

Actual asthma control in a paediatric outpatient clinic population: Do patients perceive their actual level of control?

Hammer SC, Robroeks CMHHT, van Rij C, Heynens J, Droog R, Jöbsis Q, Hendriks JHE, Dompeling E. Actual asthma control in a paediatric outpatient clinic population: Do patients perceive their actual level of control?

Pediatr Allergy Immunol 2008.

© 2008 The Authors

Journal compilation © 2008 Blackwell Munksgaard

Several epidemiological studies described poor asthma control in children. However, the diagnosis of childhood asthma in these studies is uncertain, and asthma control in children of an outpatient clinic population during treatment by a paediatrician is unknown. (1) to investigate the hypothesis that asthma control in a paediatric outpatient clinic population is better than epidemiological surveys suggest; (2) to find possible explanations for suboptimal asthma control. Asthmatic children aged 6–16 years, known for at least 6 months by a paediatrician at the outpatient clinic, were selected. During a normal visit, both the responsible physicians and parent/children completed a standardised questionnaire about asthma symptoms, limitation of daily activities, treatment, asthma attacks and emergency visits. Overall, excellent asthma control of 8.0% in this study was not significantly better than of 5.8% in the European AIR study (Chi-square, $p = 0.24$). Separate GINA goals like minimal chronic symptoms and no limitation of activities were better met in our study. Good to excellent controlled asthma was perceived by most children/parents (83%), but was less frequently indicated by the paediatrician (73%), or by objective criteria of control (45%) (chi-square, $p = 0.0001$). The agreement between patient-perceived and doctor assessed control was low, but improved in poorly controlled children. Patients were not able to perceive the difference between 'excellent asthma control' and 'good control' ($p = 0.881$). Too little children with uncontrolled disease got step-up of their asthma treatment. Although separate GINA goals like 'minimal chronic symptoms' and 'no limitation of activities' were significantly better in our study, overall, asthma control in this outpatient clinic population, treated by a paediatrician, was not significantly better than in the European AIR study. Poorly controlled disease was related to several aspects of asthma management, which are potentially accessible for improvements.

Sanne C Hammer¹, Charlotte MHHT Robroeks¹, Christian van Rij¹, Jan Heynens², Richard Droog³, Quirijn Jöbsis¹, Han JE Hendriks¹ and Edward Dompeling¹

¹Department of Paediatric Pulmonology, University Hospital Maastricht, Maastricht, The Netherlands,

²Department of Paediatrics, Maasland Hospital, Sittard, The Netherlands, ³Department of Paediatrics, Elkerliek Hospital, Helmond, The Netherlands

Key words: asthma control; children; perception; guidelines

Sanne Hammer, MD, University Hospital Maastricht, Department of Paediatrics, P.O. Box 5800, 6202 A2 Maastricht, the Netherlands
Tel.: 0031 43 3877248
Fax: 0031 43 3875246
E-mail: sannehammer@hotmail.com

Accepted 3 December 2007

Asthma is a chronic inflammatory disease of the airways with intermittent symptoms of wheezing, cough and breathlessness (1). Worldwide, the prevalence is high (2, 3), and had increased in the last two decades, especially in the Western industrialized countries (4). Recently, a stabilization or even a small decrease in prevalence was

reported in some countries, including the Netherlands (5). In 1995, the Global Initiative for Asthma (GINA) Executive Committee formulated eight specific goals for optimal long-term management of asthma (6). In 2002, 2005 and 2006, updates of the GINA guidelines came available (7).

Since the release of the GINA guidelines, several Asthma Insights and Reality (AIR) surveys worldwide aimed at determining the severity, the control, and management of asthma in children and adults by means of a cross-sectional, mostly telephone survey. Despite variations at a country level, all these surveys indicated that the level of asthma control fall short of the goals for long-term management in international guidelines (8–14). However, a problem for the interpretation of the AIR studies in children is: (i) the inclusion of a substantial number of preschool children, in which a diagnosis of asthma is not easily distinguished from transient, viral-associated wheeze; (ii) the uncertainty of a correct diagnosis of asthma in a telephone survey, in which the diagnosis cannot be confirmed by the responsible physician. So far, studies on asthma control in children of outpatient clinic populations are lacking.

Therefore, the purpose of this study was:

1. To test the hypothesis that levels of asthma control in children of a paediatric outpatient clinic, treated by a paediatrician, is better than the results of the AIR studies suggest.
2. To compare the assessment of asthma control by the responsible paediatrician with the assessment of the patient, and the objective GINA criteria. We hypothesized that patients are more optimistic about their level of asthma control than the responsible physician.
3. To find possible explanations for suboptimal asthma control in children, by assessing the relationship with prescription behaviour of paediatricians, patients' perception of asthma control, knowledge about asthma, instructions on proper inhaler technique and compliance to medication.

Methods

Patients and selection procedure

Children aged 6–16 yr, with doctor-diagnosed asthma, and known at the paediatric outpatient clinic for at least 6 months, were selected. In this way, children with transient wheezing, or children with asthma-like diseases were excluded as much as possible.

Asthma was defined as a disease with episodic cough, wheeze, dyspnoea or chest tightness, with a variable but reversible airway obstruction (7). For reasons of generalization, presence of atopy was not an obligatory criterion. Atopy was

defined as the presence of a positive Phadiatop or 1 or more RAST classes >2. Children were randomly selected for the study from the population of children attending the clinic for a normal routine visit. As a correct diagnosis was important, asthmatic children with a first visit to the outpatient clinic were excluded. Other exclusion criteria were congenital anomalies of the respiratory tract, moderate to severe mental retardation, congenital heart disease or severe concomitant infections like pneumonia. All patients/parents got written and verbal information about the study. All parents/children signed an informed consent agreement before the start of the study. The study was approved by the ethical committee of the University Hospital of Maastricht.

Patient questionnaire, peak expiratory flow measurements and asthma severity

Items of the questionnaire of this study were based on the standard questionnaire of the AIRE study (8), and on items of the Childhood Asthma Severity Scale (15). The patient questionnaire contained four domains: asthma symptoms, asthma medication, healthcare use and questions about knowledge of asthma. Symptoms in the preceding month were evaluated. Urgent care was defined as having an appointment earlier than planned because of increase in symptoms in the year preceding the study. Visiting the emergency care means that the increase in symptoms was so serious that acute treatment was necessary, during the preceding year. Parents and children completed the questionnaire together (16). All questionnaires were taken by two independent and specially trained research assistants. To avoid a disturbing influence of the physician as much as possible, the patient questionnaire was taken before the consultation of the responsible paediatrician. After completing the questionnaire, peak expiratory flow (PEF) manoeuvres were performed by the research assistant. Most children had experience with performance of PEF values, or other lung function testing. The child was asked to blow at least three reliable PEF. The highest value was used for analysis, and expressed as a percentage of the predicted value (17). On basis of the data of the questionnaire and the PEF readings, children were classified according to GINA as having 'intermittent' (MI), 'mild persistent' (MP), 'moderate persistent' (MOP) and 'severe persistent' (SP) asthma (7, 8). Neither the children and parents, nor the responsible paediatrician

Table 1. Criteria of asthma control according to GINA

	Excellent	Good	Poor
Chronic airway symptoms	≤ 1/wk	1–3/wk	>4/wk
Sleep disturbances	≤ 2/month	(>3/month; 1/wk)	>2 nights/wk
Limitation daily activity	≤ 1/month	(1/wk; <1/day)	≥1/day
Asthma attacks in preceding year			
Attacks < 2 days	≤ 4/yr	≤ 5/yr	≥6/yr
≤ 2 attacks of 2–5 days	–	≤ 4/yr	≥4/yr
≤ 1 attacks >5 days	–	≤ 2/yr	≥2/yr
Emergency room visit	–	<2/yr	≥2/yr
Urgent care visit	–	<4/yr	≥4/yr
Use β_2 -agonists	Before exercise (1/month; ≤ 1/day)		≥2/day

was aware of the result of the classification at this stage of the study. Patients/parents also indicated their perceived level of asthma control on a Visual Analogue Scale (VAS) of 0–100; score '0' meant no asthma control at all, '100' was marked with excellent asthma control. Thereafter, the child/parents visited the paediatrician for the consultation. As a result of the findings during this visit, the doctor reported his opinion of the extent of asthma control on a VAS scale of 0–100. Patients were not aware of the scoring of the doctor, and vice versa. Possible changes in medications (step-up or step-down of inhaled corticosteroids, prescription of new asthma drugs) were also reported in this part of the questionnaire. According to GINA criteria (7), control of asthma was defined as poor, good or excellent control, based on frequencies of symptoms, and use of medication (Table 1).

Sample size calculation and statistics

To establish a difference in asthma control between the $n = 753$ children of the European AIR study (8) and our study of 10%, 70 children were needed to assess this difference with a power of 80% and an alpha of 0.05. Absolute number and percentages were given

for the different items of the questionnaire and for the children with MI, MP, MOP and SP disease. Differences in patient categories with respect to prescribed medication, step-up or step-down of asthma treatment were tested by the chi-squared test. Two-side p-values <0.05 were considered statistically significant. Agreement between doctor and patient judgment of asthma control was performed by means of Spearman or Pearson correlation coefficients, dependent of a not normal or normal distribution of the data (18). In case of comparison with GINA criteria, categories of asthma control were performed: excellent asthma control (VAS score 0–20), good control (VAS score 20–50) and poor asthma control (VAS score 50–100). The results were analysed with the statistical program SPSS (Chicago, Ill, USA).

Results

Patient population

One-hundred and twelve Asthmatic children were included in the study; 35% were female, and 66% were atopic (Table 2). Using the GINA severity index, most children were classified as having MOP disease (37%), followed by 33% with SP disease, 17% MP asthma and 13% mild intermittent (MI) asthma (Table 2). According to GINA criteria, 41 (37%) of the children had good controlled asthma, nine (8%) excellent asthma control, whereas 62 (55%) had poor control (Table 2, Fig. 1a). The mean dose of budesonide (or equivalent) in the children was 390 (s.e.m. 69) μg daily.

Comparison with the European AIR study

Overall, the percentage of excellent asthma control of 8.0% in this study was not significantly better than that of 5.8% in the European

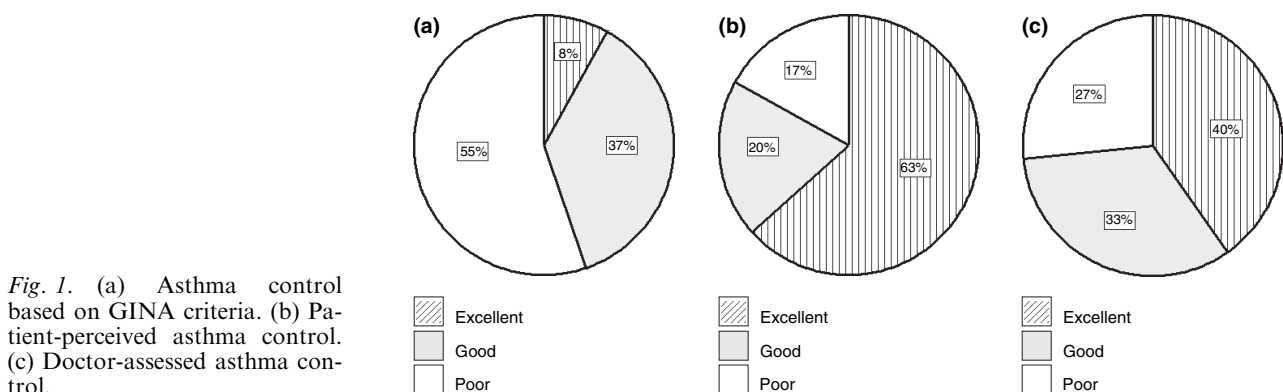


Fig. 1. (a) Asthma control based on GINA criteria. (b) Patient-perceived asthma control. (c) Doctor-assessed asthma control.

Table 2. Clinical characteristics of children with asthma in this study

No. patients	112
Age (mean $\pm$ s.d.) yr	10.1 $\pm$ 2.7
Female (%)	34
Atopy* (%)	66
Height (mean $\pm$ s.d.) cm	139.7 (16.3)
PEF (mean $\pm$ s.d.) % of predicted value	84.1 (14.1)
Asthma severity (%)	
MI	14 (13)
MP	19 (17)
MOP	42 (37)
SP	37 (33)
Asthma control according to GINA (%)	
Excellent	9 (8)
Good	41 (37)
Poor	62 (55)

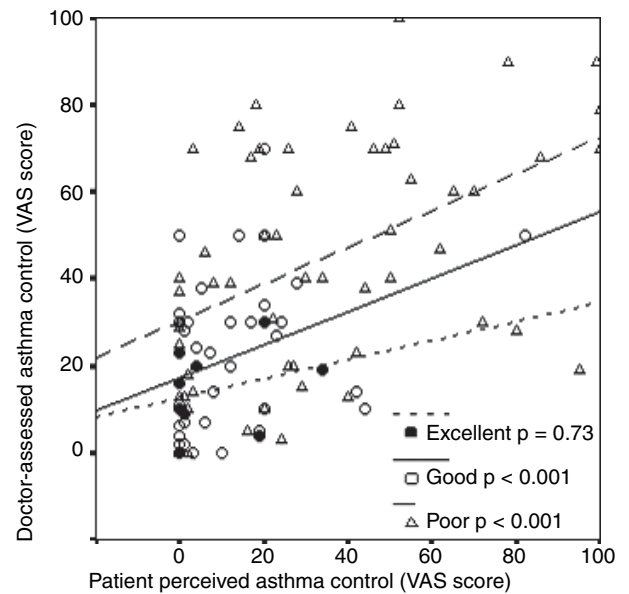
MI, mild intermittent; MP, mild persistent; MOP, moderate persistent; SP, severe persistent.

*Defined as a positive Phadiatop, or 1 or more RAST classes >2.

AIR Study (chi-squared, $p = 0.24$, Table 3). When analysing GINA goals separately, children in our study (in comparison with the European AIR study) had significantly more presence of 'minimal chronic symptoms' (difference 33%, chi-squared, $p = 0.0001$), more often 'no limitations of activities' (difference 41%, $p = 0.0001$), more often had a lung function test (difference 48%, $p = 0.0001$), but did not differ in presence of 'emergency visits' and 'unscheduled urgent care visits' ($p = 0.20$ and $p = 0.97$ respectively). More favourable in our study was minimal need for β_2 -agonist of 48% compared to 61% in the AIRE study ($p = 0.007$).

Comparison between the assessment of doctors, patient perception and GINA criteria

Patients' perception of asthma control was significantly better than of doctor-assessed asthma control, which in turn was better than asthma control according to GINA criteria (percentage excellent/good/poor asthma control of 63%/



VAS 0 = Excellent control

VAS 100 = Very poor control

Fig. 2. Relationship between patient-perceived and doctor-assessed asthma control in the categories 'excellent', 'good' and 'poor' control (according to GINA criteria).

20%/17% vs. 40%/33%/27% vs. 8%/37%/55% respectively, chi-squared, $p = 0.0001$) (Fig. 1). In general, the agreement between paediatricians and patients in assessment of asthma control was low (Fig. 2). However, in patients with poor asthma control, the agreement between doctors and patients improved (Spearman correlation coefficient r of 0.484, $p = 0.001$). There was no correlation between asthma control, and sex ($r = 0.030$, $p = 0.75$), or age ($r = -0.077$, $p = 0.42$).

In the asthma control categories 'poor' and 'good' (according to GINA criteria), patient-perceived asthma control was also significantly different (VAS score 33 vs. VAS 9, unpaired Student's t -test, $p = 0.0001$) (Fig. 3). However, patients did not perceive the difference between

Table 3. Separate GINA goals and the results of the European AIR study and our study

GINA recommendation	Frequency of symptoms	Results AIRE (%)	Results study (%)	p-Value
Minimal chronic symptoms	Daytime symptoms once a week	38	71	0.000*
No emergency visits	Unscheduled care visit during last year	36	43	0.97
	Emergency visits during last year	18	14	0.200
Minimal need for β_2 -agonists	Used as required β_2 -agonists during last month	61	48	0.007*
No limitations of activities	Limitations of activities	11–31	63	0.000*
Normal of near normal lung function	Never had a lung function test	61	13	0.000*

Differences are tested with the chi-squared test, the corresponding p-values are in the last column.

*Significant difference.

Do patients perceive their actual level of control?

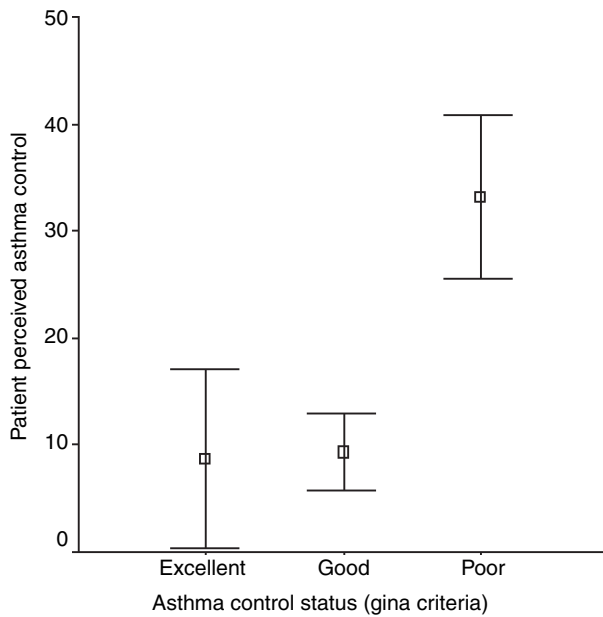


Fig. 3. Relationship between patient-perceived asthma control (VAS score, mean values $\pm$ standard deviation) and the asthma control status according to GINA (excellent, good and poor control).

the 'good' and 'excellent' asthma control status (VAS score 9 vs. 8, $p = 0.88$) (Fig. 3).

Pharmacotherapy according to the different severity classes

Almost all children were on inhaled corticosteroid treatment (Table 4). However, the frequency of prescribed inhaled corticosteroids and long-acting β_2 -agonists did not increase with increasing disease severity (Spearman correlation coefficient ranged from -0.022 to 0.063 , $p > 0.40$). There was no significant relationship between the level of asthma control (according to the GINA guidelines), and the change in asthma medication (chi-squared, $p = 0.55$) (Table 5): only 11% of the children with excellent asthma control received step-down with asthma medication, whereas step-up was only applied in 21% of the children with poor asthma control. However,

Table 4. Asthma medication in the different severity classes

	MI	MP	MOP	SP	Total
ICS	13 (93)	19 (100)	39 (95)	34 (94)	105 (96)
LABA	7 (50)	10 (53)	14 (34)	15 (42)	46 (42)
LTA	1 (7)	2 (11)	1 (2)	5 (14)	9 (8)
Oral corticosteroids	0 (0)	0 (0)	1 (2)	0 (0)	1 (1)

Values are given as number (%).

MI, mild intermittent disease; MP, mild persistent; MOP, moderate persistent; SP, severe persistent; ICS, inhaled corticosteroids; LABA, long-acting β_2 -agonist; LTA, leucotrien antagonist.

Table 5. Adjustment of prescribed asthma medication (step-up, no change, step-down) according to asthma control status (GINA criteria)

	Step down	No change	Step up	Total
Excellent	1 (11)	8 (89)	0	9
Good	4 (10)	30 (75)	6 (15)	40
Poor	8 (13)	41 (66)	13 (21)	62

Values in parenthesis are in percentage.

Table 6. Adjustment of prescribed asthma medication according to asthma control as assessed by the responsible physician

	Step down	No change	Step up	Total
Excellent	9 (20)	35 (78)	1 (2)	45
Good	2 (5)	31 (74)	9 (21)	42
Poor	2 (8)	13 (54)	9 (38)	24

Values in parenthesis are in percentage.

a significant relationship was present when doctor-assessed asthma control was used to categorize children (chi-squared, $p = 0.0001$) (Table 6). Still, too little poorly controlled children (38%) got step-up of asthma treatment.

Education, knowledge, lung function testing and asthma management

Thirty-eight per cent of patients got no instructions on a correct inhaler technique in the preceding year, 5% reported non-compliance for asthma medication (Table 7). A significant correlation existed between getting instructions of the inhaler technique and better control of asthma (Pearson correlation coefficient 0.197 , $p = 0.04$). Spirometry once or more was performed in 87% of the children. The knowledge of parents and children on the action of inhaled bronchodilators and corticosteroids appeared to be moderately good (55–92% of correct answers).

Table 7. Aspects of education, knowledge and asthma management in our population

Study result	Number (%)
No lung function testing ever	14 (13)
No explanation of correct inhalation technique in the last year	42 (38)
No or little participation in decisions about asthma management	25 (22)
Non-compliance (≥ 5 times forgotten to use medication in the last month)	10 (9)
Knowledge on asthma (% correct answers)	
'Use of short-acting bronchodilator with complaints'	64 (57)
'Inhaled corticosteroids do not act immediately'	62 (55)
'Asthma symptoms can be suppressed by medication'	103 (92)

Discussion

This study in an outpatient paediatric asthma population showed that overall, the degree of excellent asthma control was not significantly better than in the European AIR study. When analysing the GINA recommendations separately, children in this study had less chronic symptoms and less limitations in activities than in the European AIR study. However, no difference in emergency visits was found, and the use of β_2 -agonists was lower in the children of our study. Additionally, little agreement was found in asthma control as perceived by patients, paediatricians, and as indicated by objective GINA criteria. In general, patient-perceived asthma control was best with 83% of good to excellent control, compared to 73% with respect to doctor-assessed control, and 45% good to excellent control according to objective GINA criteria. Agreement between doctor and patient was better in the poorly controlled asthma children. In general, patients did not perceive the difference between an 'excellent' and a 'good' asthma control status (according to GINA criteria), whereas they were able to discern the difference between 'poor' and 'good'. The correlation between patient-assessed control and control according to GINA criteria was low, even though these parameters might not be completely independent. Applying step-up and step-down of asthma medication by paediatricians was performed only moderately. Almost all children had lung function testing once or more, and were on maintenance treatment with inhaled corticosteroids.

This is the first study on asthma control in children from paediatric outpatient clinics. So far, results on asthma control studies were based on telephonic interviews or patient questionnaires in epidemiologic surveys (8, 13, 14), which has the risk of inclusion of children with 'transient wheezing' or other diagnoses. Moreover, this is the first study comparing different information sources, like data from parents/children, the consultant paediatricians and GINA criteria. Patients were already known with a diagnosis of asthma at the outpatient clinic for 6 months, which makes the chance on misclassification unlikely (11, 19). As children were 6 yr and over, patients with 'transient wheezing' were not included. As might be expected in a specialist population, the children had most frequently MOP and SP disease, and were mostly atopic. Normal facilities at our tertiary centre were available and were being used: (i) regular visits of children took place; (ii)

on average, children got one to four lung function tests each year; (iii) both asthma nurses and physicians provided information and education; and (iv) patients were being trained and instructed, and got written asthma plans.

In general, only our results with respect to chronic symptoms and limitation of daily activities were better than those of children from the AIR studies (14). This may be the consequence of the use of maintenance treatment with inhaled corticosteroids by all children in our population, which is known to reduce (exacerbations of) symptoms and improve quality of life (7). We did not find an undertreatment with inhaled corticosteroids, nor did we find signs of over-reliance on the use of β_2 -agonists, one of the main outcomes of the worldwide AIR survey (14). However, there is room for improvement, as 43% of the children in our study reported unscheduled urgent care visits, and 14% indicated emergency room visits in the preceding year. This may be due to too little use of written asthma plans in at least a part of our population. These plans showed to contribute to good asthma control in children, as well as to good compliance (20, 21).

How can we explain the results of our study? An important cause may be poor perception of airway obstruction and symptoms in children with asthma. The children in this study were not able to perceive the difference between excellent and good asthma control. Baker et al. (22) demonstrated that of 49% of his population of asthma patients had an inadequate perception of asthma symptoms. Yoos and McMullen (23) also found poor symptom perception in childhood. These results are comparable with findings of AIR studies, that children's and parental perception of current level of asthma control differs markedly from that based on reported symptom severity (14). By example, in the SEAKK study, 89% of asthma patients thought their asthma acceptably controlled, though objective assessments indicated that asthma control was unsatisfactory poor (24).

A second reason might be that there has been an underestimation of the severity of disease when patients were first seen in the outpatient clinics. Classification of severity when asthmatic children are already on regular treatment is difficult as it is effected by this regular treatment.

A third reason for not optimal asthma control in this study might be the fact that asthma is a very dynamic disease. Calhoun et al. (25) demonstrated that asthma severity cannot be determined in many patients using discrete,

point-in-time assessments of lung function or symptoms. Asthma severity and control vary significantly in the course of time.

A fourth cause might be the relative low use of long-acting β_2 -agonists and leucotrienantagonist (LTA). In more severe paediatric asthma losing control of disease, the advice is to increase the dose of inhaled corticosteroid, or to start additional treatment with a long-acting β_2 -agonist or LTA (7). Step-up of asthma medication by the paediatrician was applied in too little children losing control.

A fifth reason might be that excellent asthma control cannot be achieved in all patients, or too much treatment with more side-effects is necessary to reach this goal. Indeed, in a 1-yr, randomized, stratified, double-blind parallel-study of 3421 patients with uncontrolled asthma, Bateman et al. (26). demonstrated that total asthma control was not reached in more than 50% of patients. In our study, children did not experience a difference in asthma control between the 'excellent' and 'good' controlled groups. Therefore, in some children with good controlled disease, the benefits of reaching excellent control will be outweighed by the (risk on) side-effects with increasing treatment.

A sixth reason may be that measurements of airway inflammation, like exhaled nitric oxide, were not performed. As asthma is a chronic inflammatory disorder, assessments of airway inflammation may be useful in reaching more optimal asthma control. Indeed, a recent study in 85 asthmatic children demonstrated that the use of FeNO to titrate inhaled corticosteroid treatment in asthmatic children resulted in better asthma control and bronchial hyperresponsiveness than use of symptoms only (27). This study has to be confirmed by others before FeNO measurements can become a daily clinical routine in asthma management, but it provides some evidence that measurements of airway inflammation may be of help in attacking the world wide problem of low asthma control in patients.

This study demonstrated that overall, the level of asthma control in children from an outpatient clinic was not significantly better than in the epidemiological survey of the European AIR study. Separate GINA goals like 'minimal chronic symptoms' and 'no limitations of activities' were better in our study. Patients' perception of disease was significantly more optimistic than that of the responsible paediatrician, which in turn was better than objective GINA criteria. Explanations for poorly controlled disease in some patients may be an inadequate patient-

perception of asthma control, the dynamic process of asthma, too little step-up of asthma treatment by the paediatrician in case of poorly controlled disease, and too little instruction on a proper inhaler technique.

References

1. BARNES P. Pathophysiology of asthma. *Br J Clin Pharmacol* 1996; 142: 3–10.
2. ECRHS. Variations in the prevalence of respiratory symptoms, self-reported asthma attacks, and use of asthma medication in the European Community Respiratory Health Survey (ECRHS). *Eur Respir J* 1996; 9: 687–95.
3. ISAAC. Worldwide variations in the prevalence of asthma symptoms: the International Study of Asthma and Allergies in Childhood (ISAAC). *Eur Respir J* 1998; 12: 315–35.
4. JANSON C, CHINN S, JARVIS D, BURNEY P. Physician-diagnosed asthma and drug utilization in the European Community Respiratory Health Survey. *Eur Respir J* 1997; 10: 1795–802.
5. VAN SCHAYCK CP, SMIT HA. The prevalence of asthma in children: a reversing trend. *Eur Respir J* 2005; 26: 647–50.
6. GLOBAL INITIATIVE FOR ASTHMA (GINA). Global Strategy for Asthma Management and Prevention. NHLBI/WHO workshop report. National Institutes of Health, National Heart, Lung and Blood Institute. NIH publications number 95-3659, 1995.
7. GLOBAL INITIATIVE FOR ASTHMA (GINA). Pocket Guide for Asthma Management and Prevention in Children. National Institutes of Health, Lung and Blood Institute. Available at: <http://www.ginasthma.com> (last accessed on December 2006).
8. RABE KF, VERMEIRE PA, SORIANO JB, MAIER WC. Clinical management of asthma in 1999: the Asthma Insights and Reality in Europe (AIRE) study. *Eur Respir J* 2000; 16: 802–7.
9. PINTO PEREIRA LM, CLEMENT Y, DA SILVA CK, MCINTOSH D, SIMEON DT. Understanding and use of inhaler medication by asthmatics in specialty care in Trinidad: a study following development of Caribbean guidelines for asthma management and prevention. *Chest* 2002; 121: 1833–40.
10. SCARFONE RJ, ZORC JJ, CAPRARO GA. Patient self-management of acute asthma: adherence to national guidelines a decade later. *Pediatrics* 2001; 108: 1332–8.
11. DIETTE GB, SKINNER EA, NGUYEN TT, MARKSON L, CLARK BD, WU AW. Comparison of quality of care by specialist and generalist physicians as usual source of asthma care for children. *Pediatrics* 2001; 108: 432–7.
12. ESHEL G, RAVIV R, BEN-ABRAHAM R, et al. Inadequate asthma treatment practices and noncompliance in Israel. *Pediatr Pulmonol* 2002; 33: 85–9.
13. LAI CK, DE GUIA TS, KIM YY, et al. Asthma control in the Asia-Pacific region: the Asthma Insights and Reality in Asia-Pacific Study. *J Allergy Clin Immunol* 2003; 111: 263–8.
14. GUSTAFSSON PM, WATSON L, DAVIS KJ, RABE KF. Poor asthma control in children: evidence from epidemiological surveys and implications for clinical practice. *Int J Clin Pract* 2006; 60: 321–34.

15. ORTEGA AN, BELANGER KD, BRACKEN MB, LEADERER BP. A childhood asthma severity scale: symptoms, medications, and health care visits. *Ann Allergy Asthma Immunol* 2001; 86: 405–13.
16. JUNIPER EF, O'BYRNE PM, GUYATT GH, FERRIE PJ, KING DR. Development and validation of a questionnaire to measure asthma control. *Eur Respir J* 1999; 14: 902–7.
17. POLGAR G, PROMADHAT V. *Pulmonary Function Testing in Children: Techniques and Standards*. Philadelphia, PA: WB Saunders Company, 1971.
18. LANDIS JR, KOCH GG. The measurement of observer agreement for categorical data. *Biometrics* 1977; 33: 159–74.
19. MEURER JR, HELSTAD CP, WIEGMANN SM, et al. Pediatric Asthma Study of the State Medical Society of Wisconsin. *WMJ* 2001; 100: 26–34.
20. CLARK NM, GONG M, SCHORK MA, et al. Long-term effects of asthma education for physicians on patient satisfaction and use of health services. *Eur Respir J* 2000; 16: 15–21.
21. BHOGAL S, ZEMEK R, DUCHARME FM. Written action plans for asthma in children. *Cochrane Database Syst Rev* 2006; 3: CD005306: 1–51.
22. BAKER RR, MISHOE SC, ZAITOUN FH, ARANT CB, LUCAS J, RUPP NT. Poor perception of airway obstruction in children with asthma. *J Asthma* 2000; 37: 613–24.
23. YOOS HL, MCMULLEN A. Symptom perception and evaluation in childhood asthma. *Nurs Res* 1999; 48: 2–8.
24. KUEHNI CE, FREY U. Age-related differences in perceived asthma control in childhood: guidelines and reality. *Eur Respir J* 2002; 20: 880–9.
25. CALHOUN WJ, SUTTON LB, EMMETT A, DORINSKY PM. Asthma variability in patients previously treated with beta2-agonists alone. *J Allergy Clin Immunol* 2003; 112: 1088–94.
26. BATEMAN ED, BOUSHEY HA, BOUSQUET J, et al. Can guideline-defined asthma control be achieved? The Gaining Optimal Asthma Control study *Am J Respir Crit Care Med* 2004; 170: 836–44.
27. PIJNENBURG MW, BAKKER EM, HOP WC, DE JONGSTE JC. Titrating steroids on exhaled nitric oxide in children with asthma: a randomized controlled trial. *Am J Respir Crit Care Med* 2005; 172: 831–6.