DEFINING AND VALIDATING CHRONIC DISEASES: AN ADMINISTRATIVE DATA APPROACH

An Update with ICD-10-CA

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Background

This report is a follow-up to the 2006 Manitoba Centre for Health Policy (MCHP) report entitled *Defining and Validating Chronic Diseases: An Administrative Data Approach* (Lix et al., 2006). In that report, six conditions were investigated to assess the validity of administrative data for ascertaining cases of chronic disease. Case ascertainment was conducted using hospital separations and physician claims data coded in the 9th revision of the International Classification of Diseases (i.e., ICD-9-CM), in addition to prescription drug data.

Beginning in the 2004/05 fiscal year, hospital separation abstracts for Manitoba are coded using the 10th revision, Canadian modification of the ICD system (i.e., ICD-10-CA). In this report, the case ascertainment methods from the 2006 report were updated to include the relevant ICD-10-CA codes for identifying cases of arthritis (including both rheumatoid arthritis and osteoarthritis), asthma, coronary heart disease, diabetes, hypertension, and stroke. As well, one new chronic health condition was considered: irritable bowel syndrome (IBS). IBS is a common gastrointestinal condition that affects an estimated 14% to 24% of the population and is characterized by abdominal pain, bloating, and disturbed defecation. It is increasingly being recognized as a condition that places a significant burden on the health system and affects the productivity and quality of life of affected individuals.

Methods

The methodology adopted in the current report mirrors the methodology adopted in the 2006 report. Data sources for the research are hospital separations, physician billing claims, and prescription drug records in the Research Data Repository housed at MCHP. Diagnostic codes in hospital data are from ICD-9-CM and ICD-10-CA and diagnostic codes in physician data are from ICD-9-CM. Medication codes in prescription drug data are from the Anatomic Therapeutic Chemical (ATC) coding system maintained by the World Health Organization (WHO) Collaborating Centre for Drug Statistics Methodology.

Chronic disease case ascertainment algorithms were validated using self-report chronic disease data from cycle 3.1 of the Canadian Community Health Survey (CCHS). The survey data were linked to administrative data using the personal health identification number (PHIN). The CCHS validation cohort included 5,099 adults 19 years of age and older and 701 youth 12 to 18 years of age. Validation indices are the kappa ( ) statistic, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and Youden's (1950) index, which is a summary measure of sensitivity and specificity.

Chronic disease prevalence estimates were generated for each algorithm. These prevalence estimates are computed for the Manitoba population using data from 2001/02 to 2005/06. Venn diagrams are used to assess the unique and shared contribution of different administrative data sources for ascertaining cases of chronic disease.

Key Findings

The findings are very similar to those summarized in the 2006 report. That is, administrative data exhibited very good to excellent validity for identifying cases of asthma, diabetes, and hypertension. Administrative data exhibited fair to good validity for identifying cases of arthritis, osteoarthritis, non-fatal heart disease, and non-fatal stroke. Administrative data exhibited poor validity for identifying cases of irritable bowel syndrome and rheumatoid arthritis. For irritable bowel syndrome, this latter finding is likely due to the nature of the disease, which has no single biological marker and is instead diagnosed using a variety of symptom-based criteria. For rheumatoid arthritis, the finding of poor validity is likely due to bias in the validation data source.

Arthritis

Sixteen algorithms were investigated for all forms of arthritis, rheumatoid arthritis, and osteoarthritis. For all forms of arthritis, agreement between survey and administrative data, as measured by κ, was highest (0.38) for the two-year algorithm based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with one or more physician billing claims. Youden's index was highest (0.44) for two of the five-year algorithms. The first algorithm was based on two or more physician billing claims and the second algorithm was based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with one or more physician billing claims. These results are virtually identical to those obtained in the 2006 report.

For rheumatoid arthritis, κ (0.21) and Youden's index (0.14) were highest for the five-year algorithm based on one or more physician billing claims. The five-year algorithm based on two or more physician billing claims also had a Youden's index of 0.14. These results are consistent with those in the 2006 report.

For osteoarthritis, κ (0.35) was highest for the five-year algorithm based on one or more physician billing claims. Youden's index was highest (0.42) for several algorithms based on three or five years of data. These results are also consistent with those in the 2006 report.

Asthma

Twenty-eight algorithms were considered and evaluated for the CCHS validation cohort that was 12+ years of age. The algorithm with the highest value of κ (0.56) was based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records in three years. The algorithm with the highest value of Youden's index (0.72) was based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records in five years. These results are consistent with those in the 2006 report.

Coronary Heart Disease

Twenty-eight algorithms were investigated. The algorithm with the highest value of κ (0.50) was based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with one or more physician billing claims in five years. The algorithm with the highest value of Youden's index (0.64) was based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records in five years. These results are somewhat different from the 2006 report, where a three-year algorithm resulted in the highest estimate of κ and the estimated agreement was also slightly higher (i.e., κ = 0.55).

Diabetes

Thirty-two algorithms were investigated. The algorithm with the highest value of κ (0.87) was based on one or more hospital separations or two or more physician billing claims or one or more prescription drug records in both one and two years. The algorithm with the highest value of Youden's index (0.92) occurred for two algorithms. The first was based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records in five years and the second was based on one or more hospital separations or one or more physician billing claims or two or more prescription drug records in five years. However, several other algorithms produced equally high values for this index, including algorithms based on all three data sources in two or three years of data. This is consistent with the results in the 2006 report.

Hypertension

Twenty-eight algorithms were considered. The highest agreement between administrative and survey data (0.70) and Youden's index (0.71) was observed for the one-year algorithm based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records. However, two other algorithms resulted in similar estimates. Again, other algorithms produced similar numeric values for the validation indices. These results are consistent with those in the 2006 report.

Stroke

A total of 24 algorithms were considered. The algorithm with the highest κ (0.46) was based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with one or more physician billing claims in three years. The algorithm with the highest Youden's index (0.62) was based on one or more hospital separations or one or more physician billing claims or one or more prescription records in five years. These results are consistent with those in the 2006 report.

Irritable Bowel Syndrome

Twenty algorithms were investigated. The algorithm with the highest value of κ (0.24) was based on one or more hospital separations or two or more physician billing claims in five years. The algorithm with the highest value of Youden's index (0.29) was based on one or more hospital separations or one or more physician billing claims in five years.

Conclusions and Recommendations

The validation results contained in this report can be used to select one or more algorithms to generate chronic disease prevalence estimates for the Manitoba population. Depending on the goals of future reports, chronic disease algorithms can be selected based on high agreement between survey and administrative data, high sensitivity to detect positive chronic disease cases, high specificity to avoid detecting false positive cases, or the maximum combination of sensitivity and specificity. This research can be conducted using multiple years of Manitoba's administrative data because it identifies relevant diagnostic codes in both the ICD-9-CM and ICD-10-CA systems.

Chapter 1: Introduction

Administrative data are being used in an increasing number of studies about chronic disease. These data are used to monitor demographic, socioeconomic, and temporal variations in prevalence and incidence of chronic disease, to detect geographic clusters of disease cases that may facilitate the study of environmental causes of disease, and to conduct comparative studies of health service use and costs for chronic disease cases and healthy controls. The popularity of administrative data stems from the fact that these data are relatively easy to access and process, can be used to monitor a variety of diseases, and can provide both cross-sectional and longitudinal information about chronic diseases.

Methods to ascertain chronic disease cases in administrative data are continually being refined as new administrative data sources are added to provincial data repositories, new validation sources are identified, and new methodologies for evaluating data quality and validity are developed. In Manitoba, one significant change to administrative data holdings was the adoption of the ICD-10-CA coding system in hospital separation abstracts in the 2004/05 fiscal year. ICD-10 was endorsed by the Forty-third World Health Assembly in May 1990 and came into use in World Health Organization (WHO) member states beginning in 1994. The WHO is the official publisher of ICD-10.

The Canadian Institutes of Health Information (CIHI) received permission from the WHO to enhance the classification system to meet Canadian needs. CIHI established the National ICD-10 Modification Advisory Task Force in August 1998 to recommend initial enhancements, if necessary, to ICD-10 for use in Canada. There was significant interest from several provinces to produce enhancements to ICD-10 prior to implementation. As a result, CIHI proceeded with developing a Canadian version of ICD-10. This type of enhancement work has occurred in several other countries (e.g., Australia), so that now there are multiple enhanced versions of ICD-10 in existence.

ICD-10 represents the broadest scope of any ICD version to date. ICD-9 has 6,969 codes while there are 12,420 codes in ICD-10. Unlike ICD-9, ICD-10-CA applies beyond acute hospital care. It also includes conditions and situations that are not just diseases but represent risk factors to health, such as occupational and environmental factors, lifestyle factors, and psycho-social circumstances.

Purpose and Objectives

The purpose of this report is to examine the validity of administrative data for monitoring the prevalence of chronic disease in Manitoba. Specific objectives are:

(1) Report relevant ICD-10-CA codes for ascertaining cases of chronic disease in administrative health data;
(2) Evaluate the validity of multiple algorithms for identifying disease cases from Manitoba administrative data.

Funding to conduct this research was provided by the Lupina Foundation. The Lupina Foundation is a private, Canadian charitable foundation established in April 2000 that is committed to research and innovation related to health and societal issues. In 2005, the Lupina Foundation established the Concept Dictionary Fund to support the development of MCHP's web-based documentation in five key areas: (a) the transition from ICD-9-CM to ICD-10-CA, (b) social determinants of health, (c) costing methodologies, (d) pharmaceutical data concepts, and (e) knowledge translation/research dissemination.

This report is being provided to you in hard copy for initial review. Its contents will be placed online in MCHP's web-based Concept Dictionary after this review is completed. The Concept Dictionary can be accessed at the following URL:
http://umanitoba.ca/faculties/medicine/units/mchp/

CHAPTER 2: METHODS

This chapter describes the methods used to identify chronic disease cases from administrative data. Much of the information is extracted from the 2006 report by Lix et al.

Sources of Administrative Data to Define Chronic Disease Algorithms

Administrative data used to define the chronic disease algorithms were obtained from the Population Health Research Data Repository housed at MCHP. Data was collected for the five year period ending March 31, 2006 for algorithm validation and prevalence estimation. The three sources of administrative data for this study were: hospital separation abstracts, physician billing claims, and prescription drug records.

Hospital abstracts are completed at the point of discharge from acute care facilities in Manitoba. They include diagnosis codes based on the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) until March 31, 2004. As of April 1, 2004 hospital abstracts moved to the International Classification of Diseases, 10th revision with Canadian Enhancements (ICD-10-CA). Only inpatient separations were used to define the algorithms.

Manitoba physicians who are paid on a fee-for-service basis submit billing claims to Manitoba Health. These claims contain a single ICD-9-CM diagnostic code. A small proportion of physicians are salaried, but most submit parallel billing claims for administrative purposes. Therefore, almost all contacts with Manitoba physicians are captured in the Repository.

The third source of data for defining chronic disease algorithms are prescription drug records from the Drug Programs Information Network (DPIN) database, an electronic, on-line, point-of-sale prescription drug database connecting all retail pharmacies in Manitoba. This database captures information about prescription drug dispensations for all Manitoba residents, regardless of insurance coverage or final payer.

Table 2-1 summarizes the ICD-9-CM codes that were selected to define the chronic diseases from physician billing claims and both the ICD-9-CM and ICD-10-CA codes that were selected to define the chronic diseases from hospital separations. The ICD-10-CA codes were selected after a thorough review of the literature on chronic disease case ascertainment methods.

Table 2-1: Diagnosis codes used to define chronic diseases with administrative data

Disease	ICD-9-CM Diagnosis Codes	ICD-10-CA Diagnosis Codes
Arthritis	714: rheumatoid arthritis 715: osteoarthritis 446, 710: connective tissue disorders (446 = Polyarteritis nodosa and allied conditions; 710 = Diffuse diseases of connective tissue) 720: ankylosing spondylitis 274: gout 711-713, 716-719, 721, 725-729, 739: other arthritis and related conditions	M05-M06: rheumatoid arthritis M15-M19: osteoarthritis M07, M10, M11-M14, M30-M36: other inflammatory and connective tissue diseases M00-M03, M20-M25, M65-M79: Other arthritis and rheumatic conditions
Asthma	493: asthma	J45: asthma J46: status asthmaticus
Coronary Heart Disease (CHD)	410 – 414: ischemic heart disease	I20 – I25: ischaemic heart diseases
Diabetes	250: diabetes mellitus	E10 – E14: diabetes mellitus
Hypertension	401: essential hypertension	I10-I14: essential (primary) hypertension
Stroke	430 – 438: cerebrovascular disease	I60 – I69: cerebrovascular disease
Irritable Bowel Syndrome (IBS)	564: functional digestive disorders not elsewhere classified (564.1: irritable bowel syndrome)	K58: irritable bowel syndrome

Assessment of Potential Diagnostic Drift in Chronic Disease ICD-10-CA Codes

The quality of ICD-10 coding has been investigated in a number of recent studies (see e.g., Henderson, Shepheard, & Sundararajan, 2006). One issue is that of diagnostic drift, instability in coding practices over time (Crow et al., 2005), which can result in bias in the ascertainment of specific types of health conditions (Terris, Litaker, & Koroukian, 2006). While diagnostic drift is most likely to occur over long time periods as a result of changes in diagnostic criteria, there is also some concern that it may arise after the introduction of a new coding system, particularly between the first and subsequent years, as coders gain familiarity with the components of the classification system.

We examined the relative frequency of diagnostic codes for ascertaining chronic disease cases between the first and second years after the introduction of ICD-10-CA in hospital separation abstracts in Manitoba. The frequency of each diagnostic code is presented in Table 2-2.

There appears to be little evidence of diagnostic drift between the first and second years after the introduction of ICD-10-CA (Table 2-2). The possible exception is for osteoarthritis codes M17 (arthrosis of knee) which exhibited a large relative increase in frequency, and M19 (other arthrosis), which exhibited a large relative decrease in frequency. This apparent change in coding practices might warrant further investigation via a validation study using trained coders to re-evaluate coding quality (Henderson et al., 2006).

Table 2-2: Frequency of diagnostic codes

		2004/05		2005/06	
	Diagnosis	**Frequency**	**Percent**	**Frequency**	**Percent**
Rheumatoid Arthritis	M05	22	4.2	19	3.5
	M06	503	95.8	517	96.5
	Total	525	100.0	536	100.0
Osteoarthritis	M15	284	8.2	283	6.5
	M16	880	25.4	1,157	26.6
	M17	1,400	40.4	1,990	45.8
	M18	25	0.7	9	0.2
	M19	879	25.3	906	20.9
	Total	3,468	100.0	4,345	100.0
Asthma	J43	144	1.9	113	1.4
	J44	5,990	77.9	6,198	78.8
	J45	1,558	20.3	1,558	19.8
	J46	0	0.0	0	0.0
	Total	7,692	100.0	7,869	100.0
CHD	I20	1,982	17.2	1,878	17.3
	I21	3,092	26.9	2,882	26.6
	I22	54	0.5	38	0.4
	I24	83	0.7	75	0.7
	I25	6,287	54.7	5,977	55.1
	Total	11,498	100.0	10,850	100.0
Diabetes	E10	1,122	8.0	995	7.2
	E11	11,914	85.5	12,086	87.2
	E13	110	0.8	93	0.7
	E14	795	5.7	692	5.0
	Total	13,941	100.0	13,866	100.0
Hypertension	I10	11,406	89.6	13,892	87.5
	I11	147	1.2	228	1.4
	I12	1,076	8.5	1,581	10.0
	I13	64	0.5	165	1.0
	I15	32	0.3	19	0.1
	Total	12,725	100.0	15,885	100.0
Stroke	I60	129	3.6	117	3.4
	I61	224	6.2	221	6.5
	I62	198	5.5	141	4.1
	I63	747	20.6	791	23.3
	I64	1,003	27.6	944	27.8
	I65	275	7.6	310	9.1
	I66	36	1.0	27	0.8
	I67	319	8.8	272	8.0
	I68	4	0.1	1	0.0
	I69	694	19.1	577	17.0
	Total	3,629	100.0	3,401	100.0

Validating Chronic Disease Algorithms

Validation Data Source

Data from the Canadian Community Health Survey (CCHS), cycle 3.1, collected from January 2005 to January 2006 were used to evaluate the agreement (κ), sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for each of the chronic disease algorithms selected for investigation. The CCHS was conducted by Statistics Canada to provide regular and timely cross-sectional estimates of health determinants, health status and health system utilization for health regions in Canada. The CCHS covered 98 per cent of their target population of individuals 12 years of age and older. Sample sizes were chosen to produce reliable estimates at the health region level. The CCHS sample size for the province of Manitoba was 7,004.

Manitoba CCHS cycle 3.1 data were linked to the administrative data in the Data Repository housed at MCHP via a unique, anonymized personal health identification number (PHIN) for individuals who consented to the linkage. The linkage was achieved for 6,232 respondents 12 years of age and older. From this sub-sample, the cohort of survey respondents with at least five years of continuous coverage under the Manitoba Health Services Insurance Plan prior to the date of their CCHS interview was created. This cohort consisted of 5,099 adults 19+ years of age and 701 youth 12 to 18 years of age. For all diseases, the validation cohort was limited to individuals with five years of coverage because all chronic disease algorithms were based on as many as five years of administrative data. Only the adult cohort (ie., 19 years of age and older) was used to validate chronic disease algorithms for arthritis, coronary heart disease (CHD), diabetes, hypertension, stroke and irritable bowel syndrome (IBS). For asthma, the algorithms were validated using both the adult and youth cohorts (i.e., 12 to 19 years).

Chronic disease algorithms were defined using one, two, three, or five years of administrative data. The years of administrative data that were searched to determine whether a survey respondent could be classified as a disease case were based on the date of the interview. For example, if an individual was interviewed on October 31, 2005 then a one-year algorithm was defined using data from November 1, 2004 to October 31, 2005.

Validation Questions

The CCHS questions used to identify survey respondents with each of the investigated chronic diseases are listed in Table 2-3. Respondents were asked to report chronic diseases according to the following directions:

Now I'd like to ask about certain chronic health conditions which you may have. We are interested in 'long-term conditions' which are expected to last or have already lasted 6 months or more and that have been diagnosed by a health professional.

These directions were repeated to survey respondents throughout their completion of the set of questions about chronic diseases.

Table 2-3: CCHS questions used to identify survey respondents with chronic diseases

Disease	Relevant CCHS Question(s)
Arthritis	Do you have arthritis or rheumatism, excluding fibromyalgia? What kind of arthritis do you have?
Asthma	Do you have asthma?
Diabetes	Do you have diabetes?
Hypertension	Do you have high blood pressure?
Coronary Heart Disease	Do you have heart disease?
Stroke	Do you suffer from the effects of a stroke?
Irritable Bowel Syndrome	Do you suffer from a bowel disorder such as Crohn's Disease, ulcerative colitis, Irritable Bowel Syndrome or bowel incontinence? What kind of bowel disease do you have?

The CCHS was selected as the validation source in this study because next to administrative data, it is the only source for obtaining population-based chronic disease prevalence estimates in Manitoba. As well, the sample size for Manitoba in cycle 3.1 of the CCHS was large enough to ensure sufficient numbers of positive disease cases even for relatively rare conditions. For details on the validity of using survey data to identify disease cases please refer to Lix et al. (2006).

It is important to note, however, that self-reported data may not be an unbiased gold standard. Under-reporting or over-reporting of some chronic diseases in surveys may occur because respondents are not aware of all the diagnoses reported in a patient chart, or because of the lack of correspondent between the lay language used in surveys and the clinical terminology used to record diagnoses in the medical chart. Accurate reporting is more likely to occur for conditions that result in frequent contacts with a health professional.

Validation Methods

The following description of the validation indices has been extracted from the report by Lix et al (2006), who use the same validation indices as this study.

Six indices were used to evaluate the validity of chronic disease algorithms. The first was the kappa statistic (κ), a measure of agreement between two sources, each of which is measured on a binary scale (ie., disease present/absent). The interpretation of κ used in this report is (Altman, 1991):

Poor agreement: $\kappa < 0.20$
Fair agreement: $\kappa = 0.20$ to 0.39
Moderate agreement: $\kappa = 0.40$ to 0.59
Good agreement: $\kappa = 0.60$ to 0.79
Very good agreement: $\kappa = 0.80$ to 1.00

Ninety-five percent confidence intervals (CIs) were calculated for κ. These intervals are calculated using the square-root of the asymptotic variable and a critical value from the standard normal distribution.

Sensitivity and specificity were calculated for each chronic disease algorithm. Sensitivity was defined as the percentage of true positive cases an algorithm detects among all positive disease cases. Positive disease cases are survey respondents in the CCHS validation cohort who reported having the specified disease. Specificity was defined as the percentage of true negative cases an algorithm detects among all the negative disease cases. Negative disease cases are survey respondents in the CCHS validation cohort who did not report having the specified disease. For both sensitivity and specificity, 95% CIs were calculated. These confidence intervals are based on the asymptotic standard error and a critical value from the standard normal distribution.

Positive predictive values (PPVs) and negative predictive values (NPVs) are also reported for each chronic disease algorithm. PPV refers to the percentage of individuals with a positive result for an algorithm among those who reported having the disease. NPV refers to the percentage of individuals with a negative result for an algorithm who did not report having the disease. Ninety-five percent CIs were also calculated for PPV and NPV, and were based on the asymptotic standard error and a critical value from the standard normal distribution.

Youden's (1950) index, which combined information on sensitivity and specificity, was computed for each algorithm. The index is defined as sensitivity + specificity – 1, where sensitivity and specificity are calculated as proportions. Youden's index has minimum and maximum values of -1 and +1, respectively, with a value of +1 representing the optimal value for an algorithm.

Calculating Provincial Estimates

The population registry in the Research Data Repository was used to define population cohorts to derive numerator and denominator data for calculating crude provincial prevalence estimates for each algorithm. Provincial prevalence estimates were calculated for the population 19 years of age and older for all chronic diseases except asthma, whose prevalence estimates were calculated for the population 12 years of age and older.

Cross-sectional provincial prevalence estimates were calculated to facilitate comparisons among the chronic disease algorithms at a single point in time. Table 2-4 lists the years that were used to calculate estimates based on algorithms defined for one-, two-, three-, and five-years of administrative data. For example, all estimates based on one year of data were defined for the Manitoba population continuously registered with the Manitoba Health Services Insurance Plan for the period April 1, 2005 to March 31, 2006.

Table 2-4: Time periods used to define provincial chronic disease prevalence estimates

# Years	Time Period
1	April 1, 2005 to March 31, 2006
2	April 1, 2004 to March 31, 2006
3	April 1, 2003 to March 31, 2006
5	April 1, 2001 to March 31, 2006

Venn diagrams were used to describe chronic disease case counts (i.e., the numerator data for provincial prevalence estimates) for each algorithm. These diagrams compare the number and per cent of disease cases obtained from each of the three sources of administrative data. This information is important for assessing potential biases in chronic disease prevalence estimates if one or more administrative data sources are not available for defining an algorithm. A Venn diagram depicts both the unique and shared number of disease cases from each source.

CHAPTER 3: ARTHRITIS

Description of Arthritis Algorithms

Table 3-1 lists the 16 algorithms that were investigated for all forms of arthritis, rheumatoid arthritis (RA), and osteoarthritis (OA) in this study. The arthritis algorithms were based on as many as five years of administrative data. Two of the four algorithms in each time period were based only on physician billing claims, one algorithm was based on a combination of physician billing claims and hospital separations and the remaining algorithm was based on a combination of all three administrative data sources. For example, algorithm #1 identified individuals as arthritis cases if they had one or more physician billing claims with an arthritis diagnosis code in a one-year period. It is important to note that none of the arthritis algorithms rely solely on prescription drug data for identification of arthritis cases.

Table 3-1: Arthritis algorithms selected for validation

# Years	Algorithm	Hospital Separations or	Physician Claims or	Physician Claims and Prescription Drug Records
1	1		1 or more	
	2		2 or more	
	3	1 or more	2 or more	
	4	1 or more	2 or more	1 and 2 or more
2	5		1 or more	
	6		2 or more	
	7	1 or more	2 or more	
	8	1 or more	2 or more	1 and 2 or more
3	9		1 or more	
	10		2 or more	
	11	1 or more	2 or more	
	12	1 or more	2 or more	1 and 2 or more
5	13		1 or more	
	14		2 or more	
	15	1 or more	2 or more	
	16	1 or more	2 or more	1 and 2 or more

Validation Results

Table 3-2 contains point estimates for the six validation indices for each of the 16 algorithms that were investigated for all forms of arthritis. The 95% CIs for the estimates are reported in Appendix Table A.1.

There was fair agreement between the administrative and survey data, with κ ranging from 0.28 to 0.38. The highest value was for the two-year algorithm based on one or more hospital separations or two or more physician billing claims or two or more prescriptions drug records in combination with one or more physician billing claims (i.e., algorithm #8). There was very little within-algorithm variation (0.2), in the values of κ for three of the two-, three-, and five-year algorithms.

Sensitivity was the highest (78.2%) for the five-year algorithm based on one or more physician billing claims (i.e., algorithm #13). There is a substantial advantage that can be gained from using multiple years of administrative data to obtain a sensitive algorithm. For example, a one unit increase in number of years caused sensitivity to increase by a minimum of 9.3% for each algorithm.

Specificity ranged from 61.5% to 95.4%. The most specific algorithms were those based on two or more physician billing claims (i.e., algorithms #2, #6, #10, and #14). However, there was a minimal difference in specificity for the algorithms based on one or more hospital separations or two or more physician billing claims (i. e., algorithms #3, #7, #11, and #15). For example, the one-year algorithm based on two or more physician billing claims (i.e., algorithm #6) had a specificity of 90.4% while the algorithm based on one or more hospital separations or two or more physician billing claims (i.e., algorithm #7) had a specificity of 90.3%. The decrease in specificity from using multiple years of administrative data is less, in absolute terms, than the increase in sensitivity as represented by an increasing Youden's index.

For all forms of arthritis, Youden's index ranged from 0.22 to 0.44, with the highest values being observed for the five-year algorithms. Youden's index varied by less than 0.04 between the four, five-year algorithms, with two of these algorithms having a value of 0.44.

The PPV of an arthritis diagnosis ranged from 35.5% to 61.5%. The highest value was observed for the one-year algorithm based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with one or more physician billing claims (i.e., algorithm #4). There was little variation in PPV for all one-year algorithms excluding the algorithm based on one or more physician billing claims (ie., algorithm #1). The NPV had less than a 10% variation among all algorithms, with the highest value (91.2%) being observed for the five-year algorithm based on one or more physician billing claims (i.e., algorithm #13).

Table 3-2: Estimates of agreement, sensitivity, specificity, and predictive value for all forms of arthritis algorithms

# Years		Algorithm	κ	Sens. (%)	Spec. (%)	Youden	PPV (%)	NPV (%)
1	1	1+ P	0.32	43.1	87.6	0.31	48.5	85.1
	2	2+ P	0.28	26.7	95.4	0.22	61.2	82.8
	3	1+ H or 2+ P	0.28	27.2	95.4	0.23	61.3	82.9
	4	1+ H or 2+ P or (1 P & 2+ Rx)	0.34	34.2	94.2	0.28	61.5	84.1
2	5	1+ P	0.33	58.8	79.0	0.38	43.1	87.6
	6	2+ P	0.35	41.6	90.4	0.32	54.1	85.1
	7	1+ H or 2+ P	0.35	41.8	90.3	0.32	54.0	85.1
	8	1+ H or 2+ P or (1 P & 2+ Rx)	0.38	48.7	88.0	0.37	52.4	86.4
3	9	1+ P	31.0	68.1	71.3	0.39	39.1	89.2
	10	2+ P	36.9	51.8	85.7	0.38	49.5	86.8
	11	1+ H or 2+ P	36.8	51.9	85.6	0.37	49.4	86.8
	12	1+ H or 2+ P or (1 P & 2+ Rx)	36.4	58.6	81.4	0.40	46.1	87.9
5	13	1+ P	0.28	78.2	61.5	0.40	35.5	91.2
	14	2+ P	0.37	66.6	76.9	0.44	43.9	89.5
	15	1+ H or 2+ P	0.36	66.7	76.7	0.43	43.7	89.5
	16	1+ H or 2+ P or (1 P & 2+ Rx)	0.35	71.7	72.3	0.44	41.2	90.4

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; PPV = Positive Predictive Value; NPV = Negative Predictive Value; 95% confidence intervals for all estimates are reported in Appendix A.

Table 3-3 contains the validation indices for the algorithms investigated for RA. There was poor to fair agreement between administrative and survey data with κ ranging from 0.16 to 0.21. The highest value occurred for the five-year algorithm based on one or more physician billing claims (i.e., algorithm #13). The remaining five-year algorithms had a slightly lower κ of 0.20.

Sensitivity ranged from 9.6% to 14.4% with the highest value being observed for two, five-year algorithms. The first algorithm was based on one or more physician billing claims and the second algorithm on two or more physician billing claims (i.e., algorithms #13 and #14). Specificity was constantly high, with a minimum value of 99.3%. Youden's index ranged from 0.10 to 0.14. All four of the five-year algorithms had a Youden's index of 0.13 or 0.14.

The PPV of a RA diagnosis ranged from 49.7% to 81.4%. The highest value was observed for the one-year algorithm based on one or more hospital separations or two or more physician billing claims (i.e., algorithm #3). However, the PPV for the one-year algorithm based on two or more physician billing claims was only slightly lower. There was almost no variation in NPV, with all 16 algorithms taking on a value of approximately 96%.

Table 3-3: Estimates of agreement, sensitivity, specificity, and predictive values for rheumatoid arthritis algorithms

# Years		Algorithm	κ	Sens. (%)	Spec. (%)	Youden	PPV (%)	NPV (%)
1	1	1+ P	0.17	10.6	99.8	0.10	70.0	96.0
	2	2+ P	0.16	9.6	99.9	0.10	81.1	95.9
	3	1+ H or 2+ P	0.17	9.9	99.9	0.10	81.4	95.9
	4	1+ H or 2+ P or (1 P & 2+ Rx)	0.17	10.1	99.9	0.10	78.7	95.9
2	5	1+ P	0.18	11.2	99.6	0.11	57.7	96.0
	6	2+ P	0.17	10.2	99.8	0.10	69.2	95.9
	7	1+ H or 2+ P	0.17	10.2	99.8	0.10	69.2	95.9
	8	1+ H or 2+ P or (1 P & 2+ Rx)	0.17	10.4	99.8	0.10	66.5	95.9
3	9	1+ P	0.19	12.4	99.6	0.12	57.6	96.0
	10	2+ P	0.17	10.6	99.8	0.10	69.3	95.9
	11	1+ H or 2+ P	0.17	10.6	99.8	0.10	69.3	95.9
	12	1+ H or 2+ P or (1 P & 2+ Rx)	0.18	11.3	99.7	0.11	67.7	96.0
5	13	1+ P	0.21	14.4	99.3	0.14	49.7	96.1
	14	2+ P	0.20	14.4	99.3	0.14	49.7	96.1
	15	1+ H or 2+ P	0.20	13.2	99.6	0.13	59.7	96.1
	16	1+ H or 2+ P or (1 P & 2+ Rx)	0.20	13.3	99.6	0.13	58.5	96.1

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; PPV = Positive Predictive Value; NPV = Negative Predictive Value; 95% confidence intervals for all estimates are reported in Appendix A.

Table 3-4 contains the validation indices for the algorithms investigated for OA. There was fair agreement between the administrative and survey data, with κ ranging from 0.23 to 0.35. The highest value occurred for both the three- and five-year algorithms based on one or more physician billing claims (i.e., algorithms #9 and #13), as well as the five-year algorithm based on one or more hospital separations or two or more physician billing claims or one or more prescription drug records in combination with one or more physician billing claims (i.e., algorithm #16). A slightly lower κ of 0.34 occurred in the remaining five-year algorithms as well as the four-year algorithm based on one or more hospital separations or two or more physician billing claims or one or more prescription drug records in combination with one or more physician billing claims (i.e., algorithms #12, #14, and #15).

Sensitivity ranged from 16.4% to 52.4%. It was consistently the highest for algorithms based on one or more physician billing claims (i.e., algorithms #1, #5, #9, and #13), with the highest value being observed for the five-year algorithm. There is an advantage that can be gained from using multiple years of administrative data to obtain a sensitive algorithm, however the advantage is not as large as that for all forms of arthritis. For example, a one unit increase in number of years caused sensitivity to increase by a minimum of 4.6% for each algorithm.

Specificity was high for all of the algorithms, ranging from 90.0% to 98.9%. In each algorithm the increase in specificity from using multiple years of administrative data outweighed the decrease in specificity. Youden's index ranged from 0.15 to 0.42. The highest value was observed for the five-year algorithm based on one or more physician billing claims (i.e., algorithm #13).

The PPV of an OA diagnosis ranged from 36.5% to 61.6%. The highest value was observed for the one-year algorithm based on two or more physician billing claims (i.e., algorithm #2). The one-year algorithm based on one or more physician billing claims was 12.7% lower than the algorithm based on two or more physician billing claims, indicating a substantial gain in PPV can be achieved by using an algorithm based on two rather than one physician billing claims. The NPV of an OA diagnosis had very little variation, ranging from 91.5% to 94.5%.

Table 3-4: Estimates of agreement, sensitivity, specificity, and predictive values for osteoarthritis algorithms

# Years		Algorithm	κ	Sens. (%)	Spec. (%)	Youden	PPV (%)	NPV (%)
1	1	1+ P	0.30	27.5	96.8	0.24	48.9	92.4
	2	2+ P	0.23	16.4	98.9	0.15	61.6	91.5
	3	1+ H or 2+ P	0.23	16.8	98.8	0.16	60.6	91.5
	4	1+ H or 2+ P or (1 P & 2+ Rx)	0.29	22.9	98.0	0.21	56.3	92.1
2	5	1+ P	0.33	35.4	94.8	0.30	42.9	93.0
	6	2+ P	0.29	23.8	97.9	0.22	55.4	92.1
	7	1+ H or 2+ P	0.29	23.9	97.8	0.22	54.3	92.1
	8	1+ H or 2+ P or (1 P & 2+ Rx)	0.33	31.2	96.6	0.28	50.0	92.7
3	9	1+ P	0.35	42.9	93.2	0.36	41.1	93.7
	10	2+ P	0.31	28.0	97.0	0.25	50.6	92.5
	11	1+ H or 2+ P	0.31	28.1	96.9	0.25	49.7	92.5
	12	1+ H or 2+ P or (1 P & 2+ Rx)	0.34	36.7	94.9	0.32	44.1	93.2
5	13	1+ P	0.35	52.4	90.0	0.42	36.5	94.5
	14	2+ P	0.34	35.3	95.4	0.31	45.9	93.1
	15	1+ H or 2+ P	0.34	35.4	95.3	0.31	45.3	93.1
	16	1+ H or 2+ P or (1 P & 2+ Rx)	0.35	46.2	92.1	0.38	39.2	94.0

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; PPV = Positive Predictive Value; NPV = Negative Predictive Value; 95% confidence intervals for all estimates are reported in Appendix A.

Provincial Estimates

Crude Prevalence Estimates

Provincial crude prevalence estimates for the 16 algorithms for all forms of arthritis, RA, and OA are reported in Table 3-5. Crude prevalence estimates varied substantially across the algorithms. For all forms of arthritis, crude prevalence estimates ranged from 9.4% to 47.7%. Crude prevalence estimates ranged from 0.5% to 1.7% for RA and from 2.4% to 14.5% for OA.

For all forms of arthritis the crude prevalence estimate for the algorithm with the highest κ (i.e., algorithm #8) was 20.4%. For the two algorithms with the highest overall values of Youden's index, (i.e., algorithms #14 and #16) the crude prevalence estimates were 31.8% and 37.8% respectively. The most sensitive algorithm (i.e., algorithm #13) produced a crude prevalence estimate of 47.6%.

For RA, the algorithm with the highest κ, sensitivity and Youden's index (i.e., algorithm #13) resulted in a crude prevalence estimate of 1.7%. Sensitivity and Youden's index

were equally as high for algorithms based on two or more physician billing claims in five-years of data (i.e., algorithm #14). This algorithm produced a crude prevalence estimate of 1.0% for the Manitoba population 19 years of age and older.

For OA the algorithm with the highest κ, sensitivity and Youden's index (i.e., algorithm #13) resulted in a crude prevalence estimate of 14.5%. Kappa was equally as high for two other algorithms (i.e., algorithms #9 and #16) which produced crude prevalence estimates of 11.0% and 12.0% respectively for the Manitoba population 19 years of age and older.

Table 3-5: Crude provincial prevalence estimates for arthritis algorithms, 2001/02 -2005/06

# Years		Algorithm	Arthritis (%)	RA (%)	OA (%)
1	1	1+ P	18.8	0.7	5.3
	2	2+ P	9.4	0.5	2.4
	3	1+ H or 2+ P	9.5	0.5	2.5
	4	1+ H or 2+ P or (1 P & 2+ Rx)	11.8	0.5	3.6
2	5	1+ P	29.2	1.0	8.6
	6	2+ P	16.7	0.6	4.5
	7	1+ H or 2+ P	16.9	0.7	4.6
	8	1+ H or 2+ P or (1 P & 2+ Rx)	20.4	0.7	6.5
3	9	1+ P	36.7	1.2	11.0
	10	2+ P	22.5	0.8	6.0
	11	1+ H or 2+ P	22.7	0.8	6.2
	12	1+ H or 2+ P or (1 P & 2+ Rx)	27.2	0.8	8.6
5	13	1+ P	47.6	1.6	14.5
	14	2+ P	31.8	1.0	8.3
	15	1+ H or 2+ P	32.0	1.0	8.6
	16	1+ H or 2+ P or (1 P & 2+ Rx)	37.7	1.1	11.9

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; 1-year estimates are for 2005/06, 2-year estimates are for 2004/05 - 2005/06, 3-year estimates are for 2003/04 - 2005/06, 5-year estimates are for 2001/02 - 2005/06.

Venn Diagrams

Venn diagrams are presented for the set of algorithms with one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with one or more physician billing claims in one-, two-, three-, or five-years (i.e., algorithms #4, #8, #12, and #16) for all forms of arthritis. The Venn diagrams describe the number and per cent of arthritis cases identified by each of the three data sources for the Manitoba population 19 years of age and older. For example, algorithm #4 resulted in the identification of 101,224 asthma cases in the province, thirty-nine per cent of which were identified from physician data alone. The gain from including hospital data is minimal, with less than one per cent of cases being identified from hospital data alone. Very few cases were identified from all three administrative data sources. Venn diagrams for RA and OA are not presented because the per cent of cases identified by each data source did not differ substantially.

Figure 3-1: Arthritis Algorithm #4: 1+ Hospital Separations or 2+ Physician Billing Claims or 2+ Prescriptions in combination with 1+ Physician Billing Claim, 1 Year

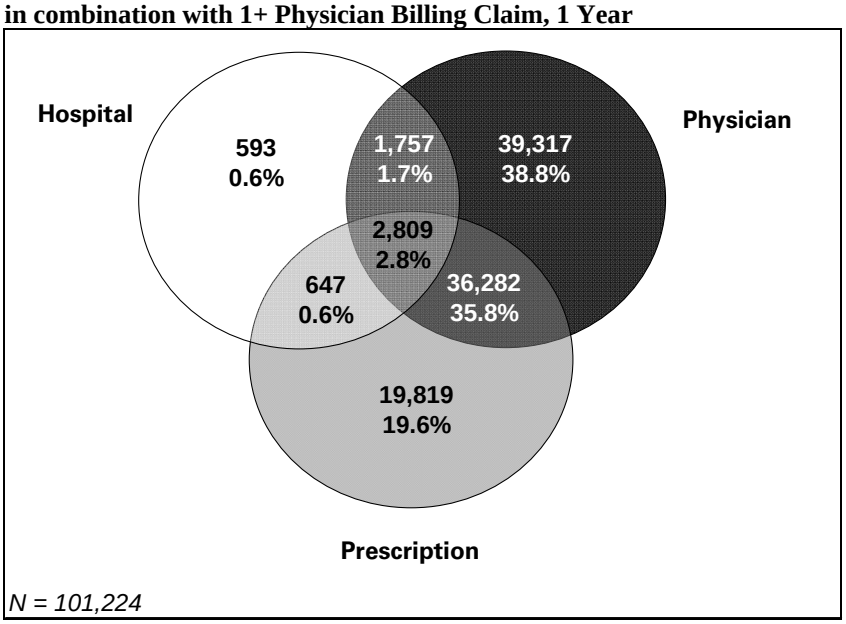


Figure 3-2: Arthritis Algorithm #8: 1+ Hospital Separations or 2+ Physician Billing Claims or 2+ Prescriptions in combination with 1+ Physician Billing Claim, 2 Years

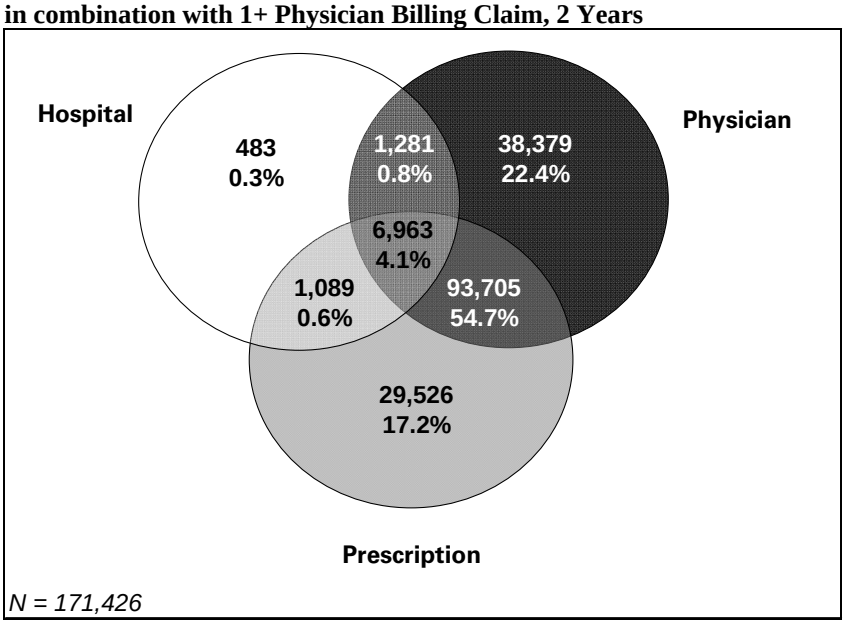


Figure 3-3: Arthritis Algorithm #12: 1+ Hospital Separations or 2+ Physician Billing Claims or 2+ Prescriptions in combination with 1+ Physician Billing Claim, 3 Years

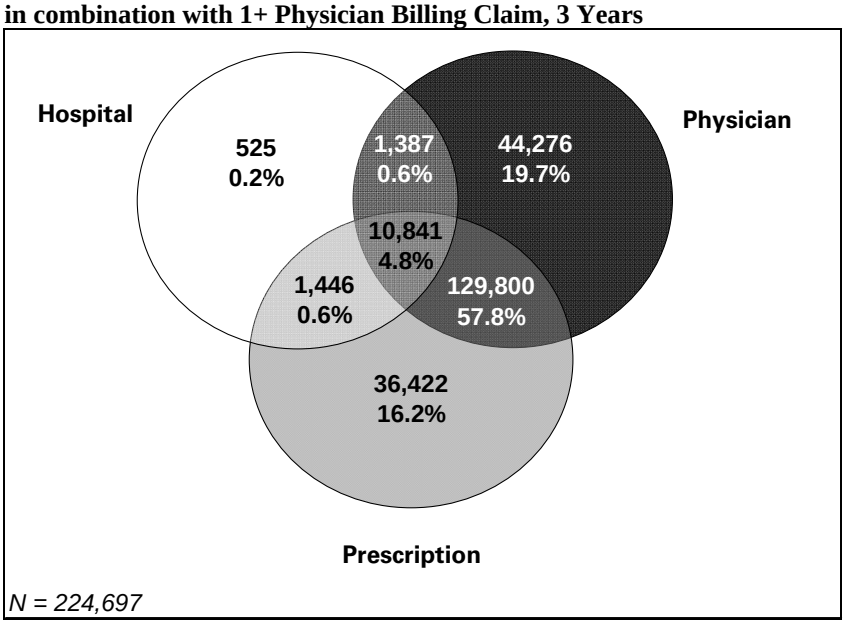
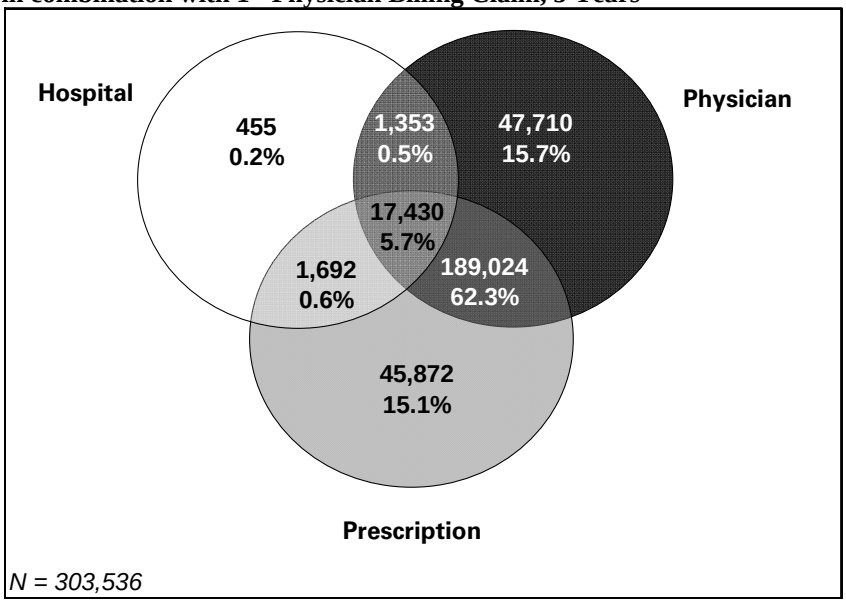


Figure 3-4: Arthritis Algorithm #16: 1+ Hospital Separations or 2+ Physician Billing Claims or 2+ Prescriptions in combination with 1+ Physician Billing Claim, 5 Years



Chapter Summary

The study results reveal that administrative data exhibited fair agreement with survey data for all forms of arthritis and osteoarthritis and poor to fair agreement for rheumatoid arthritis. The algorithm that resulted in the highest agreement between survey and administrative data was not the same for all forms of arthritis, rheumatoid arthritis, and osteoarthritis. For all forms of arthritis, the algorithm that exhibited the highest level of agreement between the two sources (0.38) was based on two years of data and relied on a combination of all three sources of administrative data. For rheumatoid arthritis, the

algorithm that exhibited the highest level of agreement (0.21) was based on five years of data and used only physician claims data. For osteoarthritis, the highest level of agreement between the two sources (0.35) was exhibited for the three- and five-year algorithms based on one or more physician billing claims and the five-year algorithm based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with one or more physician billing claims. Crude prevalence estimates for the algorithms with the highest κ were 20.4% for all forms of arthritis, 1.7% for rheumatoid arthritis, and 11.0%, 14.5%, and 12.0% for osteoarthritis.

If the maximum combination of sensitivity and specificity is the primary interest, then for all forms of arthritis one of two different five-year algorithms should be adopted. The first algorithm is based on two or more physician billing claims and the second algorithm is based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with one or more physician billing claims. For rheumatoid arthritis two of the five-year algorithms based on one or more physician billing claims and two or more physician billing claims resulted in the highest sensitivity and Youden's index. For osteoarthritis the five-year algorithm based on one or more physician billing claims resulted in the highest sensitivity and Youden's index. For all forms of arthritis and rheumatoid arthritis other algorithms based on five years of data produced similar sensitivity and specificity results. Crude prevalence estimates for the algorithms with the maximum value of Youden's index were 31.8% and 37.8% for all forms of arthritis, 1.7% and 1.0% for rheumatoid arthritis and 14.5% for osteoarthritis for the Manitoba population 19 years of age and older.

CHAPTER 4: ASTHMA

Description of Asthma Algorithms

Table 4-1 lists the 28 algorithms that were investigated for asthma in this study. The asthma algorithms were based on as many as five years of administrative data. Two of the algorithms in each time period were based only on physician billing claims, one algorithm was based only on prescription drug data, and the remaining algorithms were based on a combination of two or more of the three data sources. For example, algorithm #1 identified individuals as asthma cases if they had one or more physician billing claim with an asthma diagnosis code in a one-year period.

When assessing the results, it is important to note that all asthma algorithms did not require prescription drug records to appear in combination with a physician billing claim. This is because the drugs identified for inclusion in the study are specific to the treatment of asthma, and would be used only infrequently for the treatment of other chronic diseases.

Table 4-1: Asthma algorithms selected for validation

# Years	Algorithm	Hospital Separations or	Physician Claims or	Prescription Drug Records
1	1		1 or more	
	2		2 or more	
	3			1 or more
	4	1 or more	1 or more	
	5	1 or more	2 or more	
	6	1 or more	1 or more	1 or more
	7	1 or more	2 or more	2 or more
2	8		1 or more	
	9		2 or more	
	10			1 or more
	11	1 or more	1 or more	
	12	1 or more	2 or more	
	13	1 or more	1 or more	1 or more
	14	1 or more	2 or more	2 or more
3	15		1 or more	
	16		2 or more	
	17			1 or more
	18	1 or more	1 or more	
	19	1 or more	2 or more	
	20	1 or more	1 or more	1 or more
	21	1 or more	2 or more	2 or more
5	22		1 or more	
	23		2 or more	
	24			1 or more
	25	1 or more	1 or more	
	26	1 or more	2 or more	
	27	1 or more	1 or more	1 or more
	28	1 or more	2 or more	2 or more

Validation Results

Table 4-2 contains the point estimates for the six validation indices for each of the 28 algorithms that were investigated for the combined age group of 12 years and older. The 95% CIs for the estimates are reported in Appendix Table A.2.

There was fair to moderate agreement between the administrative and survey data, with κ ranging from 0.26 to 0.56. The highest value was for the three-year algorithm based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records (ie., algorithm #21). This estimate was almost identical (0.55) to the estimate for the corresponding five-year algorithm (i.e., algorithm #28).

Sensitivity was highly variable for the algorithms, ranging from 17.9% to 84.1%. It was consistently the highest for algorithms based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records (i.e., algorithms #6, #13, #20 and #27), and one or more prescription drug records (i.e., algorithms #1, #8, #15 and #22). In all cases the highest sensitivity was observed for the five-year algorithms.

Specificity was high for all algorithms and ranged from 87.9% to 99.3%. Overall, the most specific algorithms were those based on two or more physician billing claims (ie., algorithms #2, #9, #16 and #23). However, there was very little change in specificity when two or more physician billing claims were required instead of only one physician billing claim, and the decrease in sensitivity was substantial. For example, the one-year algorithm based on one or more physician billing claims (i.e., algorithm #1) has a sensitivity of 28.7% while the algorithm based on two or more physician billing claims (i.e., algorithm #2) had a sensitivity of 17.9%.

Youden's index ranged from 0.17 to 0.72. The highest value was observed for the five-year algorithm based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records in five years (i.e., algorithm #27). However, Youden's index was very similar for two five-year algorithms (.ie., algorithms #24 and #28). The first is based on one or more prescription drug records (0.71), and the second is based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records (0.69).

The PPV of an asthma diagnosis ranged from 35.8% to 66.9%. The highest value was observed for the one-year algorithm based on two or more physician billing claims (ie., algorithm #2). This finding held true for each of the one-, two-, three-, and five-year sets of algorithms. The NPV of an asthma diagnosis was above 93% for all of the algorithms, with the highest value (98.6%) observed for the five-year algorithm based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records (i.e., algorithm #27).

Table 4-2: Estimates of agreement, sensitivity, specificity, and predictive values for asthma algorithms

# Years		Algorithm	κ	Sens. (%)	Spec. (%)	Youden	PPV (%)	NPV (%)
1	1	1+P	0.37	28.7	98.7	0.27	64.1	94.5
	2	2+P	0.26	17.9	99.3	0.17	66.9	93.8
	3	1+Rx	0.52	57.0	96.1	0.53	53.8	96.5
	4	1+ H or 1+ P	0.38	30.1	98.6	0.29	62.6	94.6
	5	1+ H or 2+ P	0.27	19.2	99.1	0.18	63.8	93.9
	6	1+ H or 1+ P or 1+ Rx	0.52	60.5	95.6	0.56	52.2	96.8
	7	1+ H or 2+ P or 2+ Rx	0.50	47.2	97.6	0.45	60.7	95.9
2	8	1+P	0.42	38.9	97.5	0.36	55.2	95.2
	9	2+P	0.34	26.9	98.5	0.25	58.4	94.4
	10	1+Rx	0.50	65.3	94.0	0.59	46.5	97.1
	11	1+ H or 1+ P	0.43	40.8	97.3	0.38	54.4	95.4
	12	1+ H or 2+ P	0.35	28.8	98.2	0.27	56.8	94.5
	13	1+ H or 1+ P or 1+ Rx	0.49	68.6	93.0	0.62	43.8	97.4
	14	1+ H or 2+ P or 2+ Rx	0.54	59.0	96.3	0.55	56.0	96.7
3	15	1+P	0.48	49.0	96.7	0.46	54.6	96.0
	16	2+P	0.42	36.5	98.0	0.34	59.0	95.1
	17	1+Rx	0.51	72.4	92.8	0.65	44.7	97.7
	18	1+ H or 1+ P	0.49	51.2	96.5	0.48	54.2	96.1
	19	1+ H or 2+ P	0.43	38.6	97.8	0.36	57.9	95.2
	20	1+ H or 1+ P or 1+ Rx	0.48	74.4	91.4	0.66	41.0	97.8
	21	1+ H or 2+ P or 2+ Rx	0.56	65.9	95.6	0.62	54.6	97.2
5	22	1+P	0.50	60.3	94.9	0.55	48.6	96.8
	23	2+P	0.48	48.8	96.8	0.46	55.3	95.9
	24	1+Rx	0.48	80.6	90.1	0.71	39.4	98.3
	25	1+ H or 1+ P	0.50	61.5	94.7	0.56	48.2	96.9
	26	1+ H or 2+ P	0.48	50.1	96.6	0.47	54.3	96.0
	27	1+ H or 1+ P or 1+ Rx	0.44	84.1	87.9	0.72	35.8	98.6
	28	1+ H or 2+ P or 2+ Rx	0.55	75.1	93.8	0.69	49.1	97.9

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; PPV = Positive Predictive Value; NPV = Negative Predictive Value; 95% confidence intervals for all estimates are reported in Appendix A.

Provincial Estimates

Crude Prevalence Estimates

Crude prevalence estimates for the 28 asthma algorithms are reported in Table 4-3. Crude prevalence estimates are provided for the following: all ages (12 or more years), 12 to 18 years, 19 to 49 years and 50 or more years. The algorithm with the highest estimate of κ (i.e., algorithm #21) produced a crude prevalence estimate of 9.6% for all ages, 10.9% for individuals from the ages of 12 to 18, 7.8% for individuals between the ages of 19 and 49, and 11.6% for individuals over the age of 50. The algorithm with a similar κ (i.e., algorithm #28) produced crude prevalence estimates of 12.1%, 14.9%, 10.1% and 13.7% respectively. The algorithm that resulted in the highest estimate of sensitivity and Youden's index (i.e., algorithm #27) produced crude prevalence estimates of 17.9% for ages 12 and over, 21.6% for ages 12 to 18 years, 16.0% for ages 19 to 49 years, and 19.2% for ages 50 or more years for the Manitoba population.

Table 4-3: Crude provincial prevalence estimates for asthma algorithms, 2001/02 – 2005/06

# Years		Algorithms	All Ages (%)	12 - 18 Years (%)	19 - 49 Years (%)	50+ Years (%)
1	1	1+P	3.7	5.2	3.6	3.3
	2	2+P	2.0	2.6	1.9	1.9
	3	1+Rx	8.1	7.8	6.6	10.2
	4	1+ H or 1+ P	4.0	5.3	3.6	4.0
	5	1+ H or 2+ P	2.3	2.6	1.9	2.8
	6	1+ H or 1+ P or 1+ Rx	9.0	9.1	7.4	11.0
	7	1+ H or 2+ P or 2+ Rx	5.9	5.4	4.4	8.0
2	8	1+ P	5.7	8.4	5.5	5.0
	9	2+P	3.4	4.8	3.3	3.2
	10	1+Rx	10.7	11.2	9.1	12.7
	11	1+H or 1+ P	6.1	8.4	5.5	6.1
	12	1+ H or 2+ P	3.9	4.8	3.3	4.4
	13	1+ H or 1+ P or 1+ Rx	12.0	13.0	10.3	13.9
	14	1+ H or 2+ P or 2+ Rx	8.0	8.4	6.4	10.2
3	15	1+ P	7.3	11.1	7.0	6.4
	16	2+ P	4.6	6.8	4.4	4.3
	17	1+Rx	12.7	13.9	11.0	14.5
	18	1+H or 1+ P	7.7	11.2	7.1	7.4
	19	1+ H or 2+ P	5.1	6.9	4.5	5.4
	20	1+ H or 1+ P or 1+ Rx	14.2	16.2	12.5	16.0
	21	1+H or 2+P or 2+Rx	9.6	10.9	7.8	11.6
5	22	1+P	9.9	15.7	9.5	8.6
	23	2+P	6.6	10.4	6.3	6.0
	24	1+ Rx	15.9	18.6	14.0	17.3
	25	1+H or 1+ P	10.3	15.8	9.6	9.5
	26	1+ H or 2+ P	7.1	10.4	6.3	7.1
	27	1+H or 1+ P or 1+Rx	17.9	21.6	16.0	19.2
	28	1+ H or 2+ P or 2+Rx	12.1	14.9	10.1	13.7

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; 1-year estimates are for 2005/06, 2-year estimates are for 2004/05 - 2005/06, 3-year estimates are for 2003/04 - 2005/06, 5-year estimates are for 2001/02 - 2005/06.

Venn Diagrams

Venn diagrams are presented for the set of asthma algorithms with one or more hospital separations or one or more physician billing claims or one or more prescription drug records in one-, two-, three-, or five-years (i.e., algorithms #6, #13, #20, and #27). The Venn diagrams describe the number and per cent of asthma cases identified by each of the three data sources for the Manitoba population 12 years of age and older. For example, algorithm #6 resulted in the identification of 87,318 asthma cases in Manitoba. More than half (55.6%) of these cases were identified from prescription drug records alone and nine per cent from physician data alone. Thirty-one per cent were identified from both physician and prescription drug data. The gain from including hospital data in asthma algorithms is minimal, with less than one per cent of cases identified from hospital data alone.

Figure 4-1: Asthma Algorithm #6: 1+ Hospital Separations or 1+ Physician Billing Claims or 1+ Prescription Records, 1 Year

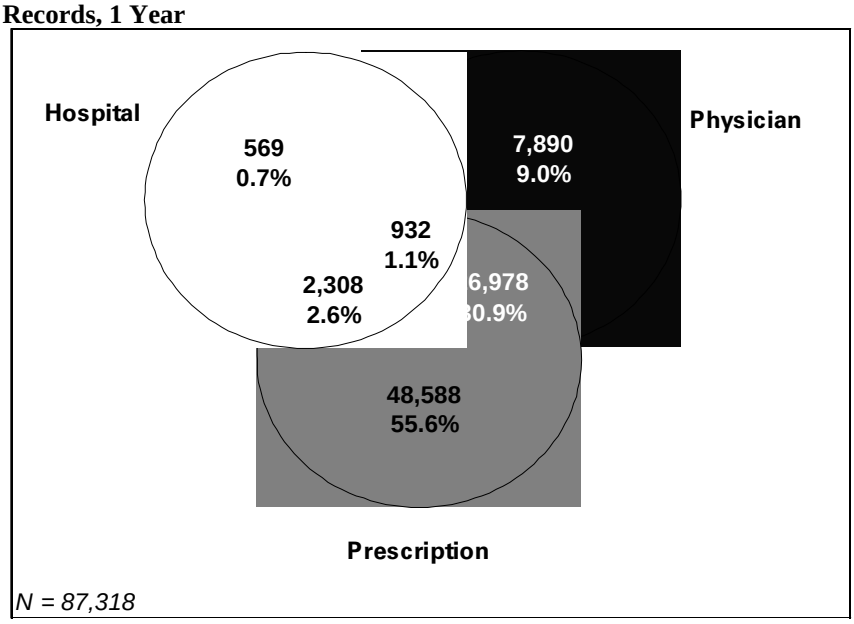


Figure 4-2 Asthma Algorithm #13: 1+ Hospital Separations or 1+ Physician Billing Claims or 1+ Prescription Records, 2 Years

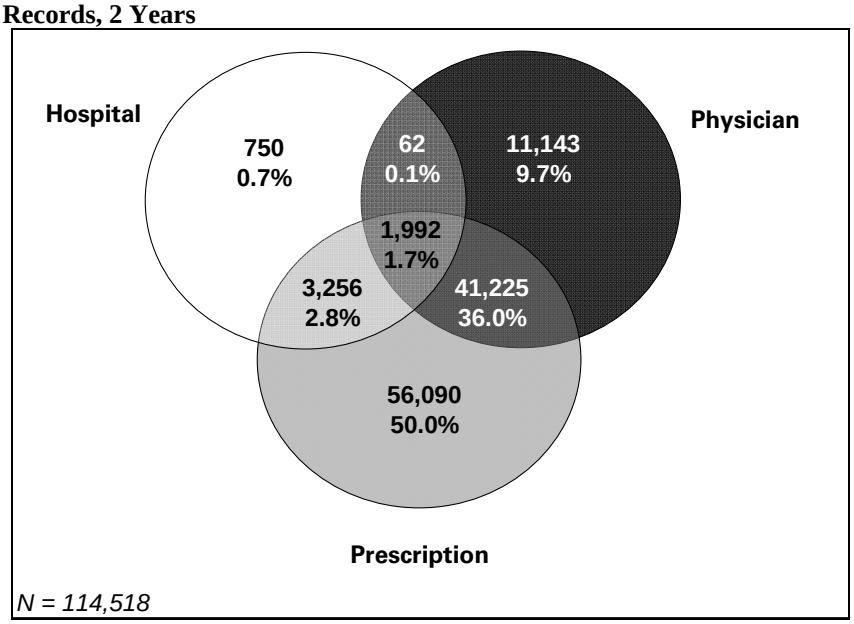


Figure 4-3: Asthma Algorithm #20: 1+ Hospital Separations or 1+ Physician Billing Claims or 1+ Prescription Records, 3 Years

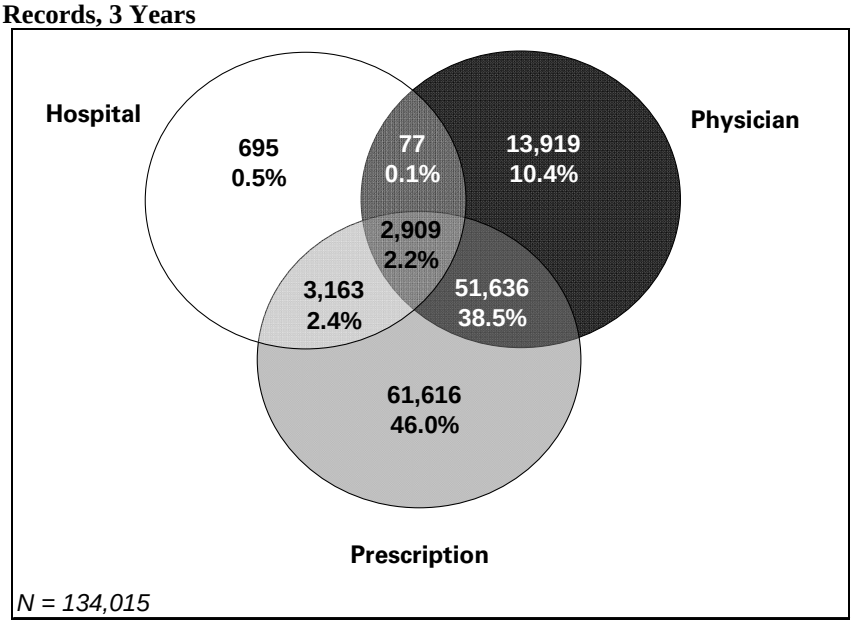
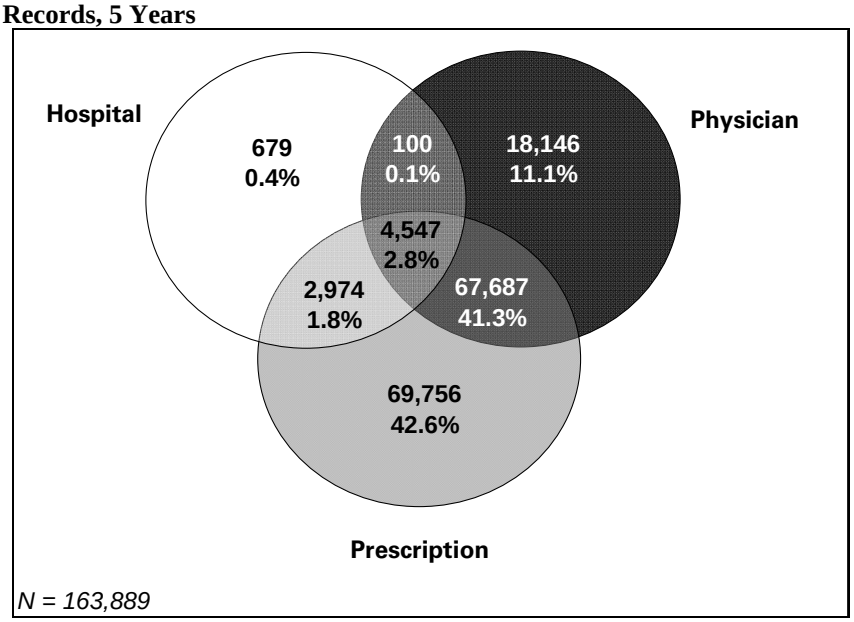


Figure 4-4: Asthma Algorithm #27: 1+ Hospital Separations or 1+ Physician Billing Claims or 1+ Prescription Records, 5 Years



Chapter Summary

The validation results indicate that administrative data exhibited fair to moderate agreement with survey data for asthma cases. The highest agreement (0.56) was observed for the algorithm based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records over three years. Crude prevalence estimates of asthma ranged from 2.0% to 17.9% for the investigated algorithms. The algorithms with the highest values of κ and Youden's index produced

crude prevalence estimates of 9.6% and 17.9%, respectively for the Manitoba population 12 years of age and older.

The most sensitive algorithms for identifying asthma cases from administrative data were obtained by using prescription drug records alone (80.6%), or in combination with hospital separations and physician billing claims (84.1%). There is a substantial advantage that can be gained from using multiple years of administrative data to obtain a valid algorithm. There is very little trade-off between sensitivity and specificity for different algorithms; the latter was very high for all of the algorithms that were investigated.

CHAPTER 5: CORONARY HEART DISEASE

Description of Heart Disease Algorithms

Table 5-1 lists the 28 algorithms that were investigated for coronary heart disease (CHD) in this study. The algorithms were based on as many as five years of administrative data. Two of the algorithms in each set were based only on physician billing claims data, two were based on both hospital or physician billing claims data and three were based on a combination of all three data sources. The first two algorithms based on all three data sources do not require prescription drug records to appear in combination with physician billing claims in order for an individual to be identified as a case while the last algorithm does. For example, algorithm #6 identified individuals as cases if they had one or more hospital separations or one or more physician billing claims or two or more prescription drug records with an IHD diagnostic or prescription drug code in a one-year period. Algorithm #7 identified individuals as cases if they had one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with a physician billing claim with an IHD diagnostic or prescription drug code in a one-year period. Crude prevalence rates dropped substantially when prescription drug records were required to appear in combination with a physician billing claim (20.4% to 3.3% for algorithm #6 and #7 respectively).

When analyzing results it is important to differentiate between the algorithms that required prescription drug records to appear in combination with a physician billing claim (i.e., algorithms #5, #6, #12, #13, #19, #20, #26, and #27), and those that did not (i.e., algorithms #7, #14, #21, and #28).

Table 5-1: Coronary heart disease algorithms selected for validation

# Years	Algorithm	Hospital Separations or	Physician Claims or	Physician Claims and Prescription Drug Records
1	1		1 or more	
	2		2 or more	
	3	1 or more	1 or more	
	4	1 or more	2 or more	
	5	1 or more	1 or more	0 and 1 or more
	6	1 or more	1 or more	0 and 2 or more
	7	1 or more	2 or more	1 and 2 or more
2	8		1 or more	
	9		2 or more	
	10	1 or more	1 or more	
	11	1 or more	2 or more	
	12	1 or more	1 or more	0 and 1 or more
	13	1 or more	1 or more	0 and 2 or more
	14	1 or more	2 or more	1 and 2 or more
3	15		1 or more	
	16		2 or more	
	17	1 or more	1 or more	
	18	1 or more	2 or more	
	19	1 or more	1 or more	0 and 1 or more
	20	1 or more	1 or more	0 and 2 or more
	21	1 or more	2 or more	1 and 2 or more
5	22		1 or more	
	23		2 or more	
	24	1 or more	1 or more	
	25	1 or more	2 or more	
	26	1 or more	1 or more	0 and 1 or more
	27	1 or more	1 or more	0 and 2 or more
	28	1 or more	2 or more	1 and 2 or more

Validation Results

Validation Indices

Table 5-2 contains the point estimates for the six validation indices for each of the 28 algorithms that were investigated for CHD. The 95% CIs for these estimates are reported in Appendix Table A.3.

There was fair to moderate agreement between the administrative and survey data, with κ ranging from 0.21 to 0.50. The highest value of the κ statistic was for the five-year algorithm based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with a physician billing claim (i.e., algorithm #28). However, a κ of 0.49 was also realized for the corresponding three-year algorithm as well as the five-year algorithm based on one or more hospital separations or one or more physician billing claims (i.e., algorithms #21 and #24).

Sensitivity was highly variable for the algorithms, ranging from 28.0% to 84.7%. It was consistently the highest for algorithms based on one or more hospital separations or one

or more physician billing claims or one or more prescription drug records (i.e., algorithms #5, #12, #19, and #26) followed closely by one or more hospital separations or one or more physician billing claims or two or more prescription drug records (i.e., algorithms #6, #13, #20 and #27). There were large gaps in sensitivity for the remaining algorithms. In all cases, the highest sensitivity was observed for the five-year algorithms.

Specificity ranged from 79.0% to 99.2% for all 28 algorithms. It was lowest for the two algorithms with the highest specificity and varied by less than 3.1% within 1-, 2-, 3- and 5-year algorithms. Youden's index ranged from 0.27 to 0.64. The highest value was observed for the five-year algorithm based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records over five years (i.e., algorithm #26). However, Youden's index was similar for the corresponding three-, two-, and one-year algorithms (0.63, 0.62 and 0.63 respectively).

Table 5-2: Estimates of agreement, sensitivity, specificity, and predictive values for ischemic heart disease algorithms

# Years		Algorithm	κ	Sens. (%)	Spec. (%)	Youden	PPV (%)	NPV (%)
1	1	1+P	0.41	35.2	98.6	0.34	55.1	96.9
	2	2+P	0.37	28.0	99.2	0.27	62.2	96.6
	3	1+H or 1+ P	0.42	36.4	98.6	0.35	55.1	97.0
	4	1+ H or 2+ P	0.38	29.3	99.1	0.28	61.9	96.7
	5	1+ H or 1+ P or 1+ Rx	0.23	80.8	82.0	0.63	17.8	98.9
	6	1+ H or 1+ P or 2+ Rx	0.23	74.1	83.4	0.57	17.7	98.5
	7	1+H or 2+P or (1 P and 2+Rx)	0.42	35.9	98.7	0.35	57.3	97.0
2	8	1+P	0.46	45.4	98.0	0.43	51.8	97.4
	9	2+P	0.41	36.3	98.5	0.35	53.5	97.0
	10	1+H or 1+ P	0.47	47.2	97.9	0.45	52.1	97.5
	11	1+ H or 2+ P	0.43	38.3	98.4	0.37	53.7	97.1
	12	1+ H or 1+ P or 1+ Rx	0.22	81.1	81.2	0.62	17.1	98.9
	13	1+ H or 1+ P or 2+ Rx	0.23	77.3	82.4	0.60	17.4	98.7
	14	1+H or 2+P or (1 P and 2+Rx)	0.48	46.8	98.1	0.45	53.8	97.5
3	15	1+P	0.48	52.2	97.3	0.49	48.0	97.7
	16	2+P	0.44	42.9	98.0	0.41	50.2	97.3
	17	1+H or 1+ P	0.48	54.0	97.1	0.51	47.3	97.8
	18	1+ H or 2+ P	0.45	45.2	97.8	0.43	49.2	97.4
	19	1+ H or 1+ P or 1+ Rx	0.22	82.8	80.4	0.63	16.9	99.0
	20	1+ H or 1+ P or 2+ Rx	0.22	78.8	81.6	0.60	17.1	98.8
	21	1+H or 2+P or (1 P and 2+Rx)	0.49	53.6	97.3	0.51	49.1	97.8
5	22	1+P	0.48	60.6	96.2	0.57	43.1	98.1
	23	2+P	0.47	51.5	97.3	0.49	47.5	97.7
	24	1+H or 1+ P	0.49	63.4	96.0	0.59	43.2	98.2
	25	1+ H or 2+ P	0.48	54.9	97.1	0.52	47.3	97.8
	26	1+ H or 1+ P or 1+ Rx	0.21	84.7	79.0	0.64	16.2	99.1
	27	1+ H or 1+ P or 2+ Rx	0.22	80.3	80.8	0.61	16.7	98.8
	28	1+H or 2+P or (1 P and 2+Rx)	0.50	63.0	96.4	0.59	45.4	98.2

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; PPV = Positive Predictive Value; NPV = Negative Predictive Value; 95% confidence intervals for all estimates are reported in Appendix A.

The PPV of a CHD diagnosis ranged from 16.2% to 62.2%. The highest value was observed for the one-year algorithm based on two or more physician billing claims (i.e.,

algorithm #2). This finding held true for each of the one-, two-, three-, and five-year sets of algorithms. The NPV of an IHD diagnosis was above 96.6% for all algorithms, with the highest value observed (99.1%) for the five-year algorithm based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records (i.e., algorithm #26).

Provincial Estimates

Crude Prevalence Estimates

Provincial crude prevalence estimates for the 28 algorithms are reported in Table 5-3. The algorithm with the highest estimate of κ (i.e., algorithm #28) produced a crude prevalence estimate of 7.2%. The algorithms with similar κ (i.e., algorithms #21 and #24) produced crude prevalence estimates of 5.7% and 7.8% respectively. The algorithm with the highest estimate of sensitivity and Youden's index (i.e., algorithm #26) produced a crude prevalence estimate of 26.3% in the Manitoba population 19 years of age and older.

Table 5-3: Crude provincial prevalence estimates for ischemic heart disease algorithms, 2001/02 -2005/06

# Years		Algorithm	Prevalence Estimates (%)
1	1	1+P	3.4
	2	2+P	2.3
	3	1+H or 1+ P	3.6
	4	1+ H or 2+ P	2.5
	5	1+ H or 1+ P or 1+ Rx	21.4
	6	1+ H or 1+ P or 2+ Rx	20.4
	7	1+H or 2+P or (1 P and 2+Rx)	3.3
2	8	1+P	4.8
	9	2+P	3.5
	10	1+H or 1+ P	5.0
	11	1+ H or 2+ P	3.8
	12	1+ H or 1+ P or 1+ Rx	23.0
	13	1+ H or 1+ P or 2+ Rx	21.8
	14	1+H or 2+P or 1 P and 2+Rx)	4.7
3	15	1+P	5.9
	16	2+P	4.3
	17	1+H or 1+ P	6.1
	18	1+ H or 2+ P	4.7
	19	1+ H or 1+ P or 1+ Rx	24.3
	20	1+ H or 1+ P or 2+ Rx	22.9
	21	1+H or 2+P or (1 P and 2+Rx)	5.7
5	22	1+P	7.5
	23	2+P	5.6
	24	1+H or 1+ P	7.8
	25	1+ H or 2+ P	6.0
	26	1+ H or 1+ P or 1+ Rx	26.3
	27	1+ H or 1+ P or 2+ Rx	24.5
	28	1+H or 2+P or (1 P and 2+Rx)	7.2

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; 1-year estimates are for 2005/06, 2-year estimates are for 2004/05 - 2005/06, 3-year estimates are for 2003/04 - 2005/06, 5-year estimates are for 2001/02 - 2005/06.

Venn Diagrams

Venn diagrams are presented for the CDH algorithms based on one or more hospital separations or two or more physician billing claims or one physician billing claim in combination with two or more prescription drug records or one over one-, two-, three- and five-years (i.e., algorithms #7, #14, #21, and #28). The Venn diagrams describe the number and per cent of IHD cases identified by each of the three data sources for the Manitoba population 19 years of age and older.

Figure 5-1: Coronary Heart Disease Algorithm #7: 1+ Hospital Separations or 2+ Physician Billing Claims or 1 Physician Billing Claim & 2+ Prescription Records, 1 Year

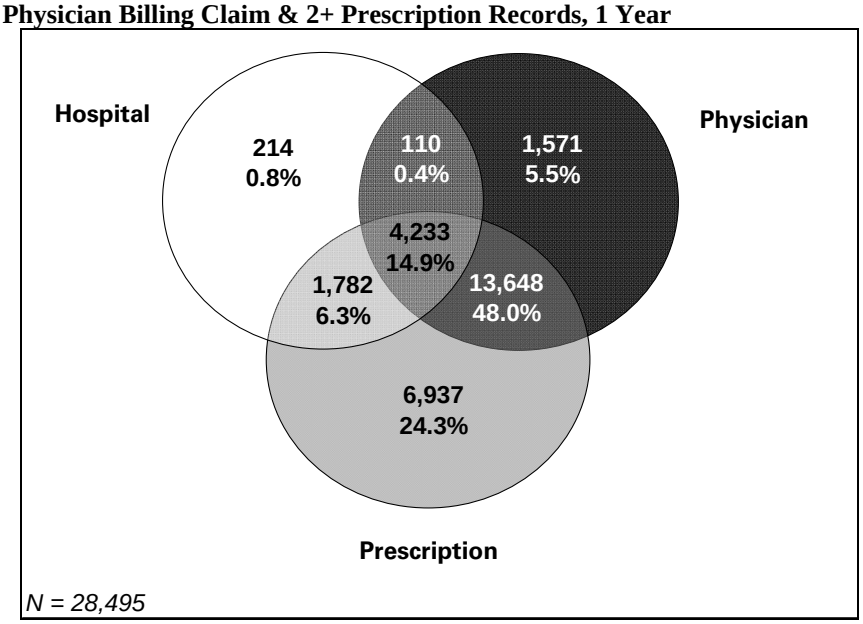


Figure 5-2: Coronary Heart Disease Algorithm #14: 1+ Hospital Separations or 2+ Physician Billing Claims or 1 Physician Billing Claim & 2+ Prescription Records, 2 Years

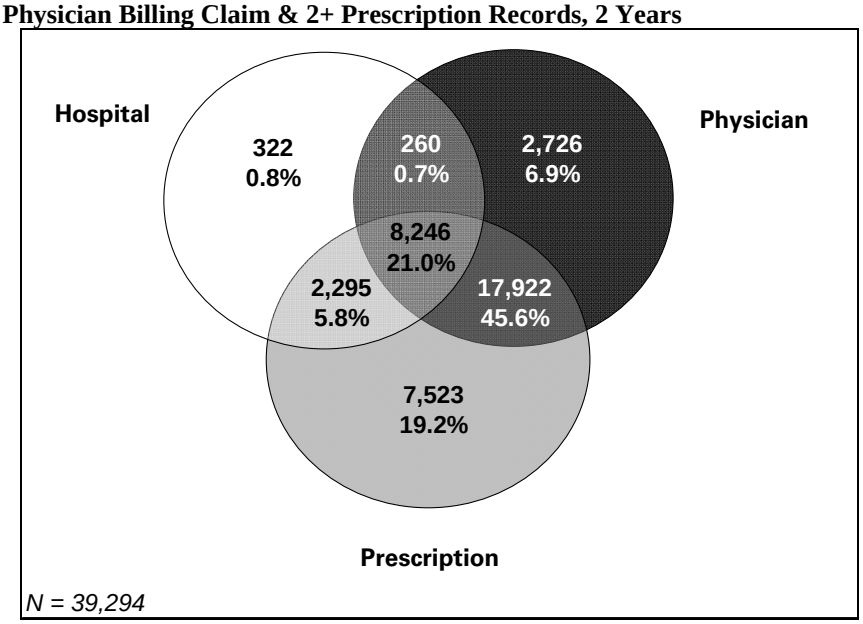


Figure 5-3: Coronary Heart Disease Algorithm #21: 1+ Hospital Separations or 2+ Physician Billing Claims or 1 Physician Billing Claim & 2+ Prescription Records, 3 Years

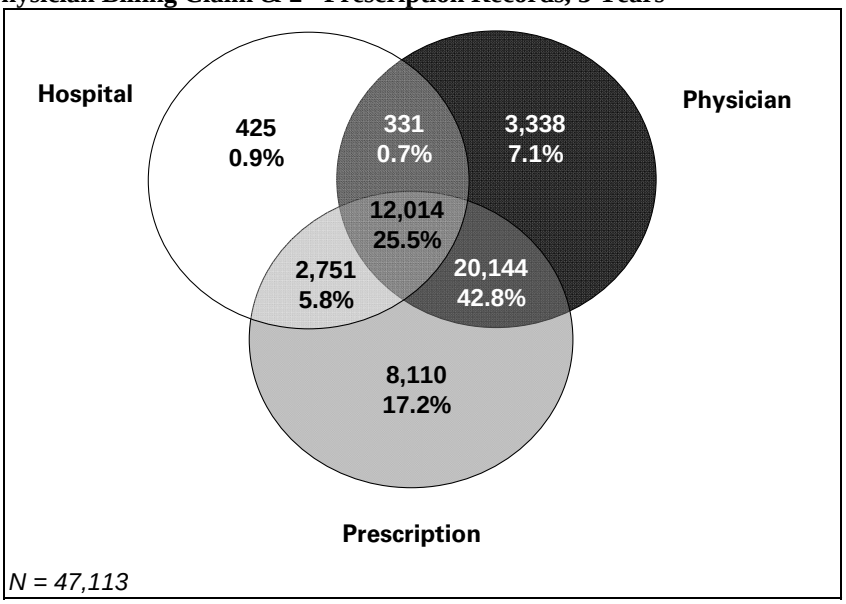
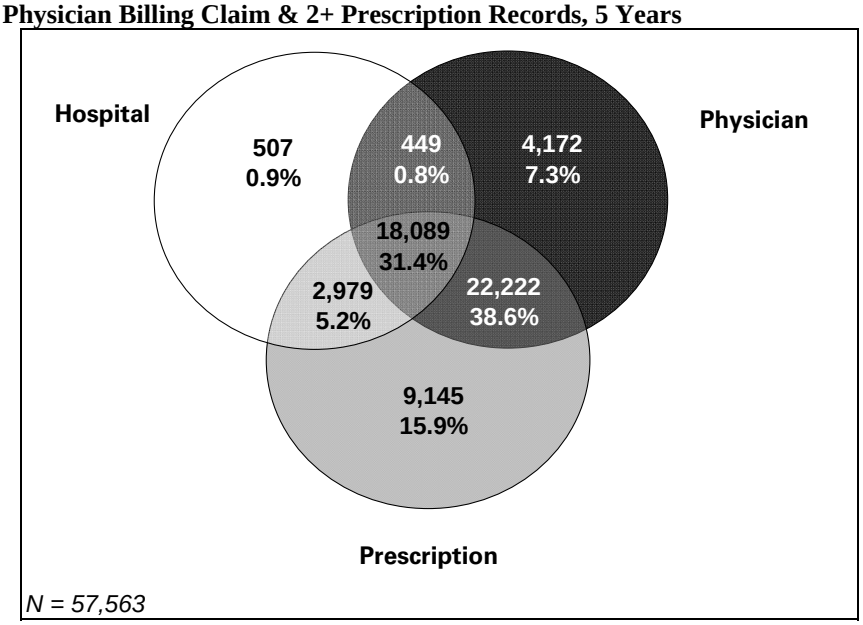


Figure 5-4: Coronary Heart Disease Algorithm #28: 1+ Hospital Separations or 2+ Physician Billing Claims or 1 Physician Billing Claim & 2+ Prescription Records, 5 Years



Chapter Summary

The study results indicate that administrative data exhibit fair to moderate agreement with survey data for identifying cases of heart disease. The highest agreement (0.50) was observed for the algorithm based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with one physician billing claim over five years. Crude prevalence estimates of ischemic heart disease ranged from 2.3% to 26.3% for the investigated algorithms. The algorithms with the highest values of κ and Youden's index produced crude prevalence estimates of 7.2% and 26.3% respectively for the Manitoba population 19 years of age and older. The crude prevalence for algorithms requiring prescription drug records to appear in combination with a physician billing claim were substantially lower than algorithms that did not require prescription drug records to appear in combination with a physician billing claim.

The most sensitive algorithms for identifying heart disease cases from administrative data were obtained from algorithms that used all three data sources. The advantage gained from using multiple years of administrative data to obtain a valid algorithm was less than the advantage for other chronic diseases investigated in this report.

CHAPTER 6: DIABETES

Description of Diabetes Algorithms

Table 6-1 lists the 32 algorithms that were investigated for diabetes in this study. The diabetes algorithms were based on as many as five years of administrative data. Two of the algorithms in each set were based only on physician billing claims data and the remaining algorithms were based on a combination of two or more of the three data sources. For example, algorithm #1 identified individuals as diabetes cases if they had one or more physician billing claims with a diabetes diagnosis code in a one-year period. Algorithm #8 identified individuals as diabetes cases if they had one or more hospital separations or two or more physician billing claims or two or more prescription drug records with relevant diagnostic or medication codes in a one-year period.

When analyzing results it is important to note that none of the diabetes algorithms required prescription drug records to appear in combination with a physician billing claim.

Table 6-1: Diabetes algorithms selected for validation

# Years	Algorithm	Hospital Separations or	Physician Claims or	Prescription Drug Records
1	1		1 or more	
	2		2 or more	
	3	1 or more	1 or more	
	4	1 or more	2 or more	
	5	1 or more	1 or more	1 or more
	6	1 or more	2 or more	1 or more
	7	1 or more	1 or more	2 or more
	8	1 or more	2 or more	2 or more
2	9		1 or more	
	10		2 or more	
	11	1 or more	1 or more	
	12	1 or more	2 or more	
	13	1 or more	1 or more	1 or more
	14	1 or more	2 or more	1 or more
	15	1 or more	1 or more	2 or more
	16	1 or more	2 or more	2 or more
3	17		1 or more	
	18		2 or more	
	19	1 or more	1 or more	
	20	1 or more	2 or more	
	21	1 or more	1 or more	1 or more
	22	1 or more	2 or more	1 or more
	23	1 or more	1 or more	2 or more
	24	1 or more	2 or more	2 or more
5	25		1 or more	
	26		2 or more	
	27	1 or more	1 or more	
	28	1 or more	2 or more	
	29	1 or more	1 or more	1 or more
	30	1 or more	2 or more	1 or more
	31	1 or more	1 or more	2 or more
	32	1 or more	2 or more	2 or more

Validation Results

Table 6-2 contains the point estimates for the six validation indices for each of the 32 diabetes algorithms that were investigated for diabetes. The 95% CIs for these estimates are reported in Appendix Table A.4.

There was good to very good agreement between the administrative and survey data, with κ ranging from 0.75 to 0.87. The highest value was for both the one- and two-year algorithms based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records and the one-year algorithm based on one or more hospital separations or two or more physician billing claims or one or more prescription drug records (i.e., algorithms #8, #16, and #6). However, several other algorithms produced estimates of κ that were higher than 0.80.

Sensitivity was high for all of the algorithms, ranging from 67.8% to 94.4%. In each case the specificity increased with number of years, meaning the highest specificity was observed for the five-year algorithms. It was consistently the highest for algorithms based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records (i.e., algorithms #5, #13, #21, and #29) followed closely by one or more physician billing claims or one or more hospital separations or two or more prescription drug records (i.e., algorithms #7, #15, #23, and #31.)

Specificity was very high for all algorithms, ranging from 97.1% to 99.6%. Overall, the most specific algorithms were those based on two or more physician billing claims (algorithms # 2, #9, #16 and #23). However, there was very little change in specificity when two or more physician billing claims were required instead of only one physician billing claim while the decrease in sensitivity was substantial. For example, the one-year algorithm based on one or more physician billing claims (i.e., algorithm #1) had a sensitivity of 77.6% while the algorithm based on two or more physician billing claims (i.e., algorithm #2) had a sensitivity of 67.8%.

Youden's index ranged from 0.67 to 0.92. The highest value was observed for two of the five-year algorithms, the first based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records and the second based on one or more hospital separations or one or more physician billing claims or two or more prescription drug records (i.e., algorithms #29 and #31). A slightly lower Youden's index of 0.91 was realized for eight algorithms.

The PPV of a diabetes diagnosis ranged from 64.6% to 90.6%. The highest value was observed for the one-year algorithm based on two or more physician billing claims (i.e., algorithm #2). This finding holds for each of the one-, two-, three-, and five-year sets of algorithm. NPV approached its upper bound for all algorithms, attaining values as high as 99.7%.

Table 6-2: Estimates of agreement, sensitivity, specificity, and predictive values for diabetes algorithms

# Years		Algorithm	κ	Sens. (%)	Spec. (%)	Youden	PPV (%)	NPV (%)
1	1	1+P	0.78	77.6	99.0	0.77	81.0	98.8
	2	2+P	0.76	67.8	99.6	0.67	90.6	98.3
	3	1+H or 1+ P	0.79	78.8	99.0	0.78	80.7	98.8
	4	1+ H or 2+ P	0.78	69.9	99.6	0.69	90.2	98.4
	5	1+ H or 1+ P or 1+ Rx	0.83	87.6	98.9	0.86	81.1	99.3
	6	1+ H or 2+ P or 1+ Rx	0.87	85.9	99.4	0.85	89.0	99.2
	7	1+ H or 1+ P or 2+ Rx	0.84	87.4	98.9	0.86	81.8	99.3
	8	1+ H or 2+ P or 2+ Rx	0.87	85.0	99.5	0.84	89.7	99.2
2	9	1+P	0.77	84.8	98.3	0.83	73.0	99.2
	10	2+P	0.82	80.0	99.3	0.79	86.0	98.9
	11	1+H or 1+ P	0.77	85.6	98.2	0.84	72.6	99.2
	12	1+ H or 2+ P	0.83	81.9	99.2	0.81	85.3	99.0
	13	1+ H or 1+ P or 1+ Rx	0.80	92.6	98.1	0.91	72.3	99.6
	14	1+ H or 2+ P or 1+ Rx	0.86	90.0	99.0	0.89	83.6	99.4
	15	1+ H or 1+ P or 2+ Rx	0.81	92.4	98.2	0.91	73.7	99.6
	16	1+ H or 2+ P or 2+ Rx	0.87	89.5	99.2	0.89	85.5	99.4
3	17	1+P	0.76	88.1	97.8	0.86	68.7	99.3
	18	2+P	0.83	84.5	99.0	0.84	82.4	99.2
	19	1+H or 1+ P	0.76	88.9	97.8	0.87	68.3	99.4
	20	1+ H or 2+ P	0.83	86.1	99.0	0.85	82.0	99.2
	21	1+ H or 1+ P or 1+ Rx	0.77	93.4	97.6	0.91	67.8	99.6
	22	1+ H or 2+ P or 1+ Rx	0.85	91.8	98.7	0.91	79.9	99.5
	23	1+ H or 1+ P or 2+ Rx	0.78	93.2	97.7	0.91	69.0	99.6
	24	1+ H or 2+ P or 2+ Rx	0.86	91.7	98.9	0.91	81.9	99.5
5	25	1+P	0.75	91.0	97.4	0.88	65.8	99.5
	26	2+P	0.85	89.0	98.9	0.88	82.0	99.4
	27	1+H or 1+ P	0.75	91.6	97.3	0.89	65.5	99.5
	28	1+ H or 2+ P	0.84	89.6	98.9	0.88	81.4	99.4
	29	1+ H or 1+ P or 1+ Rx	0.75	94.4	97.2	0.92	64.6	99.7
	30	1+ H or 2+ P or 1+ Rx	0.84	92.7	98.6	0.91	78.9	99.6
	31	1+ H or 1+ P or 2+ Rx	0.76	94.2	97.3	0.92	65.7	99.7
	32	1+ H or 2+ P or 2+ Rx	0.85	92.6	98.8	0.91	80.8	99.6

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; PPV = Positive Predictive Value; NPV = Negative Predictive Value; 95% confidence intervals for all estimates are reported in Appendix A.

Provincial Estimates

Crude Prevalence Estimates

Provincial crude prevalence estimates for the 32 diabetes algorithms are reported in Table 6-3. The crude prevalence estimates ranges from 4.8% to 10.6%. The algorithms with the highest estimates of κ (i.e., algorithms #6, #8, and #16) produced crude prevalence estimates of 6.7%, 6.6% and 7.3%, respectively. The algorithm with the highest estimates of Youden's index and corresponding highest sensitivity (i.e., algorithm #29) produced a crude prevalence estimate of 10.6%. Algorithm #31 had an equally high value of Youden's index with a similar sensitivity and it produced a crude prevalence estimate of 10.5%.

Table 6-3: Crude provincial prevalence estimates for diabetes algorithms, 2001/02 -2005/06

# Years		Algorithms	Prevalence Estimates (%)
1	1	1+P	6.5
	2	2+P	4.8
	3	1+H or 1+ P	6.7
	4	1+ H or 2+ P	5.1
	5	1+ H or 1+ P or 1+ Rx	7.6
	6	1+ H or 2+ P or 1+ Rx	6.7
	7	1+ H or 1+ P or 2+ Rx	7.5
	8	1+ H or 2+ P or 2+ Rx	6.6
2	9	1+P	7.9
	10	2+P	6.2
	11	1+H or 1+ P	8.1
	12	1+ H or 2+ P	6.5
	13	1+ H or 1+ P or 1+ Rx	8.6
	14	1+ H or 2+ P or 1+ Rx	7.5
	15	1+ H or 1+ P or 2+ Rx	8.5
	16	1+ H or 2+ P or 2+ Rx	7.3
3	17	1+P	8.8
	18	2+P	7.0
	19	1+H or 1+ P	9.0
	20	1+ H or 2+ P	7.3
	21	1+ H or 1+ P or 1+ Rx	9.4
	22	1+ H or 2+ P or 1+ Rx	8.0
	23	1+ H or 1+ P or 2+ Rx	9.3
	24	1+ H or 2+ P or 2+ Rx	7.8
5	25	1+P	10.0
	26	2+P	7.8
	27	1+H or 1+ P	10.2
	28	1+ H or 2+ P	8.1
	29	1+ H or 1+ P or 1+ Rx	10.6
	30	1+ H or 2+ P or 1+ Rx	8.6
	31	1+ H or 1+ P or 2+ Rx	10.5
	32	1+ H or 2+ P or 2+ Rx	8.5

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; 1-year estimates are for 2005/06, 2-year estimates are for 2004/05 - 2005/06, 3-year estimates are for 2003/04 - 2005/06, 5-year estimates are for 2001/02 - 2005/06.

Venn Diagrams

Venn diagrams are presented for the set of diabetes algorithms with one or more hospital separations or two or more physician billing claims or two or more prescription drug records in one-, two-, three-, and five-years (i.e., algorithms #8, #16, #24, and #32). The Venn diagrams describe the number and per cent of diabetes cases identified by each of the three data sources for the Manitoba population 19 years and older. For example, algorithm #8 resulted in 56,389 diabetes cases. More than half (52.0%) of these cases were identified from both the physician and prescription drug data. Twelve per cent were identified solely from physician data, 22.7% from prescription drug records and 1.6% from hospital data while 7.8% were identified by all three data sources.

Figure 6-1: Diabetes Algorithm #8: 1+ Hospital Separations or 2+ Physician Billing Claims or 2+ Prescriptions, 1 Year

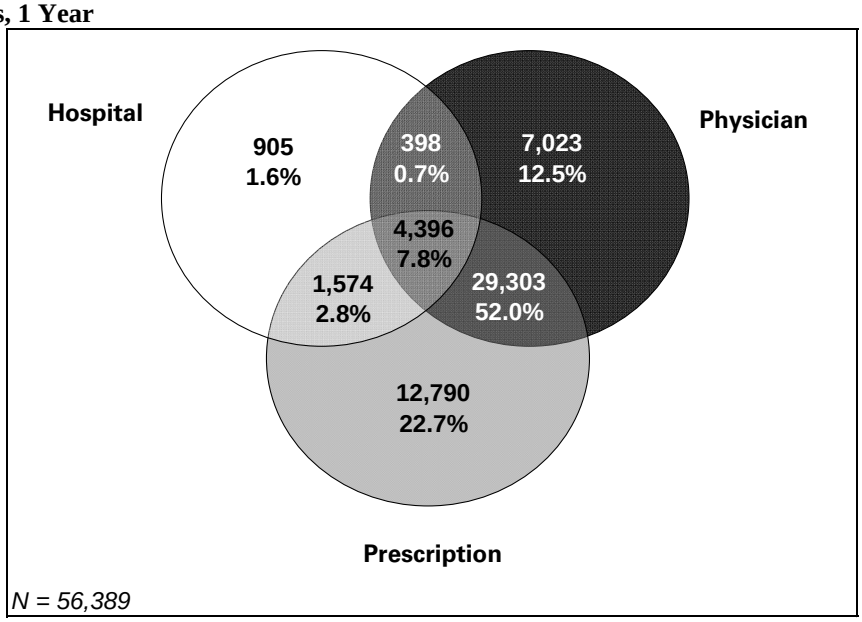


Figure 6-2: Diabetes Algorithm #16: 1+ Hospital Separations or 2+ Physician Billing Claims or 2+ Prescriptions, 2 Years

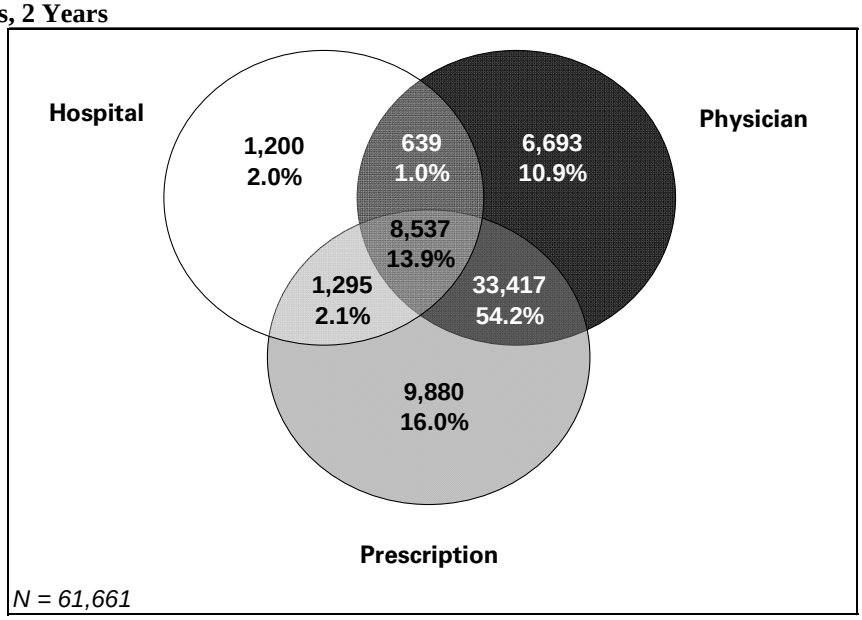


Figure 6-3: Diabetes Algorithm #24: 1+ Hospital Separations or 2+ Physician Billing Claims or 2+ Prescriptions, 3 Years

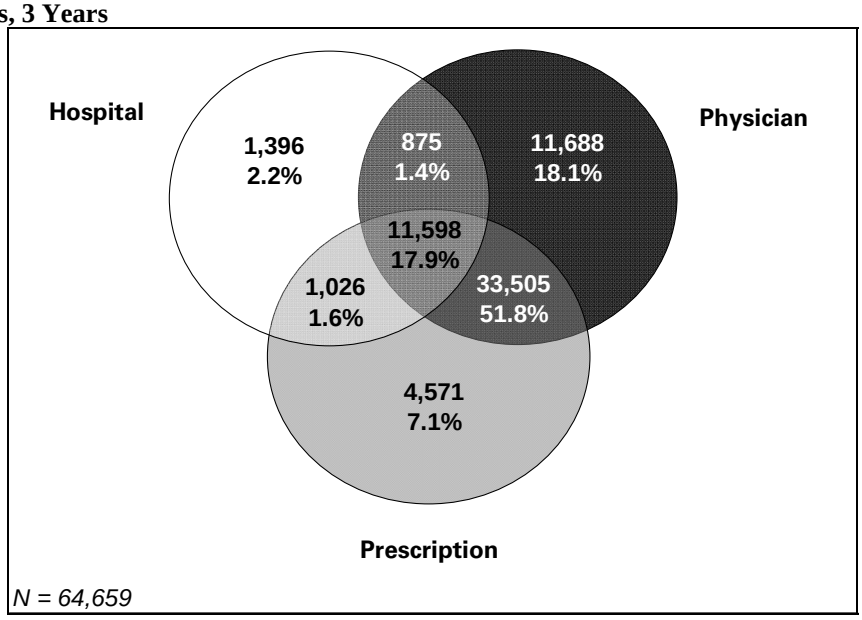
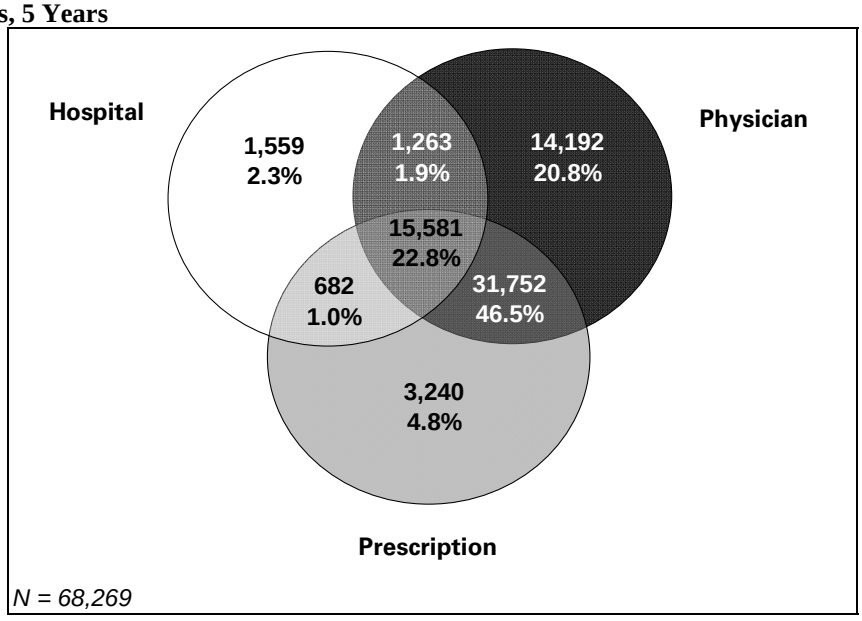


Figure 6-4: Diabetes Algorithm #32: 1+ Hospital Separations or 2+ Physician Billing Claims or 2+ Prescriptions, 5 Years



Chapter Summary

The validation results indicate that administrative data exhibit good to very good agreement with survey data for identifying cases of diabetes. The highest agreement (0.87) was observed both by one-year and two-year algorithms based on one or more hospital separations or two or more physician billing claims or two or more prescription

drug records and the one-year algorithm based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records. Crude prevalence estimates of diabetes ranged from 4.8% to 10.6% for the investigated algorithms. The algorithms with the highest value of κ produced crude prevalence estimates of 6.6%, 6.7%, and 7.3% while algorithms with the highest value of Youden's index produced crude prevalence estimates of 10.5% and 10.6% for the Manitoba population 19 years of age and older.

Sensitivity increased with number of years of data, although the advantage gained from using multiple years of administrative data to obtain a valid algorithm was less than the advantage for other chronic diseases investigated in this report.

CHAPTER 7: HYPERTENSION

Description of Hypertension Algorithms

Table 7-1 lists the 28 algorithms that were investigated for hypertension in this study. Two of the algorithms in each set were based only on physician billing claims data, two were based on both hospital or physician billing claims data and three were based on all three data sources. For example, algorithm #6 identified individuals as hypertensive cases if they had one or more hospital separations or one or more physician billing claims or two or more prescription drug records with a hypertension diagnostic or prescription drug code in a one-year period. Algorithm #7 identified individuals as hypertensive cases if they had one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with a physician billing claim with a hypertension diagnostic or prescription drug code in a one-year period. The algorithms for two-, three-, and five-years of administrative data are interpreted in a similar fashion.

When analyzing results it is important to differentiate between the algorithms that required prescription drug records to appear in combination with a physician billing claim (i.e., algorithms #7, #14, #21, and #28), and those that did not (i.e., algorithms #5, #6, #12, #13, #19, #20, #26, and #27).

Table 7-1: Hypertension algorithms selected for validation

# Years	Algorithm	Hospital Separations or	Physician Claims or	Physician Claims and Prescription Drug Records
1	1		1 or more	
	2		2 or more	
	3	1 or more	1 or more	
	4	1 or more	2 or more	
	5	1 or more	1 or more	0 and 1 or more
	6	1 or more	1 or more	0 and 2 or more
	7	1 or more	2 or more	1 and 2 or more
2	8		1 or more	
	9		2 or more	
	10	1 or more	1 or more	
	11	1 or more	2 or more	
	12	1 or more	1 or more	0 and 1 or more
	13	1 or more	1 or more	0 and 2 or more
	14	1 or more	2 or more	1 and 2 or more
3	15		1 or more	
	16		2 or more	
	17	1 or more	1 or more	
	18	1 or more	2 or more	
	19	1 or more	1 or more	0 and 1 or more
	20	1 or more	1 or more	0 and 2 or more
	21	1 or more	2 or more	1 and 2 or more
5	22		1 or more	
	23		2 or more	
	24	1 or more	1 or more	
	25	1 or more	2 or more	
	26	1 or more	1 or more	0 and 1 or more
	27	1 or more	1 or more	0 and 2 or more
	28	1 or more	2 or more	1 and 2 or more

Validation Results

Table 7-2 contains the point estimates for the six validation indices for each of the 28 algorithms that were investigated for hypertension. The 95% CIs for the estimates are reported in Appendix Table A.5.

There was moderate to good agreement between the administrative and survey data, with κ ranging from 0.49 to 0.70. The highest value occurred for three different algorithms - the one-year algorithm based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records, the one-year algorithm based on one or more hospital separations or one or more physician billing claims or two or more prescription drug records and the five-year algorithm based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with one or more physician billing claims (i.e., algorithms #5, #6 and #28).

Sensitivity was highly variable for the algorithms, ranging from 40.9% to 84.1%. It was consistently the highest for algorithms based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records (i.e., algorithms #5, #12, #19, and #26) followed closely by the algorithms based on one or more hospital separations or one or more physician billing claims or two or more prescription drug records (i.e., algorithms #6, #13, #20, and #27) and increased with the number of years of administrative data. In all cases the highest sensitivity was observed for the five-year algorithms. However the largest increase in sensitivity occurred between one- and two-year algorithms.

Specificity ranged from 84.4% to 98.6%. Youden's index ranged from 0.39 to 0.71. The highest value was observed for the one- and two-year algorithms based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records as well as the one-year algorithm based on one or more hospital separations or one or more physician billing claims or two or more prescription drug records (i.e., algorithms #6, #13, and #5). However, a slightly lower Youden's index of 0.69 or 0.70 was realized for eight algorithms.

The PPV of a hypertension diagnosis ranged from 61.6% to 89.6%. The highest value was observed for the one-year algorithm based on two or more physician billing claims (i.e., algorithm #2). This finding held true for each of the one-, two-, three-, and five-year sets of algorithms. The NPV of a hypertension diagnosis ranged from 84.9% to 94.7%. The highest value was observed for the algorithm with one or more hospital separations or one or more physician billing claims or one or more prescription drug records (i.e., algorithms #5, #12, #19, and #26) followed closely by the algorithms based on one or more hospital separations or one or more physician billing claims or two or more prescription drug records (i.e., algorithms #6, #13, #20, and #27). In all cases the highest NPV was observed for the five-year algorithms.

Table 7-2: Estimates of agreement, sensitivity, specificity, and predictive value for hypertension algorithms

# Years		Algorithm	κ	Sens. (%)	Spec. (%)	Youden	PPV (%)	NPV (%)
1	1	1+P	0.59	56.7	96.2	0.53	81.8	88.2
	2	2+P	0.49	40.9	98.6	0.39	89.6	84.9
	3	1+H or 1+ P	0.60	57.8	96.2	0.54	81.7	88.4
	4	1+ H or 2+ P	0.50	42.5	98.5	0.41	89.3	85.2
	5	1+ H or 1+ P or 1+ Rx	0.70	78.5	92.4	0.71	75.5	93.5
	6	1+ H or 1+ P or 2+ Rx	0.70	77.5	93.1	0.71	77.0	93.3
	7	1+H or 1+P or (1 P and 2+Rx)	0.61	55.9	97.4	0.53	86.5	88.1
2	8	1+P	0.63	68.6	93.0	0.62	74.5	90.9
	9	2+P	0.59	55.1	97.0	0.52	84.4	87.9
	10	1+H or 1+ P	0.64	69.9	92.8	0.63	74.1	91.2
	11	1+ H or 2+ P	0.60	56.7	96.7	0.53	83.5	88.2
	12	1+ H or 1+ P or 1+ Rx	0.66	81.4	89.1	0.70	68.9	94.1
	13	1+ H or 1+ P or 2+ Rx	0.67	80.9	90.0	0.71	70.6	94.1
	14	1+H or 2+P or (1P and 2+Rx)	0.67	67.8	95.6	0.63	82.0	90.9
3	15	1+P	0.63	73.2	90.6	0.64	69.7	91.9
	16	2+P	0.64	64.3	95.2	0.60	79.9	90.0
	17	1+H or 1+ P	0.63	74.5	90.4	0.65	69.7	92.2
	18	1+ H or 2+ P	0.65	65.9	94.9	0.61	79.4	90.4
	19	1+ H or 1+ P or 1+ Rx	0.63	82.3	86.7	0.69	64.9	94.3
	20	1+ H or 1+ P or 2+ Rx	0.65	81.9	88.0	0.70	66.9	94.2
	21	1+H or 2+P or (1P and 2+Rx)	0.68	73.0	93.7	0.67	77.5	92.1
5	22	1+P	0.64	78.4	89.1	0.67	68.0	93.3
	23	2+P	0.67	70.7	93.9	0.65	77.4	91.5
	24	1+H or 1+ P	0.65	79.8	88.9	0.69	68.1	93.7
	25	1+ H or 2+ P	0.67	72.3	93.7	0.66	77.2	91.9
	26	1+ H or 1+ P or 1+ Rx	0.61	84.2	84.4	0.69	61.6	94.7
	27	1+ H or 1+ P or 2+ Rx	0.63	83.7	86.1	0.70	64.2	94.7
	28	1+H or 2+P or (1P and 2+Rx)	0.70	77.4	92.8	0.70	76.1	93.2

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; PPV = Positive Predictive Value; NPV = Negative Predictive Value; 95% confidence intervals for all estimates are reported in Appendix A.

Provincial Estimates

Crude Prevalence Estimates

Provincial estimates are reported in Table 7-3. The crude prevalence estimates varied with the source and number of years of data. The algorithms with the highest estimate of κ returned crude prevalence rates of 24.7%, 23.9% and 23.8% (algorithms #5, #6, and #28 respectively). The algorithm with the highest estimate of Youden's index and the corresponding highest sensitivity (i.e., algorithm #13) produced a crude prevalence estimate of 26.6%.

Table 7-3: Crude provincial prevalence estimates for hypertension algorithms, 2001/02 -2005/06

# Years		Algorithm	Prevalence Estimates (%)
1	1	1+P	15.5
	2	2+P	10.1
	3	1+H or 1+ P	16.1
	4	1+ H or 2+ P	10.8
	5	1+ H or 1+ P or 1+ Rx	24.7
	6	1+ H or 1+ P or 2+ Rx	23.9
	7	1+H or 2+P or (1 P and 2+Rx)	14.3
2	8	1+P	20.1
	9	2+P	14.9
	10	1+H or 1+ P	20.7
	11	1+ H or 2+ P	15.8
	12	1+ H or 1+ P or 1+ Rx	27.5
	13	1+ H or 1+ P or 2+ Rx	26.6
	14	1+H or 2+P or (1 P and 2+Rx)	18.3
3	15	1+P	23.1
	16	2+P	17.8
	17	1+H or 1+ P	23.7
	18	1+ H or 2+ P	18.7
	19	1+ H or 1+ P or 1+ Rx	29.7
	20	1+ H or 1+ P or 2+ Rx	28.7
	21	1+H or 2+P or (1 P and 2+Rx)	20.8
5	22	1+P	26.9
	23	2+P	21.2
	24	1+H or 1+ P	27.5
	25	1+ H or 2+ P	22.1
	26	1+ H or 1+ P or 1+ Rx	33.1
	27	1+ H or 1+ P or 2+ Rx	31.7
	28	1+H or 2+P or (1 P and 2+Rx)	23.8

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; 1-year estimates are for 2005/06, 2-year estimates are for 2004/05 - 2005/06, 3-year estimates are for 2003/04 - 2005/06, 5-year estimates are for 2001/02 - 2005/06.

Venn Diagrams

Venn diagrams are presented for hypertension algorithms with one or more hospital separations or one or more physician billing claims or two or more prescription drug records in one-, two-, three-, and five-years (i.e., algorithms #6, #13, #20, and #27). The Venn diagrams describe the number and per cent of hypertension cases identified by each of the three data sources for the Manitoba population 19 years of age and older. For example, algorithm #6 resulted in the identification of 204,999 hypertension cases. Half of the cases were identified from both physician and prescription drug data and 33% were identified by prescription drug data alone. As expected, very few cases (0.22%) were identified only from hospital data.

Figure 7-1: Hypertension Algorithm #6: 1+ Hospital Separations or 1+ Physician Billing Claims or 2+ Prescription Records, 1 Year

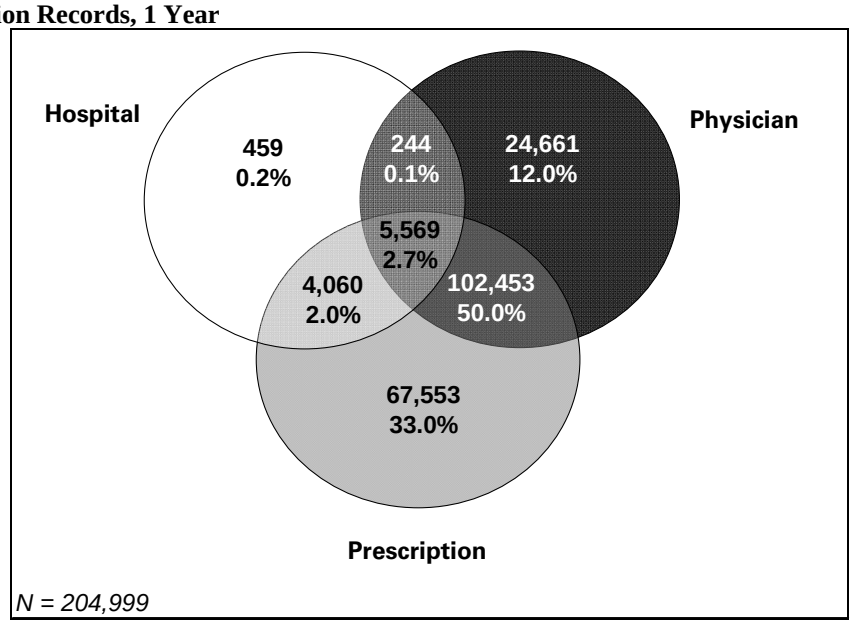


Figure 7-2: Hypertension Algorithm #13: 1+ Hospital Separations or 1+ Physician Billing Claims or 2+ Prescription Records, 2 Years

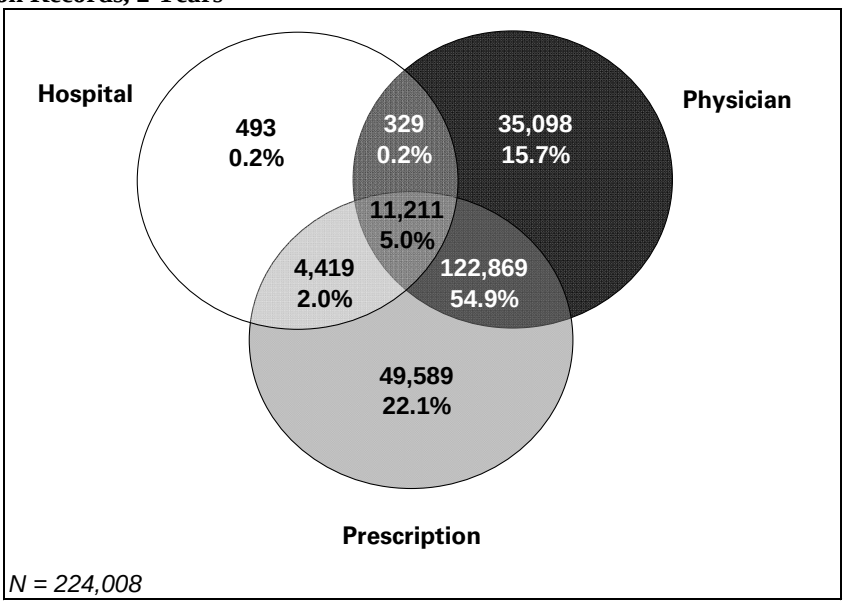


Figure 7-3: Hypertension Algorithm #20: 1+ Hospital Separations or 1+ Physician Billing Claims or 2+ Prescription Records, 3 Years

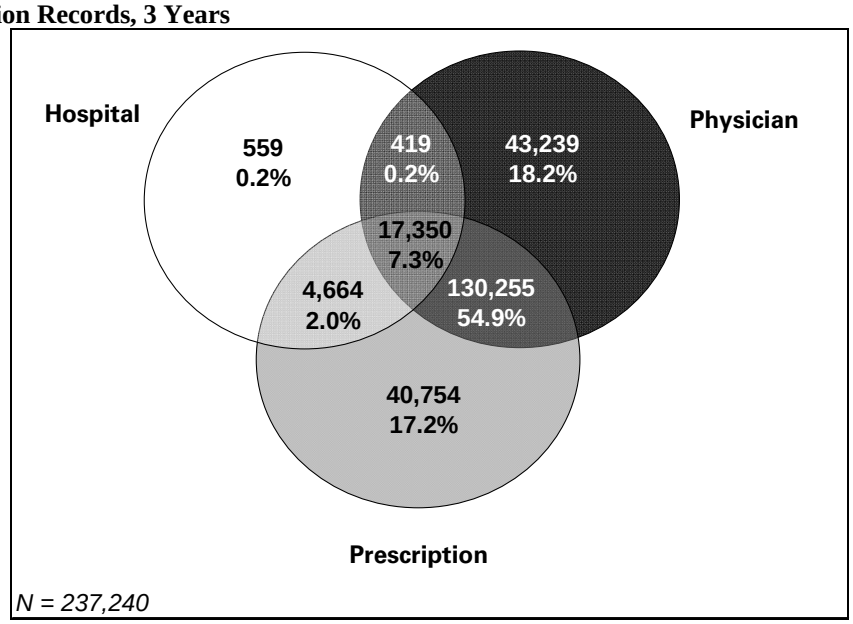
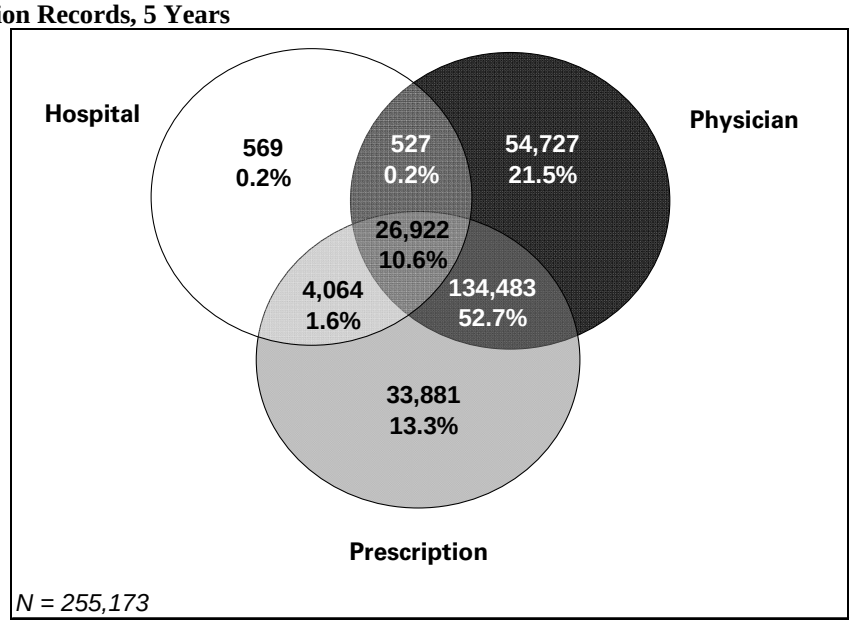


Figure 7-4: Hypertension Algorithm #27: 1+ Hospital Separations or 1+ Physician Billing Claims or 2+ Prescription Records, 5 Years



Chapter Summary

The validation results indicate that administrative data exhibit moderate to good agreement with survey data for identifying cases of hypertension. The highest agreement (0.71) was observed for three algorithms: the one-year algorithm based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records, the one-year algorithm based on one hospital separations or one or more physician billing claims or two or more prescription drug records and the five-year algorithm based on one or more hospital separations or two or more physician billing

claims or two or more prescription drug records in combination with a physician billing claim.

Crude prevalence estimates of hypertension ranged from 10.1% to 33.1% for the investigated algorithms. The algorithms with the highest values of κ produced crude prevalence estimates of 24.7%, 23.9% and 23.8% while the algorithms with the highest values of Youden's index produced crude prevalence estimates of 24.7%, 23.9% and 26.6% for the Manitoba population 19 years of age and older.

Sensitive algorithms for identifying diabetes cases from administrative data were obtained with physician billing claims data alone, a combination of physician billing claims and hospital separation data or all three sources. Although sensitivity and Youden's index increase with number of years, two one-year algorithms produce results showing good agreement with survey data.

CHAPTER 8: STROKE

Description of Stroke Algorithms

Table 8-1 lists the 24 algorithms that were investigated in this study. One algorithm in each time period was based only on physician billing claims data, two algorithms were based only on hospital separation data, one algorithm was based on both physician billing claims data and hospital separation data and the remaining algorithms were based on all three data sources. For example, algorithm #1 identified individuals as stroke cases if they had one or more hospital separations with a stroke diagnosis code in a one-year period. Algorithm #6 identified individuals as stroke cases if they had one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with one or more physician billing claims with a stroke diagnosis code in a one-year period. The algorithms for two-, three-, and five-years of administrative data are interpreted in a similar fashion.

Table 8-1: Stroke algorithms selected for validation

# Years	Algorithm	Hospital Separations or	Physician Claims or	Physician Claims and Prescription Drug Records
1	1	1 or more		
	2		1 or more	
	3		2 or more	
	4	1 or more	1 or more	
	5	1 or more	1 or more	0 and 1 or more
	6	1 or more	2 or more	1 and 2 or more
2	7	1 or more		
	8		1 or more	
	9		2 or more	
	10	1 or more	1 or more	
	11	1 or more	1 or more	0 and 1 or more
	12	1 or more	2 or more	1 and 2 or more
3	13	1 or more		
	14		1 or more	
	15		2 or more	
	16	1 or more	1 or more	
	17	1 or more	1 or more	0 and 1 or more
	18	1 or more	2 or more	1 and 2 or more
5	19	1 or more		
	20		1 or more	
	21		2 or more	
	22	1 or more	1 or more	
	23	1 or more	1 or more	0 and 1 or more
	24	1 or more	2 or more	1 and 2 or more

Validation Results

Table 8-2 contains the point estimates for the six validation indices for each of the 24 algorithms that were investigated for stroke. The 95% CIs for the estimates are reported in Appendix Table A.6.

There was poor to moderate agreement between the administrative and survey data, with κ ranging from 0.01 to 0.46. The highest value was for the three-year algorithm based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with one or more physician billing claims (i.e., algorithm #18). The estimate for the corresponding five-year algorithm was almost identical (0.45).

Sensitivity was highly variable for the algorithms, ranging from 0.6% to 68.6%. It was consistently the highest for algorithms based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records (i.e., algorithms # 5, #11, #17, #23). In all cases the highest sensitivity was observed for the five-year algorithms.

Specificity ranged from 93.8% to 100.0% for all algorithms. Overall, the most specific algorithms were those based on one or more hospital separations (i.e., algorithms #1, #7, #13, and #19). The range in specificity was minimal for algorithms within the same time period and decreased with the number of years of administrative data. Youden's index ranged from 0.01 to 0.62. The highest value was observed for the five-year algorithm based on one or more hospital separations or one or more physician billing claims or one or more prescription records (i.e., algorithm #23). Youden's index varied minimally for this algorithm when considering one, two, three, and five years of data.

The PPV of a stroke diagnosis ranged from 14.2% to 55.4%. The highest value was observed for the two-year algorithm based on one or more hospital separations (i.e., algorithm #1). The five-year algorithm followed closely at 54.3%. The NPV of a stroke diagnosis was above 98.5% for all of the algorithms. The highest value of 99.5% was observed for two-, three-, and five-year algorithms based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records (i.e., algorithm #11, #17, and #23).

Table 8-2: Estimates of agreement, sensitivity, specificity, and predictive values for stroke algorithms

# Years		Algorithms	κ	Sens. (%)	Spec. (%)	Youden	PPV (%)	NPV (%)
1	1	1+ H	0.01	0.6	100.0	0.01	19.8	98.5
	2	1+ P	0.25	24.3	99.1	0.23	28.5	98.9
	3	2+ P	0.26	20.0	99.6	0.20	40.0	98.8
	4	1+ H or 1+ P	0.25	24.3	99.1	0.23	28.2	98.9
	5	1+ H or 1+ P or 1+ Rx	0.29	63.1	96.2	0.59	20.0	99.4
	6	1+ H or 2+ P or (1 P and 2+ Rx)	0.29	23.6	99.5	0.23	40.5	98.9
2	7	1+ H	0.12	6.8	99.9	0.07	55.4	98.6
	8	1+ P	0.35	39.3	98.8	0.38	33.0	99.1
	9	2+ P	0.41	35.7	99.5	0.35	50.7	99.0
	10	1+ H or 1+ P	0.35	39.7	98.8	0.38	32.7	99.1
	11	1+ H or 1+ P or 1+ Rx	0.26	65.2	95.3	0.61	17.3	99.5
	12	1+ H or 2+ P or (1 P and 2+ Rx)	0.42	39.3	99.3	0.39	46.3	99.1
3	13	1+ H	0.21	13.4	99.8	0.13	52.4	98.7
	14	1+ P	0.38	48.0	98.6	0.47	33.2	99.2
	15	2+ P	0.42	39.5	99.3	0.39	45.8	99.1
	16	1+ H or 1+ P	0.38	48.6	98.5	0.47	32.8	99.2
	17	1+ H or 1+ P or 1+ Rx	0.23	65.2	94.7	0.60	15.6	99.5
	18	1+ H or 2+ P or (1 P and 2+ Rx)	0.46	48.2	99.1	0.47	44.7	99.2
5	19	1+ H	0.31	22.6	99.7	0.22	54.3	98.9
	20	1+ P	0.36	52.4	98.1	0.50	28.7	99.3
	21	2+ P	0.40	43.1	99.0	0.42	39.0	99.1
	22	1+ H or 1+ P	0.37	56.1	98.0	0.54	29.5	99.3
	23	1+ H or 1+ P or 1+ Rx	0.22	68.6	93.8	0.62	14.2	99.5
	24	1+ H or 2+ P or (1 P and 2+ Rx)	0.45	55.7	98.7	0.54	38.6	99.3

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; PPV = Positive Predictive Value; NPV = Negative Predictive Value; 95% confidence intervals for all estimates are reported in Appendix A.

Provincial Estimates

Crude Prevalence Estimates

Crude prevalence estimates for the 24 stroke algorithms are reported in Table 8-3 for each of the 24 algorithms. There was substantial variability within and across the one-, two-, three-, and five-year sets of algorithms. The algorithm with the highest estimate of κ (i.e., algorithm #18) produced a crude prevalence estimate of 1.3%. The algorithm with a similar κ (i.e., algorithm #24) also produced a crude prevalence estimate of 1.3%. The algorithm that resulted in the highest sensitivity and Youden's index (i.e., algorithm #23) produced crude prevalence estimates of 7.1%. The crude prevalence rate for algorithms based on one or more hospital separations or one or more physician billing claims or one or more prescription drug records (i.e., algorithms #5, #11, #17, and #23) produced substantially higher crude prevalence rates in comparison to all other algorithms.

Table 8-3: Crude provincial prevalence estimates for stroke, 2001/02 -2005/06

# Years		Algorithm	Prevalence Estimates (%)
1	1	1+H	0.2
	2	1+P	1.0
	3	2+ P	0.5
	4	1+ H or 1+ P	1.0
	5	1+ H or 1+ P or 1+ Rx	6.1
	6	1+H or 2+P or (1 P and 2+Rx)	0.7
2	7	1+H	0.4
	8	1+P	1.6
	9	2+ P	0.9
	10	1+ H or 1+ P	1.6
	11	1+ H or 1+ P or 1+ Rx	7.3
	12	1+H or 2+P or (1 P and 2+Rx)	1.2
3	13	1+H	0.4
	14	1+P	1.6
	15	2+ P	0.9
	16	1+ H or 1+ P	1.7
	17	1+ H or 1+ P or 1+ Rx	8.0
	18	1+H or 2+P or (1 P and 2+Rx)	1.3
5	19	1+H	0.4
	20	1+P	1.6
	21	2+ P	1.0
	22	1+ H or 1+ P	1.7
	23	1+ H or 1+ P or 1+ Rx	7.1
	24	1+H or 2+P or (1 P and 2+Rx)	1.3

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; 1-year estimates are for 2005/06, 2-year estimates are for 2004/05 - 2005/06, 3-year estimates are for 2003/04 - 2005/06, 5-year estimates are for 2001/02 - 2005/06.

Venn Diagrams

Venn diagrams are presented for the algorithms based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with one or more physician billing claims in one, two, three, and five years of data (i.e., algorithms #6, #12, #18, and #24). The Venn diagrams describe the number and per cent of stroke cases identified by each of the three data sources for the Manitoba population 19 years of age and older.

Figure 8-1: Stroke Algorithm #6: 1+ Hospital Separations or 2+ Physician Billing Claims or 1 Physician Billing Claim & 2+ Prescription Records, 1 Year

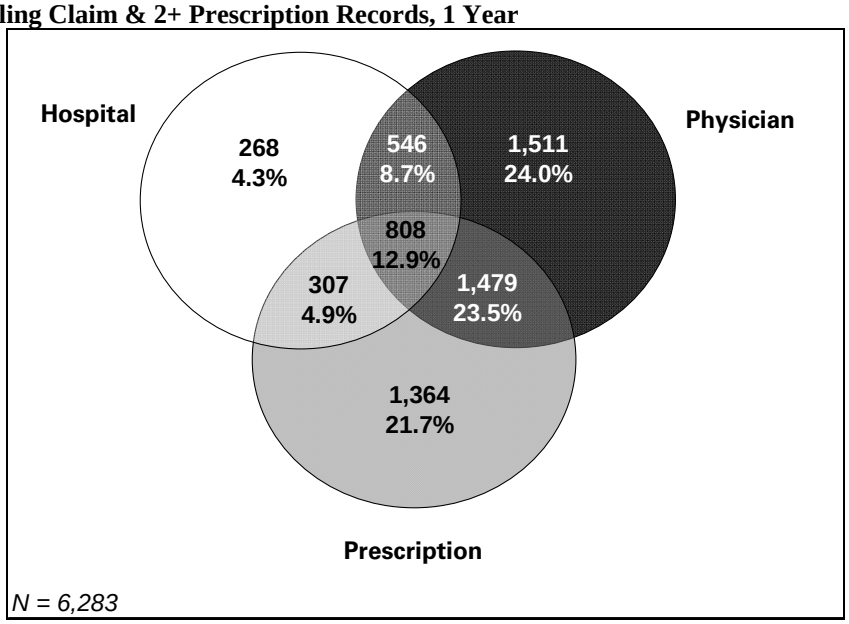


Figure 8-2: Stroke Algorithm #12: 1+ Hospital Separations or 2+ Physician Billing Claims or 1 Physician Billing Claim & 2+ Prescription Records, 2 Years

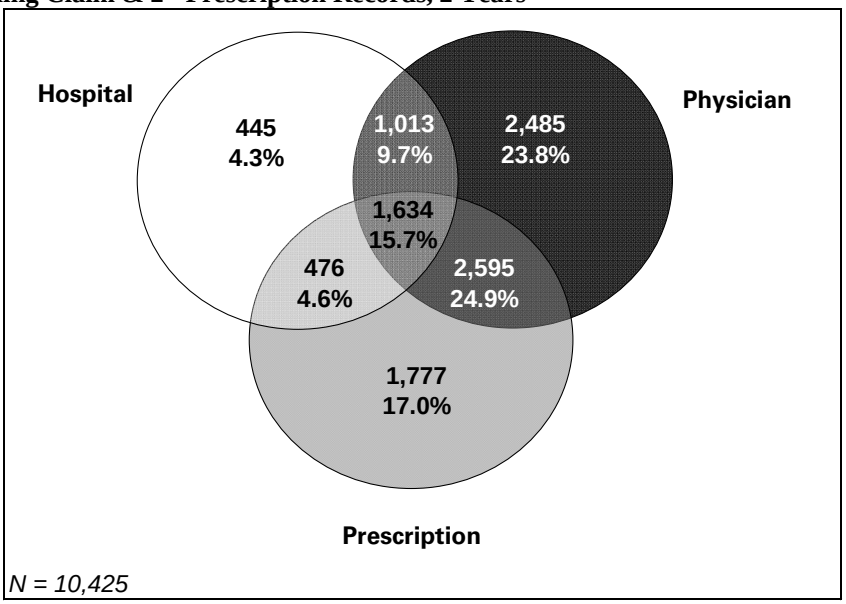


Figure 8-3: Stroke Algorithm #18: 1+ Hospital Separations or 2+ Physician Billing Claims or 1 Physician Billing Claim & 2+ Prescription Records, 3 Years

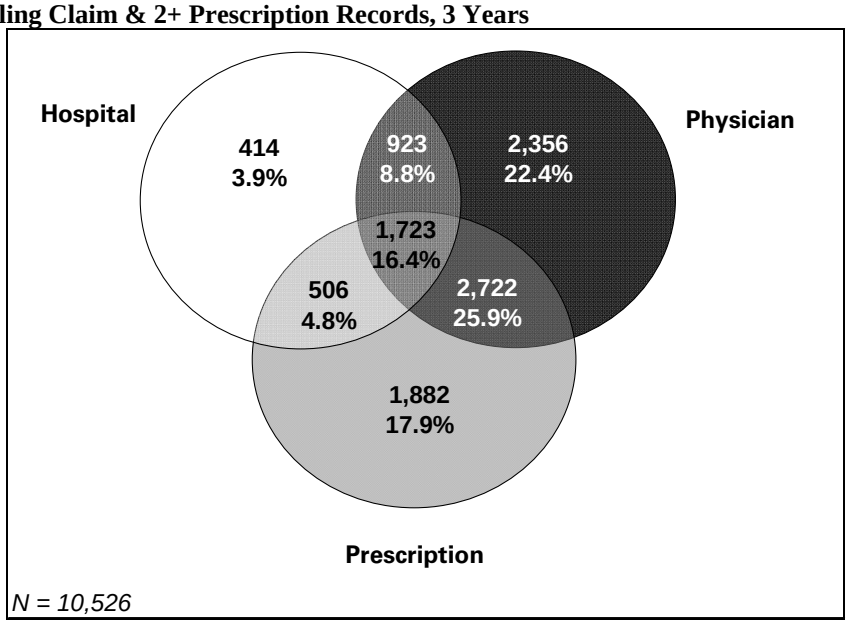
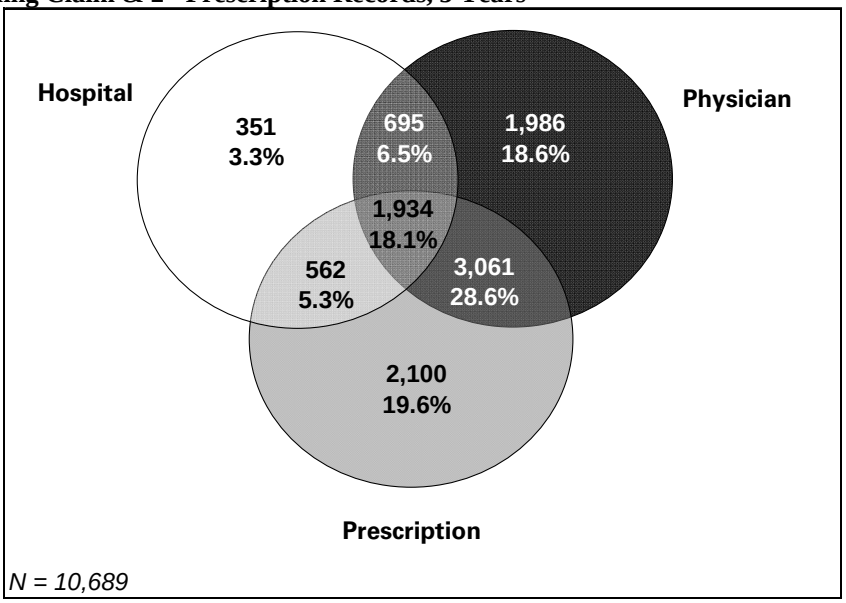


Figure 8-4: Stroke Algorithm #24: 1+ Hospital Separations or 2+ Physician Billing Claims or 1 Physician Billing Claim & 2+ Prescription Records, 5 Years



Chapter Summary

The validation results indicate that administrative data exhibit poor to moderate agreement with survey data for identifying cases of stroke. The highest agreement (0.46) was observed for the algorithm based on one or more hospital separations or two or more physician billing claims or two or more prescription drug records in combination with one or more physician billing claims over three years. Crude prevalence estimates of asthma ranged from 0.2% to 8.0% for the investigated algorithms. The algorithms with

the highest values of κ and Youden's index produced crude prevalence rates of 1.3% and 7.1% respectively.

The results of the validation study indicated that using only a single hospital separation resulted in an algorithm with very poor agreement and sensitivity. Algorithms including only physician billing claims data were improved, however a combination of all three data sets offered the highest level of agreement when prescription drug records were paired with physician billing claims data. The level of agreement between administrative and survey data increased with number of years for all but one algorithm.

CHAPTER 9: IRRITABLE BOWEL SYNDROME

Description of Irritable Bowel Syndrome Algorithms

Table 9-1 lists the 20 algorithms that were investigated for IBS in this study. The IBS algorithms were based on as many as five years of hospital separation and physician billing claims data. Prescription drug records were not used to define the algorithms because there has been because prescription drugs have not been found to be useful to distinguish IBS cases from non-cases in administrative data (Legoretta, Ricci, Markowitz, & Jhingran, 2002). The number of physician billing claims varied from one to five or more. For example, algorithm #1 identified individuals as IBS cases if they had one or more hospital separations or one or more physician billing claims. The algorithms for two-, three-, and five-years of administrative data are interpreted in a similar fashion.

It is important to note that IBS can only be definitively identified in administrative data using a four-digit ICD-9-CM code (i.e., ICD-9-CM 564.1). In Manitoba's physician claims data only a three-digit code are available, which captures a variety of non-specific gastrointestinal conditions. This was expected to have a negative influence on specificity of the case ascertainment algorithms.

Table 9-1: Irritable bowel syndrome algorithms selected for validation

# Years	Algorithm	Hospital Separations or	Physician Claims
1	1	1 or more	1 or more
	2	1 or more	2 or more
	3	1 or more	3 or more
	4	1 or more	4 or more
	5	1 or more	5 or more
2	6	1 or more	1 or more
	7	1 or more	2 or more
	8	1 or more	3 or more
	9	1 or more	4 or more
	10	1 or more	5 or more
3	11	1 or more	1 or more
	12	1 or more	2 or more
	13	1 or more	3 or more
	14	1 or more	4 or more
	15	1 or more	5 or more
5	16	1 or more	1 or more
	17	1 or more	2 or more
	18	1 or more	3 or more
	19	1 or more	4 or more
	20	1 or more	5 or more

Validation Results

Table 9-2 contains the point estimates for the six validation indices for each of the 20 algorithms that were investigated for IBS. The 95% CIs for the estimates are reported in Appendix Table A.7.

There was poor to fair agreement between the administrative and survey data, with κ ranging from 0.00 to 0.24. The highest value was for the five-year algorithm with one or more hospital separations or two or more physician billing claims (i.e., algorithm #17). The estimates for all five-year algorithms except that for one or more hospital separations or five or more physician billing claims (i.e., algorithm #20) were within 0.03 of the highest value. In general, there was a direct relationship between kappa and number of years and an inverse relationship between kappa and the number of physician billing claims.

Sensitivity ranged from 0.0% to 33.7% for the algorithms. It was consistently the highest for algorithms based on one or more hospital separations or one or more physician claims (ie., algorithms #1, #6, #11, and #16), with the highest value being observed for the five-year algorithm. Specificity was surprisingly high for all algorithms, ranging from 95.7% to 100.0%. Youden's index ranged from 0.01 to 0.29. The highest value was observed for the five-year algorithm with one or more hospital separations or one or more physician billing claims (i.e., algorithm #16).

The PPV of an IBS diagnosis ranged from 18.9% to 100.0%, although the latter value is misleading because it is associated with a sensitivity of 0.0%. The NPV of an IBS diagnosis was a minimum of 96.9%, with the highest value observed for the five-year algorithm based on one or more hospital separations or one or more physician billing claims (i.e., algorithm #16).

Table 9-2: Estimates of agreement, sensitivity, specificity, and predictive values for irritable bowel syndrome

# Years		Algorithm	κ	Sens. (%)	Spec. (%)	Youden	PPV (%)	NPV (%)
1	1	1+ H or 1+ P	0.11	9.3	98.9	0.08	21.2	97.2
	2	1+ H or 2+ P	0.05	3.5	99.6	0.03	22.1	97.0
	3	1+ H or 3+ P	0.04	2.2	99.9	0.02	36.5	97.0
	4	1+ H or 4+ P	0.03	1.4	100.0	0.01	70.3	97.0
	5	1+ H or 5+ P	0.00	0.0	100.0	0.00	100.0	96.9
2	6	1+ H or 1+ P	0.20	19.8	98.2	0.18	25.7	97.5
	7	1+ H or 2+ P	0.06	4.7	99.4	0.04	18.9	97.1
	8	1+ H or 3+ P	0.06	3.6	99.7	0.03	28.7	97.0
	9	1+ H or 4+ P	0.03	2.0	99.9	0.02	30.2	97.0
	10	1+ H or 5+ P	0.01	0.6	99.9	0.01	20.4	96.9
3	11	1+ H or 1+ P	0.22	25.6	97.4	0.23	24.0	97.6
	12	1+ H or 2+ P	0.13	9.8	99.2	0.09	28.1	97.2
	13	1+ H or 3+ P	0.11	6.6	99.7	0.06	41.4	97.1
	14	1+ H or 4+ P	0.07	3.9	99.8	0.04	45.2	97.0
	15	1+ H or 5+ P	0.02	0.9	99.9	0.01	26.0	97.0
5	16	1+ H or 1+ P	0.22	33.7	95.7	0.29	19.8	97.9
	17	1+ H or 2+ P	0.24	22.5	98.3	0.21	29.8	97.6
	18	1+ H or 3+ P	0.22	15.9	99.3	0.15	42.2	97.4
	19	1+ H or 4+ P	0.21	13.2	99.7	0.13	58.7	97.3
	20	1+ H or 5+ P	0.06	3.3	99.9	0.03	45.8	97.0

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; PPV = Positive Predictive Value; NPV = Negative Predictive Value; 95% confidence intervals for all estimates are reported in Appendix A.

Provincial Estimates

Crude Prevalence Estimates

Provincial prevalence estimates for the 20 algorithms for IBS are reported in Table 9-3. There was substantial variability within and across the one-, two-, three-, and five-year sets of algorithms. The algorithm with the highest estimate of κ (0.24) produced a crude prevalence estimate of 2.6% (i.e., algorithm #17). The algorithms with the second highest estimate (0.22) produced crude prevalence estimates of 4.2%, 6.3%, and 1.3% (i.e., algorithms #11, #16 and #18). The algorithm that resulted in the highest sensitivity and Youden's index (i.e., algorithm #16) produced a crude prevalence estimate of 6.3%. For each algorithm set the crude prevalence rate decreased with physician claims and increased with number of years.

Table 9-3: Crude provincial prevalence estimates for irritable bowel syndrome, 2001/02 -2005/06

# Years		Algorithm	Prevalence Estimates (%)
1	1	1+H or 1+P	1.7
	2	1+H or 2+P	0.5
	3	1+H or 3+P	0.2
	4	1+H or 4+P	0.1
	5	1+H or 5+P	0.1
2	6	1+H or 1+P	3.0
	7	1+H or 2+P	1.1
	8	1+H or 3+P	0.5
	9	1+H or 4+P	0.3
	10	1+H or 5+P	0.2
3	11	1+H or 1+P	4.2
	12	1+H or 2+P	1.6
	13	1+H or 3+P	0.8
	14	1+H or 4+P	0.4
	15	1+H or 5+P	0.3
5	16	1+H or 1+P	6.3
	17	1+H or 2+P	2.6
	18	1+H or 3+P	1.3
	19	1+H or 4+P	0.8
	20	1+H or 5+P	0.5

Note: H = Hospital separation; P = Physician billing claim; Rx = Prescription drug record; 1-year estimates are for 2005/06, 2-year estimates are for 2004/05 - 2005/06, 3-year estimates are for 2003/04 - 2005/06, 5-year estimates are for 2001/02 - 2005/06.

Venn Diagrams

Venn diagrams are presented for the algorithms based on one or more hospital separations or two or more physician billing claims in one-, two-, three-, and five-years (i.e., algorithms #2, #7, #12, and #17). The Venn diagrams describe the number and percent of IBS cases identified by each of the two data sources for the Manitoba population 19 years and older. For example, algorithm #2 resulted in the identification of 4,529 cases. Almost all (97.2%) of these cases were identified from physician claims data. This indicates that there is little to be gained from using hospital separation data to ascertain IBS cases.

Figure 9-1: Irritable Bowel Syndrome Algorithm #2: 1+ Hospital Separations or 2+ Physician Billing Claims, 1 Year

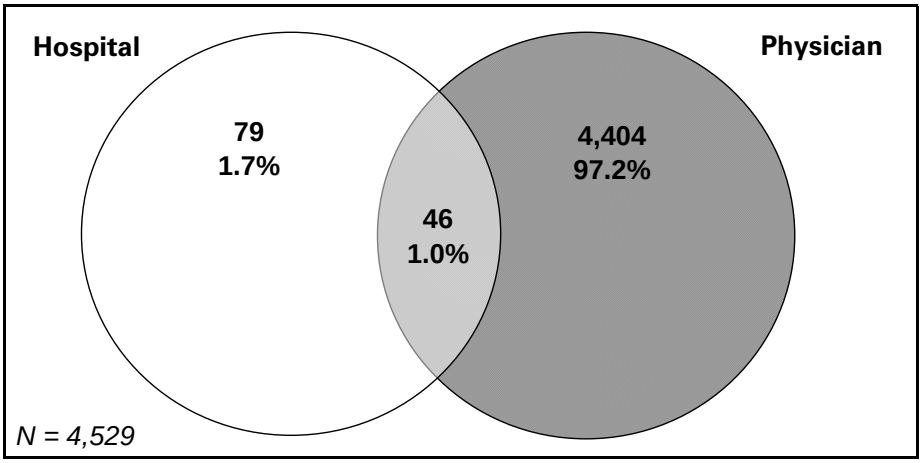


Figure 9-2: Irritable Bowel Syndrome Algorithm #7: 1+ Hospital Separations or 2+ Physician Billing Claims, 2 Years

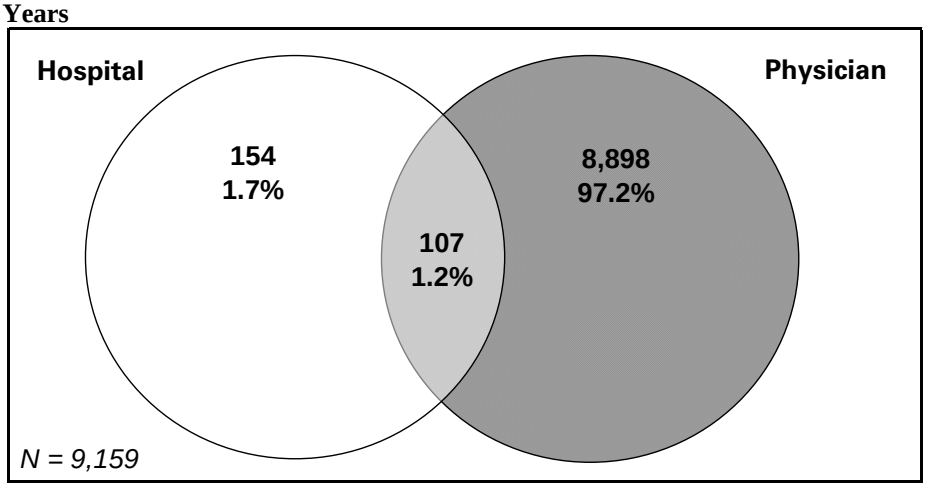


Figure 9-3: Irritable Bowel Syndrome Algorithm #12: 1+ Hospital Separations or 2+ Physician Billing Claims, 3 Years

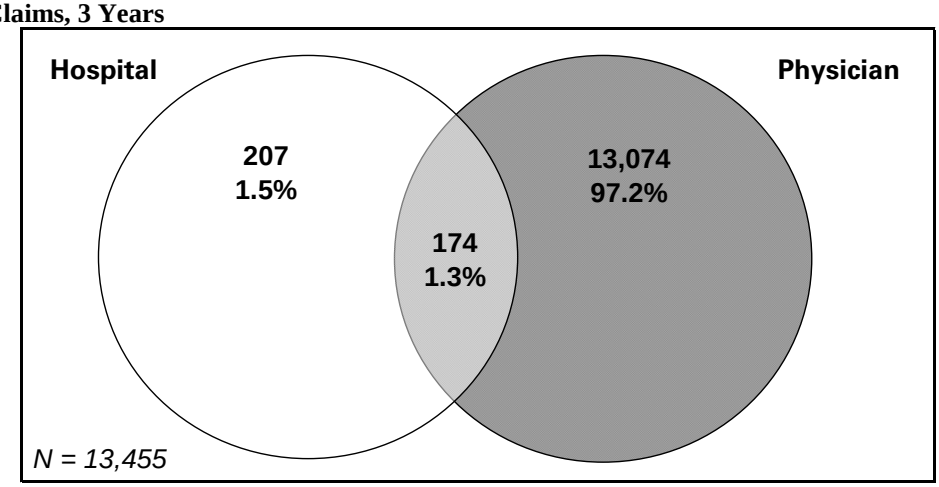
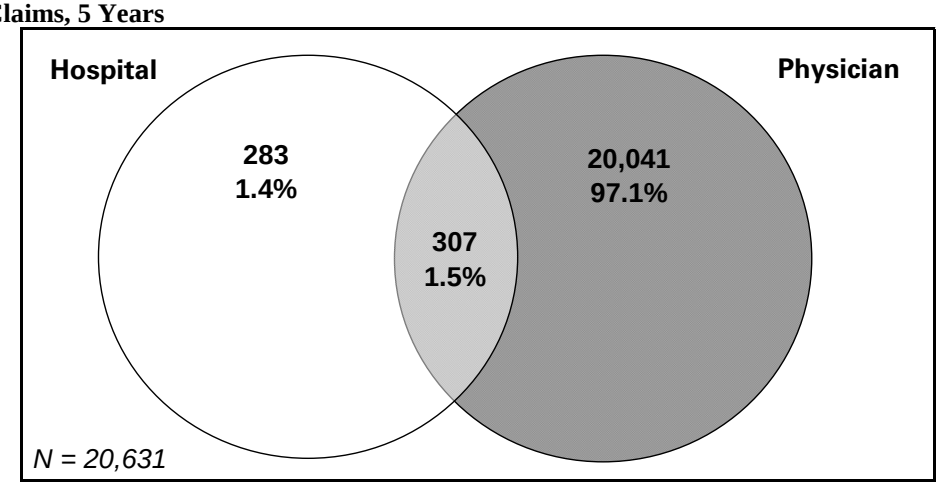


Figure 9-4: Irritable Bowel Syndrome Algorithm #17: 1+ Hospital Separations or 2+ Physician Billing Claims, 5 Years



Chapter Summary

The validation results indicate that administrative data exhibit poor to fair agreement with survey data for identifying cases of irritable bowel syndrome. The highest agreement (0.24) was observed by the five-year algorithm based on one or more hospital separations or two or more physician billing claims. However, as the Venn diagrams reveal, very few cases of irritable bowel syndrome are identified from hospital data.

Crude prevalence estimates of irritable bowel syndrome ranged from 0.1 to 6.3 per cent for the investigated algorithms, figures which are substantially lower than estimates that have been reported in the literature. The algorithm with the highest value of κ produced a crude estimate of 4.2 per cent.

Both sensitivity and Youden's index increased with the number of years of administrative data. There was very little trade-off between sensitivity and specificity for different algorithms; both were very high for all of the algorithms that were investigated.

CHAPTER 10: CONCLUSIONS AND RECOMMENDATIONS

This report follows the initial research of Lix et al. (2006) to evaluate the use of Manitoba's administrative data to identify chronic disease cases. The research adds to the body of literature on validation studies of administrative data by confirming the results obtained by Lix et al. and also by identifying relevant ICD-10-CA codes for ascertaining chronic disease cases in administrative data. The similarity of the current results to those obtained by Lix et al. show that the change in classification systems has had little impact on the ability to ascertain cases of chronic disease in administrative data. For some diseases, such as asthma, this consistency of findings occurs because relatively few cases are identified solely from diagnoses in hospital separation abstracts. For other diseases, such as diabetes, for which a relatively larger proportion of cases are ascertained solely from administrative data, the results should help to ease concerns about comparability of prevalence estimates over time.

Table 10-1 summarizes the algorithms with the maximum estimates of , sensitivity, specificity, and Youden's index for each chronic disease. Crude provincial estimates are also provided for each algorithm. For some diseases more than one algorithm had equivalent (or near equivalent) maximum estimates of these validation indices. In this table, we report on the algorithm that had the highest numeric value of a statistic but required the fewest number of years of data, the fewest number of data sources, or the fewer number of contacts in administrative data.

The summary results in this table are consistent with those reported by Lix et al., (2006), although not always identical. For example, for osteoarthritis, the algorithm with the maximum estimate of sensitivity and Youden's index is an algorithm based on two or more physician claims in five years; it results in a prevalence estimate of 14.5%. However, in the 2006 report, the algorithm with maximum estimates of sensitivity and Youden's index was the algorithm based on one or more physician claims in five years, which resulted in a prevalence estimate of 13.2%. Overall, however, the same set of data sources (i.e., physician claims only) and years of data defined the algorithm.

Table 10-1: Crude provincial prevalence estimates for chronic disease algorithms with the maximum estimates of , sensitivity, specificity, and Youden's index

Chronic Disease	Algorithm		Sens. (%)	Spec. (%)	Youden's Index	Prev. (%)
Arthritis	1+ H or 2+ P or (1P & 2+ Rx), 2 yrs	**0.38**	48.7	88.0	0.37	20.4
	1+ P, 5 yrs	0.28	**78.2**	61.5	0.40	47.6
	2+ P, 1 yr	0.28	26.7	**95.4**	0.22	9.4
	2+ P, 5 yrs	0.37	66.6	76.9	**0.44**	31.8
Rheumatoid Arthritis	1+ P, 5 yrs	**0.21**	**14.4**	99.3	**0.14**	1.6
	2+ P, 1 yr	0.16	9.6	**99.9**	0.10	0.5
Osteoarthritis	1+ P, 3 yrs	**0.35**	42.9	93.2	0.36	11.0
	2+ P, 5 yrs	0.35	**52.4**	90.0	**0.42**	14.5
	2+ P, 1 yr	0.23	16.4	**98.9**	0.15	2.4
Asthma (All Ages)	1+ H or 2+ P or 2+ Rx, 3 yrs	**0.56**	65.9	95.6	0.62	9.6
	1+ H or 1+ P or 1+ Rx, 5 yrs	0.44	**84.1**	87.9	**0.72**	17.9
	2+ P, 1 yr	0.26	17.9	**99.3**	0.17	2.0
Coronary Heart Disease	1+ H or 2+ P or (1P & 2+ Rx), 5 yrs	**0.50**	63.0	96.4	0.59	7.2
	1+ H or 1+ P or 1+ Rx, 5 yrs	0.21	**84.7**	79.0	**0.64**	10.6
	2+ P, 1 yr	0.37	28.0	**99.2**	0.27	5.1
Diabetes	1+ H or 2+ P or 1+ Rx, 1 yr	**0.87**	85.9	99.4	0.85	6.7
	1+ H or 1+ P or 1+ Rx, 5 yrs	0.75	**94.4**	97.2	**0.92**	10.6
	1+ H or 2+ P, 1 yr	0.78	69.9	**99.6**	0.69	5.1
Hypertension	1+ H or 1+ P or 1+ Rx, 1 yr	**0.70**	78.5	92.4	**0.71**	24.7
	1+ H or 1+ P or 1+ Rx, 5 yrs	0.61	**84.2**	84.4	0.69	33.1
	2+ P, 1 yr	0.49	40.9	**98.6**	0.39	10.1
Stroke	1+ H or 2+ P or (1P & 2+ Rx), 3 yrs	**0.46**	48.2	99.1	0.47	1.3
	1+ H or 1+ P or 1+ Rx, 5 yrs	0.22	**68.6**	93.8	**0.62**	7.1
	1+ H, 1 yr	0.01	0.6	**100.0**	0.01	0.2
Irritable Bowel Syndrome	1+ H or 2+ P, 5 yrs	**0.24**	22.5	98.3	0.21	2.6
	1+ H or 1+ P, 5 yrs	0.22	**33.7**	95.7	**0.29**	6.3
	1+ H or 4+ P, 1 yr	0.03	1.4	**100.0**	0.01	0.1

Note: Values in bold are the maximum , sensitivity, specificity, or Youden's index values. All prevalence estimates are defined for the population 19 years of age and older except for asthma, which is defined for the population 12 years of age and older.

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Appendix: Confidence Intervals for Validation Indices

Table A.1: 95% confidence intervals for validation indices for all arthritis algorithms, 19+ years

# of Years		Algorithm	κ			Sensitivity			Specificity			PPV			NPV		
			Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL
1	1	1+ P	0.32	0.32	0.32	43.1	42.9	43.4	87.6	87.5	87.7	48.5	48.3	48.8	85.1	85.0	85.1
	2	2+ P	0.28	0.28	0.28	26.7	26.5	26.9	95.4	95.4	95.5	61.2	60.9	61.6	82.8	82.7	82.9
	3	1+ H or 2+ P	0.28	0.28	0.29	27.2	26.9	27.4	95.4	95.3	95.4	61.3	61.0	61.7	82.9	82.8	83.0
	4	1+ H or 2+ P or (1 P & 2+ Rx)	0.34	0.34	0.34	34.2	33.9	34.4	94.2	94.1	94.3	61.5	61.1	61.8	84.1	84.0	84.2
2	5	1+ P	0.33	0.33	0.34	58.8	58.5	59.0	79.0	78.8	79.1	43.1	42.9	43.3	87.6	87.5	87.7
	6	2+ P	0.35	0.35	0.35	41.6	41.4	41.9	90.4	90.3	90.5	54.1	53.8	54.4	85.1	85.0	85.2
	7	1+ H or 2+ P	0.35	0.35	0.35	41.8	41.5	42.1	90.3	90.3	90.4	54.0	53.7	54.3	85.1	85.1	85.2
	8	1+ H or 2+ P or (1 P & 2+ Rx)	0.38	0.37	0.38	48.7	48.4	48.9	88.0	87.9	88.1	52.4	52.1	52.7	86.4	86.3	86.4
3	9	1+ P	0.31	0.31	0.31	68.1	67.9	68.4	71.3	71.1	71.4	39.1	38.9	39.3	89.2	89.1	89.3
	10	2+ P	0.37	0.37	0.37	51.8	51.5	52.1	85.7	85.6	85.8	49.5	49.3	49.8	86.8	86.7	86.9
	11	1+ H or 2+ P	0.37	0.37	0.37	51.9	51.6	52.1	85.6	85.5	85.7	49.4	49.1	49.6	86.8	86.7	86.9
	12	1+ H or 2+ P or (1 P & 2+ Rx)	0.36	0.36	0.37	58.6	58.3	58.9	81.4	81.3	81.5	46.1	45.9	46.3	87.9	87.8	88.0
5	13	1+ P	0.28	0.27	0.28	78.2	78.0	78.4	61.5	61.3	61.6	35.5	35.3	35.6	91.2	91.1	91.3
	14	2+ P	0.37	0.36	0.37	66.6	66.4	66.9	76.9	76.8	77.0	43.9	43.7	44.1	89.5	89.4	89.6
	15	1+ H or 2+ P	0.36	0.36	0.37	66.7	66.4	66.9	76.7	76.6	76.8	43.7	43.4	43.9	89.5	89.4	89.6
	16	1+ H or 2+ P or (1 P & 2+ Rx)	0.35	0.34	0.35	71.7	71.5	71.9	72.3	72.2	72.4	41.2	41.0	41.4	90.4	90.3	90.5

Note: Est. = validation index point estimate; LCL = lower confidence limit; UCL = upper confidence limit

Table A.2: 95% confidence intervals for validation indices for rheumatoid arthritis algorithms, 19+ years

# of Years		Algorithm	κ			Sensitivity			Specificity			PPV			NPV		
			Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL
1	1	1+ P	0.17	0.17	0.18	10.6	10.3	11.0	99.8	99.8	99.8	70.0	68.6	71.3	96.0	95.9	96.0
	2	2+ P	0.16	0.16	0.17	9.6	9.3	10.0	99.9	99.9	99.9	81.1	79.8	82.4	95.9	95.9	96.0
	3	1+ H or 2+ P	0.17	0.16	0.17	9.9	9.5	10.2	99.9	99.9	99.9	81.4	80.2	82.7	95.9	95.9	96.0
	4	1+ H or 2+ P or (1 P & 2+ Rx)	0.17	0.16	0.18	10.1	9.7	10.4	99.9	99.9	99.9	78.7	77.4	80.0	95.9	95.9	96.0
2	5	1+ P	0.18	0.17	0.18	11.2	10.9	11.6	99.6	99.6	99.6	57.7	56.4	59.0	96.0	95.9	96.0
	6	2+ P	0.17	0.16	0.17	10.2	9.8	10.5	99.8	99.8	99.8	69.2	67.8	70.6	95.9	95.9	96.0
	7	1+ H or 2+ P	0.17	0.16	0.17	10.2	9.8	10.5	99.8	99.8	99.8	69.2	67.8	70.6	95.9	95.9	96.0
	8	1+ H or 2+ P or (1 P & 2+ Rx)	0.17	0.16	0.17	10.4	10.0	10.7	99.8	99.7	99.8	66.5	65.1	67.8	95.9	95.9	96.0
3	9	1+ P	0.19	0.19	0.20	12.4	12.1	12.8	99.6	99.6	99.6	57.6	56.4	58.8	96.0	96.0	96.1
	10	2+ P	0.17	0.17	0.18	10.6	10.2	10.9	99.8	99.8	99.8	69.3	67.9	70.6	95.9	95.9	96.0
	11	1+ H or 2+ P	0.17	0.17	0.18	10.6	10.2	10.9	99.8	99.8	99.8	69.3	67.9	70.6	95.9	95.9	96.0
	12	1+ H or 2+ P or (1 P & 2+ Rx)	0.18	0.18	0.19	11.3	11.0	11.7	99.7	99.7	99.8	67.7	66.4	69.0	96.0	95.9	96.0
5	13	1+ P	0.21	0.20	0.21	14.4	14.0	14.8	99.3	99.3	99.3	49.7	48.6	50.7	96.1	96.1	96.1
	14	2+ P	0.20	0.20	0.21	14.4	14.0	14.8	99.3	99.3	99.3	49.7	48.6	50.7	96.1	96.1	96.1
	15	1+ H or 2+ P	0.20	0.20	0.21	13.2	12.8	13.6	99.6	99.6	99.6	59.7	58.5	60.9	96.1	96.0	96.1
	16	1+ H or 2+ P or (1 P & 2+ Rx)	0.20	0.20	0.21	13.3	12.9	13.6	99.6	99.5	99.6	58.5	57.4	59.7	96.1	96.0	96.1

Note: Est. = validation index point estimate; LCL = lower confidence limit; UCL = upper confidence limit

Table A.3: 95% confidence intervals for validation indices for osteoarthritis algorithms, 19+ years

# of Years		Algorithm	κ			Sensitivity			Specificity			PPV			NPV		
			Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL
1	1	1+ P	0.30	0.30	0.31	27.5	27.2	27.9	96.8	96.8	96.9	48.9	48.4	49.4	92.4	92.3	92.5
	2	2+ P	0.23	0.22	0.23	16.4	16.2	16.7	98.9	98.8	98.9	61.6	60.9	62.3	91.5	91.4	91.6
	3	1+ H or 2+ P	0.23	0.23	0.23	16.8	16.5	17.0	98.8	98.8	98.8	60.6	59.9	61.3	91.5	91.5	91.6
	4	1+ H or 2+ P or (1 P & 2+ Rx)	0.29	0.28	0.29	22.9	22.6	23.3	98.0	98.0	98.1	56.3	55.8	56.9	92.1	92.0	92.1
2	5	1+ P	0.33	0.32	0.33	35.4	35.0	35.8	94.8	94.8	94.9	42.9	42.5	43.3	93.0	93.0	93.1
	6	2+ P	0.29	0.29	0.29	23.8	23.5	24.1	97.9	97.9	97.9	55.4	54.8	56.0	92.1	92.1	92.2
	7	1+ H or 2+ P	0.29	0.29	0.29	23.9	23.6	24.2	97.8	97.8	97.8	54.3	53.7	54.9	92.1	92.1	92.2
	8	1+ H or 2+ P or (1 P & 2+ Rx)	0.33	0.33	0.34	31.2	30.8	31.5	96.6	96.5	96.6	50.0	49.6	50.5	92.7	92.7	92.8
3	9	1+ P	0.35	0.35	0.36	42.9	42.6	43.3	93.2	93.2	93.3	41.1	40.7	41.4	93.7	93.6	93.8
	10	2+ P	0.31	0.31	0.32	28.0	27.7	28.3	97.0	97.0	97.0	50.6	50.1	51.1	92.5	92.4	92.5
	11	1+ H or 2+ P	0.31	0.31	0.31	28.1	27.8	28.5	96.9	96.8	96.9	49.7	49.2	50.2	92.5	92.4	92.5
	12	1+ H or 2+ P or (1 P & 2+ Rx)	0.34	0.34	0.35	36.7	36.3	37.1	94.9	94.8	94.9	44.1	43.7	44.5	93.2	93.1	93.2
5	13	1+ P	0.35	0.35	0.36	52.4	52.0	52.7	90.0	89.9	90.1	36.5	36.2	36.8	94.5	94.4	94.6
	14	2+ P	0.34	0.34	0.35	35.3	34.9	35.7	95.4	95.4	95.5	45.9	45.4	46.3	93.1	93.0	93.1
	15	1+ H or 2+ P	0.34	0.34	0.34	35.4	35.0	35.8	95.3	95.3	95.4	45.3	44.9	45.7	93.1	93.0	93.1
	16	1+ H or 2+ P or (1 P & 2+ Rx)	0.35	0.35	0.36	46.2	45.8	46.6	92.1	92.0	92.2	39.2	38.8	39.5	94.0	93.9	94.0

Note: Est. = validation index point estimate; LCL = lower confidence limit; UCL = upper confidence limit

Table A.4: 95% confidence intervals for validation indices for asthma algorithms, 19+ years

# of Years		Algorithm	κ			Sensitivity			Specificity			PPV			NPV		
			Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL
1	1	1+ P	0.37	0.36	0.37	28.7	28.3	29.1	98.7	98.7	98.7	64.1	63.4	64.7	94.5	94.5	94.6
	2	2+ P	0.26	0.25	0.26	17.9	17.5	18.2	99.3	99.3	99.3	66.9	66.1	67.7	93.8	93.7	93.9
	3	1+ Rx	0.52	0.51	0.52	57.0	56.6	57.4	96.1	96.0	96.1	53.8	53.4	54.2	96.5	96.5	96.6
	4	1+ H or 1+ P	0.38	0.37	0.38	30.1	29.7	30.5	98.6	98.5	98.6	62.6	61.9	63.2	94.6	94.6	94.7
	5	1+ H or 2+ P	0.27	0.27	0.27	19.2	18.9	19.6	99.1	99.1	99.2	63.8	63.0	64.6	93.9	93.8	93.9
	6	1+ H or 1+ P or 1+ Rx	0.52	0.52	0.53	60.5	60.1	61.0	95.6	95.5	95.6	52.2	51.8	52.6	96.8	96.8	96.8
	7	1+ H or 2+ P or 2+ Rx	0.50	0.49	0.50	47.2	46.8	47.6	97.6	97.5	97.6	60.7	60.2	61.2	95.9	95.8	95.9
2	8	1+ P	0.42	0.42	0.42	38.9	38.5	39.3	97.5	97.4	97.5	55.2	54.6	55.7	95.2	95.2	95.3
	9	2+ P	0.34	0.33	0.34	26.9	26.5	27.3	98.5	98.4	98.5	58.4	57.7	59.0	94.4	94.3	94.5
	10	1+ Rx	0.50	0.50	0.50	65.3	64.8	65.7	94.0	93.9	94.1	46.5	46.1	46.9	97.1	97.1	97.2
	11	1+ H or 1+ P	0.43	0.43	0.43	40.8	40.3	41.2	97.3	97.2	97.3	54.4	53.9	54.9	95.4	95.3	95.4
	12	1+ H or 2+ P	0.35	0.35	0.35	28.8	28.4	29.2	98.2	98.2	98.3	56.8	56.2	57.4	94.5	94.5	94.6
	13	1+ H or 1+ P or 1+ Rx	0.49	0.48	0.49	68.6	68.2	69.0	93.0	92.9	93.0	43.8	43.4	44.1	97.4	97.3	97.4
	14	1+ H or 2+ P or 2+ Rx	0.54	0.54	0.54	59.0	58.6	59.5	96.3	96.2	96.3	56.0	55.5	56.4	96.7	96.7	96.8
3	15	1+ P	0.48	0.48	0.48	49.0	48.6	49.5	96.7	96.7	96.8	54.6	54.1	55.1	96.0	95.9	96.0
	16	2+ P	0.42	0.41	0.42	36.5	36.0	36.9	98.0	97.9	98.0	59.0	58.5	59.6	95.1	95.0	95.1
	17	1+ Rx	0.51	0.50	0.51	72.4	72.0	72.8	92.8	92.8	92.9	44.7	44.4	45.1	97.7	97.6	97.7
	18	1+ H or 1+ P	0.49	0.49	0.49	51.2	50.8	51.7	96.5	96.5	96.6	54.2	53.8	54.7	96.1	96.1	96.2
	19	1+ H or 2+ P	0.43	0.43	0.43	38.6	38.2	39.1	97.8	97.7	97.8	57.9	57.4	58.5	95.2	95.2	95.3
	20	1+ H or 1+ P or 1+ Rx	0.48	0.48	0.48	74.4	74.0	74.8	91.4	91.3	91.5	41.0	40.6	41.3	97.8	97.8	97.8
	21	1+ H or 2+ P or 2+ Rx	0.56	0.56	0.57	65.9	65.5	66.3	95.6	95.6	95.7	54.6	54.2	55.0	97.2	97.2	97.3
5	22	1+ P	0.50	0.49	0.50	60.3	59.8	60.7	94.9	94.9	95.0	48.6	48.2	49.0	96.8	96.7	96.8
	23	2+ P	0.48	0.48	0.49	48.8	48.4	49.3	96.8	96.8	96.9	55.3	54.8	55.7	95.9	95.9	96.0
	24	1+ Rx	0.48	0.47	0.48	80.6	80.3	81.0	90.1	90.0	90.2	39.4	39.1	39.7	98.3	98.3	98.3
	25	1+ H or 1+ P	0.50	0.49	0.50	61.5	61.1	62.0	94.7	94.7	94.8	48.2	47.8	48.6	96.9	96.8	96.9
	26	1+ H or 2+ P	0.48	0.48	0.49	50.1	49.7	50.6	96.6	96.6	96.7	54.3	53.8	54.7	96.0	96.0	96.1
	27	1+ H or 1+ P or 1+ Rx	0.44	0.44	0.45	84.1	83.8	84.4	87.9	87.9	88.0	35.8	35.5	36.1	98.6	98.5	98.6
	28	1+ H or 2+ P or 2+ Rx	0.55	0.55	0.56	75.1	74.7	75.5	93.8	93.7	93.8	49.1	48.7	49.4	97.9	97.9	98.0

Note: Est. = validation index point estimate; LCL = lower confidence limit; UCL = upper confidence limit

Table A.5: 95% confidence intervals for validation indices for coronary heart disease algorithms, 19+ years

# Years		Algorithm	κ			Sensitivity			Specificity			PPV			NPV		
			Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL
1	1	1+ P	0.41	0.40	0.41	35.2	34.7	35.8	98.6	98.6	98.7	55.1	54.4	55.8	96.9	96.9	97.0
	2	2+ P	0.37	0.36	0.37	28.0	27.5	28.5	99.2	99.2	99.2	62.2	61.4	63.0	96.6	96.6	96.7
	3	1+ H or 1+ P	0.42	0.41	0.42	36.4	35.9	37.0	98.6	98.5	98.6	55.1	54.4	55.8	97.0	97.0	97.0
	4	1+ H or 2+ P	0.38	0.37	0.39	29.3	28.8	29.8	99.1	99.1	99.2	61.9	61.1	62.7	96.7	96.6	96.7
	5	1+ H or 1+ P or 1+ Rx	0.23	0.23	0.24	80.8	80.4	81.3	82.0	82.0	82.1	17.8	17.6	18.0	98.9	98.9	98.9
	6	1+ H or 1+ P or 2+ Rx	0.23	0.23	0.23	74.1	73.6	74.6	83.4	83.3	83.5	17.7	17.5	17.9	98.5	98.5	98.6
	7	1+ H or 2+ P or (1 P and 2+ Rx)	0.42	0.41	0.43	35.9	35.3	36.4	98.7	98.7	98.7	57.3	56.6	58.0	97.0	96.9	97.0
2	8	1+ P	0.46	0.46	0.47	45.4	44.9	46.0	98.0	97.9	98.0	51.8	51.2	52.4	97.4	97.4	97.4
	9	2+ P	0.41	0.40	0.42	36.3	35.7	36.8	98.5	98.5	98.5	53.5	52.8	54.1	97.0	96.9	97.0
	10	1+ H or 1+ P	0.47	0.47	0.48	47.2	46.6	47.7	97.9	97.9	98.0	52.1	51.5	52.7	97.5	97.4	97.5
	11	1+ H or 2+ P	0.43	0.42	0.43	38.3	37.8	38.9	98.4	98.4	98.4	53.7	53.0	54.3	97.1	97.0	97.1
	12	1+ H or 1+ P or 1+ Rx	0.22	0.22	0.23	81.1	80.6	81.5	81.2	81.1	81.3	17.1	16.9	17.3	98.9	98.9	98.9
	13	1+ H or 1+ P or 2+ Rx	0.23	0.22	0.23	77.3	76.9	77.8	82.4	82.3	82.4	17.4	17.2	17.6	98.7	98.7	98.7
	14	1+ H or 2+ P or (1 P and 2+ Rx)	0.48	0.47	0.48	46.8	46.3	47.4	98.1	98.0	98.1	53.8	53.2	54.4	97.5	97.4	97.5
3	15	1+ P	0.48	0.47	0.48	52.2	51.6	52.7	97.3	97.2	97.3	48.0	47.5	48.6	97.7	97.7	97.7
	16	2+ P	0.44	0.43	0.44	42.9	42.4	43.5	98.0	97.9	98.0	50.2	49.6	50.8	97.3	97.2	97.3
	17	1+ H or 1+ P	0.48	0.47	0.48	54.0	53.5	54.6	97.1	97.1	97.2	47.3	46.8	47.9	97.8	97.7	97.8
	18	1+ H or 2+ P	0.45	0.44	0.45	45.2	44.6	45.7	97.8	97.7	97.8	49.2	48.6	49.8	97.4	97.3	97.4
	19	1+ H or 1+ P or 1+ Rx	0.22	0.22	0.22	82.8	82.4	83.3	80.4	80.3	80.5	16.9	16.7	17.1	99.0	99.0	99.0
	20	1+ H or 1+ P or 2+ Rx	0.22	0.22	0.22	78.8	78.3	79.2	81.6	81.6	81.7	17.1	16.9	17.3	98.8	98.7	98.8
	21	1+ H or 2+ P or (1 P and 2+ Rx)	0.49	0.48	0.49	53.6	53.0	54.1	97.3	97.3	97.4	49.1	48.6	49.7	97.8	97.7	97.8
5	22	1+ P	0.48	0.47	0.48	60.6	60.0	61.1	96.2	96.1	96.2	43.1	42.6	43.6	98.1	98.0	98.1
	23	2+ P	0.47	0.46	0.47	51.5	50.9	52.0	97.3	97.2	97.3	47.5	46.9	48.0	97.7	97.6	97.7
	24	1+ H or 1+ P	0.49	0.48	0.49	63.4	62.9	64.0	96.0	95.9	96.0	43.2	42.7	43.7	98.2	98.2	98.2
	25	1+ H or 2+ P	0.48	0.48	0.49	54.9	54.3	55.4	97.1	97.0	97.1	47.3	46.8	47.8	97.8	97.8	97.9
	26	1+ H or 1+ P or 1+ Rx	0.21	0.21	0.21	84.7	84.3	85.1	79.0	78.9	79.1	16.2	16.0	16.4	99.1	99.1	99.1
	27	1+ H or 1+ P or 2+ Rx	0.22	0.21	0.22	80.3	79.9	80.8	80.8	80.7	80.8	16.7	16.5	16.9	98.8	98.8	98.9
	28	1+ H or 2+ P or (1 P and 2+ Rx)	0.50	0.50	0.51	63.0	62.4	63.5	96.4	96.3	96.4	45.4	44.9	45.9	98.2	98.2	98.2

Note: Est. = validation index point estimate; LCL = lower confidence limit; UCL = upper confidence limit

Table A.6: 95% confidence intervals for validation indices for diabetes algorithms, 19+ years

# of Years		Algorithm	κ			Sensitivity			Specificity			PPV			NPV		
			Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL
1	1	1+P	0.78	0.78	0.79	77.6	77.2	78.1	99.0	99.0	99.0	81.0	80.6	81.4	98.8	98.8	98.8
	2	2+P	0.76	0.76	0.77	67.8	67.3	68.3	99.6	99.6	99.6	90.6	90.3	91.0	98.3	98.2	98.3
	3	1+H or 1+ P	0.79	0.78	0.79	78.8	78.4	79.2	99.0	98.9	99.0	80.7	80.3	81.2	98.8	98.8	98.9
	4	1+ H or 2+ P	0.78	0.77	0.78	69.9	69.4	70.4	99.6	99.6	99.6	90.2	89.8	90.5	98.4	98.3	98.4
	5	1+ H or 1+ P or 1+ Rx	0.83	0.83	0.84	87.6	87.2	87.9	98.9	98.9	98.9	81.1	80.7	81.5	99.3	99.3	99.3
	6	1+ H or 2+ P or 1+ Rx	0.87	0.86	0.87	85.9	85.6	86.3	99.4	99.4	99.4	89.0	88.6	89.3	99.2	99.2	99.3
	7	1+ H or 1+ P or 2+ Rx	0.84	0.83	0.84	87.4	87.1	87.8	98.9	98.9	99.0	81.8	81.4	82.2	99.3	99.3	99.3
	8	1+ H or 2+ P or 2+ Rx	0.87	0.86	0.87	85.0	84.6	85.4	99.5	99.4	99.5	89.7	89.4	90.0	99.2	99.2	99.2
2	9	1+P	0.77	0.77	0.78	84.8	84.5	85.2	98.3	98.3	98.3	73.0	72.6	73.4	99.2	99.1	99.2
	10	2+P	0.82	0.82	0.82	80.0	79.6	80.5	99.3	99.3	99.3	86.0	85.6	86.4	98.9	98.9	98.9
	11	1+H or 1+ P	0.77	0.77	0.78	85.6	85.2	86.0	98.2	98.2	98.3	72.6	72.2	73.0	99.2	99.2	99.2
	12	1+ H or 2+ P	0.83	0.82	0.83	81.9	81.5	82.3	99.2	99.2	99.3	85.3	84.9	85.7	99.0	99.0	99.0
	13	1+ H or 1+ P or 1+ Rx	0.80	0.80	0.80	92.6	92.3	92.8	98.1	98.0	98.1	72.3	71.9	72.8	99.6	99.6	99.6
	14	1+ H or 2+ P or 1+ Rx	0.86	0.86	0.86	90.0	89.6	90.3	99.0	99.0	99.1	83.6	83.2	84.0	99.4	99.4	99.5
	15	1+ H or 1+ P or 2+ Rx	0.81	0.81	0.81	92.4	92.1	92.7	98.2	98.2	98.2	73.7	73.3	74.1	99.6	99.6	99.6
	16	1+ H or 2+ P or 2+ Rx	0.87	0.86	0.87	89.5	89.2	89.8	99.2	99.1	99.2	85.5	85.1	85.8	99.4	99.4	99.4
3	17	1+P	0.76	0.75	0.76	88.1	87.8	88.5	97.8	97.8	97.8	68.7	68.2	69.1	99.3	99.3	99.4
	18	2+P	0.83	0.82	0.83	84.5	84.1	84.9	99.0	99.0	99.0	82.4	82.1	82.8	99.2	99.1	99.2
	19	1+H or 1+ P	0.76	0.76	0.76	88.9	88.5	89.2	97.8	97.7	97.8	68.3	67.9	68.8	99.4	99.4	99.4
	20	1+ H or 2+ P	0.83	0.83	0.83	86.1	85.7	86.5	99.0	98.9	99.0	82.0	81.6	82.4	99.2	99.2	99.3
	21	1+ H or 1+ P or 1+ Rx	0.77	0.77	0.78	93.4	93.1	93.6	97.6	97.5	97.6	67.8	67.4	68.2	99.6	99.6	99.6
	22	1+ H or 2+ P or 1+ Rx	0.85	0.84	0.85	91.8	91.5	92.1	98.7	98.7	98.8	79.9	79.5	80.3	99.5	99.5	99.6
	23	1+ H or 1+ P or 2+ Rx	0.78	0.78	0.78	93.2	93.0	93.5	97.7	97.7	97.7	69.0	68.6	69.4	99.6	99.6	99.6
	24	1+ H or 2+ P or 2+ Rx	0.86	0.85	0.86	91.7	91.4	92.0	98.9	98.9	98.9	81.9	81.5	82.3	99.5	99.5	99.6
5	25	1+P	0.75	0.75	0.75	91.0	90.7	91.3	97.4	97.4	97.4	65.8	65.3	66.2	99.5	99.5	99.5
	26	2+P	0.85	0.84	0.85	89.0	88.6	89.3	98.9	98.9	99.0	82.0	81.6	82.4	99.4	99.4	99.4
	27	1+H or 1+ P	0.75	0.75	0.75	91.6	91.3	91.9	97.3	97.3	97.4	65.5	65.1	65.9	99.5	99.5	99.5
	28	1+ H or 2+ P	0.84	0.84	0.85	89.6	89.3	89.9	98.9	98.9	98.9	81.4	81.0	81.8	99.4	99.4	99.4
	29	1+ H or 1+ P or 1+ Rx	0.75	0.75	0.76	94.4	94.1	94.6	97.2	97.1	97.2	64.6	64.2	65.0	99.7	99.7	99.7
	30	1+ H or 2+ P or 1+ Rx	0.84	0.84	0.85	92.7	92.5	93.0	98.6	98.6	98.7	78.9	78.5	79.2	99.6	99.6	99.6
	31	1+ H or 1+ P or 2+ Rx	0.76	0.76	0.76	94.2	94.0	94.5	97.3	97.3	97.4	65.7	65.3	66.1	99.7	99.7	99.7
	32	1+ H or 2+ P or 2+ Rx	0.85	0.85	0.86	92.6	92.3	92.9	98.8	98.8	98.8	80.8	80.4	81.2	99.6	99.6	99.6

Note: Est. = validation index point estimate; LCL = lower confidence limit; UCL = upper confidence limit

Table A.7: 95% confidence intervals for validation indices for hypertension algorithms, 19+ years

# Years		Algorithm	κ			Sensitivity			Specificity			PPV			NPV		
			Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL
1	1	1+P	0.59	0.59	0.60	56.7	56.5	57.0	96.2	96.2	96.3	81.8	81.6	82.0	88.2	88.1	88.3
	2	2+P	0.49	0.49	0.49	40.9	40.6	41.1	98.6	98.6	98.6	89.6	89.4	89.8	84.9	84.8	85.0
	3	1+H or 1+ P	0.60	0.60	0.60	57.8	57.5	58.0	96.2	96.1	96.2	81.7	81.5	81.9	88.4	88.4	88.5
	4	1+ H or 2+ P	0.50	0.50	0.50	42.5	42.2	42.7	98.5	98.5	98.5	89.3	89.1	89.5	85.2	85.1	85.3
	5	1+ H or 1+ P or 1+ Rx	0.70	0.70	0.70	78.5	78.3	78.8	92.4	92.4	92.5	75.5	75.3	75.7	93.5	93.5	93.6
	6	1+ H or 1+ P or 2+ Rx	0.70	0.70	0.71	77.5	77.3	77.7	93.1	93.1	93.2	77.0	76.8	77.2	93.3	93.2	93.4
	7	1+H or 1+P or(1+P and 2+Rx)	0.61	0.61	0.61	55.9	55.7	56.2	97.4	97.4	97.5	86.5	86.3	86.7	88.1	88.1	88.2
2	8	1+P	0.63	0.63	0.64	68.6	68.4	68.8	93.0	93.0	93.1	74.5	74.3	74.8	90.9	90.8	91.0
	9	2+P	0.59	0.59	0.60	55.1	54.8	55.3	97.0	96.9	97.0	84.4	84.1	84.6	87.9	87.8	88.0
	10	1+H or 1+ P	0.64	0.64	0.64	69.9	69.6	70.1	92.8	92.7	92.8	74.1	73.9	74.4	91.2	91.1	91.3
	11	1+ H or 2+ P	0.60	0.60	0.60	56.7	56.4	56.9	96.7	96.6	96.7	83.5	83.3	83.7	88.2	88.2	88.3
	12	1+ H or 1+ P or 1+ Rx	0.66	0.66	0.66	81.4	81.2	81.6	89.1	89.0	89.2	68.9	68.7	69.1	94.1	94.1	94.2
	13	1+ H or 1+ P or 2+ Rx	0.67	0.67	0.68	80.9	80.7	81.1	90.0	89.9	90.1	70.6	70.4	70.9	94.1	94.0	94.1
	14	1+H or 2+P or(1+P and 2+Rx)	0.67	0.67	0.68	67.8	67.6	68.0	95.6	95.5	95.6	82.0	81.8	82.2	90.9	90.8	91.0
3	15	1+P	0.63	0.62	0.63	73.2	73.0	73.4	90.6	90.5	90.6	69.7	69.5	69.9	91.9	91.8	92.0
	16	2+P	0.64	0.64	0.64	64.3	64.1	64.6	95.2	95.1	95.2	79.9	79.6	80.1	90.0	89.9	90.1
	17	1+H or 1+ P	0.63	0.63	0.64	74.5	74.2	74.7	90.4	90.3	90.4	69.7	69.5	69.9	92.2	92.2	92.3
	18	1+ H or 2+ P	0.65	0.64	0.65	65.9	65.7	66.1	94.9	94.9	95.0	79.4	79.2	79.6	90.4	90.3	90.4
	19	1+ H or 1+ P or 1+ Rx	0.63	0.63	0.63	82.3	82.1	82.5	86.7	86.6	86.8	64.9	64.6	65.1	94.3	94.2	94.3
	20	1+ H or 1+ P or 2+ Rx	0.65	0.65	0.65	81.9	81.7	82.1	88.0	87.9	88.0	66.9	66.7	67.1	94.2	94.2	94.3
	21	1+H or 2+P or(1+P and 2+Rx)	0.68	0.68	0.68	73.0	72.8	73.2	93.7	93.6	93.8	77.5	77.3	77.7	92.1	92.0	92.2
5	22	1+P	0.64	0.64	0.64	78.4	78.2	78.6	89.1	89.0	89.1	68.0	67.8	68.3	93.3	93.2	93.3
	23	2+P	0.67	0.66	0.67	70.7	70.4	70.9	93.9	93.8	93.9	77.4	77.2	77.6	91.5	91.4	91.6
	24	1+H or 1+ P	0.65	0.65	0.65	79.8	79.6	80.0	88.9	88.8	89.0	68.1	67.9	68.3	93.7	93.6	93.7
	25	1+ H or 2+ P	0.67	0.67	0.68	72.3	72.1	72.5	93.7	93.6	93.7	77.2	77.0	77.4	91.9	91.8	92.0
	26	1+ H or 1+ P or 1+ Rx	0.61	0.61	0.61	84.2	84.0	84.4	84.4	84.3	84.5	61.6	61.4	61.8	94.7	94.7	94.8
	27	1+ H or 1+ P or 2+ Rx	0.63	0.63	0.63	83.7	83.5	83.9	86.1	86.0	86.2	64.2	64.0	64.4	94.7	94.6	94.7
	28	1+H or 2+P or(1+P and 2+Rx)	0.70	0.70	0.70	77.4	77.2	77.6	92.8	92.7	92.9	76.1	75.9	76.4	93.2	93.2	93.3

Note: Est. = validation index point estimate; LCL = lower confidence limit; UCL = upper confidence limit

Table A.8: 95% confidence intervals for validation indices for stroke algorithms, 19+ years

# of Years		Algorithms	κ			Sensitivity			Specificity			PPV			NPV		
			Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL
1	1	1+H	0.01	0.01	0.01	0.6	0.4	0.7	100.0	100.0	100.0	19.8	15.2	24.5	98.5	98.5	98.6
	2	1+P	0.25	0.24	0.26	24.3	23.5	25.1	99.1	99.1	99.1	28.5	27.6	29.5	98.9	98.8	98.9
	3	2+ P	0.26	0.25	0.27	20.0	19.2	20.8	99.6	99.5	99.6	40.0	38.6	41.3	98.8	98.8	98.8
	4	1+ H or 1+ P	0.25	0.24	0.26	24.3	23.5	25.1	99.1	99.1	99.1	28.2	27.2	29.1	98.9	98.8	98.9
	5	1+ H or 1+ P or 1+ Rx	0.29	0.28	0.29	63.1	62.1	64.1	96.2	96.2	96.3	20.0	19.6	20.5	99.4	99.4	99.4
	6	1+H or 2+P or (1 P & 2+ Rx)	0.29	0.28	0.30	23.6	22.7	24.4	99.5	99.5	99.5	40.5	39.2	41.7	98.9	98.8	98.9
2	7	1+H	0.12	0.11	0.13	6.8	6.3	7.3	99.9	99.9	99.9	55.4	52.6	58.1	98.6	98.6	98.7
	8	1+P	0.35	0.34	0.36	39.3	38.3	40.3	98.8	98.8	98.8	33.0	32.2	33.9	99.1	99.1	99.1
	9	2+ P	0.41	0.40	0.42	35.7	34.8	36.7	99.5	99.5	99.5	50.7	49.5	51.9	99.0	99.0	99.1
	10	1+ H or 1+ P	0.35	0.34	0.36	39.7	38.7	40.7	98.8	98.8	98.8	32.7	31.9	33.5	99.1	99.1	99.1
	11	1+ H or 1+ P or 1+ Rx	0.26	0.25	0.26	65.2	64.3	66.2	95.3	95.3	95.4	17.3	16.9	17.6	99.5	99.4	99.5
	12	1+H or 2+P or (1 P & 2+ Rx)	0.42	0.41	0.43	39.3	38.4	40.3	99.3	99.3	99.3	46.3	45.3	47.4	99.1	99.1	99.1
3	13	1+H	0.21	0.20	0.22	13.4	12.7	14.0	99.8	99.8	99.8	52.4	50.5	54.4	98.7	98.7	98.7
	14	1+P	0.38	0.37	0.39	48.0	47.0	49.0	98.6	98.5	98.6	33.2	32.4	33.9	99.2	99.2	99.2
	15	2+ P	0.42	0.41	0.43	39.5	38.6	40.5	99.3	99.3	99.3	45.8	44.7	46.8	99.1	99.1	99.1
	16	1+ H or 1+ P	0.38	0.37	0.39	48.6	47.6	49.6	98.5	98.5	98.5	32.8	32.0	33.5	99.2	99.2	99.2
	17	1+ H or 1+ P or 1+ Rx	0.23	0.23	0.24	65.2	64.3	66.2	94.7	94.7	94.8	15.6	15.2	15.9	99.5	99.4	99.5
	18	1+H or 2+P or (1 P & 2+ Rx)	0.46	0.45	0.46	48.2	47.2	49.2	99.1	99.1	99.1	44.7	43.8	45.7	99.2	99.2	99.2
5	19	1+H	0.31	0.30	0.32	22.6	21.7	23.4	99.7	99.7	99.7	54.3	52.8	55.8	98.9	98.8	98.9
	20	1+P	0.36	0.35	0.37	52.4	51.4	53.4	98.1	98.0	98.1	28.7	28.0	29.4	99.3	99.3	99.3
	21	2+ P	0.40	0.39	0.41	43.1	42.1	44.1	99.0	99.0	99.0	39.0	38.1	40.0	99.1	99.1	99.2
	22	1+ H or 1+ P	0.37	0.37	0.38	56.1	55.1	57.1	98.0	98.0	98.0	29.5	28.9	30.2	99.3	99.3	99.4
	23	1+ H or 1+ P or 1+ Rx	0.22	0.21	0.22	68.6	67.7	69.5	93.8	93.7	93.8	14.2	13.8	14.5	99.5	99.5	99.5
	24	1+H or 2+P or (1 P & 2+ Rx)	0.45	0.44	0.45	55.7	54.7	56.7	98.7	98.6	98.7	38.6	37.8	39.4	99.3	99.3	99.4

Note: Est. = validation index point estimate; LCL = lower confidence limit; UCL = upper confidence limit

Table A.9: 95% confidence intervals for validation indices for irritable bowel syndrome algorithms, 19+ years

# of Years		Algorithm	κ			Sensitivity			Specificity			PPV			NPV		
			Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL	Est.	LCL	UCL
1	1	1+H or 1+P	0.11	0.11	0.12	9.3	8.9	9.7	98.9	98.9	98.9	21.2	20.4	22.0	97.2	97.1	97.2
	2	1+H or 2+P	0.05	0.05	0.06	3.5	3.3	3.8	99.6	99.6	99.6	22.1	20.7	23.5	97.0	97.0	97.1
	3	1+H or 3+P	0.04	0.03	0.04	2.2	2.0	2.4	99.9	99.9	99.9	36.5	33.8	39.2	97.0	96.9	97.0
	4	1+H or 4+P	0.03	0.02	0.03	1.4	1.2	1.5	100.0	100.0	100.0	70.3	65.8	74.8	97.0	96.9	97.0
	5	1+H or 5+P	0.00	0.00	0.00	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	96.9	96.9	97.0
2	6	1+H or 1+P	0.20	0.20	0.21	19.8	19.3	20.4	98.2	98.2	98.2	25.7	25.0	26.4	97.5	97.4	97.5
	7	1+H or 2+P	0.06	0.06	0.07	4.7	4.4	5.0	99.4	99.3	99.4	18.9	17.8	19.9	97.1	97.0	97.1
	8	1+H or 3+P	0.06	0.05	0.06	3.6	3.4	3.9	99.7	99.7	99.7	28.7	27.0	30.5	97.0	97.0	97.1
	9	1+H or 4+P	0.03	0.03	0.04	2.0	1.8	2.2	99.9	99.8	99.9	30.2	27.7	32.6	97.0	96.9	97.0
	10	1+H or 5+P	0.01	0.01	0.01	0.6	0.5	0.7	99.9	99.9	99.9	20.4	17.3	23.5	96.9	96.9	97.0
3	11	1+H or 1+P	0.22	0.22	0.23	25.6	25.0	26.2	97.4	97.4	97.5	24.0	23.4	24.6	97.6	97.6	97.7
	12	1+H or 2+P	0.13	0.13	0.14	9.8	9.4	10.2	99.2	99.2	99.2	28.1	27.0	29.1	97.2	97.2	97.2
	13	1+H or 3+P	0.11	0.10	0.11	6.6	6.3	7.0	99.7	99.7	99.7	41.4	39.7	43.1	97.1	97.1	97.2
	14	1+H or 4+P	0.07	0.06	0.07	3.9	3.7	4.2	99.8	99.8	99.9	45.2	42.9	47.5	97.0	97.0	97.1
	15	1+H or 5+P	0.02	0.01	0.02	0.9	0.8	1.1	99.9	99.9	99.9	26.0	22.9	29.2	97.0	96.9	97.0
5	16	1+H or 1+P	0.22	0.21	0.22	33.7	33.0	34.3	95.7	95.6	95.7	19.8	19.4	20.2	97.9	97.8	97.9
	17	1+H or 2+P	0.24	0.23	0.24	22.5	21.9	23.1	98.3	98.3	98.3	29.8	29.0	30.5	97.6	97.5	97.6
	18	1+H or 3+P	0.22	0.21	0.22	15.9	15.4	16.4	99.3	99.3	99.3	42.2	41.1	43.3	97.4	97.3	97.4
	19	1+H or 4+P	0.21	0.20	0.21	13.2	12.7	13.7	99.7	99.7	99.7	58.7	57.3	60.1	97.3	97.3	97.4
	20	1+H or 5+P	0.06	0.05	0.06	3.3	3.1	3.6	99.9	99.9	99.9	45.8	43.3	48.4	97.0	97.0	97.1

Note: Est. = validation index point estimate; LCL = lower confidence limit; UCL = upper confidence limit