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Identifying general practice patients diagnosed with asthma and their exacerbation episodes from prescribing data

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Abstract Objective: To determine the reliability of identifying patients diagnosed with asthma in general practice and their asthma exacerbation episodes from prescribing data.

Data source: Automated database from 17 general practitioners (29,805 patients) in the northern Netherlands.

Study design: Sensitivity, specificity and predictive values of four criteria for identifying patients diagnosed with asthma and two criteria for identifying asthma exacerbation episodes were calculated using the registered diagnosis as gold standard.

Results: Prescription of one or more anti-asthma medications identified 95% of patients with an asthma diagnosis (positive predictive value 0.70), while two or more anti-asthma medications identified 71% (positive predictive value 0.79). A combination of oral corticosteroids or antibiotics identified 55% of exacerbations.

Conclusions: Asthma patients can be identified reliably from prescribing data, but identification of asthma exacerbations was poor. The preference for one criterion over another for identifying patients diagnosed with asthma will depend on the reason for patient selection.

Keywords Asthma · Database · Drug utilisation · Prescribing data · General practice

Introduction

Within the health care system, an increasing focus is being placed on assessing and monitoring the quality of care being provided [1]. This goes together with increased attention to the development and implementation of guidelines and determining adherence to them. Based on the belief that adherence to evidence-based guidelines represents good clinical practice, such guidelines are used for the development of disease-specific indicators to assess the quality of care. Quality assessment may focus on either correct diagnosis or appropriate management. In this study, we concentrated on assessing pharmacological management of patients diagnosed with asthma. While diagnosis of asthma is an important issue, in the assessment of treatment quality we are interested in physicians' treatment decisions once a diagnosis has been made.

The validity of the data source used in assessing quality of care is an important issue. Sources containing diagnoses or clinical information on individual patients such as general practice databases provide the most complete information for assessing a physician's performance. However such detailed data is not always available. Prescribing data, for example PACT (Prescribing Analyses and Cost) data [2], are an easily accessible, relatively inexpensive source of data that are commonly used to determine prescribing quality in health care; however, with these data, no diagnosis information is available. The underlying assumption is that medication use can be used as a proxy for diagnosis information.

Indicators for measuring prescribing quality have been developed using prescribing data as an easily accessible data source [2, 3]. A good example is asthma management, the treatment of which has been the subject of several evaluations [4, 5, 6, 7, 8, 9, 10]. Different indicators of adherence to the well-accepted international asthma guideline have been used to assess the impact of

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interventions on prescribing practice and to provide feedback to prescribers. These indicators generally use prescribing data as an information source, selecting patients based on their use of anti-asthma medications. Unfortunately, the correlation between these indicators is low [11], and there is disagreement between which asthma indicators should be used [12, 13, 14]. Little is known about the validity of these indicators, and the debate regarding their appropriateness continues.

A major problem with any prescribing-based indicator is that one medication may be used for multiple diagnoses and that multiple medications can be used to treat one condition. Anti-asthma medication does not always equal an asthma diagnosis [15], indicating the need for evaluation of methods to identify diagnosed asthmatics. Identification of target patients from prescribing data is an important step when assessing the quality of prescribing. In this study, we examined the reliability of different criteria for identifying adults (18–49 years) with diagnosed asthma and their diagnosed exacerbation episodes from prescribing data in general practice.

Methods

Data source

The Registration Network Groningen (RNG) is a database containing computerised patient records of 17 general practitioners (GPs) in the northern Netherlands, including all prescribing and morbidity data for each patient. The participating GPs all use the computerised database in place of paper files in their daily practice. Within the Netherlands, patients are registered to a single GP, and records from each GP can be assumed complete for an individual patient [16]. In 1997, the number of patients included in the database was 29,805, with an average practice size of 1753 (range 116–3529) per prescriber.

A unique patient number known only to the prescriber is assigned to each patient within the database, allowing complete patient anonymity. Patient details including the unique number, month and year of birth, and prescriber are recorded. For each patient–prescriber encounter, the date, diagnosis, referrals and medication details are registered. Encounter diagnosis and medication indications use the International Classification for Primary Care (ICPC) codes [17]. The GPs in the RNG database have been trained specifically to work with the coding system, and they meet regularly to discuss possible coding problems. Further details on the structure and reliability of the database, patient population and practitioners involved have been published elsewhere [18, 19].

Patient inclusion criteria

Patient records from 1 January 1997 until 31 December 1997 were retrospectively selected from the RNG database. To be included in the cohort, patients needed a physician encounter (visit, telephone consultation or prescription request) during the study period.

Records for individuals under the age of 18 years and over 49 years were excluded to remove those age groups in which the prevalence of other diseases – for which anti-asthma treatment is used, such as hay fever, acute bronchitis or chronic obstructive pulmonary disease (COPD) [7] – is expected to be different. A data capture period of 12 months was selected after preliminary work showed that shorter periods were greatly influenced by seasonal variation. It also has the advantage that, in an international setting,

most countries will have at least one repeat prescription during a 12-month period [8].

Identification of diagnosed asthma patients

In this study, anti-asthma medication was defined as any drug belonging to the Anatomic Therapeutic Chemical (ATC)-code R03 [20]. The included R03 medications (oral and inhaled) available in the Netherlands in 1997 were:

- Short-acting bronchodilators: fenoterol, rimiterol, salbutamol, terbutaline, ipratropium
- Long-acting bronchodilators: formoterol, salmeterol
- Inhaled corticosteroids: beclomethasone, budesonide, fluticasone
- Xanthines: theophylline
- Cromoglycates: cromoglycic acid, nedocromil

The following four criteria for identification of patients diagnosed with asthma (18–49 years) were evaluated:

1. One or more anti-asthma prescriptions within 12 months
2. Two or more anti-asthma prescriptions within 12 months
3. One or more prescriptions for an inhaled short-acting bronchodilator within 12 months
4. One or more prescriptions for an inhaled short-acting bronchodilator and an inhaled corticosteroid within 12 months

The first criterion captured all patients receiving any anti-asthma medication during the study period. For the second criterion, two or more anti-asthma medications was defined as any two items – either two or more separate items or repeats of the one item or a combination of new items and repeats. Since it could be expected that most, if not all, asthmatics would be prescribed an inhaled bronchodilator, the use of these drugs was investigated in the third criterion. The fourth criterion was based on international consensus, which recommends treatment with both an inhaled bronchodilator and inhaled corticosteroid for all asthma except mild intermittent [21].

Identification of exacerbation episodes

We aimed to identify exacerbation episodes from prescribing data for those patients diagnosed with asthma, allowing for multiple episodes per patient. A sub-population of all patients prescribed two or more R03 medications during the study period was selected based on the results of the first analysis shown in Table 1. This criterion detected 71% of all asthma patients and, of all the patients identified, 79% actually had a doctor's diagnosis of asthma. The following two criteria were tested to identify asthma exacerbation episodes in this sub-population:

1. Short-course [≤ 14 days or 30 defined daily doses (DDDs)] oral corticosteroids (ATC code H02AB) in an asthma patient
2. Short-course oral corticosteroid or short-course oral antibiotics (≤ 14 days) in an asthma patient

The first exacerbation criterion concentrates on oral corticosteroid use, which is the recommended treatment for more severe exacerbations [21]. Since it is known that in general practice over 40% of asthma exacerbations may be treated outside the guidelines by antibiotics either in place of or in addition to oral corticosteroids [22, 23], our second criterion included antibiotic use. Antibiotics included in this criterion were those commonly used to treat respiratory infections [5]: tetracyclines (ATC code: J01A), penicillins (J01C), cephalosporins (J01DA), cotrimoxazole (J01EE) and macrolides (J01FA). Most of these antibiotics may also be used for other indications. Antibiotic and oral corticosteroid use was limited to use for 14 days or less to focus on exacerbations and to minimise

Table 1 Sensitivity, specificity and predictive values for criteria to identify patients diagnosed with asthma (95% confidence intervals presented in parenthesis)

Asthma patient identification criteria	Sensitivity	Specificity	Positive predictive value	Negative predictive value
1. ≥ 1 Anti-asthma medication in 12 months	0.95 (0.93–0.97)	0.99 (0.99–0.99)	0.70 (0.66–0.73)	0.99 (0.99–1.0)
2. ≥ 2 Anti-asthma medications in 12 months	0.71 (0.67–0.75)	0.99 (0.99–1.0)	0.79 (0.75–0.83)	0.99 (0.99–0.99)
3. ≥ 1 Inhaled bronchodilator in 12 months	0.60 (0.54–0.64)	0.99 (1.0–1.0)	0.80 (0.75–0.85)	0.99 (0.99–0.99)
4. ≥ 1 Inhaled bronchodilator and ≥ 1 inhaled corticosteroid in 12 months	0.41 (0.36–0.46)	0.99 (1.0–1.0)	0.84 (0.78–0.89)	0.98 (0.98–0.99)

inclusion of COPD and other non-asthma indications, which may be treated using these medications on a long-term basis.

Analysis

A diagnosis of asthma as recorded by the GP was defined as the gold standard. Chronic asthma is recorded in the RNG database by the modified ICPC code R96.5. A patient was considered asthmatic if there was at least one record, either episode diagnosis or medication indication, of chronic asthma during the study period. A modified ICPC code (R96.4) is included in the RNG database for asthma exacerbations. After consulting local experts, acute bronchitis episodes (ICPC R78) in patients with chronic asthma (ICPC R96.5) were also classified as asthma exacerbations in accordance with Flemming et al. [24].

Asthma and exacerbation identification from prescribing data using each criterion was compared with the diagnosis recorded by the GPs. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for each criterion were calculated according to the method discussed by Altman [25].

For the assessment of prescribing quality, it is important to identify as many diagnosed asthmatics as possible, ensuring at the same time that the patients included have actually been diagnosed with asthma. The highest PPV in combination with a high sensitivity can be seen as the best criterion for this research question.

Results

Records from 16,272 patients aged 18–49 years were captured from the database. Of these patients, 430 had a recorded asthma diagnosis and 587 patients had been prescribed at least one anti-asthma (R03) medication during the study period. Of the patients with a recorded asthma diagnosis, 4.9% (21 of 430) did not receive an anti-asthma medication during the study period. One GP left the practice in 1996 and, during the study period, only 100 patients remained registered to him. Since none of these 100 patients was an asthma patient aged between 18 years and 49 years, records from this prescriber were not included in this study.

Identification of diagnosed asthma patients

Criterion 1 had the highest sensitivity, identifying 95% of all possible diagnosed asthmatics; however, according to the PPV of 0.7, it included 30% of patients without an asthma diagnosis (Table 1). Criterion 2 identified fewer diagnosed asthmatics (71%) but was significantly more

accurate including fewer non-asthmatics (21%) among the patients selected. Although inhaled bronchodilators are recommended for all asthma patients, the third criterion was less sensitive in identifying asthma patients than the more general first and second criteria.

Specificity and NPVs were artificially high for all criteria due to the large numbers of non-asthmatics included in the data source.

Asthma treatment

The most commonly prescribed anti-asthma medications were the inhaled short-acting bronchodilators (Table 2). In total, these were prescribed to 74.2% ($n = 319$ of 430) of all asthma patients. This drug group also exhibited a large degree of homogeneity of use, with 70.9% ($n = 319$) of the 450 patients prescribed these drugs being patients with an asthma diagnosis. The main other indications associated with the use of these medications were acute bronchitis (7.6% without concurrent asthma diagnosis, $n = 34$ of 450) and dyspnoea (6.9% without concurrent asthma diagnosis, $n = 31$ of 450).

Inhaled corticosteroids were prescribed to 60.6% ($n = 261$) of the 430 asthma patients. Of the 332 patients prescribed this drug group, the majority (78.6%, $n = 261$ of 332) had an asthma diagnosis. Again, acute bronchitis (6.0% without concurrent asthma diagnosis, $n = 20/332$) was the main confounding indication. Interestingly, only 40.9% ($n = 176$) of the 430 asthma patients were prescribed both a short-acting bronchodilator and an inhaled corticosteroid during the study period. Five asthma patients were treated with oral, rather than inhaled, β -agonists. Of the medications included in Table 2, inhaled cromoglycates were the least specific for an asthma diagnosis (51.3% of the users had an asthma diagnosis, $n = 19/37$), while in this age group xanthines were used almost exclusively for asthma.

Identification of exacerbations

Since we were interested in finding exacerbation episodes in patients with a known asthma diagnosis, we selected the second criterion, i.e. two or more R03 medications in 12 months, as the best definition of an asthma patient. The exacerbation analysis was performed on

Table 2 Number of patients aged 18–49 years per diagnosis receiving anti-asthma medications. In total, 587 patients received prescriptions for anti-asthma medications. Numbers for each medication group cannot be summed due to patients with multiple medications and diagnoses

Indication (International Classification for Primary Care)	Total (<i>n</i> = 587)	Asthma					Other respiratory without concomitant asthma			Non-respiratory	
		Asthma (R96)	Dyspnoea (R02)	Acute bronchitis (R78)	Chronic obstructive pulmonary disease (R91/R95)	Hayfever (R97)	Other	Non- respiratory	No diagnosis		
Inhaled short-acting bronchodilator	450	319	31	34	19	15	16	9	8		
Inhaled corticosteroid	332	261	8	20	16	7	15	1	7		
Inhaled cromoglycates	37	19	4	0	3	8	2	1	0		
Xanthines	6	4	0	0	0	0	0	0	2		
Other oral anti-asthma agents	5	5	0	0	0	0	0	0	0		

this sub-population of asthma patients. This criterion showed the best possible PPV in combination with a relatively high sensitivity (Table 1). The PPVs of criteria 3 and 4 were not significantly higher, but their sensitivities were significantly lower.

Identification of asthma exacerbations using the first criteria, i.e. a short course of oral corticosteroids among patients receiving other anti-asthma medications, had a reasonable PPV (0.67); however, this criterion identified only 23% of all exacerbations (Table 3). Addition of oral antibiotics, the second criterion, increased the number of exacerbations identified to 55% but also had a corresponding decrease in the number of patients correctly identified as having an asthma exacerbation. Again high specificity and NPVs were observed.

Exacerbation treatment

In total, 261 exacerbation episodes were identified, and medication was prescribed in 40.9% (107 of 261) of these. During the study period, 146 short courses of oral corticosteroids were prescribed. A diagnosis of an asthma exacerbation was recorded for less than one-half of these courses (69 of 146; 47.3%), and only asthma was recorded for another 13.7% (20 of 146, Table 4). Acute bronchitis without concomitant asthma was the main confounding diagnosis.

A similar distribution was seen for the use of short-course antibiotics by asthma patients. According to Table 4, these medications were registered for an asthma exacerbation in less than one-third of the 249 prescriptions (75 of 249; 30.1%). In 39.0% (97 of 249), the prescriptions were recorded either for acute bronchitis without concomitant asthma or for sinusitis with or without concomitant asthma.

Discussion

With sub-optimal treatment of diagnosed patients being a major health care problem, valid identification of patients with a specific disease from easily accessible data sources plays an important role in the development of indicators for assessing the quality of prescribing. In this study, we have shown that patients with an asthma diagnosis can be identified from prescribing data, but their exacerbation episodes cannot.

In general, identification from prescribing data of patients with a particular disease relies heavily on the assumption that these patients are all receiving drugs normally associated with treatment of the condition. Anti-asthma medications are also used in the treatment of other respiratory conditions. Inhaled short-acting β -agonists, ipratropium and corticosteroids are all recommended for the treatment of COPD [26] and,

Table 3 Sensitivity, specificity and predictive values for criteria to identify asthma exacerbation from prescribing data (95% confidence intervals in parentheses)

Asthma exacerbation identification criteria	Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value (95% CI)	Negative predictive value (95% CI)
Short-course oral corticosteroid	0.23 (0.20–0.28)	0.99 (0.99–0.99)	0.67 (0.59–0.75)	0.93 (0.92–0.94)
Short-course oral corticosteroid or short-course antibiotic	0.55 (0.50–0.60)	0.96 (0.96–0.97)	0.58 (0.53–0.63)	0.95 (0.95–0.96)

Table 4 Number of prescriptions per diagnosis for short-course oral corticosteroids and antibiotics in patients aged 18–49 years receiving two or more anti-asthma medications in 12 months

Indication (International Classification for Primary Care)	Total	Asthma		Other respiratory				Non-respiratory		
		Exacerbation (R96.4/R78)	Chronic asthma (R96.5)	Acute bronchitis (R78) no concomitant asthma	Chronic obstructive pulmonary disease (R91/R95)	Upper airways infection (R74)	Sinusitis (R75)	Other respiratory	Non-respiratory	No diagnosis recorded
Short-course oral corticosteroid	146	69	20	29	7	3	1	13	4	0
Specified short-course oral antibiotics	249	75	8	56	5	16	41	23	25	0

although the Cochrane group [27] found no scientific evidence for using β -agonists for acute bronchitis, several studies have shown that these drugs are also commonly used for this indication in general practice [28, 29]. Non-asthma patients treated with asthma drugs and asthma patients not treated with asthma medications will lower the validity of using prescribing data for identifying patients. Using complete records from general practice, which included both diagnosis and medication use, we were able to take both errors into account in our evaluation.

In the general practices examined, asthma medication had been prescribed to 3.6% of all patients aged 18–49 years, and 2.6% of all patients had an asthma diagnosis. This is comparable with prevalences previously found in the same region for adult asthma and their medication use in general practice patients [30, 31]. Almost 5% of all diagnosed asthma patients did not receive any asthma medication during the study period.

PPVs and NPVs as well as sensitivities and specificities were calculated for different criteria for identifying diagnosed asthma patients and their exacerbations. The validity of a criterion, however, was determined primarily by its sensitivity, the proportion of all asthmatics or exacerbations correctly identified, and the PPV, the proportion of patients identified who actually have an asthma or exacerbation diagnosis. High specificity and NPVs can largely be attributed to the relatively large number of non-asthma patients contained in the database rather than to the accuracy of the criteria.

Selection of a particular criterion will always depend on the focus of interest. In order to assess the quality of asthma treatment provided by a doctor, it is important to find as many patients as possible who definitely have an asthma diagnosis. For this, the criterion of prescription of two or more anti-asthma medications in 12 months appears to be the most appropriate. It should be taken into account however that this criterion still provides an under-representation of all patients diagnosed with asthma, identifying 71% of all diagnosed asthmatics. Of those patients identified, it included almost 20% non-asthma patients. When the focus, for

example is on cost of asthma management, then using two or more anti-asthma medications to determine the number of asthma patients being treated may overestimate the total cost by approximately 10% due to the differences in sensitivity and PPV. If under-treatment is the specific question of interest, then using one anti-asthma medication as a selection criterion increases capture of potentially under-treated patients. Clearly, none of the criteria will be able to detect asthma patients treated with non-asthma medication or without medication [32]. A further limitation of these medication use criteria is the inability to detect patients whose asthma has not been diagnosed by the doctor.

Identification of exacerbations among asthmatic patients is more problematic than the identification of a diagnosed asthma patient. The Dutch and the international asthma guidelines emphasise treating exacerbations with inhaled or oral corticosteroids rather than with antibiotics. Although oral corticosteroids are frequently used as first-line treatment for exacerbations [33], the use of such drugs as a marker will only detect the more severe exacerbations treated in accordance with the guidelines. Our study showed that oral corticosteroids were prescribed in 26% of the 261 recorded exacerbations, while antibiotics were prescribed in 29%. Both oral corticosteroids and antibiotics are used in a large number of indications besides asthma. This lack of indication specificity contributes to the relatively low PPV seen, especially when including antibiotic treatment. Besides this, almost 60% of the recorded exacerbation episodes were treated with neither oral corticosteroids nor antibiotics. It can be expected that patients already treated with inhaled corticosteroids could be advised to increase the dose of their routine medications rather than receiving a new prescription. The use of inhaled corticosteroids for exacerbation episodes may account for the low sensitivities seen for both exacerbation criteria.

Our study focussed on the adult asthma population. Since the prevalence of other diseases for which anti-asthma medication is used is different in both children and elderly, the results cannot be generalised to those

age groups. It is expected that the PPVs of our criteria will be lower in these age groups, due to the higher prevalence of acute bronchitis and hay fever in children and of COPD in elderly. Further work determining the validity of criteria for other age groups is recommended.

Misclassification can occur in any database. In our study, 1% of the prescriptions did not have a diagnosis and another 1% of the patients receiving asthma medication only had a non-respiratory diagnosis. This indicates that coding by the GPs was sufficiently accurate.

From this study, we can conclude that prescribing data can be used to identify diagnosed asthma patients in general practice. While identification of asthma patients based on prescribing data is not ideal, it does provide a reasonable alternative if diagnosis is not available. For assessing the quality of prescribing, it seems that two or more anti-asthma items in a 12-month period, as has been proposed in earlier studies [34, 35, 36], is a valid criterion. Of course, depending on the focus of the problem, other criteria could be used. For the identification of asthma exacerbations, a reliable marker remains troublesome. Use of short courses of corticosteroids or antibiotics may be considered as a marker for exacerbations that are managed with oral treatment, but will introduce a sizeable error due to the inclusion of many acute bronchitis and sinusitis patients.

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