

Decrease in hospitalization for treatment of childhood asthma with increased use of antiinflammatory treatment, despite an increase in the prevalence of asthma

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Background: During the past 15 years, the prevalence of asthma in children in Sweden has doubled. However, since 1985, antiinflammatory treatment with inhaled steroids has increased continuously.

Objective: The aim of this study was to analyze the net effect of these changes in terms of hospitalization of children for treatment of asthma.

Methods: The numbers of hospital days, admissions, and individual patients admitted to the Children's Hospital in Göteborg because of acute asthma were recorded from 1985 through 1993. All the in-patient treatment of children is centralized at this hospital (i.e., the study was population-based). Göteborg has half a million inhabitants. Hospitalization policies were not altered during the study period.

Results: In children aged 2 to 18 years, the number of hospital days per year gradually decreased to less than a third ($r = 0.9$; $p < 0.001$), and admissions decreased by 45% ($r = 0.7$; $p < 0.05$). The decrease in hospitalization was most marked in the group older than the age of 5 years in which hospital days were reduced to one fifth ($r = 0.9$; $p < 0.0001$) and admissions were halved ($r = 0.8$; $p < 0.05$). A decreasing trend in number of hospital days was also seen in the 2- to 5-year-old group. The number of individual patients admitted did not show a statistically significant decreasing trend. In children under the age of 2 years, the number of hospital days fluctuated, and there was no clear-cut change with time.

Conclusion: Although increased concentration on the education of parents and patients may have been a contributing factor, the major reason for the decrease in hospitalization in the group of children aged 2 to 18 years is most probably antiinflammatory treatment with inhaled steroids. The results suggest that this is a very cost-effective therapeutic approach. (J ALLERGY CLIN IMMUNOL 1996;97:742-8.)

Key words: Asthma, children, hospitalization, inhaled corticosteroids, health economy

During the past 15 years, the prevalence of asthma in schoolchildren in Sweden has doubled from 2% to 3% up to 5% to 6%.¹⁻⁴ The same trend has also been demonstrated in other countries.⁵⁻⁸ In some countries, such as England and the United

States, the increase in the prevalence of asthma has led to increased hospitalization.⁹⁻¹¹

Concomitant with the increase in asthma prevalence, there has been a major change in asthma treatment during the past decade, with a shift of emphasis from bronchodilators toward continuous antiinflammatory treatment, mainly with inhaled steroids, in children with moderate or more severe asthma.¹²⁻¹⁴ In Sweden it appears that the net effect of these changes in adults has been profound in terms of reduced exacerbation rates, hospital admission rates, and number of hospital days for treatment of bronchial asthma.¹⁵ This is in contrast to reports from countries, such as Finland, of an increase in the number of asthma-related hospital treatment periods during 1972 to 1986, most pronounced among adults.¹⁶

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Since 1985, increasing numbers of children with asthma in Sweden have been treated with inhaled steroids. This study was performed to determine whether this change of treatment has had any impact on the requirement for and length of hospitalization of children with asthma in Göteborg, a major city in Sweden.

METHODS

With half a million inhabitants, Göteborg is the second largest city in Sweden. All the in-patient treatment of children is centralized at one hospital. As a result, this survey is population-based. Inpatient treatment for asthma for the period from 1985 through 1993 has been analyzed for each year in terms of the total number of hospital days, the total number of admissions, and the number of individual patients admitted. The figures for hospital days, admissions, and number of individual patients admitted were obtained from the database at the Children's Hospital. This database has been in operation since 1985 and is stored in a Digital Equipment VAX computer (Digital Equipment Corp., Maynard, Mass.). The age group younger than 2 years also included patients diagnosed as having "wheezy bronchitis." Figures for inpatient treatment of "asthmatic symptoms" are therefore given in this age group. Antiasthmatic drugs and inpatient hospital treatment are financed through taxes and are free of charge to patients. There were no major changes in the emergency room treatment of acute asthma during the study period. The same doctors were responsible for the asthma treatment policy at the department during the entire study period, and the instructions to the staff at the emergency room were not altered.

Statistical analysis of trends over the studied period was done by linear regression analysis with a StatView 4.01 package (Abacus Concepts, Inc., Berkeley, Calif.) for the Macintosh computer (Apple Computer, Inc., Cupertino, Calif.).

RESULTS

All children

From 1985 through 1993, there was a 60% reduction in the total number of hospital days, or bed days, for treatment of acute asthmatic symptoms in children, all ages included (Fig. 1, *A*). This decreasing trend was highly statistically significant ($r = 0.8$; $p < 0.01$). Focusing on admissions for treatment of asthmatic symptoms and the number of individual children admitted for inpatient treatment of asthmatic symptoms, a decreasing trend could also be seen in the number of admissions ($r = 0.7$; $p < 0.05$), whereas the number of individual patients admitted remained essentially unchanged ($r = 0.3$; $p = \text{NS}$) (Fig. 1, *B*).

Children aged 2 to 18 years

The drastic changes were particularly obvious in children older than 2 years of age, in whom there was a reduction to less than a third in the number of hospital days for asthma from 1985 through 1993 (Fig. 2, *A*). The figure gradually decreased from 1300 days per year to about 400 ($r = 0.9$; $p < 0.001$). The large reduction occurred from 1985 through 1990. The number of admissions decreased from 350 to 180 to 200 per year ($r = 0.7$; $p < 0.05$) (Fig. 2, *B*). The number of individual patients admitted in the beginning of the study period was 200 per year and about 140 at the end of the period (Fig. 2, *B*). However, this trend did not reach statistical significance ($r = 0.3$; $p = \text{NS}$).

When data for children aged 2 to 18 years were broken down by age, between 2 and 5 years and older than 5 years, it was seen that the decrease in hospitalization was most marked in the group older than the age of 5 years (Fig. 2, *A*, *hatched bars*) in which hospital days were reduced to one fifth. In this group hospital admissions per year gradually decreased from 250 to 100 to 130 per year ($r = 0.8$; $p < 0.05$) (Fig. 2, *B*, *hatched bars*). In the beginning of the period the number of individual patients admitted was 140, and at the end the number was 70 to 100 ($r = 0.5$; $p = \text{NS}$) (Fig. 2, *B*, *right, hatched bars*).

In the 2- to 5-year-old group the figure for hospital days per year was halved when the beginning and the end of the study period were compared (350 vs 140), although increases were seen in years with a high frequency of viral infections ($p = 0.05$; $r = 0.7$) (Fig. 2, *A*, *black bars*). In this age group, neither changes in admissions nor changes in number of individual patients admitted were significant ($r = 0.5$ and 0.02 , respectively) (Fig. 2, *B*, *black bars*).

Children younger than 2 years of age

In the group of children younger than 2 years of age, exactly as might be expected, the pattern was less clear-cut with an increase in the numbers of hospital days, admissions, and individual patients admitted in years with a high frequency of viral infections, particularly during those years when outbreaks of respiratory syncytial virus infections occurred (hospital days, $r = 0.5$; admissions, $r = 0.5$; individual patients, $r = 0.2$; all p values = NS) (Fig. 3).

During the study period the number of emergency room visits made because of asthma decreased by 40% in children older than 2 years of age, with a corresponding decrease in their share

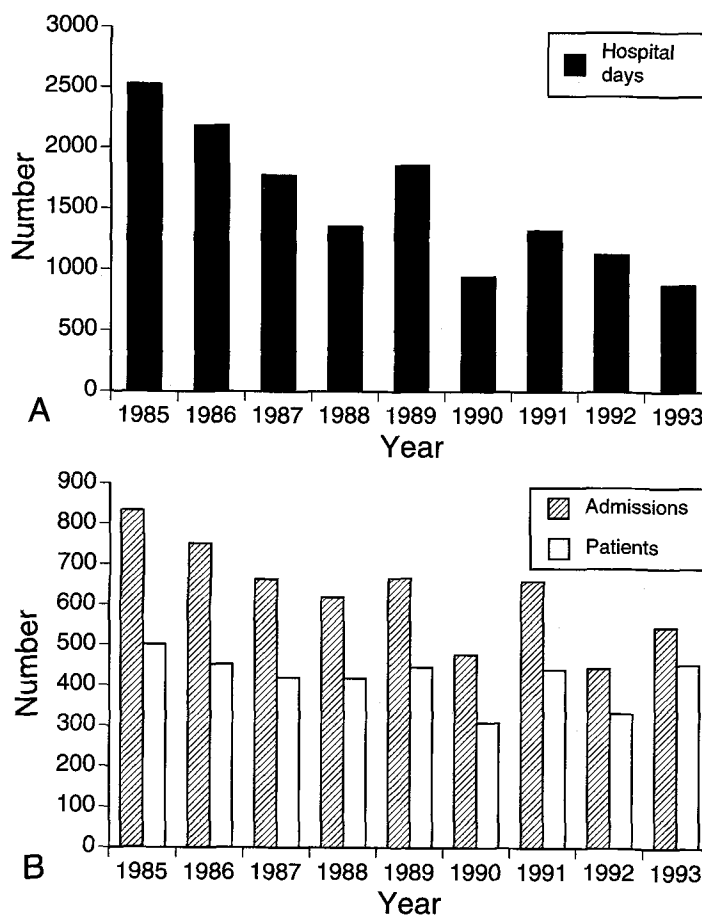


FIG. 1. Inpatient treatment in terms of number of hospital days (black bars) (A) and number of admissions (hatched bars) and individual patients admitted (unfilled bars) (B) for treatment of asthmatic symptoms, all children.

of the total number of pediatric visits, all diagnoses included, to the emergency room. In contrast, the number of visits for treatment of wheezing because of viral infections in the youngest age group (younger than 2 years) remained unchanged. During the study period there were no major changes in the population served by the hospital.

DISCUSSION

In Sweden, as in most industrialized countries, the most common chronic diseases in childhood are the atopic ones. Today, the prevalence of asthma among schoolchildren in Sweden is 5% to 6%,²⁻⁴ which constitutes a doubling of the prevalence of asthma over a period of 15 years.^{1,4} This evolutionary pattern appears to be similar to observations in other countries.⁶⁻⁸ Data available do not suggest that there has been an overall change in asthma severity in Sweden in the past 15 years, with an increase in prevalence but decrease in severity. Åberg et al.⁴ found that the

proportion of severe asthma was on the same level 1991 (24%) as in 1979 (20%). The results of their study indicate that the increased prevalence is real and not merely a reflection of an increased awareness of mild disease.

Asthma is a disease that generates high costs for the health care system. The continued increase in the number of patients with asthma emphasizes the economic problems caused by the disease. The total annual cost of asthma in the United States has been calculated to be about \$6200 million.¹⁷ For 1993 the annual cost of asthma to society in Sweden has been calculated at about \$400 million for adults and about \$70 million for children, amounting to a total of \$470 million.¹⁸

Early diagnosis and appropriate treatment of asthma reduces overall morbidity from the disease. Furthermore, optimal care and the successful implementation of asthma management plans are valuable not only for the well-being of the individ-

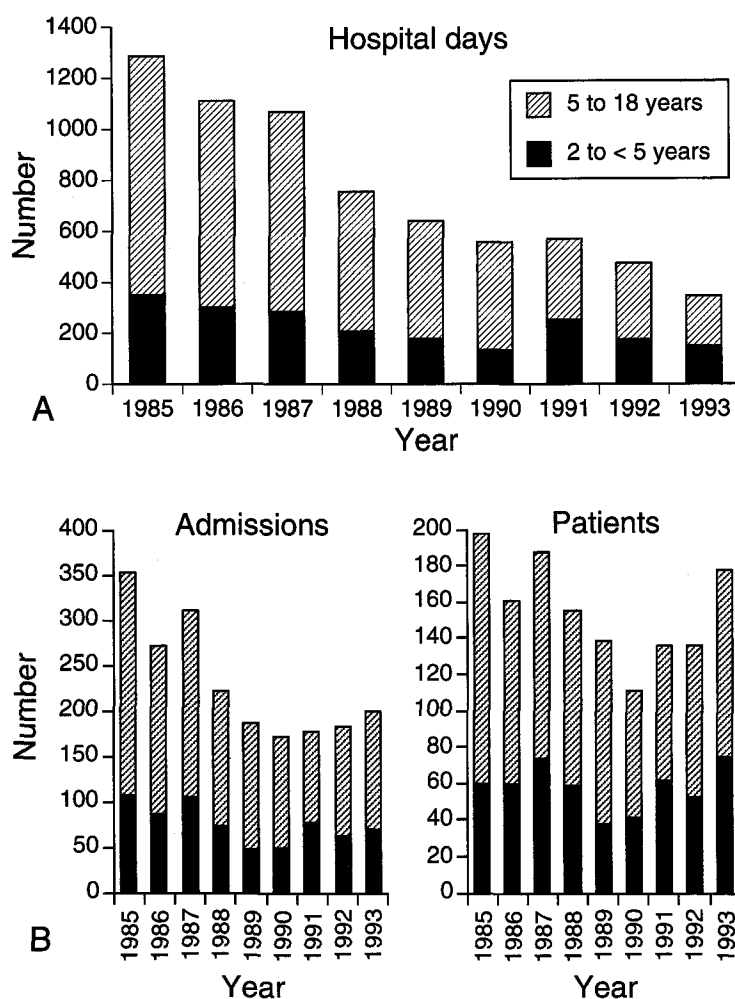


FIG. 2. Inpatient treatment in terms of number of hospital days (**A**) and number of admissions and individual patients admitted (**B**) for treatment of asthma in the group of children aged 2 to 18 years (2 to <5 years, black bars; 5 to 18 years, hatched bars), 1985 to 1993.

ual patient with asthma, but also for the profound effect they have on health economy.^{13, 19} Asthma management strategies of this type involve the avoidance of asthma triggers (e.g., passive smoking, house dust mites) and optimal drug therapy, which will definitely reduce morbidity. In addition, early intervention with effective antiinflammatory treatment most probably alters the natural course of the disease by facilitating the long-term maintenance of lung function.²⁰ Self-management plans for acute exacerbations, based on either peak flow or symptoms, have been shown to reduce asthma morbidity,²¹ and asthma education for children and adults has been demonstrated to reduce expenses, in addition to providing health benefits.^{22, 23}

Despite the increase in asthma prevalence, a decrease in the total number of days of hospital

treatment for asthma in adults and also in older children was noted in Sweden during the period from 1978 to 1989,¹⁵ and, according to this study, this decrease has also continued in recent years. This might be ascribed to the change in therapeutic approach, which has occurred during this period, with active antiinflammatory treatment, largely involving the introduction of inhaled steroids.²⁴ In Sweden inhaled steroids have been used more extensively since 1985.¹⁵

This study demonstrated a drastic reduction in the total number of hospital days required for treatment of acute asthma in children. The changes were seen in children older than 2 years of age, in whom the figure gradually decreased to less than a third. The corresponding number of admissions also decreased significantly over the period from 1985 through 1993. The children therefore

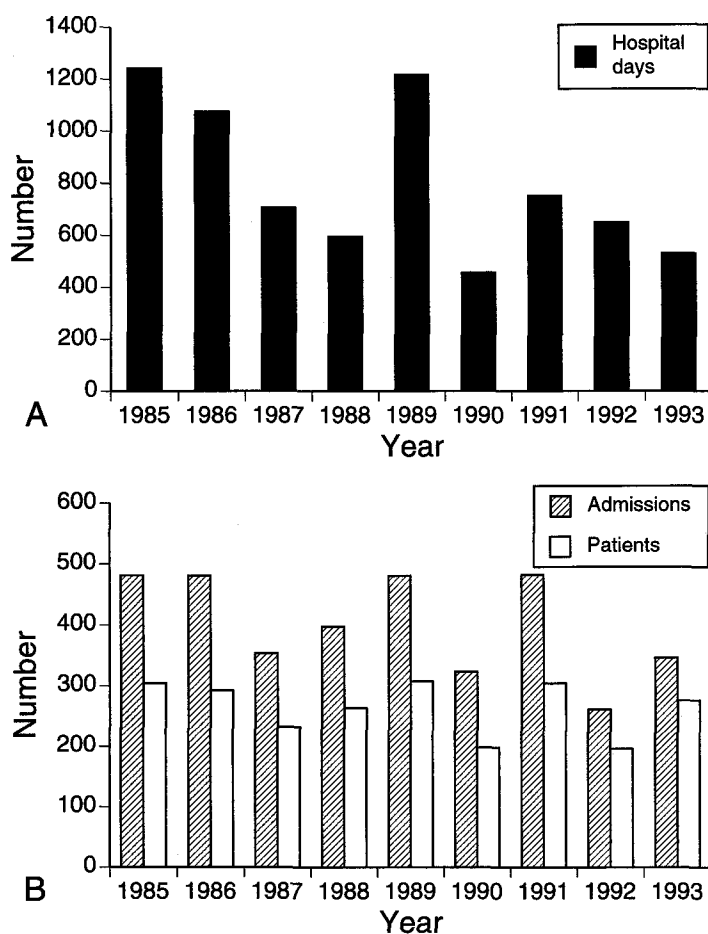


FIG. 3. Inpatient treatment in terms of number of hospital days (*black bars*) (**A**) and number of admissions (*hatched bars*) and individual patients admitted (*unfilled bars*) for treatment of asthmatic symptoms (**B**), in children younger than 2 years of age, 1985 to 1993.

required inpatient treatment less frequently, and when they did, they required a shorter hospital stay. There were no corresponding major changes in emergency unit policies for the treatment of acute asthma during this period, which could account for the observed changes. Although increased concentration on the education of parents and patients, leading to improved compliance, may have contributed favorably,²⁵ the major reason for this remarkable decrease in hospitalization in the age group older than 2 years is most probably the use of daily antiinflammatory treatment, mainly inhaled steroids.²⁶ The antiinflammatory therapeutic approach can therefore be assumed to be highly cost-effective. However, prescription of antiinflammatory treatment is without effect unless the medicine is taken. Therefore the antiinflammatory approach must be combined with parent and patient education in order to obtain good compliance.

The decreased hospitalization for treatment of asthma we have seen during the study period parallels the continuously increased overall use of inhaled steroids, and according to our experience of the individual patterns, there is usually a good correlation between introduction of maintenance treatment with inhaled steroids and achievement of asthma symptom control.

During the study period the use of β_2 -agonists and, particularly, theophyllines decreased. However, this was probably a consequence of increased use of antiinflammatory treatment and not a primary event. Therefore we do not believe that this was a contributing factor to the decreased hospitalization for treatment of asthma seen in the age group older than 2 years. Furthermore, the major decrease in hospital days for asthma occurred before the " β_2 -agonist debate"²⁷ (i.e., at a time when antiinflammatory treatment was usually combined with regular use of β_2 -agonists). Theophyl-

line treatment has been rather limited in Sweden; a further decrease has occurred in the last 5 years.

There is no evidence for any change in the prevalence of severely asthmogenic viruses prevalent in the past 15 years, which could explain our data (children aged 2 to 18 years). Neither were there any other known environmental changes during the study period, which could explain the decrease in hospitalization in the older age groups.

Asthmatic children, given effective antiinflammatory maintenance treatment, probably get less ill during deterioration of asthma and therefore probably require shorter hospital stays. It is not our impression that they were discharged earlier because of the availability of inhaled steroids.

The decrease in hospitalizations was most marked in the group older than 5 years, although a decreasing trend was also seen in the 2- to 5-year-old group. This supports an interpretation that there is a cause-and-effect relationship between the increased use of inhaled corticosteroids and the decrease in hospital days and admissions. Generally, physicians are less reluctant to prescribe inhaled steroids as the child gets older. It should, however, be recognized that we also use inhaled steroids, administered through a nebulizer or metered-dose aerosol inhaler and spacer in children younger than 5 years of age who have moderately severe and severe asthma that is not well controlled with a nonsteroidal regimen.

The assumption that the increased use of inhaled steroids is the major reason for the decrease in hospitalization for treatment of asthma is reinforced by the fact that the statistically significant changes were seen in the 2- to 18-year-old children, with the most pronounced effect in children older than 5 years, but not in those younger than 2 years of age. Treatment with inhaled steroids has been more widespread in older children than in the youngest age group. In children younger than 2 years old, hospitalization is due almost exclusively to asthmatic symptoms triggered by viral infections. This is reflected by the large fluctuations in the number of hospital days in small children, with high numbers during years characterized by high frequency of viral infections. The number of "individual patients admitted" in the group of children aged 2 to 18 years, or 5 to 18 years, did not show a statistically significant decreasing trend in contrast to the number of admissions and hospital days. This would be consistent with an increasing prevalence of asthma with a constant

inflow of new patients counterbalancing the effects of more effective treatment in children with established asthma.

In summary, the reduction of hospitalization for treatment of childhood asthma found in this study has occurred concomitantly with an increasing prevalence of the disease and is most likely due to successively increasing use of antiinflammatory treatment, largely in the form of inhaled steroids.

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