Chapter 5

Monitoring Asthma in Childhood: Still a Challenge

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Additional information is available at the end of the chapter

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Abstract

Asthma monitoring should be focused on patient outcomes and goals. Using clinical practice tools allows the clinicians to detect problems such as bad adherence to maintenance therapy, comorbidities, or other external reason for a poorly controlled asthma. To succeed in the process of asthma control, doctors need the participation of the family. Because such educational task requires good agreement between patient environment and doctor, it might be difficult to achieve. However, it is worth to implement because the benefit is a life without symptoms of asthma with a minimum medication.

Keywords: Noncontrolled asthma, management, adherence, children, monitoring

1. Introduction

Asthma is the most common chronic disease in childhood. It is clinically characterized by episodes of wheezing, dyspnea, cough, and chest tightness with different grades of severity. Most patients are free of symptoms between these episodes or "attacks," either because asthma is well controlled or because it is the natural course of the disease [1, 2]. Although this episodic nature can make patients, parents, and health care professionals interpret asthma as an acute or intermittent disease when episodes are infrequent, asthma is in fact a chronic disease characterized by ongoing inflammation of the airway mucosa, even when the patient is asymptomatic. Successful long-term management of the disease therefore requires careful

follow-up and monitoring. However, guidelines on asthma do not provide recommendations that are unanimous [3].

An overwhelming number of 334 million people suffer from asthma worldwide. The most recent global survey calculates that 14% of children experience asthma symptoms [4]. It is difficult to quantify the global economic burden of asthma, but estimates are high enough to encourage active interventions. The indirect costs for children, which are not insignificant, include school Absenteeism; whereas the direct costs are even larger, and include costs from hospitalization, emergency department (ED) visits, unscheduled doctor or nurse visits, and medication. Controlled asthma imposes far less of an economic burden. Strategies towards improving access and adherence to evidence-based therapies are, therefore, likely to be effective in reducing the economic burden of asthma [3, 5]. One of the basics for this goal in developed countries, where access to care and medication is already guaranteed, would be to achieve and maintain asthma control with the least possible medication [6]. In keeping with this paradigm, the concept of problematic severe asthma has been used to describe children who have uncontrolled asthma despite being prescribed multiple controller therapies, including inhaled corticosteroids (ICS), long-acting beta-agonists (LABA), and leukotriene receptor antagonists (LTRA). However, only a minority of children with uncontrolled or problematic severe asthma have true therapy-resistant asthma [7, 8]. Most children with poorly controlled asthma can be in fact well controlled by addressing the basics of asthma management, including patient and parent education, achieving and maintaining correct inhalation technique, avoiding exposure to relevant allergens and irritants, identifying and treating comorbidities, and, perhaps most importantly, identifying poor adherence and helping patients and parents to improve it.

This chapter reviews the recommendations on how to monitor asthma during childhood, focusing on patient outcomes and goals. Using some clinical tools will allow the clinicians to detect situations, such as poor adherence to maintenance therapy, comorbidities, or other external reasons for uncontrolled asthma. To reach a high degree of success, the participation of the whole family in the process of asthma control is needed. Such educational task requires good agreement between the patient, parents, and the health care professionals, which may be difficult to achieve. Despite these difficulties, it is worthwhile to try and implement, as the benefit is a good quality of life for the patient with asthma. We will also search in this chapter for evidence on reliable direct instruments that may be helpful to achieve asthma control.

2. Pillars of asthma management

Comprehensive asthma management includes reviewing the following items: adherence to daily controller therapy, teaching and maintaining proper inhalation technique, controlling exposure to main triggers, reconfirming the diagnosis of asthma, and excluding other causes of respiratory symptoms or comorbidities [9]. Addressing these pillars of asthma diligently management will help to ensure asthma control in most cases, without the need of increasing medication [10].

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We discuss each of these pillars of asthma management throughout this chapter, but first, we discuss the components of an asthma follow-up and monitoring program.

2.1. Asthma follow-up

2.1.1. How, when, and who?

Primary care practitioners are usually the first to encounter asthma symptoms in children. Typically, they prescribe medication after a concise education session during a short visit. Parents are encouraged to use the medication at home as long as the child is symptomatic and to come back if they encounter problems in managing the child's symptoms. This results in a relatively high proportion of unscheduled visits [11]. In addition, many parents feel that they are expected to manage their child's asthma on their own [12]. This approach has been characterized as a "reactive" follow-up strategy of asthma [11] and appears to be common in primary care, even though it does not follow national and international guidelines for the management of asthma in children.

The alternative approach to asthma management can be characterized as a proactive approach, following the pillars of asthma management as outlined in international guidelines. This approach includes scheduled follow-up visits, providing repeated tailored education, agreement on treatment goals and methods, ensuring optimal inhalation technique, and addressing patients' and parents' beliefs and concerns; which has shown to help to improve asthma control [13, 14]. This model of management is more common in secondary care centers. The evidence of its effectiveness makes follow-up and monitoring key components of successful asthma management in children [15].

After establishing that a scheduled follow-up plan is more effective, other aspects of these visits, such as who will monitor these patients and how often, need to be determined. One of the proposed models implicates the asthma nurse. This specifically trained health professional is of great importance in a close and time-consuming management. The main role of the asthma nurse is to provide reinforcement of the patient's and parents' knowledge of the disease, to promote adherence to the management plan, to check the inhalation technique, and to adjust the medication according to symptoms of asthma [10]. In fact, the recent evidence suggests that adults with selected chronic diseases can be successfully managed only by nurses [16]. The outpatient management of childhood asthma by asthma nurses has been compared to the one led by pediatricians. Childhood asthma was proven to be successfully managed by an asthma nurse, in close collaboration with a pediatrician [10].

Educational asthma programs are definitely improved if an asthma nurse is included in the team. A follow-up schedule with alternate follow-up visits by asthma nurses and pediatricians implies a follow-up visit every 3 months. Additional follow-up visits can be planned individually if needed, according to the criteria of the pediatrician or of the asthma nurse [10]. Other members of the team would include nutritionists, psychologists, or physiotherapists, when comorbidities are detected.

2.1.2. What to monitor?

2.1.2.1. Impact of symptoms on life

Symptoms presented since the last visit is the first approach to define asthma control. Although most guidelines provide control scores to establish a degree of asthma control, it is difficult to turn this evaluation into a number because asthma control is a multidimensional concept [6]. The scores of questionnaires on asthma control have several limitations. They only provide information about the situation in the preceding 4 weeks. This makes asthma control scores much variable over time and show little concordance with the risk of exacerbations [17, 18], which is one of the main issues to consider during asthma monitoring. Quality-of-life instruments should help in the task of delimiting asthma control. They share some limitations with asthma scores: children with similar degrees of asthma control or lung function impairment differ considerably in their quality-of-life questionnaire scores, which is partly explained by psychological factors influencing their disease concept [19, 20]. The current consensus is that these instruments provide independent additional information on disease status, complementing other monitoring instruments [19–21].

A way of defining the risk of asthma exacerbation could be the use of reliever medication. However, this information seems to be independent from the risk of exacerbations or other data, such as lung function or inflammation [22]. In fact, the degree of airway narrowing that is perceived as dyspnea of enough severity to prompt the use of reliever medication varies considerably between individuals [23]. Furthermore, other psychological factors influencing this perception can play an important role. Thus, the use of reliever medication is not a reliable way of measuring asthma control.

A practical clinical approach is to review symptoms during follow-up and to consider other factors of the disease. Patients and parents are most concerned about the impact of the disease on daily life [6]. The three things children worry about their asthma control are the need of daily medication, having severe asthma attacks, and not being able to engage in sports and play [24–26]. Follow-up visits should take this into account, starting the clinical interview focusing on patients' outcomes (exacerbations, visits to the ED or hospital admissions; sports limitations or other daily limitations; identified or nonidentified triggers; etc.) and discussing the use of medication, not only the rescue medication but also, most importantly, the daily medication [6].

2.1.2.2. Lung function

The latest asthma guidelines do not include lung function as a main way of monitoring asthma control [27–29]. There are different ways of measuring lung function; but the usefulness of lung function measurements in the follow-up of asthma has not been firmly established [1].

The main two ways of studying lung function are measuring forced expiratory volume in one second (FEV_1) and measuring its reversibility after administration of a bronchodilator [30]. Reduced lung function is an independent risk factor for future asthma exacerbations [31]. FEV_1 levels have shown to improve considerably during treatment with ICS. Normal FEV_1

levels are being found in most children with mild-to-moderate asthma, rendering bronchodilator reversibility negative [32]. As a practical approach, most children with stable, controlled asthma and good adherence to ICS therapy have normal values of FEV_1 [32–34]. Reduced lung function in asthma is only found when they are measured at the time when asthma symptoms are present, or when adherence to ICS is not achieved [30].

Positive bronchodilator response (PBDR), even in patients with FEV_1 >80%, could be another way of monitoring asthma. Children with PBDR have been shown to suffer from poorly controlled asthma, with increased beta2 agonist use, nocturnal symptoms, and exercise limitation [35]. Furthermore, children with consistent PBDR, defined as an increase of 12% or greater in basal FEV_1 in every scheduled visit, had more unscheduled Visits, required more systemic corticosteroids, had more nocturnal awakenings, and missed more school days [36]. However, no study has assessed whether the follow-up that includes PBDR helps to better control asthma when compared to the standard follow-up.

Peak expiratory flow (PEF) values are more effort dependent than FEV_1. Neither isolated PEF measurements nor home PEF monitoring has been demonstrated to be useful in asthma monitoring, because they are not sufficiently sensitive or reliable to monitor airway obstruction [37–39].

Whether it is possible to recognize reduced lung function relying only on history and physical examination during follow-up and whether lung function measurements are able to detect asthma risk of exacerbation with enough anticipation are yet to be answered. In fact, previous studies have shown that it is possible to predict reduced lung function or increased risk of exacerbation, without requiring objective measurements [40].

Finally, one could think that lung function monitoring would help to improve patients' and parents' adherence and, therefore, to improve asthma control. However, studies testing this hypothesis have failed to support it [38, 39].

In summary, the usefulness of lung function monitoring in asthma management is limited. It may be useful during the follow-up when a diagnosis confirmation is needed or when poorly controlled asthma is suspected [6], mainly in poor perceivers.

2.1.2.3. Airway inflammation

Exhaled nitric oxide (FeNO) has been proposed as a noninvasive marker of underlying airway inflammation. FeNO values differ widely among healthy children, which make it difficult to establish reference values. Therefore, FeNO measurement does not appear to be a reliable instrument in asthma diagnosis [41]. FeNO measurements have been thoroughly studied as a monitoring instrument in asthma. Studies in children comparing a standard follow-up with a FeNO-monitored one have shown no evidence of superiority of the FeNO monitoring approach in predicting asthma exacerbation or improving asthma symptoms, while it has been related to higher daily dose of ICS [42]. Similar results are obtained when using sputum eosinophil counts to monitor asthma [6]. As they do not seem to provide further information on asthma control and could favor a step-up of ICS, airway inflammation monitoring should not be recommended in clinical practice to follow-up asthma control.

2.1.3. Patient-centered care and self-management concept

There is a wide consensus among experts that getting the basics right in asthma management helps to control the disease in most children with uncontrolled or problematic severe asthma [9]. This starts with a patient-centered follow-up. The self-management concept is probably the best expression of this patient-focused management.

Self-management means that the patient (or in the case of children, the patient and parents) has the ability to manage symptoms, recognize their possible causes and consequences, and can institute appropriate treatment, following the plan previously agreed with the health care professional. This active role from patient/parents is needed to support the pillars of well-controlled asthma: the parents and the patient should know how to use reliever medication properly, recognize and manage exacerbations, avoid or control known triggers, and agree with the decision of giving daily controller medication to their child [43].

Patients and their parents have certain perceptions of their illness and medication, which strongly determine their self-management behavior [25]. These beliefs can be modified by good asthma education [14]. A prerequisite for successful asthma education is to establish an effective patient–physician partnership through the use of appropriate communication skills. However, this is difficult to achieve, because most doctors have not been trained in communication techniques required for this patient-focused care. This consists of discussing illness and medication perceptions of the parents, shared decision making, and motivational interviewing. It has been shown that physicians trained in communication skills obtain better adherence and improve their patients' asthma control [43–46], as patients are more likely to take the steps necessary to improve their asthma control (if they are satisfied with the partnership) [47].

Compared to a doctor-centered consultation, a patient-focused follow-up interview has some differences: approaches must be based on equality, by listening to patients' concerns and preferences showing genuine interest, and offering medical advice based on patients' preferences. This interview should finally arrive to an agreed management plan [48, 49]. Nowadays, asthma guidelines strongly recommend such tailored management plans, as a way of improving asthma control [27]. During follow-up, this agreed plan needs to be reviewed and adapted when necessary. In this sense, starting the follow-up interview letting the patient or their parents talk about their concerns since the last visit, is a good way of reinforcing patient–physician partnership [43]. However, soliciting the patient's agenda (patients' worries and questions) has only limited effects on health outcomes by itself. The beneficial effects of patient-centered care are more pronounced when it includes facilitation of the patient to ask questions, to take the initiative, to provide information, and to be actively involved in controlling the consultation and in disease management [50]. Patients are more forthcoming with questions, opinions, concerns, and preferences when the physician uses partnership building, such as direct question about patient's views and open-ended questions and avoiding interruptions. The process of giving medical advice comprises discussing available options and supported deliberation. After taking in consideration both the medical evidence and the patient's perspective, the deliberation should come to certain point where one of the options appears to be the best possible strategy. Sometimes, patients and parents need time to consider this,

discuss it at home, and then come back for a further round of deliberations. The final result of this process of negotiation is a mutually agreed solution, which the patient and parents are happy to embrace and follow [47].

In summary, what patients need for effective self-management is that the medical visit provides understanding of the disease state, the treatment options, the need for lifestyle changes, the need for daily medication, and the willingness to consider changes in the management. These strategies supported on patient concerns and preferences and shared decision making, will cover the patient needs [47]. **Figure 1** shows the process of patient-focused visit and self-management.

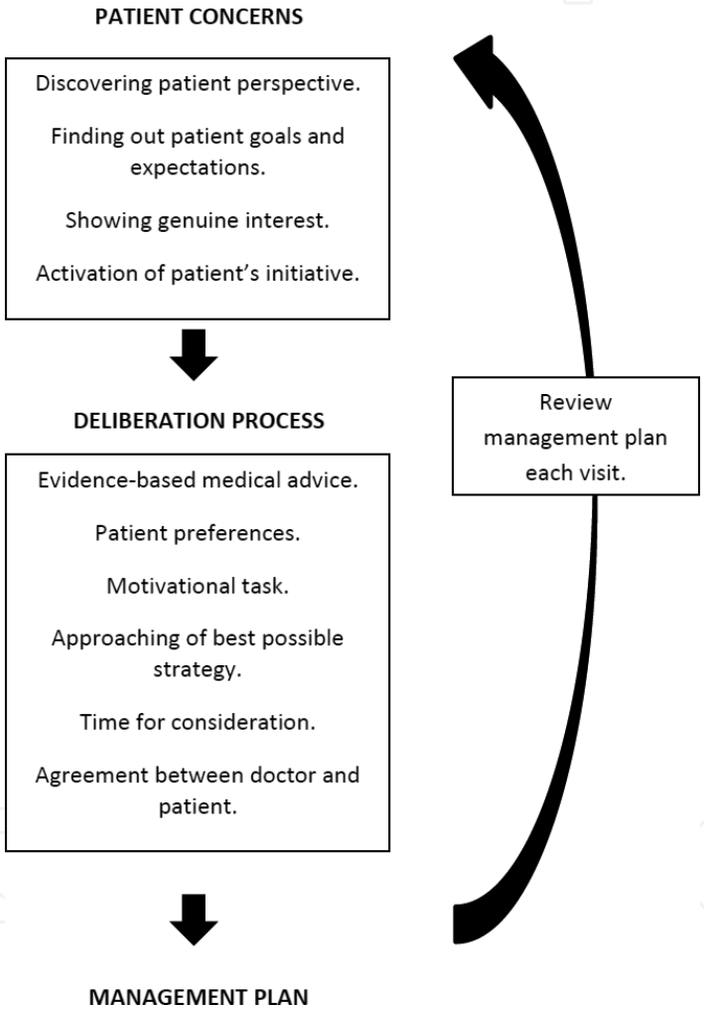

Figure 1. Process of the patient-focused visit and self-management.

2.2. Adherence to daily therapy

Adherence to daily medication is one of the pillars of successful asthma management. Studies reveal that children with asthma only take between 30% and 70% of the prescribed doses [51]. Poor adherence appears to be the main reason why the patient remains symptomatic despite

treatment with ICS [9, 10]. Adherence to controller medication has been strongly linked with better asthma outcomes, making adherence a modifiable factor and a potential target for reducing economic burden of asthma [5]. Adherence should be over 75% of the prescribed doses to influence clinical outcomes [52]. In this section, we will discuss the different kinds of adherence barriers, how to measure them, and how we should manage them.

2.2.1. Adherence barriers

A useful model for daily practice divides nonadherence into four categories [53]:

- Unwitting nonadherence: When patients misunderstand medical indications/advice. This usually occurs when there has been a lack of information and can be addressed through proper education. This adherence barrier should be detected by interviewing the parents about the prescribed treatment (what inhalator should be taken, when, and why).

  It could be thought that adherence is directly related to education on the asthma disease, but this is not the case. Consistent evidence shows that adherence to daily medication is not significantly related to knowledge about asthma; therefore, this is neither the only nor the main barrier for asthma control, but it should always be investigated during follow-up [54].

- Intentional nonadherence: This occurs when parental or patient illness perceptions or medication beliefs are in conflict with the medical advice. These cognitions have consistently proved to be a strong determinant of adherence [13, 50, 53]. Illness perceptions are built from earlier experiences and from information collected from the media and people from closer social circles. This modulates their view of necessity for treatment. For example, it is common that a patient with episodic attacks, who is asymptomatic in between attacks, perceives asthma as an intermittent disease for which daily medication is not necessary. However, if parents understand that asthma is a chronic condition with ongoing inflammation even when asymptomatic, they are more likely to recognize daily medication as a way of preventing asthma attacks. On the other hand, fear of ICS side effects could be the reason for adherence resistance [54].

  When confronted with poor adherence to the recommendation to give daily ICS, many physicians respond by repeating asthma education and re-emphasizing the importance of daily controller medication. However, as unwitting nonadherence is a minor cause of nonadherence [54], this approach is likely to be ineffective [55, 56]. Dealing with patients' and parents' perceptions is sometimes difficult, but eliciting them during follow-up visits is important to detect poor adherence. After illness or medication beliefs have been explored in a supportive and nonjudgmental way, it could be discovered that they do not correspond to the medical model of asthma. At this point, the physician's task is to discuss these perceptions from the empathy and the genuine interest of the patient's and parents' concerns. Showing this predisposition to listen has been shown to increase patient's satisfaction, which is directly related to their adherence [57]. Although these communication skills require an effort, they are very effective when used during the deliberating process in self-management, and normally an agreement is achieved, resulting in both parts being satisfied with the decision made [47, 57]. This is one of the keys of intentional adherence

maintenance, as shaping perception and beliefs have demonstrated to help to a good asthma control [14].

- Unplanned nonadherence: Even if patients have agreed to follow daily ICS, a number of barriers can prevent them from doing so, causing what is called "unplanned" nonadherence. Examples include the lack of family routines, the time for medication competing with important activities on the child's schedule, child raising issues, and social or family complex environment (economic issues, parental psychiatric illnesses, etc.). A recent surprising finding was that excessive responsibility for medication taking was being given to the child at a relatively young age, without proper parental supervision. Self-management should not be expected until 12 years of age [51].

  Incorporating behavioral components into educational efforts to improve adherence increases their potential efficacy. Home visits may be an efficient method to collect information on such barriers, specially in patients with severe asthma. It is important to listen to patient's preferences and try to look for some room in the schedule in which remembering and using the daily medication is easy for him/her [54]. All these specifically tailored interventions could be successful and cost-effective; but until now, studies on this subject have just shown to achieve a temporary adherence improvement [58].

- Incorrect inhalation technique: Although it is not the most frequent adherence barrier [9], many patients use their inhaler device incorrectly. The first step for a successful inhalation technique is an adequate device prescription. After this, comprehensive inhaling instructions must be provided [59]. From all ways of checking inhalation technique, the patient-demonstrated technique appears to be the most effective, at least when speaking of metered dose inhaler (MDI) [59]. In the case of MDIs, it is important that the patient or parent actually demonstrates the maneuver himself/herself and to adjust the technique afterwards, if required. Not shaking the canister at the beginning of the maneuver tends to be the most common error in the inhalation technique of patients using an MDI device. On the other hand, patients using a dry powder inhaler (DPI) prepare their inhaler device correctly, but they inhale inadequately through the device, without sufficient peak inspiratory flow (PIF), which is necessary to release medication from the device. Therefore, before prescribing a DPI, it is essential to consider whether the patient will be able to do it forcefully and deeply enough. An inspiration whistle can be used for this purpose, ensuring that the patient is able to achieve a sufficient PIF. It is important to note, however, that sufficient PIF alone is not enough to guarantee for an adequate drug delivery from a DPI [60]. Poor inhalation technique is more frequent in newly referred children using a DPI than in children using an MDI/s device [56]; but there are no significant differences in the correct inhalation technique for the different inhaler devices, when all patients receive repeated inhalation instructions. This means that inhaling technique instructions would not be enough if provided once at the time of prescription. Repeating inhaling instructions can improve correct technique up to 30% [59].

Although the classification in these types of nonadherence is useful from a daily practice point of view, adherence is a complex behavioral process influenced by more interacting conscious and unconscious factors. Therefore, all effective interventions improving adherence to long-

term therapies are complex and multidimensional [55]. **Table 1** summarizes patterns of nonadherence and how to manage them.

Patterns of adherence barrier	Investigate for	How to manage them
Unwitting non-adherence	• Misunderstanding of medical indications/ advice	• Education
Intentional non-adherence	• Illness perceptions Medication beliefs	• Discussing patient/parents' perceptions • Expressing genuine interest • Partnership between physician and patient/parents • Concordance on treatment and patient/parents' goals • Stressing importance of daily ICS adherence • Self-management
Unplanned non-adherence	• Forgetting doses • Child-raising issues • Economic issues • Parental psychiatric illnesses • Excess of responsibility relaying on the child	• Establish easy routines • Avoid complicated treatment regimens • Home supervision • Child self-management achieved gradually
Incorrect inhalation technique	• Check technique • Check PIF for DPI device	• Choose suitable device • Provide patient demonstrated technique • Repeat training

PIF, peak inspiratory flow; DPI, dry powder inhaler.

Table 1. Patterns of nonadherence and how to manage them.

A proposed formula to achieve the best adherence to maintenance medication in asthma is the result of a medical team providing evidence-based education, tailored to the patient's (and parents') context, self-management education provided in an organized and repeated way (scheduled follow-up visits), and coupled with goal setting and other behavioral approaches[57].

2.2.2. Adherence measurements

Apart from self-reporting during the clinical interview, there are other ways of measuring adherence. More reliable ways could be used when poor adherence is suspected. The Medication Adherence Rating Scale (MARS) is one example. In this case, the patient responds to 10 items of the questionnaire and chooses the answer that best describes their behavior or attitude toward their medication during the past week [61]. This scale has been used previously to assess ICS adherence in adults with asthma [62]. In children, it has only been used to assess medication adherence in other chronic diseases, including pills taking [63]. However, later research has shown that its reliability is not sufficient [64].

Nowadays, validated electronically measured adherence with smart inhalers that register date and time of each ICS actuation is universally accepted to be the most reliable way of measuring adherence [61, 65]. Its use is limited by the high cost of the device, but it is particularly useful with those parents and patients who are not aware of their poor adherence, or in those cases in which the physician is not able to detect whether poor adherence is the problem for uncontrolled asthma.

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