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Impact of delay in asthma diagnosis on health care service use

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Abstract

Delays in diagnosing asthma in children are common and are known to delay asthma-specific treatment. Few studies have investigated whether a delay in asthma diagnosis impacts the use of health care services. This study was designed to assess whether a delay in diagnosis of asthma influences the use of health care services. This was a retrospective cohort study with subjects elicited from a convenience sample of 839 healthy children. The criteria for asthma was met in 276 (33%) subjects; of these subjects 179 (65%) had a delay in the diagnosis of asthma and 97 (35%) had a timely diagnosis. Data on health care services (*e.g.*, flu shot, availability of a peak flow meter, hospitalizations, and urgent care or emergency department visits) and the frequency of systemic steroid treatments were collected from medical records during the first 18 years of life. The frequencies of health service and use of systemic steroids were compared using Poisson and logistic regression models in asthmatic children with and without a delay in asthma diagnosis. Children with a delay in asthma diagnosis were more likely to visit urgent care centers at least once (40.8% versus 21.6%; $p < 0.001$), compared with those with a timely diagnosis. There were no significant differences in other health care service or systemic steroid use. A delay in the diagnosis of asthma was associated with an increase in urgent care visits suggesting suboptimal care. Clinicians should be aware that a delay in the diagnosis of asthma in children may result in the use of suboptimal health care services.

Keywords

Accessibility; adolescent; asthma; child; control; delivery of health care; diagnosis; health services; treatment; urgent care

To improve the value of asthma care, it is critical to evaluate the importance of establishing a timely asthma diagnosis. We previously described two important durations that precede the establishment of the diagnosis of asthma: (1) the duration between the onset of asthma symptoms and index date (when a patient first meets criteria for the diagnosis of asthma) and (2) the duration between the index date and the date of asthma diagnosis by clinicians.¹ We define the asthma index date as the date at which emerges the earliest constellation of

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symptoms that meet predefined criteria for asthma regardless of whether or not a clinician diagnoses the patient at that time with asthma. The duration between onset of asthma symptoms and index date may closely relate to the nature of the disease and may reflect the natural history of asthma. The duration between the index date of asthma and the diagnosis of asthma may relate to health care use as well as the efficiency of diagnosis and may reflect access of asthmatic patients to therapeutic and preventive health services for asthma.

Delays in diagnosing asthma in children are common.^{2–6} For example, we previously reported that almost two-thirds of children who met the criteria for asthma had a delay in diagnosis of asthma and the delay was as long as 3 years from the time when one met the criteria for asthma.² A delay in the diagnosis of asthma is associated with suboptimal or no treatment for asthma.^{3,4,6} Early identification and treatment of asthma with inhaled corticosteroids can decrease airway inflammation and may result in more optimal disease control in the long term.⁷ However, little is known about the impact of the delay in asthma diagnosis on asthma-related health care service use. The delay in the diagnosis of asthma becomes a significant clinical and public health concern because appropriate asthma-specific care should prevent patients from serious illnesses or complications. For example, the Advisory Committee on Immunization Practices in 2009 recommended asthma as a priority group to receive the limited supply of novel H1N1 influenza vaccine.⁸ Thus, it is important to assess the potential impact of a delay in the diagnosis of asthma on asthma-related health care services.

Previous studies investigating the effects of a delay in the diagnosis of asthma relied on parental report, did not follow patients longitudinally, and did not use an index date of asthma ascertained by predetermined criteria for asthma. We hypothesize that a delay in asthma diagnosis will increase systemic steroid use, hospitalizations for asthma, and overall emergency department (ED) and urgent care visits while decreasing the use of influenza vaccine, asthma action plans, and peak flow meters. To test this hypothesis, we addressed the limitations of previous studies by conducting a retrospective cohort study that ascertained asthma status by predetermined criteria for asthma, determined the index date of asthma as the beginning point of a delay in the diagnosis of asthma, and collected all therapeutic and preventive health care services for asthma from the index date.

METHODS

Study Design and Setting

The study was a retrospective cohort study conducted in Rochester, MN, located in Olmsted County. The study protocol was approved by the Institutional Review Board at both the Mayo Clinic and the Olmsted Medical Center. Because of the geographic isolation, medical care in Rochester is virtually self-contained within these two medical centers and all inpatient and outpatient data have been unified and indexed for research in an automated form since 1935.⁹ With the exception of a higher proportion of the working population employed in the health care industry, the characteristics of the city of Rochester and Olmsted County population are similar to those of the U.S. white population.¹⁰

Study Subjects

The details about the study subjects were previously described by Molis *et al.*² Briefly, the original study cohort (a population-based stratified sample) of 876 children aged 5–12 years at the time of the original study was identified and enrolled from all children who attended the Rochester School District in 1993. At the time of our data collection between 2002 and 2008, the study subjects were 14 years old. Among these 876 children, 276 met the criteria for asthma and were the subjects for this present study.

Ascertainment of Asthma Cases

We ascertained asthma status by using predetermined criteria for asthma listed in the publication by Molis *et al.*² Therefore, ascertainment of asthma status was independent of the physician diagnosis of asthma. The details of how the criteria were applied were previously described by Molis *et al.*² Previous asthma epidemiology research has also used these same criteria to define asthma and found this to be reliable.^{10,11}

Dependent Variables

The dependent variables in this study included frequency of systemic steroid treatment episodes and the use of asthma-related health care services (asthma action plan, any influenza vaccine, the availability of a peak flow meter, asthma-specific hospitalizations, and asthma-specific urgent care or ED visits). Urgent care is defined as outpatient clinical care for acute illness or injury in a location other than a primary care office or the ED. We calculated the frequency of systemic corticosteroid therapy and asthma-related health care service use from the index date of asthma (*i.e.*, when one met the criteria for asthma) to the last follow-up before 18 years of age or 18th birthday, whichever came first.

Independent Variable

The independent variable for this study was timeliness of asthma diagnosis. The details of how timeliness of asthma diagnosis was determined were described previously by Molis *et al.*² Briefly, timeliness of asthma diagnosis was defined when the index date of asthma and asthma diagnosis date were the same. A delay in the diagnosis of asthma was defined if there was a discrepancy between the index and diagnosis date of asthma documented in medical records.

Statistical Analysis

The primary analysis was to compare the frequency of asthma-related health care service use. The occurrence of each outcome was limited to the time interval between the time the subject met the asthma criteria (*i.e.*, index date) and their last follow-up before 18 years of age or 18th birthday, whichever came first. The association between the timeliness of asthma diagnosis and the number of visits or treatments (asthma-related urgent care or ED visits and systemic steroid treatments over the time interval, respectively) was assessed by fitting separate Poisson regression models. The observations used in the Poisson regression models were the actual number of visits or treatments, which were offset by the natural logarithm of the duration of follow-up described previously. Overdispersion was accounted for by estimating a dispersion parameter (*i.e.*, deviance divided by its degrees of freedom), which was then used to adjust the variance of the parameter estimates. For each binary outcome variable (availability of peak flow meter, availability of asthma action plan, administration at least one influenza vaccine, and any asthma-related hospitalizations), the association with the timeliness of asthma diagnosis was assessed by fitting separate logistic regression models adjusted for the natural logarithm of the duration of follow-up for each individual subject. All calculated *p* values were two-sided and values of *p* < 0.05 were considered statistically significant. Statistical analyses were performed using the SAS software package (SAS Version 8.2; SAS Institute, Inc., Cary, NC).

RESULTS

Study Cohort

The details of sociodemographic characteristics and risk factors affecting timeliness of asthma diagnosis in our cohort were previously reported.² Briefly, of the 276 children with asthma, 54% were boys and 96.6% were white. Among the 276 asthmatic children, 179

(65%) had a delay in asthma diagnosis (a median delay of 3.3 years; interquartile range [IQR], 0.6–7.6 years) and 97 (35%) had a timely diagnosis. Of the 179 children with delayed diagnosis, 57 (32%) had not received an asthma diagnosis before their last follow-up or 18th birthday and the median delay for the other 122 children was 1.4 years (IQR, 0.2–3.8 years). The median age at the index date of asthma was 8.0 and 7.7 years, respectively, for those with versus those without a delayed diagnosis. The median duration of follow-up was 9.3 (IQR, 6.1–13.1 years) and 7.9 (IQR, 3.4–13.3 years) years, respectively, for those with versus those without a delayed diagnosis.

Influence of a Delay in the Diagnosis of Asthma

The results on the influence of a delay in the diagnosis of asthma on asthma-related health care service use and systemic corticosteroid use are summarized in Table 1. Children with a delay in asthma diagnosis were more likely to visit urgent care centers (mean of 2.9 visits/10,000 person-days versus 1.1 visits/10,000 person-days; $p < 0.001$), compared with those without a delay in diagnosis. In particular, 73 (40.8%) of the 179 children with a delay in their asthma diagnosis had at least one visit to an urgent care center compared with 21 (21.6%) of the 97 children without a delay in diagnosis (95% CI for difference [19.1%] = 8.2–30.0%). However, there was no significant difference between the two groups in the number of asthma-related ED visits or hospitalizations. Children with a delay in the diagnosis of asthma were more likely treated with systemic corticosteroids and were less likely to have a written asthma action plan compared with children with a timely diagnosis but these associations were not statistically significant.

DISCUSSION

Our results show that children with a delay in the diagnosis of asthma are more likely to visit an urgent care setting compared with those without such a delay. Inadequate preventative asthma therapy and its resulting poor control of asthma or parental anxiety regarding respiratory symptoms without a diagnosis of asthma may be factors contributing to increased urgent care use in children with a delay in the diagnosis of asthma.

Our observation of more frequent urgent care visits among children with a delay in the diagnosis of asthma needs to be understood under a framework that parents (*e.g.*, understanding of asthma and proficiency of asthma management), clinicians (*e.g.*, quality of asthma care), patients (*e.g.*, clinical nature of asthma), health care systems (*e.g.*, access), and other environmental factors (*e.g.*, physical or social factors) interplay. The important basis of this framework would be the ecological model of asthma and health care in general.^{12–14} We postulate a few explanations for increased urgent care visits among children with a delay in the diagnosis of asthma under this framework.

For the parental domain, a diagnostic delay may lead to parental uncertainty or even anxiety regarding the etiology of respiratory symptoms in the absence of a diagnosis of asthma, which may prompt parents to seek medical care at an urgent care setting. In addition, parents of children without a diagnosis of asthma are less likely to visit with a physician on a regular basis for proper education and management of asthma⁵ and lack a proper understanding and care plan (*e.g.*, asthma action plan) as shown in our data, which may lead parents to frequent asthma-related urgent care visits. Previous studies revealed that children are more likely to have a timely diagnosis of asthma if there is a family history of asthma.^{2,15} It is possible that a family history of asthma may be a surrogate indicator of parents' asthma knowledge or proficiency of asthma management through their own experiences with asthma management.

For the health care provider domain, frequent urgent care visits among children with a delay in the diagnosis of asthma may be caused by poorly controlled asthma secondary to

inadequate therapy by clinicians given the urgent care use as a marker for poorly controlled asthma.^{16,17} The Tuscon Children's Respiratory Study found that 92% of diagnosed asthma patients with wheeze used an asthmatic medication at least once compared with only 46% of children with wheeze who did not have a diagnosis of asthma ($p < 0.00001$).⁶ Yeatts *et al.* found that 12% of undiagnosed frequent wheezers used inhalers during the past 12 months compared with 78% of children diagnosed with asthma ($p < 0.0001$).⁵ Thus, clinicians may be still in a position to reduce urgent care visits by ascertaining asthma status in a timely manner and improving asthma care.

For the patient domain, it is possible that patients with a timely diagnosis may have had the confounding risk factor of a more severe underlying disease. A prior analysis of our study cohort showed that children with a timely asthma diagnosis were more likely to have definite instead of probable asthma symptoms (risk ratio, 3.3; 95% CI, 2.43–4.47; $p < 0.001$) and moderate to severe clinician-graded asthma severity (risk ratio, 1.59; 95% CI, 0.95–3.36; $p = 0.081$) instead of mild intermittent or inactive asthma.² Asthmatic children with a delayed asthma diagnosis may have less severe underlying disease and may rely on more episodic asthma care from urgent care centers.

For the health care system, the increased urgent care visits might be a cause of a delay in the diagnosis of asthma instead of an effect of a delay in the diagnosis of asthma because the increased urgent care visits might have interfered with the integrity of the medical home and continuity of medical care by the primary care clinician. Proprietors of urgent care centers do not intend for them to diagnose and manage chronic health conditions such as asthma when compared with medical homes or primary care practices. Perhaps a delay in the diagnosis of asthma and frequent urgent care visits may be different outcomes of a common underlying construct such as access to appropriate health care (*e.g.*, primary care service) instead of a causal relationship between a delay in the diagnosis of asthma and frequent urgent care visits. However, fragmented care between primary care and urgent care can be mitigated by technological advancement such as electronic medical records linking primary care and urgent care services and implementation of continuity of care between these two settings.¹⁸ Our data may highlight the need for better coordinated care between primary care and urgent care centers. For other environmental factors, we did not assess the role of such factors but the literature suggests the importance of such environmental factors (*e.g.*, physical, language, socioeconomic status, cultural, and neighborhood factors) and future studies should take into account these factors.^{19–24}

The strengths of our study include the fact that our data were obtained by comprehensive medical record review during the first 18 years of life of subjects in a virtually self-contained health care environment with a unified medical record system. Our asthma ascertainment is based on predetermined criteria for asthma, which is more accurate than parental report or ICD code alone.²⁵ Our study subjects were a population-based sample from the Rochester School District, which may help to minimize susceptibility bias. Our study has an inherent limitation as a retrospective study. The unique sociodemographics of Olmsted County, especially with the predominantly white study subjects and the large proportion of people who work in the health care industry, may limit generalizability to children in different settings or with other ethnic backgrounds. Our study did not assess the role of many relevant factors under each domain of the framework as discussed previously and future studies need to address this limitation. Finally, our study was limited by a small sample size and, thus, the main results in Table 1 should be interpreted in this context.

In conclusion, a delay in diagnosis of asthma in children may lead to increased urgent care visits, suggesting suboptimal asthma control or care. Clinicians must remain cognizant to the

fact that there is often a delay in the diagnosis of asthma in children, which may result in suboptimal asthma management and control.

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Table 1

Association of timeliness of asthma diagnosis on health care service use and systemic steroid therapy

Parameter <i>n</i> (%)	No delay (<i>n</i> = 97)	Delay (<i>n</i> = 179)	<i>p</i> Value
No. of p.o. or i.v. steroids			0.25
None	75 (77.3)	128 (71.5)	
1	12 (12.4)	24 (13.4)	
2	10 (10.3)	27 (15.1)	
No. of asthma-related ER visits			0.93
None	68 (70.1)	133 (74.3)	
1	19 (19.6)	24 (13.4)	
2	10 (10.3)	22 (12.3)	
No. of asthma-related urgent care visits			<0.001
None	76 (78.4)	106 (59.2)	
1	17 (17.5)	35 (19.6)	
2	4 (4.1)	38 (21.2)	
Availability status of peak flow meter	26 (26.8)	46 (25.7)	0.77
Availability status of asthma action plan	9 (9.3)	8 (4.5)	0.11
Flu shot	23(23.7)	35 (19.6)	0.33
Any asthma-related hospitalizations	4 (4.1)	9 (5.0)	0.86

Poisson regression models (SAS procedure GENMOD; SAS Institute, Inc., Cary, NC) were fit to evaluate the association between timeliness of asthma diagnosis (delay vs no delay) and the number of outpatient medical visits and the number of systemic steroid treatments. The maximum number of visits or treatments are truncated in the table for display purposes only. Logistic regression models were fit to evaluate the association between timeliness of asthma diagnosis and whether the patient received each of the treatments (yes vs no). The models were adjusted for the natural logarithm of the duration of follow-up (time interval between the time the child met the asthma criteria and the date of their last follow-up before 18 years of age or 18th birthday, which ever came first).

ER = emergency room.