

Case verification of children with asthma in Ontario

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Asthma is an important chronic childhood illness. A population-based surveillance program could measure the burden of illness, but first, the validity of an administrative diagnosis of asthma must be confirmed. The objective was to evaluate the accuracy of population-based outpatient administrative data in identifying children with asthma for the purpose of on-going asthma surveillance and research. Twenty-one primary care physician (PCP) clinics in Ontario participated. Patients under 18 yr old were categorized into three diagnosis categories according to administrative data diagnosis codes: asthma, asthma-related, and non-asthma. In each PCP clinic, for each diagnosis category, 10 charts were randomly selected for abstraction. A panel of experts (blind to the code) reviewed the abstracted charts and identified them as asthma or non-asthma. The reviewers' diagnosis was considered the gold standard. The accuracy of the administrative data diagnosis coding was analyzed using the concepts of diagnostic test evaluation. Six hundred and thirty patient charts were abstracted and reviewed. Overall agreement between the diagnosis provided by expert chart review and the administrative data diagnosis code was 84.8% ($p < 0.001$), and was 60.2%, 94.8% and 99.5% for the asthma, asthma-related, and non-asthma categories, respectively. Additionally, the sensitivity and specificity were 91.4% and 82.9%, respectively. Agreement between the administrative data diagnosis code and the PCP chart diagnosis was 99.4% ($p < 0.001$). An administrative data diagnosis code of asthma is sensitive and specific for identifying asthma. By using the results of this study as a starting point, future research will create a cohort of children with asthma to be used for population-based surveillance and research.

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Asthma is the most common chronic childhood illness in North America (1). Estimates from population-based survey data revealed that in 1994/95 there were 672,000 Canadian children with asthma, a prevalence of 11.2% (2). Prevalence estimates of childhood asthma calculated from a standardized questionnaire used around the world, range from 1.6% to 36.8%, with westernized countries having the highest prevalence (3). Although prevalence estimates calculated from cross-sectional survey data are useful, they are less informative than estimates calculated from population-based longitudinal surveillance data. Population-based surveillance

programs provide the opportunity not only to count the number of affected individuals, but to follow individuals forward in time and examine their health care utilization. In Canada, there has never been a population-based longitudinal surveillance program implemented to examine the burden of childhood asthma and to track its natural history prospectively.

In order to create an accurate and comprehensive surveillance system, population-based data that capture all hospital and emergency department admissions/discharges, physician visits, laboratory and diagnostic tests are necessary. However, a surveillance program based on these

data cannot succeed without first confirming the validity of the asthma diagnosis. Thus, verification of the asthma diagnosis in secondary data is a critical step for studying the burden and trajectory of asthma.

Canadian hospital discharge data are routinely audited and the accuracy of the data is greater than 95% (4). However, the accuracy of physician billing records for outpatient services for children has not been assessed. There are concerns regarding the validity of the administrative outpatient data, first, in regard to physicians accuracy in completing the data, and second, in regard to the diagnosing of asthma in children. Identifying asthma in children as it emerges and differentiating it from other respiratory diseases, such as transient wheezing disorders and viral illness, is problematic (5, 6).

For these reasons, this case verification study concentrated on validating the identification of pediatric asthma cases from billing records of primary care practitioners (PCPs), a major source of outpatient services. The objective of this research was to evaluate the accuracy of outpatient population-based administrative data for identifying children with asthma for the purpose of population-level asthma surveillance.

Methods and materials

Twenty-one PCP clinics were selected from across Ontario. The sampling frame from which these physicians were selected included all general practitioners and pediatricians less than 65 yr of age, treating over 30 pediatric asthma patients per year, and identified from the Canadian Medical Directory Database. This frame was then stratified according to the Ontario Ministry of Health's seven planning regions and subsequently, three PCPs were randomly selected from each region. A letter was mailed to the selected PCPs inviting them to participate in the study. If the PCP refused or did not qualify for participation, a replacement PCP was randomly selected and invited. Final selection of PCPs to participate was done on a 'first invited, first agreed' basis. It was necessary that participant PCP had the time and space available for our research and used an electronic Ontario Health Insurance Plan (OHIP) billing system. OHIP is the provincial insurance plan, covering health care for all Ontario citizens. Physicians are reimbursed by OHIP by submitting claims to OHIP for medical services provided. A diagnosis is provided as part of these records.

From each of the 21 clinics, their electronic OHIP billing system was used to create a

sampling frame that included all patients born after April 1, 1983 and who were seen in the clinic between April 1, 2000 and March 31, 2001. These dates corresponded to an age range of 0–18 yr. The sampling frame was then stratified into three diagnosis categories, according to the OHIP administrative data diagnosis code submitted by the PCP clinic to OHIP for the patient visit that occurred during the specified year. The OHIP administrative data diagnosis codes used for stratification can be seen in Table 1. The three diagnosis categories were asthma, asthma-related respiratory conditions, and non-asthma conditions. The diagnosis codes for asthma-related conditions were chosen because they are the main respiratory diseases and disorders that could be confused with asthma. This diagnostic group was included to examine the accuracy of billing and to examine the frequency of false negative cases. The codes for the non-asthma conditions were chosen because they are common conditions that could not be confused with asthma. It is possible for a child to have a diagnosis of asthma on one contact, and an asthma-related or non-asthma diagnosis in another (groups not mutually exclusive). In these situations, children with a diagnosis of asthma were analyzed as asthmatic.

In each of the 21 clinics, 10 charts were randomly selected and abstracted from each of the three diagnosis categories, using a random number list, by one trained abstractor. The patient's entire chart was reviewed, including consultation notes. The abstractions were completed using a standardized abstraction form and included information on demographics, risk factors for asthma (exposure to smoking,

Table 1. The administrative data diagnosis codes used to define asthma, asthma-related conditions, and non-asthma conditions

	Administrative diagnosis code	Description
Asthma	493	Asthma
Asthma-related conditions	466	Acute bronchitis/bronchiolitis
	490	Bronchitis not otherwise specified
	480–486	Pneumonia
	462	Acute pharyngitis
	464	Acute laryngitis and tracheitis
Non-asthma conditions	465	Acute upper respiratory infections
	009	Diarrhea, gastro-enteritis, viral gastro-enteritis
	079	Other viral disease
	799	Non-specific abnormal findings, other ill-defined conditions
	787*	Signs and symptoms of the digestive system not yet diagnosed

*Used at two clinics due to differences in coding practices.

allergies, etc.), medical history, family history, concurrent medical conditions, medications prescribed, pulmonary function, and radiographic examinations. Although the charts were initially stratified according to the diagnosis code in the physicians' electronic billing system, if the abstractor came upon a diagnosis of asthma within the chart for a patient initially categorized as asthma-related or non-asthma, the child was reclassified as asthmatic and an additional asthma-related or non-asthma chart was randomly selected as a replacement. Upon completion of the abstractions, the study co-ordinator reviewed the abstracts and two were excluded due to faulty abstraction. Two extra charts were then abstracted from the Northern region to ensure that the desired sample size of 630 charts was obtained.

A general pediatrician and a pediatric respirologist, who were blinded to the administrative data diagnosis codes but not blinded to the objectives of the study, reviewed the patient chart abstracts independently to identify the cases as asthma or non-asthma. The identification of an asthma diagnosis was determined according to pre-defined criteria based on the Canadian Asthma Consensus Report (7). Over the course of the review process, two meetings were held to discuss cases of disagreement and to attempt to reach a consensus for each one. Subsequently, the criteria used for establishing an asthma diagnosis were slightly modified to reflect the cursory level of information available based on chart abstraction. It was decided that each of the following criterion constituted sufficient evidence for a diagnosis of asthma in this study: (i) clear documentation of at least two separate episodes of wheezing or (ii) clear documentation of one episode of wheezing and a well-delineated risk factor for asthma and/or a significant response to treatment with asthma medication. If consensus could not be reached, a second pediatric respirologist was consulted as the third reviewer. This third reviewer independently reviewed the charts and was considered the 'tie-breaker'. The consensus reached by this panel of reviewers was considered the 'gold standard' for asthma diagnosis.

Data were imported into SAS Version 8e (Cary, NC, USA) for analysis. Overall inter-rater agreements between the reviewers and kappa statistics were calculated. The accuracy of the administrative data diagnosis codes submitted to OHIP by the PCP clinics was then analyzed using the concepts of diagnostic test evaluation. First, the agreement between the PCP's diagnosis abstracted from the patient

charts and the administrative data diagnosis code was determined. Second, since the expert panel's diagnosis of asthma or non-asthma was considered the gold standard, the sensitivity and specificity of using administrative data diagnosis codes from physician's billing data for the identification of asthma cases could be evaluated. Also, the proportion of false positives and false negatives were measured. A *false positive* was defined as a patient who was coded as having asthma in the administrative data but was assigned a non-asthma diagnosis by the reviewers in the chart review diagnosis. A *false negative* was defined as a patient who was coded as non-asthma in the administrative data but was assigned an asthma diagnosis by the reviewers in the chart review diagnosis.

Necessary ethics approval was obtained from the institute's ethics board prior to the commencement of this study.

Results

Recruitment of PCPs

To obtain the desired 21 PCP clinics, 431 letters were mailed out. There were 264 responses received, resulting in a crude response rate of 61.3%. Thirty-eight of the responding PCPs agreed and qualified to participate in the study. Since only 21 of the 38 agreeing PCPs were needed for this study, 16 general practitioners and 5 pediatricians were selected to represent the distribution of the specialties in the Ontario physician population. Selection was completed on a 'first invited, first accepted' basis.

Chart abstraction

From the 21 participating clinics, 630 patient charts were abstracted and examined. Characteristics of the final study population, categorized according to the asthma status identified by the administrative data diagnosis code, are summarized in Table 2. Most of the characteristics of interest, including personal history of allergy, family history of asthma, exposure to smoking, and diagnostic tests, were not documented in the patients' charts. The percentage of 'not documented' characteristics ranged from 76.0% to 99.7%. Specific to the use of diagnostic tests, the non-documentation indicated, for most cases, that the test was not required or not appropriate, rather than a lack of information. For example, the majority of charts had no documentation of a Methacholine Challenge test because the test was not warranted, or the child was too young.

Table 2. Demographic and asthma related characteristics for patients categorized as having asthma or non-asthma according to administrative diagnosis code

	Frequency (%)		p-Value
	Asthma (n = 211)	Non-asthma (n = 419)	
Male gender	131 (62.38)	216 (51.55)	0.010
Age category			
0–2 yr	31 (14.79)	103 (24.58)	0.005
3–5 yr	39 (18.48)	81 (19.33)	
6–9 yr	43 (20.38)	86 (20.53)	
10–14 yr	78 (38.81)	100 (25.58)	
15–18 yr	20 (9.48)	49 (11.69)	
Maternal smoking during pregnancy			
Yes	6 (2.84)	3 (0.72)	<0.001
No	32 (15.17)	26 (6.21)	
Not documented	173 (81.99)	390 (93.08)	
Current parental smoking			
Yes	29 (13.74)	17 (4.06)	<0.001
No	30 (14.22)	23 (5.49)	
Not documented	152 (72.04)	378 (90.21)	
Personal history of allergy			
Yes	48 (22.75)	44 (10.50)	<0.001
No	18 (8.53)	18 (4.30)	
Not documented	145 (68.72)	357 (85.20)	
Family history of atopy			
Yes	29 (13.74)	44 (10.50)	0.001
No	28 (13.27)	23 (5.49)	
Not documented	154 (72.99)	352 (84.01)	
Family history of asthma			
Yes	43 (20.38)	33 (7.88)	<0.001
No	31 (14.69)	44 (10.50)	
Not documented	137 (64.93)	342 (81.62)	
Skin test			
Yes	41 (19.43)	45 (10.54)	0.003
Not documented	170 (80.57)	374 (89.26)	
Referral to lung specialist			
Yes	28 (32.18)	12 (2.86)	<0.001
Not documented	59 (67.82)	146 (34.84)	
Methacholine challenge			
Yes	2 (0.95)	0	0.046
Not documented	209 (99.05)	419 (100.0)	
Spirometry			
Yes	41 (19.43)	14 (3.34)	<0.001
Not documented	170 (80.57)	405 (96.66)	
Peak expiratory flow			
Yes	16 (7.58)	1 (0.24)	<0.001
Not documented	195 (92.42)	418 (99.76)	
Concurrent medical condition			
Yes	9 (4.27)	4 (0.95)	0.006
Not documented	202 (95.73)	415 (99.05)	

Among the children with asthma, a higher proportion were male, were exposed to parental smoking, had a history of allergies and had a family history of asthma as compared to the children without asthma (Table 2).

Between PCP chart diagnosis and administrative data diagnosis code

To ensure that the diagnosis noted in the chart by the PCP was the same as the code entered into

administrative data, the charted diagnosis and the administrative data diagnosis codes were compared. From Table 3 the agreement between the PCP chart diagnosis and the administrative data diagnosis code for all patients, and patients coded for asthma, asthma-related conditions and non-asthma conditions can be seen. The kappa could only be calculated for the overall table because of the small sample size and zero cells in the remaining tables. The overall agreement between the PCP chart diagnosis and the administrative data diagnosis code was 99.4% and the kappa value was 0.99. When the three groups defined by the administrative data diagnosis codes were examined individually, the asthma group had an agreement of 98.1% while both the asthma-related group and the non-asthma group had an agreement of 100.0%.

Chart review – between reviewers

The patient charts abstracted from the PCP clinics were given to the reviewers for diagnosis determination. The overall inter-rater agreement for asthma diagnosis was 92.9% with a kappa of 0.79 ($p < 0.001$). When the three diagnosis categories defined by the administrative data diagnosis code were examined individually, the agreement was 87.7%, 92.0%, and 99.0% for the asthma, asthma-related, and non-asthma groups, respectively. Of the 630 charts reviewed, there were 45 disagreements. Twenty-six (57.8%) of the disagreements were from patient charts with an administrative data diagnosis code of asthma, 17 (37.8%) were from patient charts that were asthma-related, and 2 (4.4%) were from patient charts that were non-asthma. Following consensus meetings, an overall agreement of 99.5% and a kappa of 0.99 was achieved ($p < 0.001$). However, there were still three charts where a consensus could not be reached. A third expert was used as the ‘tie-breaker’ to determine if the patient had asthma. This resulted in 139 (22.0%) chart review diagnoses of asthma and 491 (77.9%) chart review diagnoses of non-asthma.

Between chart review diagnosis and administrative data diagnosis code

To determine if the chart review asthma diagnosis was in agreement with what the PCPs coded in OHIP for billing, the chart review asthma diagnosis and administrative data diagnosis code were compared. Table 4 shows the diagnostic test evaluation statistics, including the agreement, kappa, sensitivity, specificity, false positive rate and false negative rate calculated for the chart

Table 3. The agreement between the chart review diagnosis and the primary care physicians' chart diagnosis with the administrative data diagnosis codes for all patients, patients in the asthma group, the asthma-related group, and the non-asthma group

Group	Diagnosis	Concordant		Discordant		Agreement (%)	Kappa
		Confirmed* asthma	Confirmed non-asthma	Non-confirmed† asthma	Non-confirmed non-asthma		
Overall	Chart review	127	407	84	12	84.8	0.63 (p < 0.001)
	PCP chart	207	418	4	0	99.4	0.99 (p < 0.001)
Asthma	Chart review	127	0	84	0	60.2	—
	PCP chart	207	0	4	0	98.1	—
Asthma-related	Chart review	0	202	0	11	94.8	—
	PCP chart	0	213	0	0	100.0	—
Non-asthma	Chart review	0	205	0	1	99.5	—
	PCP chart	0	205	0	0	100.0	—

PCP, primary care physician.

*Confirmed asthma or non-asthma means the chart review diagnosis or PCP chart diagnosis, as indicated, of asthma or non-asthma was in agreement with the administrative data diagnosis code.

†Non-Confirmed asthma or non-asthma means the chart review diagnosis or PCP chart diagnosis, as indicated, of asthma or non-asthma was NOT in agreement with the administrative data diagnosis code.

Table 4. The diagnostic test evaluation statistics calculated for a chart review diagnosis of asthma compared to an administrative data diagnosis code of asthma, for each of the 21 clinics

Site	n	Agreement (%)	Kappa	Sensitivity (%)	Specificity (%)	False positive (%)	False negative (%)	p-Value
1	30	80.0	0.50	83.3	79.2	16.7	3.3	0.009
2	30	76.7	0.36	100.0	74.1	23.3	0.0	0.030
3	30	93.3	0.84	100.0	90.9	6.7	0.0	<0.001
4	30	86.7	0.67	100.0	83.3	13.3	0.0	<0.001
5	30	90.0	0.77	88.9	90.5	6.7	3.3	<0.001
6	29	89.7	0.73	100.0	87.0	10.3	0.0	<0.001
7	30	83.3	0.57	100.0	80.0	16.7	0.0	0.002
8	30	93.3	0.84	100.0	90.9	6.7	0.0	<0.001
9	30	83.3	0.59	85.7	82.6	13.3	3.3	0.002
10	30	86.7	0.68	87.5	86.4	10.0	3.3	<0.001
11	30	86.7	0.67	100.0	83.3	13.3	0.0	<0.001
12	30	83.3	0.59	85.7	82.6	13.3	3.3	0.002
13	29	89.7	0.75	100.0	86.4	10.3	0.0	<0.001
14	30	86.7	0.67	100.0	83.3	13.3	0.0	<0.001
15	30	83.3	0.62	77.8	85.7	10.0	6.7	0.002
16	30	86.7	0.67	100.0	83.3	13.3	0.0	<0.001
17	30	76.7	0.43	71.4	78.3	16.7	6.7	0.026
18	32	71.9	0.29	100.0	69.0	28.1	0.0	0.044
19	30	76.7	0.43	71.4	78.3	16.7	6.7	0.026
20	30	90.0	0.76	100.0	87.0	10.0	0.0	<0.001
21	30	86.7	0.68	87.5	86.4	10.0	3.3	<0.001
Total	630	84.8	0.63	91.4	82.9	13.3	1.9	<0.001

PPV, positive predictive value; NPV, negative predictive value.

review asthma or non-asthma diagnosis compared to the OHIP administrative data diagnosis code for the 21 clinics. The agreement between the chart review diagnosis and the administrative data diagnosis code ranged from 71.9% to 93.3% and the kappas ranged from 0.29 (p = 0.044) to 0.84 (p < 0.001). The kappas, however, should be interpreted with caution due to the extremely small cell counts in some of the tables. The

sensitivity between the chart review diagnosis, used as the reference diagnosis or gold standard, and the administrative data diagnosis code for each site ranged from 71.4% to 100.0% and the specificity ranged from 69.0% to 90.9%. The overall sensitivity and specificity were 91.4% and 82.9%, respectively.

From Table 3 the agreement between the chart review diagnosis and the administrative data diagnosis code for all patients, and patients coded for asthma, asthma-related conditions, and non-asthma conditions can be seen. The kappa could only be calculated in the overall table because of the small sample size and zero cells in the remaining tables. The overall agreement between the chart review diagnosis and the administrative data diagnosis code was 84.8% and the kappa was 0.63. When agreement was examined by age group, it was found that the sensitivity was 75.0%, 96.0%, 87.5%, 95.9%, and 94.1%, and the specificity was 83.9%, 84.2%, 84.5%, 76.0%, and 92.3% for the children aged 0–2, 3–5, 6–9, 10–14, and 15–18 yr, respectively (results not shown).

Overall, there were 84 cases classified as false positive asthma cases, where the patient was coded as asthma in the administrative data but assigned a non-asthma diagnosis by the reviewers in the chart review diagnosis. There were 12 false negative cases, where the patient was coded as non-asthma in the administrative data but assigned an asthma diagnosis by the reviewers. Comparisons of patient characteristics between the cases that did not have agreement between the chart review diagnosis and the administrative data diagnosis code, and the cases that did have agreement were conducted and no significant

differences between the two groups were found (results not shown). Of the 84 false positive cases, 78.5% had a PCP chart diagnosis of 'asthma', 17.9% had a 'query asthma' diagnosis, and 3.6% had a non-asthma diagnosis noted in the chart. This distribution suggests that approximately one-fifth of the false positive cases may be attributed to diagnostic uncertainty and less than 4% to inappropriate coding.

Finally, when the three groups defined by the administrative data diagnosis codes were examined individually, the asthma group had an overall agreement of 60.2%, the asthma-related group had an agreement of 94.8% and the non-asthma group had an agreement of 99.5%.

Discussion

The results of this study indicate that one asthma diagnosis code from outpatient administrative data is reasonably accurate for the identification of pediatric asthma cases. It was previously thought that the diagnosis in the OHIP administrative data would not be accurate because the diagnosis code on OHIP billing records is not a required field, thus there is no incentive for the physician to fill the diagnosis code accurately. However, this study found that the agreement between the PCP chart diagnosis and the administrative data diagnosis code was very high, indicating that physicians complete the OHIP billing claims accurately and completely.

When the administrative data diagnosis code was compared to the chart review diagnosis, the overall sensitivity and specificity was found to be very high. The kappa was 0.63, which was similar to that found between administrative data and survey data (8). A previous study comparing the asthma diagnosis in administrative data to self-reported symptoms and conditions obtained through a survey found that, in adults, approximately two-thirds of patients who stated they had suffered from an asthma attack in the previous year or were taking asthma medication had a record of seeing a physician for asthma within the previous 5 yr and almost all patients with an administrative asthma diagnosis had reported some asthma symptoms in the previous year (8). Additionally, the sensitivity and specificity of 91% and 83% found in the current study are similar to that found in other studies. A study comparing the administrative data diagnosis of asthma-like conditions, including diagnoses for asthma, bronchitis and bronchiolitis, to administrative asthma drug prescription data found a sensitivity and specificity of 74% and 91%, respectively (9). However, the study concluded

that one administrative asthma diagnosis was not sufficient to identify children with persistent asthma but that multiple asthma diagnoses over time were more accurate at identifying children with persistent asthma (9).

There is no universal definition for pediatric asthma (5, 9) and pediatric asthma is difficult to identify and differentiate from other respiratory diseases, especially in very young children. The initial diagnosis of asthma in children is a complex decision and there is a great debate between physicians as to which symptoms and factors are necessary to be present in establishing an asthma diagnosis (6). The complexity and variation was compounded by the fact that pulmonary functions tests cannot be conducted adequately on small children (6). However, in this study the agreement between the chart review diagnosis and the administrative data diagnosis code were similar in all age groups including children aged 0–2 yr. This suggests that there is diagnostic uncertainty in pediatric asthma as a whole. Therefore, in this study there is the potential for misclassification of asthma both in regard to the PCP diagnosis and the chart review diagnosis. When the 84 cases of false positive asthma (chart review diagnosis was non-asthma and the administrative data diagnosis code was asthma) were examined, it was found that few did not have an asthma diagnosis in the actual PCP chart, indicating that the majority of discrepancies were due to diagnostic uncertainty.

Misclassification of asthma by the chart review diagnosis is the main limitation of this case verification study. Asthma was possibly underdiagnosed by the reviewers due to the lack of documentation in the charts. The foremost troubles found were incomplete documentation of medical history, poor documentation of symptoms, lack of documentation of risk factors, or non-specific documentation of physical examination findings and response to treatment. It was necessary to adjust the initial asthma definition for chart review diagnosis in light of the lack of data in the medical charts. Nonetheless, the initial inter-rater agreement was excellent. However, it is possible that some of the 84 false positive cases may have in fact been true asthma, but due to the lack of data in the medical chart the reviewers were unable to label them as asthma. Therefore, even though the chart review diagnosis was used as the gold standard it may be slightly 'tarnished' due to the lack of information within the medical charts. The false positives may therefore, be more accurately named 'non-confirmed asthma' since

the data in the chart did not allow the reviewers to confirm the child's asthma diagnosis.

While the reviewers were labeling the children, the possibility of children developing asthma over the next year was of concern to the reviewers. They agreed that although the diagnosis of asthma may not have been established then, the possibility of it being confirmed in the next year was a concern. With an ongoing surveillance system, these potential cases or at-risk cases for the development of asthma could be monitored and redefined as time goes by and more information is available. Previous research has suggested that children with wheezing illnesses that were distinct from asthma could be differentiated from children with asthma through the use of administrative health care data examined longitudinally (10). The different trajectories of various wheezing syndromes that were distinct from asthma were determined in previous research (10) thus children with asthma could be identified and reclassified in a population-based longitudinal surveillance system using administrative data.

The purpose of this study was to determine the accuracy of outpatient administrative data so that it may be used in the creation of a population-based longitudinal surveillance system. The results suggested that the data were sufficiently accurate to be used for this purpose. This study found few false negative cases but a substantial number of false positive cases. Given the missing data bias that the reviewers were forced to operate under, a substantial proportion of false positive cases may have been a result of poor documentation in the patient charts, rather than actual false positive diagnosis. The 60.2% agreement between the chart review diagnosis and the administrative diagnosis codes along with the considerable number of potential false positives highlight the need to further refine the definition of asthma for the identification of asthmatic children from administrative data. The creation of a cohort of children with asthma from administrative data based on the criteria of one administrative data diagnosis code of asthma might possibly incorporate a number of non-asthmatic children. However, these non-asthmatics could be removed with a more vigorous asthma definition of, for example, two administrative data asthma diagnoses over a specified time period. It is easier to initially create a large cohort and exclude patients than to have a small cohort and try to incorporate more patients. Therefore, the next step in developing an asthma cohort from administrative data will be to create a stricter administrative data asthma definition

involving more than just one asthma diagnosis code to classify a child as having asthma.

Additional limitations of this study should be noted. First, the expert reviewers were not blinded to the objective of the study and thus knew that one third of the charts had an administrative data diagnosis code of asthma. This knowledge may have biased the reviewers to code more charts as asthma. However, this does not seem to be the case as only 22% of the charts had a chart review diagnosis of asthma. Second, the way in which the participating PCPs were chosen may have introduced some bias into the study. Since only a small percentage of the invited PCPs qualified and agreed to participate, and of those, the 21 participants were chosen on a 'first invited, first accepted' basis, it is possible that the participating PCPs do not represent all general practitioners and pediatricians. The participant PCPs may have better coding practices than physicians who did not agree or qualify to participate, thus biasing the results. However, through the use of 21 PCPs who were distributed throughout Ontario, including both rural and urban areas, a wide range of setting were examined and all had similar results. Additionally, the chart review was retrospective in nature and therefore, the PCPs could not intentionally code better for the study. Furthermore, since we examined a wide range of codes and did not find one area particularly better than the others, it is unlikely that the selection bias in this study could explain the entire results. Nonetheless, future research should focus on examining the accuracy of diagnostic coding from other physicians to see if it is consistent over time. Finally, due to the specific nature of OHIP and Ontario physicians, the sensitivity and specificity found for asthma diagnoses in administrative data may not extend to other health care systems, the results of this study are not intended to be generalizable to other Canadian provinces or internationally. However, since there are many similarities between health care systems in Canada and internationally, the approach used in this study is generalizable. Therefore, similar research is necessary within other health care systems to confirm the results of this study. While the cost and resources needed for this study were quite high, the quality of the resulting data, the overall implications and application of the study outweigh the costs.

Despite the limitations, this study provides a first look at physician's diagnostic coding of asthma. There are no previous benchmarks about the accuracy of OHIP diagnosis codes and the results of this study have demonstrated

acceptable agreement for identifying children with asthma for surveillance research. Additionally, this study is only the first step to creating a population-based longitudinal surveillance system in which cases can be followed forward and reclassified as more information is obtained. Using this discrete and crude method as a starting point we can move forward to determine an algorithm using a number of asthma diagnoses within a specified time period to be the asthma definition. The inclusion of hospital and emergency room data will further enhance the asthma definition algorithm to create an accurate and comprehensive population-based asthma surveillance system.

Conclusion

This study's results suggest that an algorithm based on a single asthma diagnosis code from administrative data is sensitive and specific for identifying asthma. Although a substantial number of false positive cases may be obtained, few false negative cases would be missed. By using the results of this study as a starting point, future research will create and refine an administrative data asthma definition, involving more than one asthma diagnosis code, to create a cohort of children with asthma to be used for the purposes of population-based surveillance and research.

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