

Original article

Association between allergic rhinitis and hospital resource use among asthmatic children in Norway

Background: Preliminary evidence suggests that inadequately controlled allergic rhinitis in asthmatic patients can contribute towards increased asthma exacerbations and poorer symptom control, which may increase medical resource use. The objective of this study was therefore to assess the effect of concomitant allergic rhinitis on asthma-related hospital resource utilization among children below 15 years of age with asthma in Norway.

Methods: A population-based retrospective cohort study of children (aged 0–14 years) with asthma was conducted using data from a patient-specific public national database of hospital admissions during a 2-year period, 1998–1999. Multivariate linear regression, adjusting for risk factors including age, gender, year of admission, urban/rural residence and severity of asthma episode, estimated the association between allergic rhinitis and total hospital days. A multivariate Cox proportional-hazards model estimated relative hazard of readmission according to concomitant allergic rhinitis status.

Results: Among 2961 asthmatic children under 15 years of age with at least one asthma-related hospital admission over a 2-year period, 795 (26.8%) had a recorded history of allergic rhinitis. Asthmatic children with allergic rhinitis had a 1.72-times greater hazard of asthma-related readmissions than asthmatic children without allergic rhinitis. Multivariate analysis revealed that history of concomitant allergic rhinitis was a significant predictor of increased number of hospital days per year (least-squares mean difference 0.23 days, $P < 0.05$).

Conclusions: Concomitant allergic rhinitis in asthmatic children was associated with increased likelihood of asthma-related hospital readmissions and greater total hospital days.

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Key words: allergic rhinitis; asthma; children; hospitalization; readmissions.

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Accepted for publication 12 July 2004

Allergic rhinitis in conjunction with asthma is very common and it has been theorized that both conditions are expressions of a single inflammatory process (1–4). Canonica has noted that the association between asthma and rhinitis is supported by epidemiologic, histologic, physiologic and immunopathologic data. A recent World Health Organization (WHO) panel recommended that patients with asthma should be appropriately evaluated for allergic rhinitis and that a combined strategy should be used to treat the upper and lower airway diseases (5). Allergic rhinitis has been estimated to be present in nearly 15% of asthmatic children 6–7 years of age and in nearly 40% of 13–14 years old children with asthma (6, 7).

Emergency care is responsible for only approximately 1% of direct medical costs associated with allergic rhinitis (8, 9). However, emergency care visits or hospitalizations

account for 62% of expenditures on childhood asthma (10). Some evidence from the literature has shown that asthmatic children with comorbid allergic rhinitis utilize more health care resources than patients without allergic rhinitis (11). Allergic rhinitis was estimated to be 10–40% of total patient visits in 50% of primary care clinics in a survey of Singapore general practitioners (12).

The study reported here was undertaken to examine the association between allergic rhinitis and hospital resource use among asthmatic children in Norway. The specific objectives were to: assess and compare total hospital days experienced by asthmatic children with allergic rhinitis compared with those without allergic rhinitis and secondly, to estimate the relative hazard of readmission (RHR) among asthmatic children with allergic rhinitis as compared with those without allergic rhinitis.

Materials and methods

Data source and study design

The study was conducted as part of a larger project that examined variations in pediatric asthma resource use in Nordic countries and has been previously reported (13). The current retrospective cohort analysis focused on a subset of that data to examine the impact of allergic rhinitis on hospitalizations among pediatric asthma patients in five Norwegian regions (East, West, Mid, North and South). Longitudinal data on individual hospital admissions from a publicly available validated nationwide inpatient registry/database for children below 15 years of age were used. The study covered a 2-year period from 1998 through 1999.

Data on inpatient hospitalizations and inpatient resource use were extracted by identifying individuals recorded as hospitalized due to acute asthma exacerbation (ICD-codes 493.x, J45.x, J46.x) any time during 1998–1999. Variables for which data were collected included gender, age at first admission during the study period, comorbidities (up to eight), county of residence, and county of the hospital in which the stay occurred. Individuals were classified as having allergic rhinitis if they had any recorded allergic rhinitis diagnosis (ICD-10 codes J30.x and J45.0 and ICD-9 diagnoses 477.x and 493.0) by the physician who admitted them to the hospital due to asthma during the period from 1998 through 1999. Asthma patients with comorbidities other than allergic rhinitis were excluded. Therefore, the comparison groups consisted of asthmatics with allergic rhinitis as the only recorded comorbidity and asthmatics with no recorded comorbidities.

Statistical analyses

Multivariate regression was used to examine the association between total annual hospital days and allergic rhinitis while controlling for individual's age, gender, asthma type (based on ICD-codes), individual's home region, year of hospitalization (1998 or 1999), and urban/rural status. Bootstrap resampling with 250 iterations was used to estimate 95% confidence intervals (CI) for mean number of hospitalizations per year. The Cox proportional-hazards model was used to estimate RHR for patients with and without allergic rhinitis while controlling for covariates including age, gender, asthma type (based on ICD-codes), urban/rural status, and region. A readmission was defined as a separate admission to the hospital more than 1-week after the previous admission during the study period. A minimum of 7 days between hospitalizations was required to ensure that a subsequent hospitalization was due to a new exacerbation, and not an unresolved complication of the earlier admission, or transfer between departments. All statistical analyses were performed using SAS Version 8.2.

Results

Sample characteristics

A total of 2961 individuals with pediatric asthma constituted the sample and Table 1 shows their baseline characteristics. Approximately two-thirds of the children were males. However, as shown in Table 2, the prevalence of allergic rhinitis was approximately equal across males (25.6%) and females (26.0%). There was a pattern of increasing prevalence of documented allergic rhinitis with older age. The prevalence of allergic rhinitis in children

Table 1. Characteristics of hospitalized asthmatic children with and without allergic rhinitis (AR) in Norway (1998–1999)

	All children [n = 2961 (%)]	Children with asthma [n = 2166 (73%)]	Children with asthma-with-AR [n = 795 (27%)]	P-value*
Girls	984 (33)	732 (34)	252 (32)	NS
Age				
<2 years old	902 (30)	676 (31)	226 (28)	NS
2–5 years old	1,416 (48)	1,053 (49)	363 (46)	NS
6–14 years old	643 (22)	437 (20)	206 (26)	0.0008
Urban residence	783 (26)	568 (26)	215 (27)	NS
Severe asthma†	42 (1.4)	40 (1.85)	2 (0.25)	0.0011
Rehospitalized‡	295 (10)	184 (8.5)	111 (14)	<0.0001

*Statistical difference between patients with asthma alone vs patients with asthma-with-AR was tested using chi-square/Fisher's exact test for categorical data. NS, not statistically significant at $P = 0.05$.

†Reason for hospitalization was coded as severe asthma using ICD codes.

‡During the 1998–1999 period.

Table 2. Characteristics of hospitalized asthmatic children with allergic rhinitis (AR) [n = 795] in Norway (1998–1999)

	n (%)
AR rates by gender	
Proportion of boys with AR	543 (27.5)
Proportion of girls with AR	252 (25.6)
AR rates by age	
Proportion of patients <2 years old with AR	226 (25.1)
Proportion of patients 2–5 years old with AR	363 (26.0)
Proportion of patients 6–14 years old with AR	206 (32.0)

with asthma under 2 years of age was 25.0% but the prevalence was 32.0% in children aged 6–14 years.

Total annual hospital days

After controlling for gender and asthma severity, the number of total annual hospital days was positively associated with the presence of allergic rhinitis ($P < 0.0023$). As shown in Fig. 1, the mean total annual hospital days over the 2-year period adjusted for gender, age, urban/rural status, asthma severity, and location was 2.79 days for individuals having allergic rhinitis as compared with 2.56 for individuals without allergic rhinitis. The least-squares mean ($\pm 95\%$ CI) difference between the two groups was 0.23 (0.06–0.41). Total annual hospital days were also positively associated with certain age groups: <2 years ($P < 0.0001$) and 6–14 years ($P < 0.026$), with rural residence ($P < 0.0001$), and region where treated. Children from the South region had significantly more hospital days ($P < 0.0042$), while children from the North region had significantly lower hospital days ($P < 0.0001$) as compared with children from the East, i.e. Oslo region. Length of stay per hospital admission (mean 2.25 days, 95% CI 2.18–2.32), however did not differ between asthmatic children with (2.28 days,

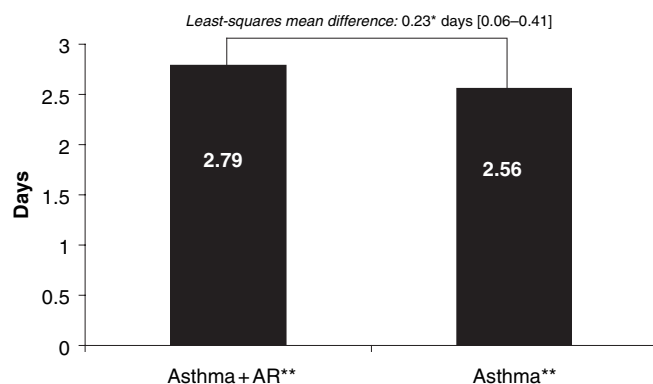


Figure 1. Mean total annual hospital days¹ per asthmatic child with and without allergic rhinitis (AR) in 1998–1999.

¹Predicted value of THD was modeled as $\ln \text{THD} = f(\text{AR}, \text{gender}, \text{age}, \text{urban/rural status}, \text{year}, \text{severity}, \text{location})$. Adjusted mean THD per 2-year study period was estimated as $\exp(\text{mean} + \frac{1}{2}\text{SD})$. 95% CI for the least-squares mean difference between groups was estimated via a bootstrap resampling procedure with 250 iterations. *Significant difference from zero at $P < 0.05$. **Significant difference between the groups at $P < 0.05$.

Table 3. Comparison of hospital readmissions among asthmatic children with AR and asthmatic children without allergic rhinitis (AR)

Relative hazard of readmission with 95% CI*,†	1.72‡ (1.34–2.21)
Proportion of children with AR re-hospitalized	110 (15%)
Proportion of children without AR re-hospitalized	182 (9%)

*Relative hazard ratio of readmission for 1998–1999 with 95% CI compares children with and without allergic rhinitis using Cox proportional hazards model adjusted for gender, age, asthma severity, urban/rural status, and geographic location.

†Odd ratio and 95% CI estimated with unadjusted chi-square test.

‡Significantly higher hazard of readmission at $P < 0.0001$.

95% CI 2.14–2.42) compared with those without concomitant allergic rhinitis (2.24 days, 95% CI 2.16–2.32).

Hazard of readmission

Table 3 illustrates the relative hazard ratios for patients with and without allergic rhinitis. Asthmatic children with allergic rhinitis had 1.72 times greater risk of experiencing at least one readmission for an asthma-related hospitalization as compared with those without allergic rhinitis ($P < 0.05$). The total percentage of asthmatic children with allergic rhinitis who experienced an asthma-related readmission (15%) was significantly higher than for asthmatic children without allergic rhinitis (9%).

Discussion

Several limitations should be considered in interpreting the study findings. Existing archival data, validated for

use in health services research (13) and used by ministries of health in respective countries, were used for this retrospective analysis. Hence, data on objective outcome measures such as lung function and disease history were not available. Therefore, it was not possible to conduct a detailed comparison of the severity of underlying asthma across the groups. It was possible only to establish severity of the current asthma episode. That was approximated through use of ICD codes in the database. The current analysis assumed the diagnosis of asthma as a cause of admission through ICD coding is reliable within the country and database examined. As ICD coding is not used for direct billing purposes in Nordic countries as it is in the US, adverse behavior with respect to coding would not be expected. However, if such behavior did exist, there is little reason to believe it would have a specific bias toward either of the comparison groups. Evidence also suggests that when classifying severity, which is based upon pathophysiology of the disease as well as medication use (18), patients may be falsely assessed with respect to asthma severity level on the part of physicians. Some of the patients might fall into a higher severity category, based on their underlying pathophysiology, but were well controlled at the time of assessment and were, ‘upgraded’ to a milder asthma category. This illustrates how assessment of severity level is inextricably confounded with the level of control (19). Hence, underlying asthma severity assessment may be problematic in itself. In addition, the specificity of the asthma diagnosis is probably low particularly in the younger children but lack of specificity of diagnosis is unlikely to significantly affect the comparison between the groups examined. Another limitation may be the diagnosis of allergic rhinitis, which was recorded as comorbidity by the physician who admitted the patient into the hospital due to asthma. The definition of allergic rhinitis was ICD-10 codes J30.x or J45.0 and ICD-9 codes 477.x or 493.0. The allergic rhinitis diagnosis could lack specificity, particularly in younger children as no specific tests were carried out to confirm the diagnosis. Physician assessment was the only means of determining the presence of comorbidity and allergic rhinitis was identified based on ICD codes assigned during hospitalization. If the physician perceived allergic rhinitis to be less important than other comorbidities, this may lead to underreporting. However, up to eight comorbidities were recorded for each admitted patient, reducing the likelihood of under recording. Despite this, caution should be exercised when interpreting the results.

The current findings confirm previous reports regarding the high prevalence of comorbid allergic rhinitis among asthmatics. For example, the International Study of Asthma and Allergies in Childhood (ISAAC) has reported comorbid allergic rhinitis in up to 40% of children 13–14 years of age with asthma (6, 7). Although, this study focused on patients who experienced asthma-related hospitalizations, allergic rhinitis was present in one-fourth of hospitalized asthmatic children under the

age of 2 years and 32% of children between 6 and 14 years and hospitalized for asthma. The lower prevalence in the current study may be due to ICD coding discussed above.

The overall impact of co-morbid allergic rhinitis in our study was higher total number of hospital days in children with asthma and allergic rhinitis than in asthmatics without allergic rhinitis even after adjusting for age, gender, asthma severity, year of admission, and residence region. However, the length of stay per hospital admission did not differ between the two groups (2.24 days in pure asthma group *vs* 2.28 days in comorbid group) so the difference in total hospital days may be partially attributed to higher rehospitalization rates for those with allergic rhinitis (15% *vs* 9%).

A recent study in a managed care organization reported hospitalization costs for their asthma patients did not account for as large a proportion of total costs as reported in other studies. Yet such costs still accounted for nearly one-third of asthma-related costs in that organization (11). Lozano et al. found that children with asthma had 2.4 times the total health care charges of the general population of children and had 3.5 times as many hospitalizations. Among children with asthma, the youngest children (1–4 years) used more services than 10–17-year-old children, who used more than 5–9-year-old children (10). A recent study of children with asthma in Finland also found that younger children (2–5 years old) consumed three times more inpatient resources than older (6–14 years old) children (14). Although it was not possible to compare resource use with that of children without asthma in the current study, more hospital days were used by the youngest age group (<2 years old).

Yawn et al. found a greater than 50% prevalence of allergic rhinitis in children and young adults with

symptomatic asthma (15). Yearly medical care charges were on average 46% higher for individuals with asthma and allergic rhinitis than for persons with asthma alone after controlling for age and gender (15). In a historical cohort study of children in a US staff model health maintenance organization, a significant positive association was found between having allergic rhinitis and belonging to the highest quintile of asthma cost (OR: 4.10) for allergic rhinitis (16). Adam et al. in a retrospective cohort study of 13 844 members of a managed care organization with asthma found that treating nasal conditions with intranasal corticosteroids reduced asthma exacerbations and emergency visits (17).

In conclusion, the presence of concomitant allergic rhinitis in children under 15 years of age with asthma is associated with greater total asthma-related hospital days as compared with those for asthmatic children without allergic rhinitis. Allergic rhinitis increased the likelihood of asthma-related hospital readmissions. These findings support the WHO recommendations for appropriate evaluation of both upper and lower airway disease in asthmatics. The current findings would seem to support further exploration of special effort to identify children with both diseases to assure appropriate management of both aspects of their disease to improve outcomes and reduce resource utilization. Appropriate focus on the dual nature or comorbid nature of asthma in many children may assist in improving control of exacerbations and reducing the additional resource use among asthmatic children with allergic rhinitis.

Acknowledgments

The study was supported in part by a research grant from Merck & Co., Inc., Whitehouse Station, NJ, USA.

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