Identifying children with persistent asthma from health care administrative records

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BACKGROUND: Investigation into the origins of asthma is contingent on definitions of asthma, which can differentiate asthma from transient wheezing syndromes in children.

OBJECTIVES: This research was undertaken to develop a definition for asthma derived from health care administrative records, which would identify children with persistent asthma.

PATIENTS AND METHODS: Using population-based, health care administrative data, children with possible asthma were identified as having one or more physician visits or hospitalizations for asthma or bronchitis diagnoses from January 1995 to December 1995, or, in the absence of asthma-like diagnoses, one or more prescriptions for asthma prophylaxis drugs or ketotifen concomitant with a beta-agonist, or two or more prescriptions for beta-agonists.

RESULTS: The likelihood of persistent asthma, defined as repeated health care and prescription use for asthma from 1996 to 1998, was assessed for various asthma markers and risk factors in 29,198 children with possible asthma. Children with asthma prescription drugs or asthma health care use not limited to the winter season were three to six times more likely than children without these characteristics to have persistent asthma. The likelihood of persistent asthma was elevated to a substantial degree in the presence of both of these markers.

CONCLUSIONS: The inclusion of these measures in a diagnosis-based definition improves the ability to identify persistent asthma in children.

Key Words: Asthma; Child; Databases; Drug; Epidemiology; Prescriptions

Investigation into the origins of asthma is contingent on valid definitions of childhood asthma (1,2). Numerous definitions have been used (3). Symptom-based definitions of asthma are reproducible (4-6), but cannot distinguish asthma from transient wheezing syndromes (3,7,8). Measures based on physician diagnoses of asthma are subject to similar limitations and have the potential caveat of biased assignment of diagnosis (9-11). Physiological measures, such as bronchial reactivity tests, are highly correlated with the underlying inflammatory

Le dépistage des enfants atteints d'asthme permanent à partir des dossiers de santé administratifs

HISTORIQUE : Les explorations sur les origines de l'asthme dépendent des définitions de l'asthme, qui peuvent distinguer l'asthme des syndromes de wheezing transitoire chez l'enfant.

OBJECTIFS : La présente recherche a été entreprise pour élaborer une définition de l'asthme dérivée des dossiers de santé administratifs permettant de dépister les enfants atteints d'asthme permanent.

PATIENTS ET MÉTHODOLOGIE : Au moyen de dossiers administratifs de santé de la population, des enfants susceptibles de souffrir d'asthme ont été dépistés selon au moins une consultation auprès d'un médecin ou au moins une hospitalisation découlant d'un diagnostic d'asthme ou de bronchite entre janvier et décembre 1995 ou, en l'absence de diagnostic semblable à l'asthme, au moins une ordonnance de médicament en prophylaxie de l'asthme ou de kétotifène prescrit conjointement avec un bêta-agoniste ou au moins deux ordonnances de bêta-agoniste.

RÉSULTATS : La probabilité d'asthme permanent, défini comme des soins répétés et le recours à des prescriptions contre l'asthme entre 1996 et 1998, a été évaluée selon divers marqueurs et facteurs de risque d'asthme chez 29 198 enfants peut-être asthmatiques. Les enfants à qui on avait prescrit des médicaments contre l'asthme ou qui avaient reçu des soins à cet égard au cours d'autres saisons que la saison hivernale étaient de trois à six fois plus susceptibles de souffrir d'asthme permanent que les autres. La probabilité d'asthme permanent augmentait à un degré substantiel en présence de ces deux marqueurs.

CONCLUSION : L'inclusion de ces mesures dans une définition diagnostique améliore la capacité de dépister l'asthme permanent chez les enfants.

process of asthma, but are not commonly performed beyond the research setting (12-15). Asthma drug therapy-based measures identify children currently experiencing asthma symptoms, but because asthma drugs are also used in the symptomatic treatment of wheezing disorders, these measures may lack specificity (16-18).

Improvements in the validity of definitions for childhood asthma have been achieved by various combinations of the symptom, diagnosis, drug and physiological measures (19,20).

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The inclusion of factors that predict persistent asthma versus transient wheezing, such as history of allergy and the presence of year-round symptoms, have the potential to further improve validity (7,21-24). Health care administrative records, which can be linked longitudinally to create histories of health care use (25), hold promise in testing the predictive value of these definitions in differentiating transient wheezing from persistent asthma. The objective of this research was to identify measures from population-based health care administrative records that predict persistent asthma in children.

PATIENTS AND METHODS

Data for this study were obtained from four population-based, electronic databases maintained by the Manitoba Health Services Insurance Plan (MHSIP): registration files, physician reimbursement claims for diagnosis information, hospital discharge abstracts for diagnosis information and records of prescriptions dispensed in retail pharmacies. The study protocol was approved by the Health Research Ethics Board, University of Manitoba (Winnipeg, Manitoba) and the Manitoba Health Access and Confidentiality Committee.

The MHSIP registration files contain records for every individual eligible to receive insured health services, and records of birth date, sex and geographical location. Records of physician reimbursement for medical care provided are submitted under a fee-for-service arrangement and contain information on patient diagnosis at the three-digit level of the International Classification, Ninth Edition, Clinical Modification (ICD-9-CM) classification system and physician specialty. Discharge abstracts for hospital services include information on up to 16 ICD-9-CM diagnostic codes, of which the first diagnosis is the primary diagnosis responsible for the hospital stay. Prescription records, which are submitted by retail pharmacies for reimbursement by provincial drug insurance plans and for drug use review purposes, contain data on the date of prescription dispensing, drug name and identification number, dose form and quantity dispensed. The reliability and validity of the MHSIP databases have been shown to be high for describing population drug use and health care contact for specific conditions (26,27). The prescription database captures virtually all prescriptions dispensed in retail pharmacies. Record links among databases were created using anonymous personal identifiers to create longitudinal histories of health care use.

Children, aged five to 15 years in January 1995 and registered with the MHSIP until March 1998, were identified as having possible asthma on the basis of the following, documented in the MHSIP's databases from January to December 1995: at least one physician visit or hospitalization (primary diagnostic field) for asthma-like diagnoses (asthma, ICD-9 code 493; bronchitis, ICD-9 codes 490 and 491; bronchiolitis ICD-9 code 466); in the absence of these diagnoses, at least one prescription for an inhaled corticosteroid (beclomethasone, budesonide, fluticasone) or cromone, for ketotifen concomitant with an inhaled or oral beta-agonist (salbutamol, fenoterol), or two or more prescriptions for an inhaled or oral beta-agonist. Asthma-like conditions were included to prevent exclusion of children with asthma, but who were diagnosed with bronchitis (24,28). The definition excluded children with singular use of bronchodilators and no asthma diagnosis (16).

Using the cohort of children with possible asthma, several validity assessments were undertaken to refine further the asthma definition. These included comparisons with survey estimates of asthma prevalence reported in the literature, cross-validation of the drug and diagnosis components of the definition, and tests of discriminant construct validity to differentiate between persistent asthma and not persistent asthma (29). Persistent asthma was defined as repeated physician visits or hospitalizations for asthma-like conditions or prescriptions for asthma drugs. It was applied to health care administrative records of children with possible asthma as follows: at least one health care visit for an asthma-like condition (asthma, bronchitis, bronchiolitis) or one prescription for an asthma drug (inhaled or oral beta-agonist, corticosteroid or cromone) in the next two years, January 1996 to March 1998. Not persistent asthma was defined as the absence of these criteria. For the cross-validation exercise, the proportion of children with asthma prescription drugs who also had an asthma diagnosis was determined. The prescription of an asthma drug was used as the gold standard, because all children with asthma are treated with asthma drugs at some point, especially children experiencing current symptoms (17,18).

The discriminant construct validity analysis identified database-derived asthma markers or risk factors that distinguished between persistent and not persistent asthma (30). The purpose of this analysis was to identify predictors of persistent asthma that could be added to enhance health care database definitions of asthma in children. A cohort of children with health care for asthma-like conditions or asthma drug prescriptions from January to December 1995 was followed longitudinally to identify children with persistent asthma, as defined in the previous paragraph. The likelihood (odds ratio) of persistent versus not persistent asthma for individual measures was determined from multivariate logistical regression models. All measures were derived from health care and prescription databases for the calendar year 1995, with the exception of those that were assessed from the time of birth. In addition to physician diagnosis (at least one asthma diagnosis versus bronchitis diagnoses only since birth) and prescription drug measures (at least one inhaled beta-agonist [salbutamol, fenoterol], at least one maintenance drug such as inhaled corticosteroids [beclomethasone, budesonide, fluticasone] or cromones, at least one oral corticosteroid), the following measures were tested in the multivariate models: age, sex, prematurity status at birth (gestational age 36 weeks or less or a diagnosis of prematurity, respiratory distress syndrome or bronchopulmonary dysplasia within one year of birth recorded in hospitalization records), time since first health care contact for an asthma-like condition, number of hospitalizations per year for asthma-like conditions from birth to January 1995, physician visits or hospitalizations for allergic disorders (eg, hayfever, eczema) and pattern of health care use (1,9,19,20,22,23,31-34). The latter measure classified children as having winter-only health care for asthma-like conditions or asthma drug prescriptions, or not winter-only health care if health care use was not limited to the winter season (November to February) (21,24). Low-income neighbourhood status (from Census 1996 household income data [35-37]), treaty Indian status and single-parent, income-assisted household status were included in models to adjust for sociocultural differences in health care use (38). Aside from age, number of hospitalizations and time since first contact, study measures were added to regression models in the categorical format. The logistical regression analysis was conducted using the

TABLE 1
Sensitivity and specificity of asthma diagnoses using asthma drugs as the gold standard (children in 1995)

	Asthma drug prescription (n)	No asthma drug prescription (n)	Total (n)
Asthma-like diagnosis	11,514*	13,626	25,140
No asthma-like diagnosis	4058	145,010†	149,068
Total	15,572	158,636	174,208

*Sensitivity = $11,514/15,572 \times 100 = 73.9\%$; †Specificity = $145,010/158,636 \times 100 = 91.4\%$

TABLE 2
Likelihood of persistent asthma* in children with asthma diagnoses and asthma drug prescriptions, 1995

Measure	Children with persistent asthma (%)	Adjusted† odds ratio for asthma diagnosis or drug versus none (95% CI)
Asthma diagnosis (n=18,955)	75.5	1.72 (1.61 to 1.84)
Bronchitis diagnosis (n=10,243)	33.3	1.00 reference
Inhaled beta-agonists (n=15,669)	84.3	5.51 (5.16 to 5.88)
No beta-agonists (n=13,529)	33.2	1.00 reference
Maintenance drugs‡ (n=10,690)	86.6	2.71 (2.51 to 2.92)
No maintenance drugs (n=18,508)	45.7	1.00 reference
Oral corticosteroids (n=4796)	93.0	6.59 (5.83 to 7.46)
No oral corticosteroids (n=24,402)	54.3	1.00 reference

*Health care for asthma-like diagnoses and prescriptions for asthma drugs in 1996 to 1998; †Adjusted for treaty Indian status, single-parent, income-assisted households and neighbourhood income, and all measures in Table; ‡Inhaled corticosteroids, sodium cromoglycate, ketotifen and salmeterol

stepwise forward elimination process, and variables were retained at the 95% level of confidence.

RESULTS

Among 174,208 Manitoba children aged five to 15 years, 25,140 (14.4%) had at least one physician visit or hospitalization attributed to an asthma-like condition over the time period from January 1995 to December 1995. Over the same time period, 15,572 (8.9%) had received at least one prescription for an asthma drug (excluding singular use of bronchodilators). A total of 29,198 children or 17% of Manitoba children met the case definition for possible asthma, based on the presence of asthma-like diagnoses or asthma prescription drugs. Seventy-four per cent of children with an asthma drug prescription had a health care visit for an asthma-like diagnosis in the calendar year 1995, known as sensitivity (Table 1). In the absence of a prescription for an asthma drug, 91% of children had no health care contact for asthma-like diagnoses (known as specificity). Sixty per cent of the 29,198 children followed longitudinally had further health care use during 1996 to 1998, corresponding to a prevalence of 10% of children with persistent asthma.

Children with asthma diagnoses were almost twice as likely as children with bronchitis diagnoses only to have persistent asthma (Table 2). However, one-quarter of the children with a physician diagnosis of asthma did not have persistent

TABLE 3
Likelihood of persistent asthma* in children with asthma diagnoses, asthma drug prescriptions and other asthma risk factors, 1995

Measure	Adjusted† odds ratio	95% CI
Asthma diagnosis and		
Winter-only use plus no asthma drugs	1.00	Reference
Not winter-only use plus no asthma drugs	5.66	4.90 to 6.53
Not winter-only use plus inhaled beta-agonist	31.1	26.4 to 36.7
Not winter-only use plus maintenance drug‡	11.4	7.90 to 16.5
Not winter-only use plus oral corticosteroid	19.3	14.9 to 24.8
Bronchitis diagnosis§ and		
Winter-only use plus no asthma drugs	1.00	Reference
Not winter-only use plus no asthma drugs	3.91	3.48 to 4.40
Not winter-only use plus inhaled beta-agonist	14.9	12.6 to 17.6
Not winter-only use plus maintenance drug‡	5.24	3.79 to 7.26
Not winter-only use plus oral corticosteroid	45.4	34.4 to 59.8
Female	1.00	Reference
Male	0.93	0.87 to 0.99
Absence of health care for allergic diagnoses	1.00	Reference
Presence of health care for allergic diagnoses	1.29	1.21 to 1.37
Asthma or bronchitis hospitalizations per year from birth (increase in number)	2.26	1.72 to 2.98
Time since first contact for asthma/bronchitis (year increase)	1.05	1.03 to 1.06
Age (one year increase)		NS

*Health care for asthma-like diagnoses and prescriptions for asthma drugs in 1996 to 1998; †Adjusted for treaty First Nations status, low neighbourhood income status, single-parent, income-assisted household status and all measures in Table; ‡Inhaled corticosteroid, sodium cromoglycate, ketotifen and salmeterol; §Bronchitis, but no asthma diagnosis since birth. NS Not significant

asthma. The presence of an asthma prescription drug was associated with persistent asthma (eg, OR=5.5 for beta-agonists) to a greater extent than having an asthma diagnosis (OR=1.7). In the full multivariate model (Table 3), children with asthma or bronchitis diagnoses and no asthma drugs were fivefold more likely to have persistent asthma if they did not have winter-only rather than if they had winter-only health care use for asthma. Not having winter-only use for asthma, concomitant with an asthma drug prescription, increased the likelihood of persistent asthma in children to a substantial degree, especially in children with bronchitis diagnoses and prescriptions for oral corticosteroids. Other risk factors, such as history of allergy, longer duration since first physician contact for asthma and a greater number of previous hospitalizations for asthma, were independently associated with persistence of asthma. Prematurity increased the likelihood of persistent asthma in univariate but not multivariate analyses (data not shown).

DISCUSSION

Among 174,000 Manitoban schoolchildren, 29,198 children (17%) had health care contacts for asthma-like diagnoses or received asthma drug prescriptions during 1995. Similarly, a population-based survey in the United Kingdom reported a prevalence of wheezing in children aged five to 17 years of 13% to 17% (17). Further, the 1995 to 1996 Student Lung Health Survey (39) reported that 11% of Winnipeg schoolchildren diagnosed with asthma, and a further 20% of students

never diagnosed with asthma, had asthma-like symptoms or received asthma drugs. In our cross-validation analysis, asthma-like diagnoses were present in 74% of children receiving prescriptions for asthma drugs over a one-year period. Others have reported a medical record diagnosis of asthma in 80% of persons receiving asthma drug prescriptions over a three-year period; for an asthma-like condition, the per cent agreement was 100% (5,18,40). Our lower rate of agreement is likely the outcome of asthmatic children receiving asthma drugs but not seeing a physician that year. Surveys report that 90% of schoolchildren had taken their asthma drugs in the past year, but only 70% had seen their physician (5,39). In addition, children with asthma drugs but no health care visits were potentially using the emergency room for health care, data which are not completely captured by Manitoba's health care administrative databases. Thus, the inclusion of data on asthma prescription drugs in the asthma definition identified 14% of children with asthma that otherwise would have been excluded if a diagnosis-based definition had been used. This is an important finding, because many health care databases do not contain information on prescriptions dispensed for whole populations of children (41).

Compatible with the natural history of wheezing in childhood, 60% of children treated for asthma in 1995 had contact with the health care system three years later (1,8). The corresponding prevalence for persistent asthma is close to the 11% of Winnipeg schoolchildren with current asthma in the 1995 to 1996 Student Lung Health Survey. Discriminant validity analysis identified a list of factors that were associated with persistent asthma, a construct that has been used to distinguish asthma from transient wheezing syndromes (22). Children with prescriptions for inhaled beta-agonists or oral corticosteroids were five to six times more likely, and children with maintenance drug prescriptions were three times more likely, to have persistent asthma than children without asthma drug prescriptions. Current use of an inhaled beta-agonist or an oral corticosteroid may indicate continued symptoms or exacerbation of asthma (42). Maintenance drugs such as inhaled corticosteroids are very effective in preventing asthma exacerbations (43), but not all asthmatic children are prescribed these drugs or are compliant with their use (40,44). Although the association was of a lesser magnitude, independent of drug therapy, the likelihood of persistent asthma was almost two-fold greater in the presence of an asthma diagnosis than in its absence. Toelle et al's (19) longitudinal evaluation of three case definitions for childhood asthma showed that children diagnosed with asthma were more likely to have severe asthma 10 years later than children with wheezing symptoms who had not received a diagnosis of asthma.

The presence of risk factors for asthma, as measured by health care administrative records, was associated with an increased likelihood of persistent asthma. A history of allergy is a well-known risk factor for the development of asthma and distinguishes children with transient wheezing from those with asthma (22,31). Other risk factors for persistent asthma, such as longer duration since first health care contact for asthma-like diagnoses and higher number of asthma hospitalizations at

an earlier age, have also been documented (19,24,34). Prematurity at birth was not a significant predictor in the multivariate model but potentially was correlated with other risk factors (33). Not winter-only health care use for asthma-like diagnoses or asthma drug prescriptions was associated with persistent asthma to a substantial degree. This finding is compatible with clinical observations of wheezing in children; children with asthma have year-round symptoms, whereas those with transient wheezing have winter-only symptoms (24,45). Moreover, it has been recently documented that children with viral-associated wheeze in the winter season have different airway inflammatory cells than children with continuous wheezing (21). We translated the concept of year-round asthma symptom occurrence into the measure of not winter-only asthma health care use patterns, with the anticipation that it would be associated with asthma persistence. Due to the strength of the association between not winter-only health care use patterns and persistent of asthma, we believe that this measure would be a valuable addition to the case definition of asthma in childhood.

Two methodological issues arise when health care database records are used to define childhood asthma: under-representation subsequent to children not seeing their physician regularly and over-representation when asthma diagnoses are assigned to children who present with transient wheezing syndromes and not asthma. We addressed the former by including in the asthma definition, information on asthma prescription drugs, as well as diagnosis data from health care visits for asthma. In terms of diminishing the potential for over-representation, we used the longitudinal capabilities of the health care administrative databases to identify the persistence of asthma, defined as repeated health care use for asthma. This definition of persistent asthma has some limitations, especially when classifying repeated use of beta-agonist prescriptions in the absence of asthma diagnoses or other asthma drugs. We potentially misclassified 372 children as having persistent asthma on the basis of multiple prescriptions of beta-agonists, when, in fact, these children may have had isolated episodes of respiratory tract infections that were not asthma. Measures such as not winter-only health care use may help to resolve some of these issues. For example, based on our analysis, children with bronchitis diagnoses, which traditionally have been excluded from definitions of 'pure' asthma (9), could have asthma if there is concomitant use of asthma drug prescriptions, health care visits for allergic disorders or not winter-only health care use for bronchitis.

CONCLUSIONS

We have identified markers from health care use records that can be used to form a case definition of persistent asthma in children. To further assess the validity of this case definition, we are in the process of recruiting children for clinical assessment of asthma and linking this data to health care administrative records.

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