on the patient and on the physician's experience with what therapies are most effective for the particular patient. The primary therapies for exacerbations are the repetitive administration of inhaled beta$_2$-agonist and the early introduction of corticosteroids. General guidelines applicable to most patients are discussed in this section. Specific protocols for treatment and drug doses are available in the respective country documents (see Resources).

The aims of treatment are to:

• Relieve airway obstruction as quickly as possible
• Relieve hypoxaemia
• Restore lung function to normal as soon as possible
• Plan avoidance of future relapses
• Develop a written action plan in case of a further exacerbation.

Crucial to successful treatment is close monitoring of the patient's condition and response to treatment with serial measurement of lung function. Assessment of the patient's pulse, respiratory rate, and current symptoms also guides treatment decisions, but objective measures of lung function are critical.

Patients at high risk of asthma-related death require particularly intensive patient education, close monitoring, and prompt care. This includes patients with a history of:

• Current use of or recent withdrawal from systemic corticosteroids
• Hospitalization for asthma in the past year
• Emergency care visit for asthma in the past year
• Prior intubation for asthma
• Psychiatric disease or psychosocial problems
• Noncompliance with asthma medication plan.

Full recovery from asthma exacerbations is usually gradual; it may take many days for lung function to return to normal and weeks for airway hyperresponsiveness to decrease. Symptoms and physical signs are not accurate indicators of airflow. The increased treatment should continue until objective measures of lung function (PEF or FEV_1) return to normal, or the patient's personal best.

Figure 4. – Severity of Asthma Exacerbations

	Mild	Moderate	Severe	Respiratory arrest imminent
Breathless	Walking Can lie down	Talking Infant-softer shorter cry; difficulty feeding Prefers sitting	At rest Infant-stops feeding Hunched forward	
Talks in	Sentences	Phrases	Words	
Alertness	May be agitated	Usually agitated	Usually agitated	Drowsy or confused
Respiratory rate	Increased	Increased	Often >30/min	
	Guide to rate of breathing associated with respiratory distress in awake children: *Age* — *Normal rate* <2 months — <60/min 2–12 months — <50/min 1–5 years — <40/min 6–8 years — <30/min			
Accessory muscles and suprasternal reactions	Usually not	Usually	Usually	Paradoxical thoraco-abdominal movement
Wheeze	Moderate, often only end expiratory	Loud	Usually loud	Absence of wheeze
Pulse/min.	<100	100–120	>120	Bradycardia
	Guide to limits of normal pulse rate in children: Infants 2–12 months - Normal rate <160/min Preschool 1–2 year - <120/min School age 2–8 years - <110/min			
Pulsus paradoxus	Absent <10 mmHg	May be present 10–25 mmHg	Often present >25 mmHg (adult) 20–40 mmHg (child)	Absence suggests respiratory muscle fatigue
PEF after initial bronchodilator % predicted or % personal best	Over 70–80%	Approx. 50–70%	<50% predicted or personal best (<100 L/min adults) or response lasts <2 hrs	
Pao_2 (on air)†	Normal Test not usually necessary	>60 mmHg	<60 mmHg Possible cyanosis	
and/or $Paco_2$†	<45 mmHg	<45 mmHg	>45 mmHg: Possible respiratory failure (see text)	
Sao_2 % (on air)†	>95%	91–95%	<90%	
	Hypercapnia (hypoventilation) develops more readily in young children than in adults and adolescents.			

**Note:* *The presence of several parameters, but not necessarily all, indicates the general classification of the exacerbation.*
*†: **Note:** Kilopascals are also used internationally; conversion would be appropriate in this regard.*

Assessment of severity of the exacerbation

The severity of the exacerbation determines the treatment administered. Figure 4 provides a guide to the severity of an exacerbation of asthma at the time the examination is made. Since these are guidelines only, all features in a category need not be present. A more severe grading should be given if the patient has a lack of response to initial treatment, if the attack has progressed quickly, or if the patient is at high risk historically as just defined.

Indices of severity, particularly peak expiratory flow (in patients over 5 years old), pulse, and respiratory rate should be monitored during treatment. Any deterioration may require prompt intervention.

Home management of exacerbations

Initiation of anti-asthma therapy at the earliest possible sign of deteriorating control of asthma is important in the successful management of asthma exacerbations. When patients are able to begin treatment at home, they not only avoid delays in treatment but also add to their sense of control over their asthma. The degree of care provided in the home depends on the physician and patient's (or parents') experience and the availability of emergency care. Figure 5 illustrates the approach to home treatment that is discussed below. Home PEFR determinations are an integral part of home management strategies. Ideally, all patients should have a written action plan that outlines how to:

- recognize signs of deterioration
- start treatment
- get to medical care.

Treatment

- **Bronchodilators.** For mild to moderate exacerbations, repetitive administration of inhaled short acting $beta_2$-agonists (2–4 puffs every 20 minutes for first hour) is usually the best method to achieve rapid reversal of airflow obstruction. During more severe exacerbations, higher than usual doses of $beta_2$-agonist are often needed-*e.g.* 4–10 puffs, with or without a spacer, of a standard $beta_2$-agonist may be needed or a nebulizer may be used for children [2, 3]. Increased inhaled $beta_2$-agonists alone may be continued if there is a complete response (PEF returned to >80% predicted) and the response lasts at least 3 to 4 hours.

- **Corticosteroids.** If the response to the inhaled $beta_2$-agonist alone is not prompt and sustained (*e.g.*, PEF greater than 80 percent of predicted or personal best) after 1 hour, oral corticosteroids should be used to speed resolution of the exacerbation.

Additional care. If there is sustained improvement in PEF and symptoms, care may be continued at home under the supervision of a clinician. Full recovery from the exacerbation is often gradual and medications for the exacerbation may need to be continued for several days to sustain relief of symptoms and improvement in PEF.

Patients should not delay in seeking medical help if:

- The patient is at high risk, as previously defined.
- The exacerbation is severe (*e.g.*, PEF less than 50 percent of predicted or personal best, see Figure 2).
- The response to the bronchodilator is not prompt and sustained for at least 3 hours.
- Inhaled $beta_2$-agonist every 3 to 4 hours is required for more than 24 to 48 hours.
- There is no improvement within 2–6 hours after corticosteroid treatment was started.
- There is further deterioration.

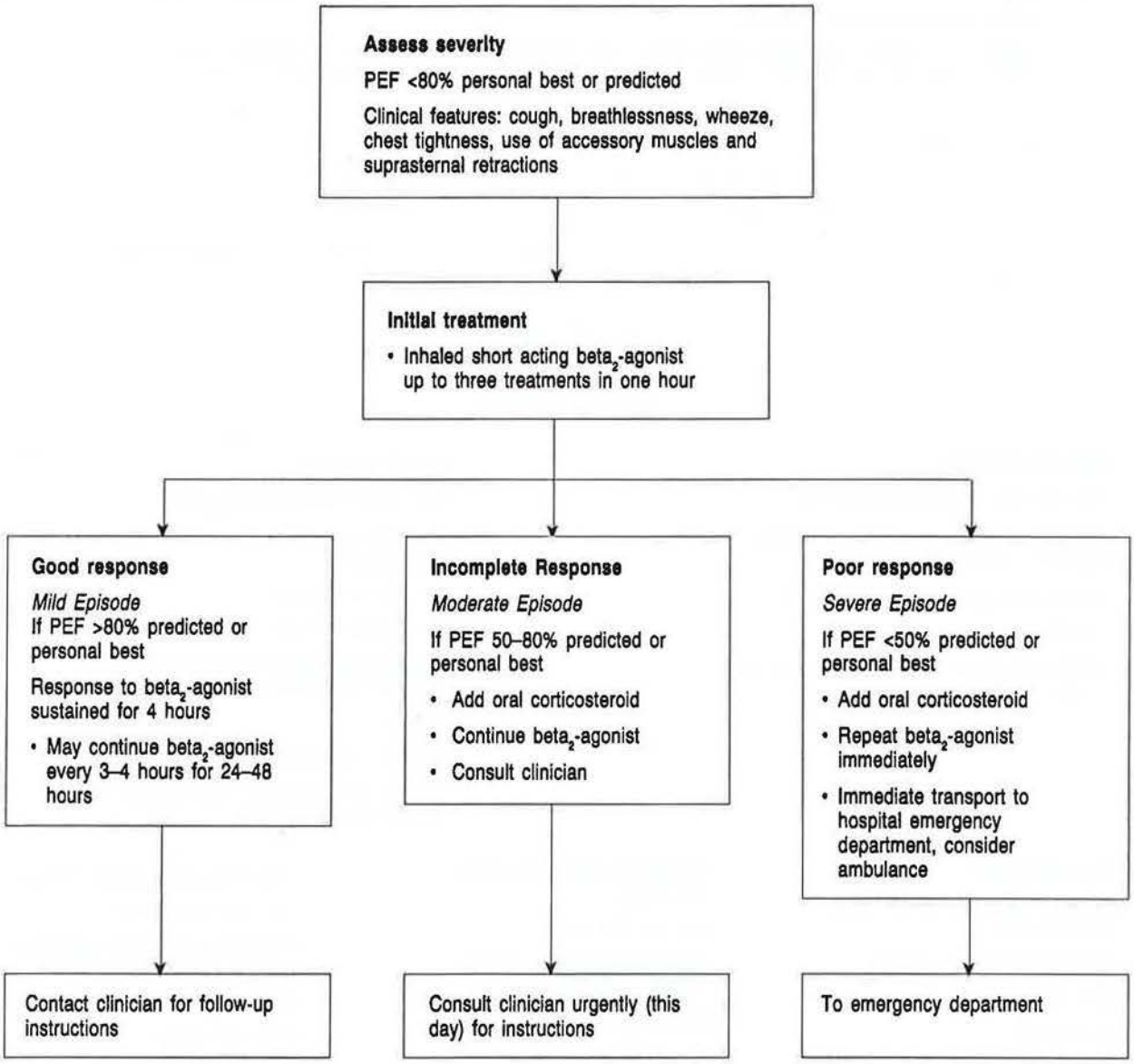
Hospital-based management of exacerbations

Severe exacerbations of asthma are potentially life threatening. Care must be expeditious and, in most cases, treatment is most safely undertaken in a hospital based emergency department. Figure 6 illustrates the approach to hospital-based management of exacerbations that is discussed in this section.

Assessment. A brief history and physical examination pertinent to the exacerbation are appropriate prior to treatment.

- *The brief history* will document:
  - Severity of symptoms, including exercise limitation and sleep disturbance
  - All current medication
  - Time of onset and cause of present exacerbation
  - Prior hospitalizations and emergency department visits for asthma.
- *The physical examination* will:
  - Assess severity of exacerbation (see Figure 4)
  - Identify complications (*e.g.*, pneumonia, atelectasis, pneumothorax, or pneumomediastinum).
- *Functional assessments* include-
  - PEF or FEV_1 at least hourly, with initial measures made before treatment if possible – Arterial oxygen saturation by pulse oximetry, where available.
- *Laboratory studies* should not be permitted to delay initiation of treatment. After initial treatment the following are indicated as appropriate:
  - Complete blood count in patients with purulent sputum or fever
  - Chest X-ray if complicating cardiopulmonary process is suspected
  - Arterial blood gas measurement in patients with PEF 30–50 percent predicted, or severe distress after initial treatment. A Po_2 <60 mm Hg and/or Pco_2 >45–50 mmHg indicate respiratory failure. Admission to an intensive care unit for continuous monitoring should be considered.
- *Special considerations for children and infants.* Several differences in lung anatomy and physiology place infants at greater risk than older children for respiratory failure. Close monitoring, using a combination of the parameters listed in Figure 3 other than PEF, will permit a fairly accurate assessment.

Fig. 5. – Management of Exacerbation of Asthma: Home Treatment



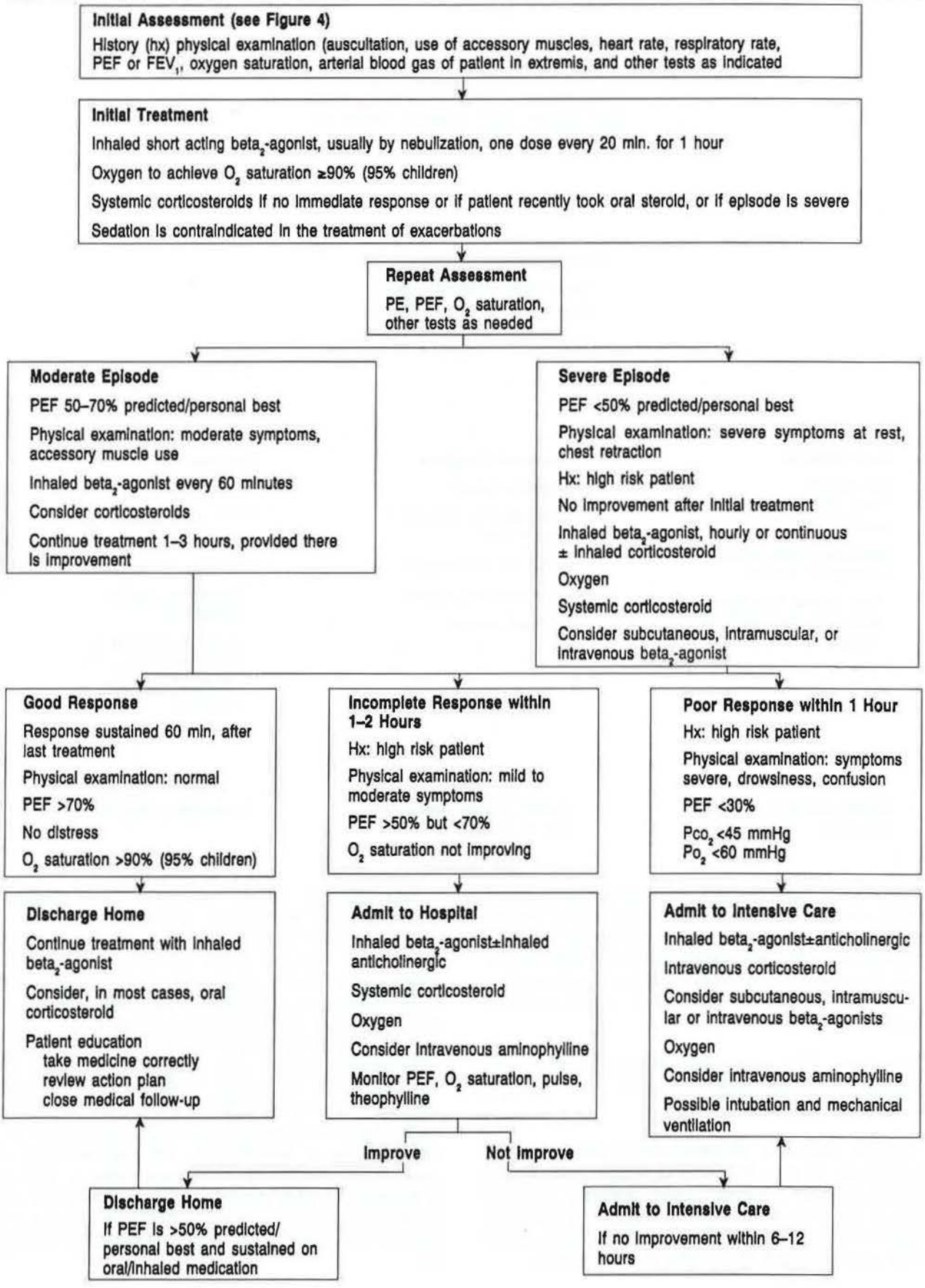
Because of their ventilation/perfusion abnormalities, infants become hypoxaemic earlier than adults. Oxygen saturation measurements should be performed on infants by pulse oximetry and should be greater than 95 percent. Arterial or arterialized blood gas measurement should be performed in infants with oxygen saturation less than 90 percent.

Treatment. The following treatments are usually administered concurrently to achieve the most rapid resolution of the exacerbation.

• **Oxygen.** should be administered (by nasal cannulae, or by mask, or by a head box or oxygen tent in some infants), to achieve arterial oxygen saturation of greater than or equal to 90 percent (95 percent in children). Supplemental oxygen should be administered to patients when arterial oxygen monitoring is not available.

• **Beta$_2$-agonists.** Inhaled beta$_2$-agonists are generally administered by nebulization. The beta$_2$-agonist may be nebulized with oxygen instead of air. The initial treatment is one dose every 20 minutes for 1 hour. Subsequently, hourly administration of beta$_2$-agonist or even continuous nebulization increases rapidity of bronchodilation in hospitalized children [4]. Some studies suggest that high doses of beta$_2$-agonist from a metered-dose inhaler with a spacer (4–8 puffs per treatment) may be equally effective [5]. Parenteral beta$_2$-agonists may be added if there is no response to high-dose or continuous nebulized medication [6]. Intramuscular or subcutaneous beta$_2$-agonists may be used. Administration by intravenous bolus or infusion is preferred in some countries, although metabolic and cardiovascular consequences have been reported [7]. Inhaled beta$_2$-agonists are clearly preferred for children [8].

Fig. 6. – Management of Exacerbation of Asthma: Hospital-Based Care



• **Epinephrine** by subcutaneous or intramuscular injection may be indicated for acute treatment of anaphylaxis, angio-oedema, or, rarely, for asthma with sudden severe exacerbations unrelieved by inhaled $beta_2$-agonist.

• **Additional bronchodilators.** Combination nebulized $beta_2$-agonist with anticholinergic (ipratropium bromide) may produce better bronchodilation than either drug alone [9] and may be administered before aminophylline is considered.

The role of theophylline/aminophylline in treating exacerbations remains controversial. Although it may provide no additive bronchodilator effect over adequate doses of $beta_2$-agonists [10–11] it may benefit respiratory drive or respiratory muscle function and prolong or sustain the response to $beta_2$-agonist between doses. Intravenous aminophylline is not recommended in the emergency department within the first 4 hours of treatment; however, it may have a role in the treatment of patients hospitalized with severe acute asthma [12]. Serum concentration should be monitored and the dose adjusted accordingly, with consideration given to factors influencing metabolism of theophylline.

• **Corticosteroids**. Systemic corticosteroids speed resolution of exacerbations refractory to bronchodilators [13]. Systemic corticosteroids administered by ingestion are usually as effective as those administered intravenously [14]. Intravenous administration is recommended if IV access is desirable or if there is possible impairment of gastrointestinal absorption [15]. Corticosteroids require at least 4 hours to produce clinical improvement. Initiate corticosteroids if:
– The exacerbation is moderate-severe (see Figure 4),
– The initial inhaled $beta_2$-agonist dose has failed to achieve improvement, or
– The exacerbation developed despite the regular use of oral corticosteroids,
– Previous exacerbations required oral corticosteroids.

• **Other treatments.**
– Antibiotics are not a direct part of treating exacerbations, but they are indicated for patients with fever and purulent sputum (due to polymorphs not eosinophils), which suggest bacterial infection, especially if bacterial sinusitis is suspected.
– Inhaled mucolytic drugs have not been shown to benefit treatment of exacerbations, and in severe exacerbations they may worsen cough or airflow obstruction.
– Sedation should be strictly avoided during exacerbations of asthma because of the respiratory depressant effect of anxiolytic and hypnotic drugs.
– Antihistamines have no established role in the treatment of exacerbations.
– Magnesium sulphate has not been established as an effective bronchodilator and is therefore not recommended.
– Chest physical therapy is not beneficial among patients with normal respiratory muscle strength and effective cough and may be unnecessarily stressful for the severely breathless patient.
– Hydration with large volumes of fluids does not play a role in the management of severe exacerbations in adults and older children.

• **Special considerations for children and infants.**
Rehydration may be necessary for infants and young children, who may become dehydrated as a result of increased respiratory rates and decreased oral intakes.

When treatments offer similar profiles for efficacy and safety, non-invasive procedures are preferred in order to avoid pain and anxiety. Thus, inhaled or oral $beta_2$-agonist and corticosteroid therapy is preferred over intravenous or subcutaneous therapy, and pulse oximetry is preferred over arterial blood gas measurements.

Criteria for admission to hospital. Factors favouring hospitalization include:
• Inadequate response to therapy within 1 to 2 hours of treatment
• Persisting severe airflow limitation (PEF_2 less than 40 percent of predicted or personal best)
• Past history of severe asthma, particularly if hospitalization was required
• Presence of high risk factors
• Prolonged symptoms before the current emergency department visit
• Inadequate access at home to medical care and medications
• Difficult home conditions
• Difficulty obtaining transport to hospital in event of further deterioration.

Criteria for admission to intensive care unit. Intensive care, generally in an intensive care unit with consultation of a critical care specialist experienced in treating asthma, is indicated if the patient has any of the following:
• A lack of response to initial therapy in the emergency department
• Presence of confusion, drowsiness, other signs of impending respiratory arrest or loss of consciousness
• Impending respiratory arrest: Hypoxaemia despite supplemental oxygen (Po_2 <60 mmHg) and/or Pco_2 greater than 45 mmHg (although respiratory failure may occur with either a high or a low Pco_2).

Intubation may be needed if there is continued deterioration in clinical features despite optimal therapy, the patient is exhausted, and/or if the Pco_2 is increasing. Intubation is extremely difficult and usually requires the expertise of a specialist.

Discharge from hospital-based care.
• *Discharge from emergency department.* Patients with a good response to emergency department therapy (*e.g.*, PEF returned to greater than or equal to 70 percent of predicted or personal best) require at least a 60 minute period of observation after the last dose of bronchodilator to ensure stability of response before discharge to home.

At discharge, the following actions are recommended:
– Identify and avoid the trigger factor that precipitated the exacerbation

– Instruct the patient to contact the patient's family clinician or specialist within 24 hours of discharge. Emphasize the need for continuous, regular care in an outpatient setting. A follow-up appointment with the patient's family physician or specialist should be made within a few days of discharge to assure that treatment is continued until best lung function is reached.

Further, the occurrence of a severe exacerbation indicates the need to review the regular, long term medication plan and modify it if necessary.
– Prescribe at minimum a 3- to 5-day treatment regimen for the patient to continue after discharge. In most cases, this will include a course of oral corticosteroids [16] and will include continuation of $beta_2$-agonist therapy on a gradually reduced dose, based on the patient's status.
– Review the patient's inhaler technique and use of peak flow meter to monitor therapy at home.
– Review and, if necessary, modify the patient's (and family's) action plan for managing exacerbations
. recognize signs that asthma is worsening
. start treatment
. reach medical care.

• **Discharge from hospital.** There are no absolute criteria for discharge from hospital; however, patients should be on discharge medications for at least 12 hours, preferably 24 hours, before leaving the hospital to assure that the patient's symptoms are controlled on the treatment they will take at home. Generally, the following criteria should be met when discharge doses of oral and inhaled medications have been reached:
– Short acting inhaled $beta_2$-agonist is needed no more frequently than every 4 hours.
– Patient is able to walk comfortably.
– Patient is not waking at night or in the early morning needing a bronchodilator.
– Clinical examination is normal or near-normal.
– PEF or FEV_1 is more than 70 to 80 percent of predicted or personal best after short acting inhaled $beta_2$-agonist, and PEF variability is reduced, ideally to less than 20 percent variability.
– Patient is able to use inhaler devices correctly.
– Patient's previous Action Plan is reviewed and modified if necessary.
– Patient understands (written) plan for discharge medications.
– Arrangements are made for follow-up medical care.

Following discharge from hospital, the patient should be reviewed by the patient's family physician or specialist regularly over the subsequent weeks, until best lung function is reached. Plans for longer term treatment, including adjustment of the overall treatment plan, should then be made.

Part 6. Provide regular follow-up care

Patients with asthma need regular supervision and support by a clinician who is knowledgeable about the condition. Continual monitoring is essential to assure that therapeutic goals are met.

• While the patient is achieving control of asthma, frequent follow-up visits are necessary to review home PEF and symptom records, the techniques in using medication, and environmental aggravators and efforts to control them.
• Consultation with an asthma specialist is recommended under certain circumstances when:
– The patient has had a life-threatening asthma exacerbation, has poor self-management ability, or has difficult family dynamics.
– Signs and symptoms are atypical or there are problems in differential diagnosis.
– Clinical entities complicate asthma (*e.g.*, sinusitis, nasal polyps, aspergillosis, severe rhinitis).
– Additional diagnostic testing is indicated (*e.g.*, skin testing, rhinoscopy, complete pulmonary function studies, provocative studies).
– The patient is not responding optimally to the asthma therapy.
– The patient requires Step 3 or 4 care (moderately severe to severe asthma) to control asthma.
– The patient requires guidance on environmental control, consideration of immunotherapy, smoking cessation, complications of therapy, or difficult compliance issues.
• Once control is established, regular follow-up visits (at 1 to 6 month intervals as appropriate) continue to be essential: Clinicians need to monitor and review the treatment plans, the medications, and the patient's management techniques (*e.g.*, for using medicines and peak flow meters, for controlling the environment), and the level of asthma control (PEF and symptom reports).

References

a) Medications

1. Newhouse MT, Dolovich MB. – Control of asthma by aerosols. *New Engl J Med*, 1986; 315: 870–874.
2. Newman SP, Moren F, Pavia D, Little F, Clarke SW. – Deposition of pressurized suspension aerosols inhaled through extension devices. *Am Rev Respir Dis*, 1981; 124: 317–320.
3. Prahl P, Jensen T. – Decreased adreno-cortical suppression utilizing the Nebuhaler for inhalation of steroid aerosols. *Clin Allergy*, 1987; 17: 393–398.
4. Farrer M, Frances AJ, Pearce SJ. – Morning serum cortisol concentrations after 2 mg inhaled beclomethasone dipropionate (BDP) in normal subjects: effect of a 750 ml spacing device. *Thorax*, 1990; 45: 740–742.
5. Fuglsang G, Pedersen S. – Comparison of Nebuhaler and nebulizer treatment of acute severe asthma in children. *Eur J Respir Dis*, 1986; 69: 109–113.
6. Warner I *et al.* – Asthma: a follow-up statement from an international pediatric asthma consensus group. *Arch Dis Childhood*, 1992; 67: 240–248.
7. Kerrebijn KF, Van Essen-Zandvliet EM, Neijens HJ. – Effect of long-term treatment with inhaled corticosteroids and beta-agonists on the bronchial responsiveness in children with asthma. *J Allergy Clin Immunol*, 1987; 79: 653–659.
8. Juniper EF, Kline PA, Vanzieleghem MA, Ramsdale EH, O'Bryme PM, Hargreave FE. – Effect of long-term treatment with an inhaled corticosteroid on airway hyperresponsiveness and clinical asthma in nonsteroid-dependent asthmatics. *Am Rev Respir Dis*, 1990; 142: 632–636.

9. Salmeron S, Guerin JC, Godard P *et al.* – High doses of inhaled corticosteroids in unstable chronic asthma. *Am Rev Respir Dis*, 1989; 140: 167–171.
10. Tobachnik E, Zadik Z. – Diurnal cortisol secretion during therapy with inhaled beclomethasone dipropionate in children with asthma. *J Pediatr, 1991;* 118: 294–297.
11. Capewell S, Reynolds S, Shuttleworth D, Edwards C, Finlay AY. – Purpura and dermal thinning associated with high dose inhaled corticosteroids. *Br Med J*, 1990; 300: 1548–1551.
12. Toogood JH. – Complications of topical steroid therapy for asthma. *Am Rev Respir Dis*, 1990; 141: S89–S96.
13. Lauter R, Rockoff JB, De Masi J, Boran-Ragotzy M, Middleton E. – Fatal varicella in a corticosteroid dependent asthmatic receiving trioleandomycin. *Allergy Proc*, 1990; 11: 83–87.
14. Altounyan REC. – Review of clinical activity and mode of action of sodium cromoglycate. *Clin Allergy*, 1980; Suppl 10: 481–489.
15. Leung KB, Flint KC, Brostoff J, Hudspith BN, Johnson NM, Lau HY, Liu WL, Pearce FL. – Effects of sodium cromoglycate and nedocromil sodium on histamine secretion from human lung mast cells. *Thorax*, 1988; 43: 756–761.
16. Kay AB, Walsh GM, Moqbel R, MacDonald AJ, Nagakura T, Carroll MP, Richerson HB. – Disodium cromoglycate inhibits activation of human inflammatory cells *in vitro*. *J Allergy Clin Immunol*, 1987; 80: 1–8.
17. Eigen H, Reid JJ, Dahl R, Del Bufalo C, Fasano L, Gunella G *et al.* – Evaluation of the addition of cromolyn sodium to bronchodilator maintenance therapy in the long-term management of asthma. *J Allergy Clin Immunol*, 1987; 80: 612–621.
18. Busse WW, Orr TSC, Pauwels R. – International symposium on nedocromil sodium. *Drugs*, 1989; 37: Suppl 1: 1–137.
19. Auty RM, Holgate ST. – Nedocromil sodium: a review of its anti-inflammatory properties and clinical activity in the treatment of asthma. *In*: Allergy and Asthma: New Trends and Approaches to Therapy. Kay AB (ed.), Academic Press, London, 1989; 177–188.
20. Thomson NC. – Nedocromil sodium: an overview. *Respir Med*, 1989; 83: 269–276.
21. Bel EH, Timmers MC, Hermans J, Dijkman JH, Sterk PJ. – The long-term effects of nedocromil sodium and beclomethasone dipropionate (BDP) diproprionate on bronchial responsiveness to methacholine in non-atopic asthmatic subjects. *Am Rev Respir Dis*, 1990; 141: 21–28.
22. Cherniak RM, Wasserman Sl, Ramsdell JW *et al.* – A double-blind multicentre group comparative study of the efficacy and safety of nedocromil sodium in the management of asthma. *Chest*, 1990; 97: 1299–1306.
23. Nelson HS. – Adrenergic therapy of bronchial asthma. *J Allergy Clin Immunol*, 1986; 77: 771–785.
24. Kerrebijn K. – Beta agonists. *In*: Kaliner MA, Barnes PJ, Persson CGA (Eds). Asthma. Its pathology and treatment. Marcel Dekker. New York 1990; Chapter 20.
25. Twentyman OP, Finnerty JP, Harris A, Palmer J, Holgate ST. – Protection against allergen-induced asthma by salmeterol. *Lancet*, 1990; 336: 1338–1342.
26. Wong BJO, Kamada DH, Ramsdale EH, O'Byrne P, Denburg JA, Dolovich J, Hargreave FE. – Effect of formoterol compared with beclomethasone and placebo on allergen induced airway responses. *Thorax*, 1991; 46: 770P.
27. Lawford P, Jones BJM, Milledge JS. – Comparison of intravenous and nebulized salbutamol in initial treatment of severe asthma. *Br Med J*, 1978; II: 84.
28. Sears MR, Taylor DR, Pruit CG, Lake DC, Li Q, Flannery EM, Yates DE, Lucas MK, Herbison GP. – Regular inhaled beta-agonist treatment in bronchial asthma. *Lancet*, 1990; 336: 1391–1396.
29. Van Schayck CP, Dompeling E, Van Herwaarden CLA. – Bronchodilator treatment in moderate asthma or chronic bronchitis: continuous or demand. A randomized control trial. *Br Med J*, 1991; 303: 1426–1431.
30. Fitzpatrick MF, Mackey T, Driver H, Douglas NJ. – Salmeterol in nocturnal asthma: a double blind, placebo controlled trial of long acting agonist. *Br Med J*, 1990; 301: 1365–1368.
31 . Pauwels RA. – New aspects of the therapeutic potential of theophylline in asthma. *J Allergy Clin Immunol*, 1989; 83: 548–553.
32. Weinberger M, Hendeles L. – Slow-release theophylline: rationale and basis for product selection. *N Engl J Med*, 1983; 308: 760–764.
33. Woodcock AA, Johnson MA, Geddes DM. – Theophylline prescribing, serum concentrations and toxicity. *Lancet*, 1983; ii: 610–612.
34. Gross NJ. – Ipratropium bromide. *N Engl J Med*, 1988; 319: 486–494.
35. Rebuck AS, Chapman KR, Aboud R, Pare PD, Kreisman H, Wolkove N, Vickerson F. – Nebulized anticholinergic with sympathomimetic: treatment of asthma and chronic obstructive airways disease in the emergency room. *Amer J Med*, 1987; 82: 59–64.
36. Tinkelman DG, Moss BA, Bukantz SC *et al.* – A multicentre trial of the prophylactic effect of ketotifen, theophylline and placebo in atopic asthma. *J Allergy Clin Immunol*, 1985; 76: 487-497.

b) stepwise approach

1. Barnes PJ. – A new approach to the treatment of asthma, *New Engl J Med*, 1989; 321: 1517–1527.
2. British Thoracic Society, Research Unit of Royal College of Physicians, Kings Fund Centre, National Asthma Campaign. Guidelines for management of asthma in adults. I: Chronic persistent asthma. *Br Med J*, 1990; 301: 651–653.
3. Hargreave FE, Dolovich J, Newhouse MT (Eds). – The assessment and treatment of asthma: A conference report. *J Allergy & Clin Immunol*, 1990; 85: 1098–1111.
4. Mayo PH, Richman J, Harris HW. – Results of a programmeme to reduce admissions for adult asthma. *Ann Intern Med*, 1990; 112: 864–871.
5. Reed CE. – Aerosol steroids as primary treatment of mild asthma. *New Engl J Med*, 1991; 325: 425–426.
6. Rees J. – Beta$_2$-agonists and asthma. *Brit Med J*, 1991; 302: 1166–1167.
7. National Asthma Education Programme, Expert Panel on the Management of Asthma, National Heart, Lung, and Blood Institute. Guidelines for the Diagnosis and Management of Asthma. *J Allergy & Clin Immunol*, 1991; 88: 425–534.
8. Warner JO, Götz M, Landau Ll, Milner AD, Pedersen S, Silverman M: Management of Asthma: a consensus statement. *Arch Dis Childhood*, 1989; 64: 1065–1079.
9. International Pediatric Consensus Group Asthma. – A follow-up statement from an international pediatric consensus group. *Archives of Dis in Childhood*, 1992; 67: 240–248.
10. Brunette MG, Lands L, Thibodau L-P. – Childhood asthma: prevention of attacks with short-term corticosteroid treatment of upper respiratory tract infection. *Paediatrics*, 1988; 81: 624–629.

c) Asthma management zone system

1. Lewis CE, Rachelefsky G, Lewis MA, de la Sota A, Kaplan M. – A randomized trial of A.C.T. (asthma care training for kids). *Paediatrics*, 1984; 74: 478–486.
2. Mendoza GR, Sander N, Scherrer A. – A User's Guide to Peak Flow Monitoring. Mothers of Asthmatics, Inc., 1988.
3. Plaut TF. – Children with Asthma: A Manual for Parents, Amherst, MA, Pedipress, 1988; 94–105.

d) Establishing plans

1. McFadden ER, Kiser R, De Groot WJ. – Acute bronchial asthma: Relations between clinical and physiological manifestations. *New Engl J Med*, 1973; 288: 221–225.
2. Henry RL, Milner AD, Davies, JG. – Simple drug delivery system for use by young asthmatics. *Brit Med J*, 1983; 286: 2021.
3. Mestitz H, Copland Janet M, McDonald Christine F. – Comparison of outpatient nebulized *vs* metered dose inhaler terbutaline in chronic airflow obstruction. *Chest*, 1989; 96: 1237–1240.
4. Robertson CF, Smith F, Beck R, Levison H. – Response to frequent low doses of nebulized salbuterol in acute asthma. *J Pediatr*, 1985; 106: 672.
5. Salzman GA, Steele MT, Pribble JP, Elenbaas RM, Pyszczynski DR. – Aerosolized metaproterenol in the treatment of asthmatics with severe airflow obstruction. Comparison of two delivery methods. *Chest*, 1989; 95: 1017–1020.
6. Williams S, Seaton A. – Intravenous or inhaled salbutemol in severe acute asthma. *Thorax*, 1977; 32: 555–528.
7. Ballester E, Reyes A, Rodriguez-Roisin R, Roca J, Guitart R, Wagner PD. – Ventilation-perfusion mismatching in acute severe asthma: effects of salbutamol and 100% oxygen. *Thorax*, 1989; 44: 258–267.
8. Becker AB, Nelson NA, Simons FE. – Inhaled salbutomol (albuterol) *vs* injected epinephrine in the treatment of acute asthma in children. *J Paediatrics*, 1983; 102: 465–469.
9. Rebuck AS, Chapman KR, Aboud R, Pare PD, Kreisman H, Wolkove N, Vickerson F. – Nebulized anticholinergic with sympathomimetic: treatment of asthma and chronic obstructive airways disease in the emergency room. *Amer J Med*, 1987; 82: 59–64.
10. Fanta CH, Rossing TH, McFadden ER. – Treatment of acute asthma: is combination therapy with sympathomimetics and methylxanthines indicated? *Am J Med*, 1986; 85: 5–10.
11. Siegel D, Sheppard D, Gelb A, Weinberg PF. – Aminophylline increases the toxicity but not the efficacy of an inhaled beta adrenergic agonist in the treatment of exacerbations of asthma. *Amer Rev Respir Dis*, 1985; 132: 283–386.
12. Kelly WH, Murphy S. – Should we stop using theophylline for the treatment of the hospitalized patient with status asthmaticus? DICP, *Annals of Pharmacotherapy*, 1990; 24: 409.
13. Haskell RJ, Wong BM, Hansen JE. – A double-blind randomized clinical trial of methylprednisolone in status asthmaticus. *Arch Intern Med*, 1983; 143: 1324–1327.
14. Ratto D, Alfaro C, Sipsey J *et al.* – Are intravenous corticosteroids required in status asthmaticus? *JAMA*, 1988; 260: 527–529.
15. Harrison BDW, Stokes TC, Hart GJ, Vaughan DA, Ali NJ, Robinson AA. – Need for intravenous hydrocortisone in addition to oral prednisolone in patients admitted to hospital with severe asthma without ventilatory failure. *Lancet*, 1986; 1: 181–184.
16. Chapman KR, Verbeek PR, White JG, Rebuck AS. – Effect of a short course of prednisone in the prevention of early relapse after the emergency room treatment of acute asthma. *N Engl J Med*, 1991; 324: 788–794.
17. Brunette MG, Lands L, Thibodau LP. – Childhood asthma: prevention of attacks with short-term corticosteroid treatment of upper respiratory tract infection. *Paediatrics*, 1988; 81: 624–629.

Special considerations

This chapter addresses special considerations in managing asthma in relation to pregnancy; surgery; physical activity; rhinitis, sinusitis, and nasal polyps; occupational asthma; respiratory infections; gastro-oesophageal reflux; aspirin-induced asthma; complicated asthma; and psychosocial factors.

Pregnancy

Although it cannot be predicted, retrospective studies suggest that during pregnancy in approximately one-third of women asthma becomes worse; in one-third asthma becomes less severe; and in the other one-third it remains unchanged. Although concern exists with the use of medications in pregnancy, poorly controlled asthma can have an adverse effect on the fetus, resulting in increased perinatal mortality, increased prematurity, and low birth weight. For this reason, using medications to obtain optimal control of asthma is justified even when their safety in pregnancy has not been unequivocally proven. For most drugs used to treat asthma and rhinitis, with the exception of alpha-adrenergic compounds, brompheniramine and epinephrine, there is little to suggest an increased risk to the fetus. Appropriately monitored theophylline, sodium cromoglycate, inhaled beclomethasone dipropionate (BDP), and inhaled beta$_2$-agonists are not associated with an increased incidence of fetal abnormalities. Acute exacerbations should be treated aggressively in order to avoid fetal hypoxia. Treatment should include nebulized beta-agonists and oxygen; systemic corticosteroids should be instituted when necessary. As in other situations, the focus of asthma treatment must remain on control of symptoms and maintenance of normal pulmonary function.

All patients require adequate opportunity to discuss the safety of their medication, but this is especially important for the expectant mother. Pregnant patients with asthma should be advised that the bigger risk to their baby lies with poorly controlled asthma and the safety of most modern asthma treatments should be stressed. Even with a good patient/physician relationship, independent printed material will provide important additional reassurance.

Surgery

Bronchial hyperresponsiveness, airflow obstruction, and mucus hypersecretion predispose asthma patients to intra-operative and postoperative respiratory complications. The likelihood of these complications depends upon many factors, including the severity of asthma at the time of surgery, the type of surgery (thoracic and upper abdominal pose the greatest risks), and the type of anaesthesia (general anaesthesia with endotracheal intubation carries the greatest risk). These variables need to be assessed prior to surgery by history, physical examination, and especially measurement of pulmonary function. If possible, this evaluation should be undertaken several days before the surgery to allow time for additional treatment. In particular, if FEV_1 values are less than 80 percent of the patient's personal best, a brief course of corticosteroids is required to reduce airflow obstruction. Furthermore, patients who have received systemic corticosteroids within the past 6 months should have systemic coverage during the surgical period (*i.e.*, 100 milligrams of hydrocortisone every 8 hours intravenously) and rapidly reduced within 24 hours following surgery. Prolonged steroid therapy may inhibit wound healing.

Physical activity

For a majority of asthma patients, physical activity is an important trigger of asthma exacerbations. For some patients, it is the only trigger. This condition, in which post-exertional airway obstruction resolves spontaneously within 30 to 45 minutes following physical activity, is referred to as exercise-induced asthma (EIA). Some forms of exercise, such as running, are more potent triggers. EIA may occur in any climatic condition, but it increases substantially in breathing dry cold air.

Exercise-induced asthma is one expression of airway hyperresponsiveness, not a special form of asthma. ELA often indicates that the patient's asthma is not properly controlled; therefore, appropriate anti-inflammatory therapy generally results in the disappearance of exercise-related symptoms. For those patients who still experience exercise-induced asthma despite appropriate therapy and for those in whom exercise-induced asthma is the only manifestation of asthma, the inhalation of beta$_2$-agonist before exercising is the most effective treatment for preventing asthma exacerbations. Many other compounds (cromolyn sodium, nedocromil, anticholinergic agents, theophylline, inhaled corticosteroids, and antihistamine-H_1-antagonist) have been demonstrated to modulate EIA. Training and sufficient warming up also reduce the incidence and severity of exercise-induced asthma.

Because the treatment of EIA is so effective, there is no need for patients to avoid physical activity. Instead, a goal of asthma management is to enable patients to participate in any activity they choose without experiencing symptoms. In addition, physical activity should be part of the therapeutic regimen of subjects with EIA. Physical training decreases the ventilation necessary to maintain a certain level of activity; because the severity of EIA depends on ventilation, a well-trained subject with EIA experiences post-exertional

symptoms only at a higher degree of physical activity than before training. Therefore, it is important to recommend that sports and physical activity not be avoided in asthma patients with EIA.

Rhinitis, sinusitis, and nasal polyps

Upper airway diseases can influence lower airway function in some asthma patients. For example, patients with active allergic rhinitis and sinusitis can have increased asthma symptoms. Although the mechanisms associated with these relationships have yet to be established, the clinical association should be considered in the treatment of asthma.

Allergic rhinitis. During periods of active allergic rhinitis, some patients experience increased bronchial reactivity and even clinical asthma. In one study, treatment of allergic rhinitis with topical corticosteroids diminished the intensity of concomitant asthma symptoms [1]. Whether similar control is achieved with antihistamines (H_1- antagonist) or nasal cromoglycate is not established.

Sinusitis. Sinusitis is a complication of upper respiratory infections, allergic rhinitis, nasal polyps, and other forms of nasal obstruction. Both acute and chronic sinusitis can provoke asthma; furthermore, some investigators feel that persistent sinusitis is a major factor in chronic, unremitting asthma. Further studies are needed to confirm these suspicions. Diagnosis of sinusitis requires either x-ray or CAT scan confirmation; clinical findings of sinusitis are often too subtle to make the diagnosis.

Antibiotic therapy of sinusitis has been associated with a reduction in asthma severity. Such therapy is more likely to be effective if antibiotics are given for at least 3 weeks. Treatment should also include medications (topical nasal decongestants or topical nasal corticosteroids) to reduce nasal congestion. However important these treatments are, they remain adjunct to primary asthma therapy.

Nasal polyps. Nasal polyps associated with asthma and rhinitis, and often with aspirin sensitivity [7] are seen primarily in patients who are over 40 years old and are more prevalent in patients who have negative skin tests. Children with nasal polyps should be assessed for cystic fibrosis and immotile cilia syndrome. Nasal polyps are remarkably responsive to corticosteroids. Patients who have chronic nasal obstruction that persists in spite of treatment may benefit from surgery.

Occupational asthma. Occupational asthma is defined as asthma caused by exposure to an agent in the work environment. This may either cause a deterioration of pre-existing asthma, or it may induce asthma *de novo.* Sensitization may occur after a latent interval from months to years after exposure [1]. Figure 7 lists common agents known to cause occupational asthma.

The detection of asthma of occupational origin requires a systematic inquiry about the patient's occupation as part of the clinical history. Occupational asthma is suggested by symptoms of asthma during or shortly after exposure to certain fumes, gases, or dusts (usually); or by periodicity of symptoms, with improvements during days away from work. A decline in PEF may be delayed – it may occur hours, or even a few days, after leaving the worksite [2]. Confirmation of occupational asthma should ideally be made with objective measurements such as PEF monitoring at home and at work or, in some cases, with supervised inhalation challenge [2].

Once the diagnosis is established, complete avoidance of exposure is mandatory to permit remission of asthma [1, 2]. However, once well established, occupational asthma may not be completely reversible [3]. Continued exposure may cause greater sensitization to minute concentrations of the sensitizer(s), increasingly severe and potentially fatal [4] asthma attacks with less chance of subsequent remission, and, ultimately, permanently impaired lung function [5].

Pharmacological therapy is identical to other forms of asthma, but it is not a substitute for adequate avoidance. Consultation with a specialist in asthma management or occupational medicine is advised.

Pre-existing asthma or atopy as well as tobacco smoking may predispose some workers to higher risk in specific occupations, but screening measures are believed to be of limited value in most industries [1]. Prevention of sensitization by adequate occupational hygiene measures is most important. Advice may be given to atopic patients to avoid certain occupations.

Respiratory infections. Respiratory infections have an important relationship to asthma and provoke wheezing in many patients. Epidemiological studies have found that respiratory viruses, possibly chlamydia, but seldom bacteria, are the infectious microorganisms associated with increased asthma. In particular, respiratory syncytial virus, para-influenza, rhinovirus and influenza are the most frequently identified viruses associated with increased wheezing. [1, 2]. A number of mechanisms have been identified to explain wheezing and increased bronchial reactivity with respiratory infections including damage to airway epithelium, stimulation of virus-specific IgE antibody, enhanced mediator release and the appearance of a late asthmatic response to inhaled antigen [3]. Thus, there is evidence that viral infections are an "adjuvant" to the inflammatory response and promote the development of airway injury by enhancing bronchial inflammation [4]. Treatment of an infectious exacerbation follows the same principles as in other asthma exacerbations - that is, inhaled $beta_2$-agonist and the early introduction of corticosteroids are recommended. Because increased asthma symptoms can often last for weeks beyond the infection, anti-inflammatory treatment should be continued for weeks to ensure adequate control. Furthermore, there is evidence that influenza immunization diminishes the likelihood for this infection to provoke asthma [5].

Figure 7. – Agents Causing Asthma in Selected Occupations

Occupation or Occupational Field	Agent
laboratory animal workers, veterinarians	dander and urine proteins
food processing	shellfish, egg proteins, pancreatic enzymes, papain, amylase
dairy farmers	storage mites
poultry farmers	poultry mites, droppings and feathers
granary workers	storage mites, aspergillus, indoor ragweed, and grass pollen
research workers	locusts
fish food manufacturing	midges
detergent manufacturing	*Bacillus subtilis* enzymes
silk workers	silk-worm moths and larvas
	Plant Proteins:
bakers	flour, amylase
food processing	coffee bean dust, meat tenderizer (papain), tea
farmers	soy bean dust
shipping workers	grain dust (molds, insects, grain)
laxative manufacturing	ispaghula, psyllium
sawmill workers, carpenters	wood dust (western red cedar, oak, mahogany, zebrawood, redwood, Lebanon cedar, African maple, eastern white cedar)
electric soldering	colophony (pine resin)
cotton textile workers	cotton dust
nurses	psyllium, latex
	Inorganic Chemicals:
refinery workers	platinum salts, vanadium
plating	nickel salts
diamond polishing	cobalt salts
manufacturing	aluminium fluoride
beauty shop	persulfate
welding	stainless steel fumes chromium salts
	Organic Chemicals:
manufacturing	antibiotics, piperazine, methyl dopa, salbutamol, cimetidine
hospital workers	disinfectants (sulfathiazole, chloramine, formaldehyde, glutaraldehyde)
anesthesiology	enflurane
poultry workers	aprolium
fur dyeing	paraphenylene diamine
rubber processing	formaldehyde, ethylene diamine, phthalic anhydride
plastics industry	toluene diisocyanate, hexamethyl diisocyanate, dephenylmethyl isocyanate, phthalic anhydride, triethylene tetramines, trimellitic anhydride, hexamethyl tetramine
automobile painting	dimethyl ethanolamine diisocyanates
foundry worker	reaction product of furan binder

Gastro-oesophageal reflux

The relationship of increased asthma symptoms, particularly at night, to gastro-oesophageal reflux remains an issue of debate, although this condition is nearly three times as prevalent in all patients with asthma. Most of these patients also have an hiatal hernia; furthermore, the use of xanthines may increase the likelihood of symptoms by relaxing the lower oesophageal ring. Diagnosis can best be made be simultaneously monitoring oesophageal pH and pulmonary functions. Medical management is often effective and includes eating smaller, more frequent meals; avoiding food or drink between meals and especially at bedtime; avoiding fatty meals, alcohol, theophylline and oral $beta_2$-agonists; using H-2 antagonists; using drugs that increase lower oesophageal pressure; and elevating the head of the bed. Surgery is reserved for the severely symptomatic patient with well-documented oesophagitis and failure of medical management; it is not successful for everyone. It should be demonstrated that the reflux causes asthma symptoms before surgery is advised for asthma patients.

Aspirin-induced asthma

In about 4–28 percent of adults with asthma, but rarely in children with asthma, aspirin and other nonsteroidal anti-inflammatory drugs (NSAID) precipitate asthma exacerbations. The variability depends on the diagnostic criteria [1]. The course of the disease and its clinical picture are very characteristic. The majority of patients first experience symptoms during the third to fourth decade of life. The typical patient experiences intense vasomotor rhinitis characterized by intermittent and profuse rhinorrhoea. Over a period of months, chronic nasal congestion occurs, and physical examination often reveals nasal polyps. Bronchial asthma and intolerance to aspirin develop during subsequent stages of the illness. In these individuals, asthma runs a protracted course. The intolerance presents itself as a unique picture: Within an hour following ingestion of aspirin, an acute asthma exacerbation develops, often accompanied by rhinorrhoea, conjunctival irritation, and scarlet flush of the head and neck. These reactions are dangerous; indeed, a single therapeutic dose of aspirin or other anticyclooxygenase agent can provoke violent bronchospasm, shock, loss of consciousness, and respiratory arrest [2, 3].

Tolerance to different nonsteroidal anti-inflammatory, medications is noted in Figure 9. Not all of the offending drugs produce adverse reactions with the same frequency. This depends on a drug's anticyclooxygenase potency and dosage as well as on the individual sensitivity of the patient [4]. Although a patient's clinical history may raise suspicion of aspirin-induced asthma (AIA), the diagnosis can be established with certainty only by aspirin challenge, conducted only where facilities for pulmonary resuscitation exist. There are no *in vitro* tests suitable for routine clinical diagnosis. If necessary for the diagnosis of AIA, patients are challenged when their asthma is in remission and their FEV_1 is greater than 70 percent of personal or predicted best. Oral challenge tests are most commonly performed. All challenges are carried out in the morning with a highly trained experienced physician present and emergency treatment available. The reaction is considered positive if at least a 15 percent decrease in FEV_1 or PEF occurs, accompanied by symptoms of bronchial obstruction and irritation of nose or eyes. In the absence of these clinical findings, the reaction is considered positive only if a fall in FEV_1 or PEF greater than 20 percent occurs.

Once aspirin or NSAID intolerance develops, it is present for life. Patients with aspirin-induced asthma should avoid aspirin, all products containing it, other analgesics that inhibit cyclooxygenase and hydrocortisone hemisuccinate [5]. For NSAID sensitive asthma patients who require NSAID for other medical conditions, a desensitization may be conducted in the hospital under the care of a specialist [6].

Psychosocial factors

Asthma, as other chronic diseases, may be affected by the psychosocial problems of patient and family and may produce psychological reactions itself. Several recent studies suggest that depression may increase the risk of mortality in asthma, particularly in children [1–4]. Mortality from asthma has also been associated with alcohol abuse, schizophrenia, recent unemployment, and recent family loss or disruption [4]. Clinicians should be alert to these risk factors, give patients an opportunity to discuss these problems, and obtain referrals for psychological counselling where needed. Clinicians should also recognize that patients without significant psychosocial dysfunction may nevertheless experience significant stress in living with asthma, including panic during asthma exacerbations, low self-esteem, social stigmatization, tension in family relationships, and difficulty accepting asthma [5]. By identifying and discussing these problems, clinicians can help patients adjust to living with asthma, improve adherence, and identify problems that require referrals for education or counselling.

Figure 8. – Tolerance of Nonsteroidal Anti-Inflammatory Drugs in Aspirin-Induced Asthma

Precipitate Asthma Exacerbations	Well tolerated (cause no bronchoconstriction)
Salicylates	Sodium salicylate
Aspirin	Choline salicylate
Diflunisal	Choline magnesium trisalicylate
Salesate (salicylsalicylic acid)	Salicylamide
Polycyclic acids	Dextropropoxyphene
Acetic acids	Azapropazone
Indomethacin	Benzydamine
Suliudac	Chloroquine
Tolmetin	Paracetamol*
Aryl aliphatic acids	
Naproxen	
Diclofanac	
Fenoprofen	
Ibuprofen	
Ketoprofen	
Tiaprofenic acid, Fluribrofen	
Enolic acids	
Piroxicam	
Fenamates	
Mefenamic acid	
Flufenamic acid	
Cyclofenamic acid	
Pyrazolones	
Aminopyrine	
Noramidopyrine	
Sulfinpyrazone	
Phenylbutazone	

* When beginning therapy, give half a tablet of paracetamol and observe patients 2 to 3 hours for symptoms that occur in no more than 5 percent of patients.

References

Pregnancy

1. Schatz M, Zeiger RS, Hardin KM, *et al.* – The safety of inhaled beta-agonist bronchodilators during pregnancy. *J Allergy Clin Immunol*, 1988; 82: 686–695.
2. Schatz M, Harden KM, Forsythe A, *et al.* – The course of asthma during pregnancy, post partum, and with successive pregnancies: a prospective analysis. *J Allergy Clin Immunol*, 1988; 81: 509–517.

Surgery

1. Fung DL. – Emergency anaesthesia for asthma patients. *Clin Rev Allergy*, 1985; 3: 127.
2. Kingston HG, Hirshman CA. – Perioperative management of the patient with asthma. *Anesth Analg*, 1984; 63: 844–855.
3. Oh SH, Patterson R. – Surgery in corticosteroid-dependent asthmatics. *J Allergy Clin Immunol*, 1974; 53: 345.

Physical activity

1. Reiff DB, Choudry NB, Pride PW, Ind PW. – The effect of prolonged submaximal warm-up exercise on exercise-induced asthma. *Am Rev Respir Dis*, 1989; 139: 479–484.
2. Schnall RP, Landau L. – Protective effects of repeated short sprints in exercise-induced asthma. *Thorax*, 1980; 35: 828–832.

Rhinitis, sinusitis, and nasal polyps

1. Welsh PW, Strickler WE, Chi C-P, Naessens JM, Reese ME, Reed CE, Marcoux JP. – Efficacy of beclomethasone dipropionate (BDP) nasal solution, flunisolide, and cromolyn in relieving symptoms of ragweed allergy. *Mayo Clin Proc*, 1987; 62: 125–134.
2. Ramsdale EH, Morris MM, Roberts RS, Hargreave FE. – Asymptomatic bronchial hyperresponsiveness in rhinitis. *J Allergy Clin Immunol*, 1985; 75: 573–577.
3. Crimi E, Voltolini S, Gianiorio P, Orengo G, Troise C, Brusasco V, Crimi P, Negrini AC. – Effect of seasonal exposure to pollen on specific bronchial sensitivity in allergic patients. *J Allergy Clin Immunol*, 1990; 85: 1014–1019.
4. Madoniini E, Briatico-Vangosa G, Pappacoda A, Maccagni G, Cardani A, Saporiti F. – Seasonal increase of bronchial reactivity in allergic rhinitis. *J Allergy Clin Immunol*, 1987; 79: 358–363.
5. Slavin RG, Cannon RF, Friedman WH, Palitang E, Sundaram M. – Sinusitis and bronchial asthma. *J Allergy Clin Immunol*, 1980; 66: 250–257.
6. Rachelefsky GS, Katz RM, Siegel SC. – Chronic sinus disease associated with reactive airway disease in children. *Pediatr*, 1984; 73: 526–529.
7. Stevenson DD, Simon RA. – Aspirin sensitivity: respiratory and cutaneous manifestations. *In*: Middleton E, Reed C, Ellis EF, *et al.*, eds: Allergy principles and practice, ed. 3, St. Louis: The CV Mosby Co., 1988.

Occupational asthma

1. Chan-Yeung M, Lam S. – State of the art: occupational asthma. *Am Rev Respir Dis*, 1986; 133: 686–703.
2. Mapp CE, Chiesura-Corona P, De Marzo N, Fabbri LM. – Persistent asthma due to isocyanates. *Am Rev Respir Dis*, 1988; 137: 1326–1329.
3. Bernstein DI (Ed). – Guidelines for the diagnosis and evaluation of occupational lung diseases. *J Allergy Clin Immunol*, 1989; 84: 820–822.
4. Fabbri LM, Danieli D, Crescioli S *et al.* – Fatal asthma in a subject sensitized to toluene diisocyanate. *Am Rev Respir Dis*, 1988; 137: 1494–1498.
5. Malo JL. – Compensation of occupational asthma in Quebec. *Chest*, 1990; 98 (Suppl): 236s–239s.

Respiratory infections

1. Martinez FD, Morgan WJ, Wright AL, Holberg CJ, Taussig LM. – Diminished lung function as a predisposing factor for wheezing respiratory illnesses in infants. *N Engl J Med*,1988; 319: 1112–1117.
2. Lemanske RF Jr., Dick EC, Swenson CA, Vrtis RF, Busse WW. – Rhinovirus upper respiratory infection increases airway reactivity in late asthmatic reactions. *J Clin Invest*, 1989; 83: 1–10.
3. Weiss ST, Tager IB, Munoz A, Speizer FE. – The relationship of respiratory infections in early childhood to the occurrence of increased levels of bronchial responsiveness and atopy. *Am Rev Respir Dis*, 1985; 131: 573–578.
4. Busse WW. – Respiratory infections: their role in airway responsiveness and the pathogenesis of asthma. *J Allergy Clin Immunol*, 1990; 85: 671–688.
5. Bell TD, Chai H, Berlow B, Daniels G. – Immunization with killed influenza virus in children with chronic asthma. *Chest*, 1978; 73: 187–192.

Gastro-oesophageal reflux

1. Nelson HS. – Worsening asthma: is reflux oesophagitis to blame? *J Respir Dis*, 1990; 11: 827–844.
2. Barish CF, Wu SC, Cartell DO. – Respiratory complications of gastro-oesophageal reflux. *Arch Intern Med*, 1985; 145: 1882–1888.

Aspirin-induced asthma

1. Slepian IK, Mathews KP, McLean JA. – Aspirin-sensitive asthma. *Chest*, 1985; 87: 386–391.
2. Stevenson DD. – Diagnosis, prevention, and treatment of adverse reactions to aspirin and nonsteroidal anti-inflammatory drugs. *J Allergy Clin Immunol*, 1984; 76: 617–622.
3. Szczeklik A, Virchow C, Schmitz-Schumann M. – Pathophysiology and pharmacology of aspirin-induced asthma. *In*: Page CP, Barnes PJ, (eds): Handbook of Experimental Pharmacology, Pharmacology of Asthma, vol 98. Berlin, Springer Verlag, 1991; pp. 291–314.
4. Szczeklik A. – The cyclooxygenase theory of aspirin-induced asthma. *Eur Respir J*, 1990; 3: 588–593.
5. Szczeklik A, Nizankowska E, Czemiawska-Mysik G, Sek S. – Hydrocortisone and airflow impairment in aspirin-induced asthma. *J Allergy Clin Immunol*, 1985; 76: 530–536.
6. Pleskow WW, Stevenson DD, Mathison DA, Simon RA, Schatz M, Zeiger RS. – Aspirin desensitization in aspirin-sensitive asthmatic patients: clinical manifestations and characterization of the refractory period. *J Allergy Clin Immunol*, 1982; 69: 11–19.

Psychosocial factors

1. Miller BD. – Depression and asthma: a potentially lethal mixture. *J Allergy Clin Immunol*, 1987; 80(3): 481–486.
2. Struck RC. – Identification of the fatality-prone subjects with asthma. *J Allergy Clin Immunol*, 1989; 83: 477–485.
3. Fritz GK, Rubinstein S, Lewiston NJ. – Psychological factors in fatal childhood asthma. *Am J Orthopsychiatry*, 1987; 57(2): 253–257.
4. Rea HH, Scragg R, Jackson R, Beaglehole E, Fenwick J, Southerland D. – A case-controlled study of deaths from asthma. *Thorax*, 1986; 41: 833–839.
5. Clark NM, Feldman CH, Freudenberg N, Millman EJ, Wasilewski Y, Valle I. – Developing education for children with asthma through study of self-management behaviour. *Health Education Quarterly*, 1980; 7: 278–296.

Directions for research

In developing this consensus statement on what constitutes an effective general approach to asthma therapy, the project participants discussed differences in opinions about specific treatment modalities. These differences reflect areas requiring scientific investigation to improve our understanding of asthma and its treatment. The following areas were highlighted:

• Although inflammation is a critical feature of asthma, direct measures of inflammation are difficult to accomplish. The link between PEF measurement and inflammation and the link between inflammation and hyperresponsiveness need more rigorous assessment and definition.

• The recommended zones for therapy reflect expert opinion about what PEF ranges are appropriate. Sufficient data are lacking to establish precise zones for therapy. Studies are needed to identify more specifically what levels of PEF measures and PEF variability are required to achieve therapeutic objectives. Further, it will be useful to investigate if achieving maximal lung function is requisite for accomplishing the other goals of therapy.

• Recent studies have suggested that the chronic, regularly scheduled administration of short acting inhaled $beta_2$-agonists may be deleterious. Further studies will be important to clarify the role of short acting inhaled

beta$_2$-agonist in regularly scheduled versus as needed asthma therapy.
• The role of ipratropium bromide and other anticholinergic agents, theophylline, and the new, long acting inhaled beta$_2$-agonists in the chronic care of asthma require further investigation relative to their efficacy and long-term adverse effects.
• Comparative studies are recommended that will evaluate both the effectiveness in achieving control of asthma and the long-term adverse effects for inhaled beta$_2$-agonists; inhaled corticosteroids, and sodium cromoglycate or nedocromil in children and adults. Parameters for assessing efficacy might include clinical, quality of life, and physiological assessments as well as biopsy and bronchial lavage.
• There is considerable debate over appropriate dosages for inhaled corticosteroids. Studies are needed to identify dose ranges (high, medium, and low doses) that define appropriate ranges for long-term administration and to evaluate long-term adverse effects. More data are needed on the possible long term adverse effects of higher doses of regularly scheduled inhaled corticosteroids, especially in children.
• Investigations evaluating if anti-inflammatory treatment of mild asthma can modify the course of the disease will also be important.
• The use of immunotherapy continues to be an area of controversy. Further studies of the effectiveness and relative safety of specific immunotherapy treatment and newer forms of immunomodulation, particularly newer epitopes, are required.

The project participants also expressed the need to evaluate the efficacy of the International Asthma Project's recommended six-part asthma management programme in accomplishing the stated goals of therapy, using the goals as outcome measures. This evaluation should include assessment of the epidemiologic and socioeconomic impact of the varying treatment recommendations. Such investigation is necessary to confirm the scientific opinions represented in the recommendations and will provide a clearer understanding about how to improve the quality of life for asthma patients.

Resources

Guidelines for asthma management developed by members of the International Project.

Australia and New Zealand

– "The Asthma Management Plan." 1st Edition 1990.
– "The Pediatric Asthma Management Plan." 1st Edition 1991. To be used in conjunction with "The Asthma Management Plan." (Woolcock AJ, Rubinfeld AR, Seale JP, *et al*: Asthma Management Plan, 1989. *Med J Austr*, 1989; 151: 650–653).
– "The Pharmacists' Asthma Management Plan." 1st Edition 1991.
– Patient Action Plan Cards-to be completed by doctor.
Available from:

National Asthma Campaign
5th Floor, 615 St. Kilda Rd, Melbourne, Victoria 3004, Australia
Tel (03) 521–1983
Fax (03) 521–1284
or
Thoracic Society of Australia & New Zealand, 145 Macquarie St. Sydney, NSW, 2000, Australia
Tel (02) 255–5457

Canada

Hargreave FE, Dolovich J, Newhouse MT (Eds). – The assessment and treatment of asthma: a conference report. *J Allergy Clin Immunol*, 1990; 85: 1098–1111.

United Kingdom

British Thoracic Society, Research Unit of the Royal College of Physicians of London, King's Fund Centre, National Asthma Campaign. "Guidelines for Management of Asthma I-Chronic Persistent Asthma and II-Acute Severe Asthma". *British Medical Journal*, 1990; 301: 651–653, also available from:

British Thoracic Society
1 St Andrews Place
London NW1 4LB

Warner JO, Götz M, Landau LI, Levison H, Milner AO, Petersen S, Silverman. – "Management of Asthma: A Consensus Statement." *Arch Dis Childhood,* 1989; 64: 1065–1079

International Pediatric Consensus Group. "Asthma: A Follow-up Statement from an International Consensus Group." *Arch Dis Childhood*, 1992; 67: 240–248.

Patient Action Cards are available from:
The National Asthma Campaign
Providence House, Providence Place
London N1 0NT

United States

National Heart, Lung, and Blood Institute. "National Asthma Education Programme Expert Panel Report: Guidelines for the Diagnosis and Management of Asthma".
Available from:

National Heart, Lung, and Blood Institute Information Centre
7200 Wisconsin Avenue, Box 329
Bethesda, MD 20814–4820.

Appendix

YOUR ASTHMA ACTION PLAN

Name: _____

Address _____

_____

Phone _____ Date of Birth: _____

Doctor: _____ Phone: _____

Hospital: _____ Ambulance: _____

Fold backwards . . . . . .

Usual medication: _____

_____

_____

_____ Best PEF _____ L/min.

THIS ACTION PLAN WILL TELL YOU:

- How to recognise worsening asthma.
- How to act promptly to prevent it getting worse.
- What to do in an emergency.

Fold forwards . . . . . .

Asthma attacks usually develop slowly, but they can start suddenly.

These are the signs of worsening asthma:

- Increasing cough, chest tightness, wheeze, or trouble breathing (especially at night).
- Needing asthma medications more often; or medications not helping as they usually do.
- Peak Flow measurements below your best, despite increased asthma medications.

National Asthma Campaign

IF YOUR ASTHMA IS WORSENING

If your Peak Flow is below your best but over you should then use:

1: _____

every _____

2: _____

every _____

3: _____

every _____

and see your doctor today.

If your asthma keeps worsening, get medical help urgently.

IF YOU HAVE A SEVERE ATTACK

These signs indicate that an attack is potentially dangerous:

- If you are frightened.
- If you have had a severe attack before.
- If this attack has started suddenly.
- If you are short of breath while resting or speaking a few words.
- If your Peak Flow reading is less than _____ even after extra doses of medication.

YOU SHOULD ACT IMMEDIATELY

1 _____

2 _____

3 _____

Call an ambulance. Say "Severe Asthma Attack".

Give your address or location.

Use _____

until the ambulance arrives.

National Asthma Campaign

Developed by The Australian National Asthma Campaign, 5th Floor, 615 St. Kilda Road, Melbourne, Victoria 3004, Australia

TREATMENT OF A SEVERE ATTACK

Suggestions for emergency doctor:

1. Give salbutamol/terbutaline either via nebuliser 2.5–5mg or via larger spacer 8–16 puffs.
2. Give 40mg oral prednisolone if not already taken.
3. Give oxygen if available.
4. Step 1 may need repeating.
5. Injected therapy is sometimes necessary.
   - preferably slow s/c, i/m or i/v injection of:

     terbutaline) or) salbutamol) 0.25–0.5mg (0.5–1ml)

     or rarely aminophylline 250mg over at least 5 min.i/v (not s/c; not if on oral xanthines)

   - 200mg hydrocortisone hemisuccinate i/v

5

CARD CHECKED:

Date	Initials	Date	Initials

Produced by:
NATIONAL ASTHMA CAMPAIGN
Combined Charities of the
Asthma Research Council and Asthma Society
300 Upper Street, London N1 2XX
Tel: 01 (071 from May 1990) 226 2260

6

ADULT'S ASTHMA CARD

Patient's Name _____
Address _____
_____
_____
Tel.No. _____
General Practitioner _____
Address: _____
_____
_____
Tel.No.: _____
Consultant _____
Hospital: _____
Hospital Reference No.: _____
Tel.No.: _____

Always carry this card with you.

1

TREATMENT TO BE TAKEN REGULARLY

Treatment:	Dose: (No.of puffs or tablets)	No. of doses daily:

Don't forget your regular treatment

2

RELIEF TREATMENT IF YOUR ASTHMA GETS WORSE

For sudden chest tightness wheeze or breathlessness take:- _____

- If that fails take _____
- If that fails follow instructions for bad attack.

For gradual deterioration, night time wakening, a cold which goes on to the chest or morning peak flow regularly below _____ L/min.

- Start you steroid inhaled (_____)*
- OR increase its dose to (_____)*
- OR start a course of steroids (_____)* with _____ mg. (_____ tablets) daily AND see your doctor.

***Doctor to complete/delete as appropriate**

3

BAD ATTACK

What to look for

- Very tight chest, great difficult breathing.
- Too wheezy to walk or talk properly.
- No response to relief treatment or effect doesn't last
- Peak flow under _____ and little or no improvement after relief treatment.

What to do:-

- Repeat relief treatment.
- AND take ____ mg. (____ tabs.) prednisolone

AT THE SAME TIME

- Call your GP.
- Or dial 999.
- Or go to nearest hospital.

Take this card with you whenever you see your doctor.

4

Produced by: National Asthma Campaign, Combined Charities of the Asthma Research Council and Asthma Society, 300 Upper Street, London N1 2XX.

ASTHMA CONTROL PLAN FOR _____
(name of patient)

PREPARED BY _____ ,M.D.

This plan will help you control your asthma and do the right thing if you have an asthma episode. Keeping your asthma under control will help you:

- Be active without having asthma symptoms. This includes being active in exercise or sports.
- Sleep through the night without having asthma symptoms.
- Prevent asthma episodes (attacks).
- Have the best possible peak flow rate.
- Avoid side effects from medicines.

Here are three ways to control your asthma:

■ Follow your medicine plan (see the next page).
-Following your Green Zone plan every day to keep most asthma symptoms from starting.
-Recognize your symptoms of an asthma episode. Act quickly to stop them.
-Follow the Yellow Zone plan to stop asthma symptoms and to keep an asthma episode from getting serious.
-Follow the Red Zone plan to take care of a serious episode. This is an emergency plan!

■ Whenever possible, stay away from things that bring on your asthma symptoms. Follow you asthma trigger control plan to reduce the number of things in your home, workplace, or classroom that bother your asthma.

■ See your doctor regularly. Review this plan with your doctor when you visit him/her. Your doctor will write on the plan what you should do.

Your plan has these medicines:

_____

_____

_____

_____

_____

_____

Important Information:

Doctor _____ **Hospital** _____

Telephone _____ Telephone _____

Address _____ Address _____

_____ _____

Ambulance or Emergency Rescue Squad _____ **Friend to Call** _____

Telephone _____ Telephone _____

Taxi _____

For more Information on Asthma:
National Asthma Education Program
Information Center
P.O. Box 30105
Bethesda, MD 20824–0105
(301) 951–3260

Adapted from National Asthma Education Program "Clinician's Guide: Teaching Your Patients About Asthma," National Heart, Lung, and Blood Institutes of Health, United States.

ASTHMA CONTROL PLAN FOR _____
(name of patient)

PREPARED BY _____ ,M.D.

Green Zone: All Clear
This is where you should be every day.
Peak flow between _____ (80–100% of personal best)*

No symptoms of an asthma episode. You are able to do your usual activities and sleep without having symptoms.

The doctor will check which applies to you.

☐ Take these medicines.

Medicine	*How much to take*	*When to take it*

☐ Follow your asthma trigger control plan to avoid things that bring on your asthma.
☐ Take _____ (medicine) before exercise.

Yellow Zone: Caution

This is not where you should be every day. Take action to get your asthma under control.

Peak flow between _____ (50–80% of personal best)*

You may be coughing, wheezing, feel short of breath, or feel like your chest is tight. These symptoms may keep you from your usual activities or keep you from sleeping

☐ ***First,*** take this medicine:

Medicine	*How much to take*	*When to take it*

☐ ***Next,*** if you feel better in 20 to 60 minutes and peak flow is over _____ (70% of personal best) then:
☐ Take this medicine

Medicine	*How much to take*	*When to take it*

☐ Keep taking your green zone medicine(s).
☐ ***But,*** if you DO NOT feel better in 20–60 minutes or your peak flow is under _____ (70% of personal best), **follow the Red Zone Plan.**

Let the doctor know if you keep going into the Yellow Zone. Your Green Zone medicine may need to be changed to keep other episodes from starting.

Red Zone: Medical Alert
This is an emergency! Get help.
Peak flow under _____ (50% of personal best)*

You may be coughing, very short of breath, and/or the skin between your ribs and your neck may be pulled in tight. You may have trouble walking or talking. You may not be wheezing because not enough air can move out of your airways.

☐ ***First,*** take this medicine:

Medicine	*How much to take*	*When take it*

☐ ***Next,*** **call the doctor** to talk about what you should do next.
☐ ***But,*** **see the doctor RIGHT AWAY or go to the hospital if *any* of these things are happening:**
–Lips or fingernails are blue
–You are struggling to breathe
–You do not feel any better 20 to 30 minutes after taking the extra medicine and your peak flow is still under _____ (50% of personal best).
–Six hours after you take the extra medicine, you still need an inhaled $beta_2$-agonist medicine every 1 to 3 hours and your peak flow is under _____ (70% of personal best).

This is a general guideline only. Some people have asthma that gets worse very fast. They may need to have a yellow zone at 90–100% of personal best.