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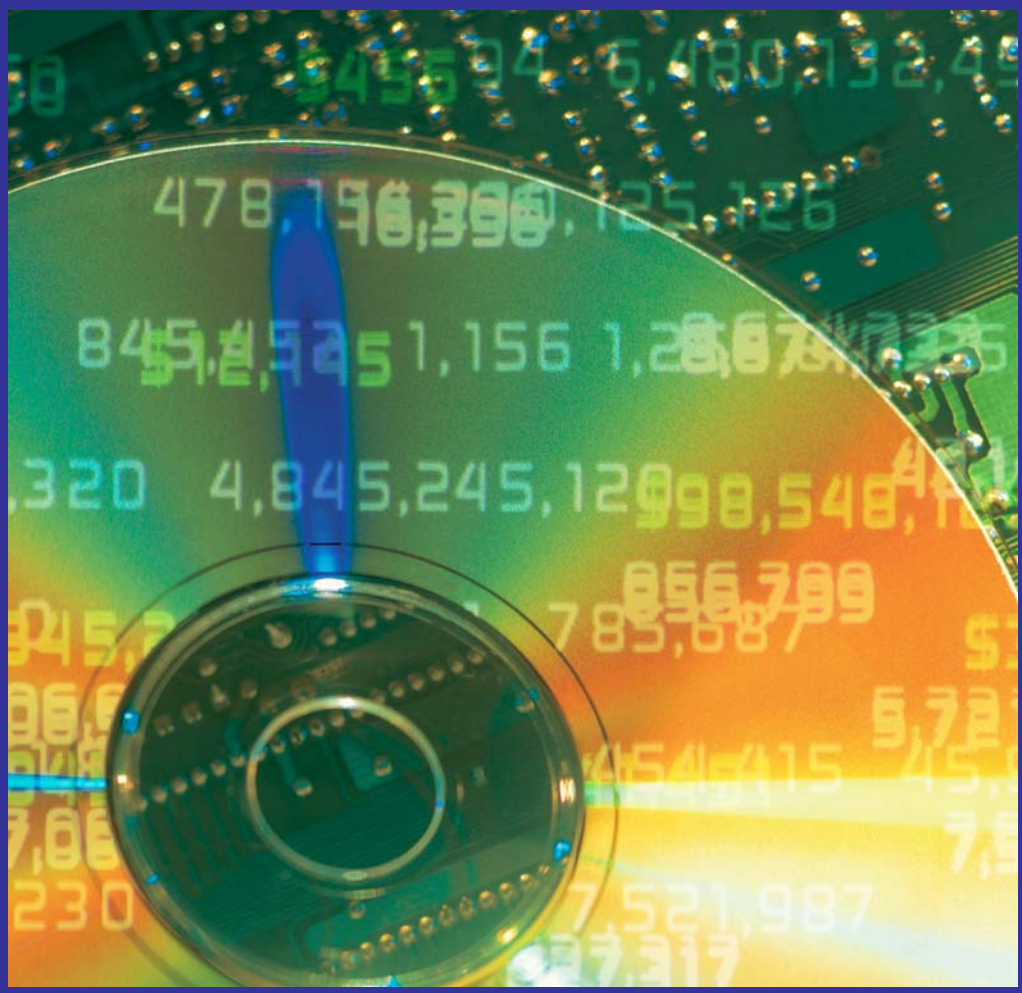
Canadian Institute for Health Information Discharge Abstract Database: A Validation Study



ICES Investigative Report

June 2006

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About ICES

Ontario's resource for informed health care decision-making

The Institute for Clinical Evaluative Sciences (ICES) is an independent, non-profit organization that conducts research on a broad range of topical issues to enhance the effectiveness of health care for Ontarians. Internationally recognized for its innovative use of population-based health information, ICES knowledge provides evidence to support health policy development and changes to the organization and delivery of health care services.

Unbiased ICES evidence provides fact-based measures of health system performance; a clearer understanding of the shifting health care needs of Ontarians; and a stimulus for discussion of practical solutions to optimize scarce resources.

Key to ICES' research is our ability to link anonymous population-based health information on an individual patient basis, using unique encrypted identifiers that ensure privacy and confidentiality. This allows scientists to obtain a more comprehensive view of specific health care issues than would otherwise be possible. Linked databases reflecting 12 million of 30 million Canadians allow researchers to follow patient populations through diagnosis and treatment, and to evaluate outcomes.

ICES brings together the best and the brightest talent under one roof. Many of our faculty are not only internationally recognized leaders in their fields, but are also practising clinicians who understand the grassroots of health care delivery, making ICES knowledge clinically-focused and useful in changing practice. Other team members have statistical training, epidemiological backgrounds, project management or communications expertise. The variety of skill sets and educational backgrounds ensures a multi-disciplinary approach to issues management and creates a real-world mosaic of perspectives that is vital to shaping Ontario's future health care.

ICES collaborates with experts from a diverse network of institutions, government agencies, professional organizations and patient groups to ensure research and policy relevance.

Contents

Executive Summary

The Ontario Ministry of Health and Long-Term Care (MOHLTC), the Canadian Institute for Health Information (CIHI), and CHIM Information Consulting Inc. (CHIM) jointly conducted a reabstraction study to review the clinical coding practices of Ontario's ten case costing hospital corporations. This is the largest reabstraction study ever conducted in Canada, and among the largest studies ever conducted internationally. Approximately 14,500 discharges were reabstracted from the 18 hospital sites for the 2002/03 and 2003/04 fiscal years.

A report jointly produced by the MOHLTC / CIHI / CHIM describes the general findings of the reabstraction study. To further explore the accuracy of coding at case costing facilities, we conducted a detailed assessment of agreement for common diagnoses and procedures using the same data.

We found that some data elements were coded with a high degree of accuracy. Demographic data and, with a few exceptions, most procedures (e.g., operations, imaging, endoscopy and biopsy, and procedures relating to childbirth) were very well coded, with high sensitivity and often near-perfect specificity. The quality of diagnosis coding, however, was considerably more variable.

The m*ost responsible diagnosis* (the one diagnosis accountable for the greatest portion of the length of stay or greatest use of resources) tended to be well coded overall, although some diagnoses were far better coded than others. Conversely, coding of comorbid diagnoses—those present prior to admission (Type 1 diagnoses) or those developing in hospital (Type 2 diagnoses)—was frequently very poor. For example, for roughly half of all Type 1 and 2 diagnoses, no agreement was evident between the trained reabstractor and the original record, even though agreement was defined broadly, using the first three characters of the diagnosis code.

We also found that several facilities exhibited relatively high sensitivity and consistency in the coding of these relatively common conditions, but one hospital exhibited considerably lower sensitivity. In addition, comorbidity coding was highly dependent on the disorder in question. Myocardial infarction and peptic ulcer were relatively well coded, but most other disorders were coded in a poor and highly variable fashion.

Two important interpretive cautions are warranted regarding these findings. First, the reabstraction study involves the 10 hospital corporations (18 facilities) participating in the Ontario Case Costing Initiative (OCCI), and although this represents a sizeable portion of Ontario's data within the Discharge Abstract Database (DAD), the generalizability of our findings to other facilities in Ontario and across Canada is unknown. Second, for all analyses of sensitivity, specificity, etc., we deemed the CIHI-trained reabstractor as the reference standard. However, even trained reabstractors may disagree regarding a specific diagnosis, particularly when documentation in the medical record is suboptimal. Indeed, as part of the reabstraction study, approximately 800 charts were reabstracted twice to explore inter-rater agreement. Despite the intuitive assumption that agreement between trained reabstractors would be better, on average, than agreement with the original CIHI record, this was not the case for many diagnoses. As such, the reabstracted record cannot be considered as a 'gold standard'.

In conclusion, our analysis documents strengths and weaknesses of coding practices at OCCI facilities. The results highlight the need for caution among health services researchers and policy makers who use CIHI data; the importance of initiatives to improve data quality in Ontario; and, the need for periodic reassessment of data quality.

Introduction

High quality administrative data are essential to policy makers and health services researchers. By their nature, however, administrative data are imperfect and can be improved. Much of the research conducted at the Institute for Clinical Evaluative Sciences (ICES) relies heavily on the Canadian Institute for Health Information (CIHI) Discharge Abstract Database (DAD), which contains detailed clinical, demographic, and administrative data for hospital admissions and day surgeries throughout Canada. Recently, concern has surfaced about the accuracy of data recorded in the DAD.[1]

As part of the Ontario Case Costing Initiative (OCCI), trained chart abstractors have performed detailed chart abstractions on a sample of approximately 14,500 admission records from 18 hospital sites between April 1, 2002 and March 31, 2004. An as-yet unpublished analysis conducted jointly by the Ontario Ministry of Health and Long-Term Care (MOHLTC) and CIHI describes this exercise in considerable detail, and provides valuable insights into certain aspects of agreement within the OCCI.

Among the main findings of this report were:

- Agreement was excellent (in excess of 97%) for nonmedical information, such as demographic data.
- An overall 85% exact match was found on diagnosis codes across both fiscal years of the project.
- Major reasons for discrepancies between the original and reabstracted records included:
  a) overlooking information on the chart;
  b) different interpretation of the same documentation;
  c) incomplete documentation at the time of original abstraction;
  d) inconsistent or conflicting documentation on the paper chart ; and,
  e) existence of documentation that supported selection of more (or less) specific codes.
- About 20% of diagnoses originally deemed to significantly contribute to length of stay or resources used during the visit were deemed nonsignificant by the reabstractor.
- Hospitals that participated in the OCCI exhibit differential coding practices, particularly with regard to the assignment of significance (as noted above) and diagnosis type. The latter had a substantial influence on complexity assignment.
- Agreement was a function of the complexity of a given case. In general, agreement was very good for less complex cases, but considerably poorer for more complex cases.

Objectives

The purpose of this work is to explore in detail the extent to which the diagnostic and procedural information contained in the original records of the Discharge Abstract Database agree with data collected by trained reabstractors. This builds upon the previously noted reabstraction study by:

1. Providing additional data on agreement for individual diagnoses.
2. Providing additional data on agreement for common procedures.
3. Examining specific instances in which agreement might influence the interpretation of studies conducted at ICES.
4. Examining the extent to which coding of common comorbidities varies among facilities.

While the Case Costing Study used a stratified random sample design and presented data using sample weights, our analyses are performed using unweighted (raw) data for two reasons. First, unweighted data are easily interpreted, and readers can draw inferences about how stable (or unstable) an estimate might be based upon the sample size involved. For instance, a conclusion such as Positive Predictive Value (PPV) based upon 10 occurrences of a particular diagnosis or procedure is more prone to instability than a conclusion based on 100 occurrences. Second, by using raw data, tests of statistical significance (p values and 95% confidence intervals) are constructed using the actual data rather than weighted values, which are typically much larger. Had weighted estimates been used instead, inappropriately high levels of statistical significance would have been afforded to our conclusions.

As a consequence of using unweighted data, some analyses in this document may yield slightly different results than outwardly similar comparisons contained in the Ministry of Health and Long-Term Care—Canadian Institute for Health Information report.

Overview

This section provides information on the terminology used in this report relating to health data, coding practices, and inter-rater reliability.

Discharge Abstract Database

The Discharge Abstract Database (DAD) contains data on inpatient hospital discharges across Canada, supplied to Canadian Institute for Health Information (CIHI) from participating hospitals. The DAD contains demographic, administrative and clinical data for hospital discharges (inpatient acute, chronic, rehabilitation) and day surgeries.

In addition to clinical information, the DAD contains some nonmedical data elements related to demographic and administrative information for each separation.

Diagnoses

Diagnosis coding

Diagnosis coding refers to the practice of reviewing a patient's chart to identify pertinent health information and reporting it in a standardized format. Generally performed by health information professionals, the diagnostic information contained in the patient chart is assigned diagnosis codes using the International Classification of Diseases and Related Health Problems - Tenth Revision, Canada (ICD-10-CA). ICD-10 is developed and maintained by the World Health Organization; CIHI is charged with ensuring that the version is appropriate for Canadian use through the development and maintenance of enhancements for morbidity coding in Canada.

Diagnosis typing

Diagnosis typing is used to indicate the relationship of a diagnosis to the patient's stay in a hospital. A diagnosis type is required for every ICD-10-CA code collected on the DAD abstract. The purpose of typing is to differentiate conditions that influence the patient's length of stay and/or resource intensity from those that do not. Typing also flags significant conditions that either coexist at the time of admission (pre-admit comorbidity) or develop subsequently in hospital (post-admit comorbidity). Some common diagnoses types are described below.

Type M: Most responsible diagnosis (MRDx)—This refers to the one diagnosis or condition that is accountable for the greatest portion of the length of stay or greatest use of resources. It is not necessarily the diagnosis or condition for which the patient sought care.

Type 1: Pre-admit comorbidity—This refers to conditions that exist prior to admission and satisfy the requirements for determining comorbidity. Selection of a condition as a Type 1 depends on whether it satisfies the requirements of significance (see below), according to diagnosis typing definitions.

Type 2: Post-admit comorbidity—Conditions that arise following admission and satisfy the requirements for determining comorbidity. Selection of a condition as a Type 2 depends on whether it satisfies the requirements of significant, according to diagnosis typing definitions. A post-admission can also be a MRDx; for example, when a stroke occurs following elective surgery and becomes the dominant reason for a prolonged hospital stay.

Type 3: Secondary diagnosis—Conditions for which a patient may or may not receive treatment and does not satisfy the requirements for determining comorbidity.

Type 9: External cause / place / activity—Analogous to E codes in the ICD-9 system, Type 9 is applicable to External Causes of Morbidity and Mortality, and a Type 9 diagnosis is mandatory with codes attributable to injury.

Types W, X, and Y: Service transfer diagnoses—These refer to ICD-10-CA diagnosis codes associated with first / second / third patient service transfers.

For the purposes of diagnosis typing, **significant comorbidities** are all conditions that exist at the time of admission or develop subsequently *and* demonstrate *at least one of* the following:

- Significantly influences the treatment received;
- Requires treatment beyond maintenance of the pre-existing condition; and,
- Increases the length of stay by at least 24 hours.

It is important to note that the documentation of ongoing medication for treatment of a pre-existing condition does not in itself denote significance. If coded, conditions not qualifying as significant comorbidities should be classified as diagnosis Type 3.

Intervention codes and attributes

Intervention data are coded using the Canadian Classification of Health Interventions (CCI). CCI was developed by CIHI to complement ICD-10-CA and is the national standard for inpatient coding. CCI has an expanded scope to encompass a broad spectrum of interventions to meet the needs across the continuum of health services in Canada. Interventions are grouped largely into therapeutic, diagnostic, and obstetrical, in addition to other interventions.

Attributes are separate data elements that provide additional detail about an intervention. Attributes are related to the intervention code and include: status (e.g., the circumstance under which the procedure was performed), location (e.g., operating room, emergency department, etc.), extent, and mode of delivery. While most attributes are optional for DAD submission, some interventions have mandatory attributes.

Measures of agreement

Several common measures of agreement are used throughout this report. For descriptive purposes, the trained reabstractor is identified as the *reference standard*, and most analyses derive from the following general scheme:

		Reabstracted Chart		
		Diagnosis Present & Significant/Mandatory	**Diagnosis Absent & Significant/Mandatory**	**TOTAL**
Original Chart	**Diagnosis Present & Significant/Mandatory**	A	B	**A+B**
	Diagnosis Absent & Significant/Mandatory	C	D	**C+D**
	TOTAL	**A+C**	**B+D**	**A+B+C+D**

The following standard definitions are used widely throughout this report:

Sensitivity

- The proportion of all records in which a diagnosis or procedure is present (i.e., defined by reabstractor) and identified as such by the original CIHI record.
- A ÷ (A + C)

Specificity

- The proportion of all records in which a diagnosis or a procedure is NOT present (defined by reabstractor) but was identified as present by the original CIHI record. In most instances, because

the original and reabstracted records agree that a diagnosis or procedure is not present (i.e., cell D dominates B), specificity tends to be very high and as such is generally suppressed.
- D ÷ (B + D)

Positive predictive value
- The proportion of all records in which a diagnosis or a procedure is identified as present (as defined by the original CIHI record) that are also identified as such by the reabstractor.
- A ÷ (A + B)

Negative predictive value
- The proportion of all records in which a diagnosis or a procedure is identified as NOT present (as defined by the original CIHI record) that are also identified as such by the reabstractor.
- D ÷ (C + D)

Kappa
- A measure of the extent of agreement, after correcting for agreement that might occur by chance alone.[2,3]

Kappa Value*	Degree of Agreement Beyond Chance
0	None
0.01 to 0.20	Slight
0.21 to 0.40	Fair
0.41 to 0.60	Moderate
0.61 to 0.80	Substantial
0.81 to 1.00	Almost perfect

(* While uncommon, kappa values < 0 are mathematically possible).

- It should be noted that the characterization of agreement as slight, fair, etc. in the table above applies only to the kappa statistic and not to other measures such as sensitivity, specificity, etc. In many instances, sensitivity and positive predictive value are more meaningful indicators of the utility of a particular diagnosis code than the kappa statistic.

It should be noted that all of the calculations described above are performed only on conditions that were abstracted (i.e., that met the criteria for significance, as determined by the coders). Throughout the report, 95% confidence intervals (for proportions or the kappa statistic) are also presented, and are calculated using standard methods.

Chapter 1—Agreement Between the CIHI DAD and Reabstractors

Introduction

These analyses will examine the concordance between the original Canadian Institute for Health Information (CIHI) record and reabstracted record in three spheres (demographics, diagnosis codes and interventions) using standard measures of agreement.

Agreement on demographic variables

As a prelude to the main analyses, we undertook an assessment of the extent of agreement between the original coder and reabstractor on selected nonmedical data elements in the Ontario Case Costing Initiative (OCCI) dataset. These are outlined in the table below. As expected, and consistent with the findings of the CIHI-Ministry of Health and Long-Term Care (MOHLTC) study, agreement on demographic data within the CIHI Discharge Abstract Database (DAD) is uniformly excellent.

Table 1.1 Agreement on demographic variables

Variable	Exact Match (n, %) (Total = 13,803)
Gender	13,803 (100)
Birthdate	13,799 (99.9)
Health card number	13,778 (99.8)
Admission date	13,794 (99.9)
Discharge date	13,792 (99.9)
Total length of stay	13,786 (99.9)
Admission category	13,655 (98.9)

We also examined agreement concerning interfacility transfer of patients when either the original or the reabstracted record indicated that a transfer took place (total n = 3,168). *Institution to* and *Institution to type* denote the receiving facility and its type (e.g., acute care hospital, long-term care facility, etc.), while *Institution from* and *Institution from type* denote the same for the hospital of origin.

Table 1.2 Agreement on Interfacility transfers

Variable	Agreement (Total = 3,168)
Institution from	3,025 (95.4%)
Institution from type	3,013 (95.1%)
Institution to	3,009 (95.0%)
Institution to type	3,018 (95.2%)

As expected, these findings suggest that the CIHI DAD is highly reliable with regard to important nonclinical data elements.

Agreement on diagnosis and related fields

We conducted a variety of analyses on agreement for most common diagnoses in the OCCI dataset. We did not undertake formal statistical tests of diagnostic agreement for uncommon conditions because these were sufficiently infrequent to render such analyses imprecise and difficult to interpret.

For each illness, we present several measures of agreement using the reabstractor as the reference standard. This approach has some limitations, however, in light of a validation exercise conducted on approximately 800 charts (roughly 5% of charts collected at each facility) by MOHLTC/CIHI. This exercise, described in detail in the report, found that trained reabstractors do not themselves agree on diagnosis codes or diagnosis types in many instances. As such, they cannot be considered a 'gold standard', and in the analyses that follow they are considered as the reference standard for illustrative purposes only.

When presenting measures of agreement for individual diagnoses or procedures, we have suppressed information regarding specificity and negative predictive value from the tables. This is because in virtually all instances, these parameters are both high (usually in excess of 0.95) and precise, since most charts in the dataset do not contain the diagnosis or a procedure in question. As a result, the 2 x 2 agreement tables are invariably weighted toward the null cell (cell D) for both the original coder and the trained reabstractor.

Agreement on most responsible diagnosis

The most responsible diagnosis (MRDx) is the diagnosis that contributes to the greatest extent to the length of stay in hospital, and may or may not be the original reason for admission.

Of the 13,803 instances where a diagnosis type of M (indicating MRDx) was coded by the original coder, 9,328 (67.6%) agreed on the exact diagnosis code while another 1,301 (9.4%) agreed on the first three characters of the diagnosis code assigned by the reabstractor. In 1,153 instances (8.4%), the reabstractor identified the code of interest but categorized it as another diagnosis type, generally as Type 1 (n=869), Type 2 (n=105), or Type 3 (n=143). In 2,021 cases (14.6%), the reabstractor did not identify the first three characters of the original diagnosis code as any diagnosis type. These findings indicate that the reabstractor agreed at least in part with the original coder regarding the MRDx about 85% of the time.

The table below provides some common measures of agreement for the 50 most common diagnoses in the OCCI dataset, from most common to least common (according to the original record), using only the first three characters of the diagnosis code.

Table 1.3 Agreement for the Top 50 most responsible diagnosis codes

Dx Code (First 3 characters)	Diagnosis	N	Kappa	Sens (95% CI)	PPV (95% CI)
I25	Chronic ischaemic heart disease	686	0.86 (0.85 to 0.88)	0.83 (0.80 to 0.85)	0.92 (0.90 to 0.94)
I21	Acute myocardial infarction	564	0.87 (0.85 to 0.90)	0.89 (0.86 to 0.92)	0.87 (0.83 to 0.89)
I50	Heart failure	448	0.82 (0.79 to 0.84)	0.79 (0.75 to 0.83)	0.85 (0.82 to 0.89)
J18	Pneumonia, organism unspecified	361	0.73 (0.70 to 0.77)	0.80 (0.75 to 0.85)	0.69 (0.64 to 0.73)
S72	Fracture of femur	356	0.95 (0.94 to 0.97)	0.95 (0.93 to 0.97)	0.95 (0.92 to 0.97)
J44	COPD	349	0.78 (0.75 to 0.81)	0.68 (0.64 to 0.72)	0.94 (0.91 to 0.96)
Z51	Other medical care	280	0.64 (0.59 to 0.68)	0.63 (0.57 to 0.68)	0.66 (0.61 to 0.72)
J96	Respiratory failure NEC	238	0.61 (0.55 to 0.67)	0.79 (0.72 to 0.85)	0.50 (0.44 to 0.57)
I63	Cerebral infarction	208	0.81 (0.77 to 0.85)	0.76 (0.70 to 0.81)	0.87 (0.82 to 0.91)
C34	Malignant neoplasm of bronchus and lung	205	0.76 (0.71 to 0.81)	0.87 (0.80 to 0.91)	0.69 (0.62 to 0.75)
E11	Type 2 Diabetes mellitus	162	0.66 (0.61 to 0.72)	0.57 (0.50 to 0.64)	0.80 (0.73 to 0.86)
P07	Disorders related to short gestation and low birth weight NEC	158	0.91 (0.87 to 0.94)	0.93 (0.87 to 0.96)	0.89 (0.83 to 0.93)
M17	Arthrosis of the knee	157	0.95 (0.93 to 0.98)	0.95 (0.90 to 0.98)	0.96 (0.91 to 0.98)
A41	Other septicaemia	156	0.66 (0.59 to 0.72)	0.69 (0.61 to 0.76)	0.63 (0.55 to 0.71)
I20	Angina pectoris	155	0.63 (0.56 to 0.70)	0.82 (0.73 to 0.89)	0.52 (0.43 to 0.60)
C79	Secondary malignant neoplasm of other sites	154	0.69 (0.64 to 0.75)	0.62 (0.55 to 0.69)	0.79 (0.71 to 0.85)
C18	Malignant neoplasm of colon	149	0.87 (0.83 to 0.91)	0.88 (0.82 to 0.93)	0.86 (0.79 to 0.91)
I64	Stroke, not specified as haemorrhage or infarction	139	0.74 (0.68 to 0.80)	0.81 (0.73 to 0.88)	0.69 (0.61 to 0.77)

Dx Code (First 3 characters)	Diagnosis	N	Kappa	Sens (95% CI)	PPV (95% CI)
C78	Secondary malignant neoplasm of respiratory and digestive organs	134	0.68 (0.62 to 0.75)	0.66 (0.57 to 0.73)	0.72 (0.63 to 0.79)
T81	Complications of procedures, NEC	122	0.69 (0.62 to 0.75)	0.63 (0.55 to 0.71)	0.75 (0.67 to 0.83)
K56	Paralytic ileus and intestinal obstruction without hernia	119	0.73 (0.67 to 0.79)	0.69 (0.60 to 0.77)	0.78 (0.70 to 0.85)
M16	Coxarthrosis [arthrosis of hip]	114	0.94 (0.90 to 0.97)	0.92 (0.85 to 0.96)	0.96 (0.90 to 0.99)
O70	Perineal laceration during delivery	113	0.81 (0.75 to 0.86)	0.86 (0.78 to 0.92)	0.76 (0.67 to 0.84)
Z38	Liveborn infants according to place of birth	113	0.94 (0.91 to 0.97)	0.88 (0.81 to 0.93)	1.00 (0.97 to 1.00)
N39	Other disorders of urinary system	111	0.79 (0.73 to 0.85)	0.81 (0.72 to 0.88)	0.77 (0.69 to 0.85)
I48	Atrial fibrillation and flutter	97	0.85 (0.79 to 0.90)	0.87 (0.78 to 0.93)	0.82 (0.73 to 0.89)
I71	Aortic aneurysm and dissection	95	0.94 (0.90 to 0.97)	0.94 (0.87 to 0.98)	0.94 (0.87 to 0.98)
I35	Nonrheumatic aortic valve disorders	92	0.87(0.82 to 0.92)	0.89 (0.80 to 0.94)	0.86 (0.77 to 0.92)
T84	Complications of internal orthopaedic prosthetic devices, implants and grafts	91	0.88 (0.84 to 0.93)	0.85 (0.76 to 0.91)	0.92 (0.85 to 0.97)
K57	Diverticular disease of intestine	89	0.84 (0.78 to 0.90)	0.82 (0.73 to 0.89)	0.87 (0.78 to 0.93)
J69	Pneumonitis due to solids and liquids	87	0.65 (0.57 to 0.73)	0.59 (0.49 to 0.69)	0.72 (0.62 to 0.81)
N17	Acute renal failure	85	0.66 (0.58 to 0.75)	0.71 (0.59 to 0.81)	0.62 (0.51 to 0.73)
F32	Depressive episode	83	0.80 (0.74 to 0.87)	0.84 (0.74 to 0.92)	0.77 (0.67 to 0.86)
N18	Chronic renal failure	81	0.49 (0.38 to 0.59)	0.67 (0.52 to 0.80)	0.38 (0.28 to 0.50)
F31	Bipolar affective disorder	75	0.93 (0.88 to 0.97)	0.92 (0.84 to 0.97)	0.93 (0.85 to 0.98)
K50	Crohn's disease	75	0.90 (0.85 to 0.95)	0.96 (0.87 to 0.99)	0.85 (0.75 to 0.92)
K80	Cholelithiasis	75	0.83 (0.76 to 0.90)	0.85 (0.74 to 0.92)	0.81 (0.71 to 0.89)
S06	Intracranial injury	75	0.78 (0.70 to 0.85)	0.77 (0.66 to 0.86)	0.79 (0.68 to 0.87)
T82	Complications of cardiac and vascular prosthetic devices, implants and grafts	74	0.70 (0.62 to 0.78)	0.64 (0.53 to 0.74)	0.78 (0.67 to 0.87)
Z54	Convalescence	73	0.63 (0.55 to 0.72)	0.55 (0.45 to 0.65)	0.75 (0.64 to 0.85)
L03	Cellulitis	71	0.80 (0.72 to 0.87)	0.88 (0.77 to 0.95)	0.73 (0.61 to 0.83)
O68	Labour and delivery complicated by fetal stress [distress]	70	0.84 (0.78 to 0.91)	0.81 (0.70 to 0.89)	0.89 (0.79 to 0.95)
K35	Acute appendicitis	69	0.94 (0.89 to 0.98)	0.92 (0.83 to 0.97)	0.96 (0.88 to 0.99)
F20	Schizophrenia	68	0.94 (0.90 to 0.98)	0.95 (0.87 to 0.99)	0.93 (0.84 to 0.98)
S82	Fracture of lower leg, including ankle	68	0.99 (0.96 to 1.00)	0.99 (0.92 to 1.00)	0.99 (0.92 to 1.00)
C92	Myeloid leukaemia	67	0.84 (0.77 to 0.91)	0.94 (0.85 to 0.99)	0.76 (0.64 to 0.86)

Dx Code (First 3 characters)	Diagnosis	N	Kappa	Sens (95% CI)	PPV (95% CI)
K70	Alcoholic liver disease	66	0.84 (0.77 to 0.91)	0.84 (0.73 to 0.92)	0.85 (0.74 to 0.92)
K92	Other diseases of digestive system	63	0.71 (0.62 to 0.80)	0.72 (0.59 to 0.83)	0.70 (0.57 to 0.81)
E10	Type 1 Diabetes mellitus	59	0.84 (0.78 to 0.91)	0.81 (0.70 to 0.90)	0.88 (0.77 to 0.95)
I61	Intracerebral haemorrhage	59	0.79 (0.71 to 0.87)	0.75 (0.63 to 0.84)	0.85 (0.73 to 0.93)

From this, the median and interquartile ranges (IQR) for the top 50 most responsible diagnoses are: kappa 0.81 (0.70 to 0.87), sensitivity 0.82 (0.71 to 0.89), and positive predictive value 0.82 (0.74 to 0.89). These results indicate that agreement for many diagnoses is good to excellent, but that there is substantial variability in the sensitivity and positive predictive value in the original CIHI record, since 25% of all codes exhibit a sensitivity of less than 0.71 and a positive predictive value of less than 0.74. These attributes (sensitivity and PPV) are of particular interest to health services researchers, depending on the diagnosis of interest. Some variability is expected, and is also clinically intuitive because many diagnoses are simply more 'obvious' than others in terms of their presence, their contribution to the length of stay or resource utilization, or both. This is perhaps most evident for the 'surgical' diagnoses (e.g., fracture of femur), for which agreement was generally very good.

The DAD appears to be an extremely reliable source of information for diagnoses including fracture of femur (S72) or lower leg (S82), acute myocardial infarction (I21), arthrosis of the knee (M17) or hip (M16), aortic aneurysm (I71), and acute appendicitis (K35) when these are the MRDx. Many of these conditions have been the subject of research conducted by ICES in the past, and they are relatively unambiguous from a clinical and coding perspective. In contrast, coding is considerably poorer for MRDx of Type 2 diabetes mellitus (E11) (see Appendix for more detail), chronic renal failure (N18), pneumonitis due to solids and liquids (J69), and convalescence (Z54), among others outlined below. This may reflect, in part, the difficulty in ascertaining the presence of these diagnoses retrospectively, uncertainty regarding the type of diagnosis (e.g., MRDx vs. Type 2), ambiguity in coding nomenclature, or other limitations noted in the MOHLTC-CIHI report (summarized in Section 1, bullet 3 of that report).[4] For example, 'convalescence' (Z54) may be a good example of ambiguity in coding nomenclature because the term implies the process of healing after an acute illness. However, the illness itself (and not convalescence per se) might reasonably be considered as the MRDx by some coders.

Diagnoses with especially high agreement or disagreement

The following table lists the 20 most responsible diagnoses with the highest percentage agreement in the dataset, from highest to lowest, based upon the first three characters of the diagnosis code. (This differs from Table 1.3, which addressed the 50 *most common* diagnoses.) Note that the following analysis is restricted to diagnoses occurring 10 or more times in the original abstracted dataset, since a falsely high or low percentage agreement is easily obtained when only a few instances are considered.

Table 1.4 Most responsible diagnoses with highest percentage agreement

Diagnosis Code (First 3 characters)	Diagnosis	N	% Agreement
Z38	Liveborn infants according to place of birth	113	100.0
F43	Reaction to severe stress, and adjustment disorders	14	100.0
M31	Other necrotizing vasculopathies	12	100.0
N62	Hypertrophy of breast	12	100.0
P59	Neonatal jaundice from other and unspecified causes	11	100.0
S82	Fracture of lower leg, including ankle	68	98.5
D70	Agranulocytosis	55	98.2
K35	Acute appendicitis	69	95.7
M16	Coxarthrosis [arthrosis of hip]	114	95.6

Diagnosis Code (First 3 characters)	Diagnosis	N	% Agreement
M17	Gonarthrosis [arthrosis of knee]	157	95.5
S72	Fracture of femur	356	95.2
J93	Pneumothorax	20	95.0
D32	Benign neoplasm of meninges	18	94.4
S12	Fracture of neck	17	94.1
J44	Other COPD	349	94.0
I71	Aortic aneurysm and dissection	95	93.7
F31	Bipolar affective disorder	75	93.3
S36	Injury of intra-abdominal organs	15	93.3
D35	Benign neoplasm of other and unspecified endocrine glands	15	93.3

Table 1.5 lists the 20 most responsible diagnoses with the lowest percentage agreement in the dataset, from lowest to highest. This analysis is also restricted to diagnoses occurring 10 or more times in the original record.

Table 1.5 Most responsible diagnoses with lowest percentage agreement

Diagnosis Code (First 3 characters)	Diagnosis	N	% Agreement
R33	Retention of urine	12	16.7
C80	Malignant neoplasm without specification of site	15	26.7
I97	Postprocedural disorders of circulatory system, NEC	11	27.3
R64	Cachexia	11	27.3
R02	Gangrene, not elsewhere classified	10	30.0
I73	Other peripheral vascular diseases	26	30.8
J81	Pulmonary oedema	18	33.3
Z50	Care involving use of rehabilitation procedures	29	34.5
I23	Certain current complications following acute myocardial infarction	17	35.3
N18	Chronic renal failure	81	38.3
R11	Nausea and vomiting	19	42.1
I12	Hypertensive renal disease	42	42.9
Z48	Other surgical follow-up care	20	45.0
J43	Emphysema	11	45.5
J98	Other respiratory disorders	13	46.2
R53	Malaise and fatigue	27	48.2
G30	Alzheimer's disease	39	48.7
P05	Slow fetal growth and fetal malnutrition	12	50.0
D48	Neoplasm of uncertain or unknown behaviour of other and unspecified sites	10	50.0
J96	Respiratory failure, not elsewhere classified	238	50.4

Of note, some of these diagnoses may have been identified by the reabstractor but recorded as a diagnosis type other than MRDx.

Agreement on secondary (Type 1 and 2) diagnoses

The OCCI dataset also contains information on other diagnoses. As noted earlier, Type 1 diagnoses are those that represent pre-admit comorbidities, while Type 2 diagnoses are those that represent post-admission comorbidities.

In the OCCI dataset, there were 52,114 diagnoses originally assigned a diagnosis type of either 1 or 2. The reabstractor agreed on the exact diagnosis in 21,630 (41.5%) instances, and on the first three characters of the diagnosis code in another 2,754 (5.3%) instances. For more than half of all diagnoses (n=27,730; 53.2%) however, there was no agreement between the reabstractor and the original record on even the first three characters of the code.

We examined these 27,730 instances of disagreement in detail. In 2,527 instances, these diagnoses were captured by the reabstractor as another diagnosis type; 1,965 as an exact code match; and, another 562 as a match on the first three characters, most often as Type M or Type 3. However, in a substantial number of instances, (25,203 or 90.9%), no corresponding diagnosis was recorded by the reabstractor, either because it was not identified or because it did not meet the criteria for significance.

Table 1.6 provides some common measures of agreement for the 50 most common Type 1 and Type 2 diagnoses in the OCCI dataset, as determined from the original CIHI record. Specificity and negative predictive value are uniformly high, as expected, and are not shown.

Table1.6 Agreement for the top 50 Type 1 and 2 diagnoses

Code	Diagnosis	N	K (95% CI)	Sens (95% CI)	PPV (95% CI)
E11	Type 2 diabetes mellitus	1575	0.63 (0.60 to 0.65)	0.79 (0.77 to 0.81)	0.58 (0.55 to 0.60)
E87	Other disorders of fluid, electrolyte and acid-base balance	1550	0.49 (0.46 to 0.51)	0.80 (0.77 to 0.83)	0.40 (0.37 to 0.42)
I50	Heart failure	1371	0.71 (0.69 to 0.73)	0.82 (0.80 to 0.84)	0.68 (0.65 to 0.70)
I10	Essential (primary) hypertension	1128	0.31 (0.28 to 0.34)	0.75 (0.70 to 0.79)	0.22 (0.20 to 0.25)
I48	Atrial fibrillation and flutter	1097	0.67 (0.64 to 0.69)	0.84 (0.82 to 0.87)	0.59 (0.56 to 0.62)
N39	Other disorders of urinary system	1064	0.64 (0.61 to 0.66)	0.82 (0.79 to 0.85)	0.55 (0.52 to 0.58)
D64	Other anaemias	1033	0.48 (0.45 to 0.51)	0.62 (0.59 to 0.66)	0.44 (0.41 to 0.47)
J18	Pneumonia, organism unspecified	1029	0.66 (0.64 to 0.69)	0.73 (0.70 to 0.76)	0.65 (0.62 to 0.68)
T81	Complications of procedures, not elsewhere classified	1018	0.68 (0.66 to 0.71)	0.72 (0.69 to 0.75)	0.70 (0.67 to 0.72)
D62	Acute post-haemorrhagic anaemia	926	0.40 (0.37 to 0.43)	0.65 (0.61 to 0.70)	0.32 (0.29 to 0.35)
I25	Chronic ischaemic heart disease	911	0.53 (0.49 to 0.56)	0.79 (0.75 to 0.83)	0.42 (0.39 to 0.45)
N17	Acute renal failure	747	0.69 (0.66 to 0.72)	0.81 (0.78 to 0.84)	0.63 (0.59 to 0.67)
R41	Other symptoms and signs involving cognitive functions and awareness	726	0.38 (0.34 to 0.42)	0.77 (0.71 to 0.82)	0.27 (0.24 to 0.31)
J90	Pleural effusion, not elsewhere classified	715	0.45 (0.41 to 0.48)	0.78 (0.73 to 0.83)	0.33 (0.30 to 0.37)
I21	Acute myocardial infarction	653	0.76 (0.73 to 0.79)	0.78 (0.75 to 0.81)	0.76 (0.73 to 0.79)

Code	Diagnosis	N	K (95% CI)	Sens (95% CI)	PPV (95% CI)
A41	Other septicaemia	588	0.63 (0.59 to 0.66)	0.72 (0.68 to 0.76)	0.58 (0.54 to 0.62)
R50	Fever of unknown origin	568	0.53 (0.49 to 0.57)	0.78 (0.72 to 0.82)	0.42 (0.38 to 0.46)
J44	Other chronic obstructive pulmonary disease	561	0.52 (0.48 to 0.56)	0.73 (0.68 to 0.78)	0.43 (0.39 to 0.47)
J96	Respiratory failure, not elsewhere classified	550	0.67 (0.63 to 0.70)	0.72 (0.67 to 0.76)	0.65 (0.61 to 0.69)
I20	Angina pectoris	545	0.60 (0.56 to 0.64)	0.74 (0.69 to 0.78)	0.52 (0.48 to 0.57)
N18	Chronic renal failure	533	0.40 (0.36 to 0.45)	0.74 (0.67 to 0.80)	0.29 (0.25 to 0.33)
I95	Hypotension	476	0.50 (0.45 to 0.54)	0.72 (0.66 to 0.78)	0.39 (0.35 to 0.44)
J98	Other respiratory disorders	468	0.26 (0.22 to 0.31)	0.71 (0.61 to 0.79)	0.17 (0.14 to 0.21)
E86	Volume depletion	463	0.65 (0.61 to 0.69)	0.67 (0.62 to 0.71)	0.66 (0.61 to 0.70)
D68	Other coagulation defects	458	0.35 (0.30 to 0.40)	0.78 (0.70 to 0.85)	0.23 (0.20 to 0.28)
L89	Decubitus ulcer	419	0.68 (0.64 to 0.72)	0.86 (0.82 to 0.90)	0.57 (0.52 to 0.62)
R13	Dysphagia	397	0.47 (0.42 to 0.52)	0.76 (0.69 to 0.82)	0.35 (0.30 to 0.40)
C78	Secondary malignant neoplasm of respiratory and digestive organs	393	0.61 (0.57 to 0.65)	0.78 (0.72 to 0.83)	0.51 (0.46 to 0.56)
J95	Postprocedural respiratory disorders, not elsewhere classified	391	0.55 (0.52 to 0.59)	0.46 (0.42 to 0.50)	0.75 (0.70 to 0.79)
C79	Secondary malignant neoplasm of other sites	385	0.54 (0.49 to 0.59)	0.82 (0.76 to 0.87)	0.42 (0.37 to 0.47)
Z51	Other medical care	379	0.49 (0.45 to 0.54)	0.57 (0.51 to 0.62)	0.46 (0.41 to 0.51)
E83	Disorders of mineral metabolism	375	0.35 (0.30 to 0.41)	0.76 (0.67 to 0.83)	0.24 (0.20 to 0.28)
K91	Postprocedural disorders of digestive system, not elsewhere classified	358	0.70 (0.66 to 0.74)	0.67 (0.62 to 0.71)	0.76 (0.71 to 0.80)
J69	Pneumonitis due to solids and liquids	320	0.69 (0.65 to 0.73)	0.74 (0.68 to 0.79)	0.67 (0.61 to 0.72)
K92	Other diseases of digestive system	309	0.60 (0.55 to 0.65)	0.75 (0.68 to 0.81)	0.51 (0.45 to 0.57)
I97	Postprocedural disorders of circulatory system, not elsewhere classified	305	0.47 (0.43 to 0.51)	0.37 (0.33 to 0.42)	0.70 (0.64 to 0.75)
R33	Retention of urine	301	0.61 (0.56 to 0.66)	0.86 (0.80 to 0.91)	0.48 (0.42 to 0.54)
A04	Other bacterial intestinal infections	275	0.80 (0.76 to 0.84)	0.82 (0.76 to 0.86)	0.79 (0.74 to 0.84)
I80	Phlebitis and thrombophlebitis	274	0.76 (0.72 to 0.80)	0.84 (0.79 to 0.89)	0.70 (0.64 to 0.75)

Code	Diagnosis	N	K (95% CI)	Sens (95% CI)	PPV (95% CI)
K56	Paralytic ileus and intestinal obstruction without hernia	272	0.57 (0.52 to 0.63)	0.74 (0.67 to 0.80)	0.47 (0.41 to 0.54)
T82	Complications of cardiac and vascular prosthetic devices, implants and grafts	271	0.61 (0.56 to 0.66)	0.64 (0.58 to 0.70)	0.60 (0.54 to 0.66)
K52	Other noninfective gastroenteritis and colitis	270	0.53 (0.48 to 0.59)	0.65 (0.58 to 0.72)	0.46 (0.40 to 0.52)
Z75	Problems related to medical facilities and other health care	268	0.44 (0.38 to 0.50)	0.55 (0.47 to 0.62)	0.38 (0.32 to 0.44)
G81	Hemiplegia	267	0.45 (0.38 to 0.51)	0.78 (0.69 to 0.85)	0.32 (0.26 to 0.38)
I12	Hypertensive renal disease	258	0.47 (0.42 to 0.53)	0.54 (0.47 to 0.60)	0.44 (0.38 to 0.50)
D70	Agranulocytosis	254	0.78 (0.74 to 0.82)	0.86 (0.81 to 0.90)	0.72 (0.66 to 0.77)
F05	Delirium, not induced by alcohol and other psychoactive substances	245	0.56 (0.50 to 0.62)	0.70 (0.62 to 0.77)	0.47 (0.41 to 0.54)
R18	Ascites	240	0.67 (0.61 to 0.72)	0.83 (0.77 to 0.89)	0.56 (0.50 to 0.63)
F03	Unspecified dementia	238	0.45 (0.38 to 0.52)	0.75 (0.66 to 0.83)	0.33 (0.27 to 0.39)
R11	Nausea and vomiting	238	0.47 (0.40 to 0.53)	0.72 (0.63 to 0.80)	0.35 (0.29 to 0.42)

From this, the median and interquartile ranges (IQR) for the top 50 Type 1 or Type 2 diagnoses are: kappa 0.56 (0.47 to 0.67), sensitivity 0.75 (0.71 to 0.79), and positive predictive value 0.48 (0.38 to 0.65). These results imply that coding accuracy of Type 1 and Type 2 diagnoses is far poorer than coding for Type M diagnoses. In general, the sensitivity of these diagnoses is higher than the positive predictive value. One interpretation of this observation is that when a Type 1 or 2 diagnosis is present in the CIHI DAD, it cannot always be subsequently identified as present or as significant by trained reabstractors. Alternately, if the condition was deemed a Type 3 diagnosis, the reabstractor may simply not have recorded the condition.

This suggests that common comorbidities are frequently 'overcoded' in the case costing hospitals, an observation consistent with previous reports. This finding is of particular relevance to administrative database studies that do not rely exclusively on Type M diagnoses. Coding deficiencies of this nature may threaten the conclusion of studies that rely on non-M diagnosis types within the CIHI DAD to identify an outcome, to select a cohort of patients, and so on. The extent to which this might influence such a study's finding is unpredictable, but is influenced both by the diagnosis in question as well as the balance between Type M and Type 1 or 2 diagnoses in the study. In other words, a disorder that is generally not a Type M diagnosis (such as diabetes, Parkinson's disease, etc.; discussed in detail in the Appendix) are more likely to be threatened by miscoding.

Some examples of particularly high and low percentage agreement for Type 1 or 2 diagnoses, according to the first three characters of the diagnosis code, are outlined in Tables 1.7 and 1.8.

Table 1.7 Diagnoses (Type 1 or 2) with highest percentage agreement

Code	Diagnosis	N	% Agreement
Z30	Contraceptive management	24	100.0
S92	Fracture of foot, except ankle	12	100.0
P61	Other perinatal haematological disorders	43	97.7
P07	Disorders related to short gestation and low birth weight, NEC	104	92.3
O60	Preterm delivery	26	92.3
T46	Poisoning by agents primarily affecting the cardiovascular system	13	92.3
K43	Ventral hernia	53	90.6
S42	Fracture of shoulder and upper arm	50	90.0
S82	Fracture of lower leg, including ankle	31	87.1
I33	Acute and subacute endocarditis	14	85.7
P22	Respiratory distress of newborn	81	85.2
S02	Fracture of skull and facial bones	47	85.1
O48	Prolonged pregnancy	37	83.8
P70	Transitory disorders of carbohydrate metabolism specific to fetus and newborn	17	82.4
K42	Umbilical hernia	45	82.2
I22	Subsequent myocardial infarction	16	81.3
P52	Intracranial nontraumatic haemorrhage of fetus and newborn	21	81.0
O70	Perineal laceration during delivery	72	80.6
P59	Neonatal jaundice from other and unspecified causes	72	80.6
O34	Maternal care for known or suspected abnormality of pelvic organs	20	80.0

Table 1.8 Diagnoses (Type 1 or 2) with lowest percentage agreement

Code	Diagnosis	N	% Agreement
Z48	Other surgical follow-up care	35	0.0
I69	Sequelae of cerebrovascular disease	30	0.0
B96	Other bacterial agents as the cause of diseases classified to other chapters	24	0.0
F00	Dementia in Alzheimer's disease (G30.-+)	24	0.0
Z92	Personal history of medical treatment	16	0.0
K30	Dyspepsia	14	0.0
G99	Other disorders of nervous system in diseases classified elsewhere	13	0.0
M90	Osteopathies in diseases classified elsewhere	13	0.0
E78	Disorders of lipoprotein metabolism and other lipidaemias	187	1.1
R78	Findings of drugs and other substances, not normally found in blood	26	3.9
Z53	Persons encountering health services for specific procedures, not carried out	22	4.6
M19	Other arthrosis	43	4.7
R54	Senility	21	4.8
Z29	Need for other prophylactic measures	71	5.6
G80	Infantile cerebral palsy	16	6.3
Z95	Presence of cardiac and vascular implants and grafts	30	6.7
R15	Faecal incontinence	70	7.1
E53	Deficiency of other B group vitamins	14	7.1
Z71	Persons encountering health services for other counselling and medical advice, not elsewhere classified	26	7.7
J02	Acute pharyngitis	12	8.3

Agreement on interventions

The Canadian Classification of Health Interventions (CCI) was developed by CIHI to complement ICD-10, and is the national standard for identifying procedures for hospital inpatients. The CCI system categorizes procedures according to thematically similar sections (e.g., operative procedures, endoscopy, parturition, etc.)

Of the 24,508 procedures identified by the original coder, 18,906 (77.1%) were matched exactly by reabstractors. The vast majority of these (97.3%) also matched exactly on the date of the procedure. A partial match (i.e., on the 5-digit rubric) was found for another 1,553 (6.3%) procedures, but a total of 4,049 (16.5%) were not identified by reabstractors. Some of this discrepancy may reflect interventions in the original data that were not mandatory for the reabstractors to record.

Tables 1.9 – 1.12 outline various measures of agreement for up to 50 interventions (where available) for each of the key CCI sections: Section 1 (Surgical procedures); Section 2 (Endoscopy and biopsy); Section 3 (Imaging); and, Section 5 (Procedures related to childbirth).

Table1.9 CCI Section 1 (Surgical Procedures)

CCI Code	Intervention	N	K (95% CI)	Sens (95% CI)	PPV (95% CI)
1IS53	Implantation of internal device, vena cava (superior and inferior)	954	0.93 (0.92 to 0.94)	0.91 (0.90 to 0.93)	0.96 (0.95 to 0.97)
1GZ31	Ventilation, respiratory system NEC	717	0.98 (0.97 to 0.99)	1.00 (0.99 to 1.00)	0.96 (0.95 to 0.98)
1LZ37	Installation of external appliance, circulatory system NEC	652	0.98 (0.98 to 0.99)	1.00 (0.99 to 1.00)	0.97 (0.96 to 0.98)
1IJ76	Bypass, coronary arteries	614	1.00 (1.00 to 1.00)	1.00 (0.99 to 1.00)	1.00 (0.99 to 1.00)
1PZ21	Dialysis, urinary system NEC	530	0.98 (0.98 to 0.99)	1.00 (0.99 to 1.00)	0.97 (0.95 to 0.98)
1KR58	Procurement, veins of leg NEC	474	0.98 (0.97 to 0.99)	1.00 (0.98 to 1.00)	0.97 (0.95 to 0.98)
1GJ77	Bypass with exteriorization, trachea	459	0.99 (0.99 to 1.00)	0.99 (0.98 to 1.00)	0.99 (0.98 to 1.00)
1NF53	Implantation of internal device, stomach	389	0.87 (0.85 to 0.90)	0.93 (0.90 to 0.96)	0.83 (0.79 to 0.87)
1VA53	Implantation of internal device, hip joint	339	0.97 (0.96 to 0.99)	0.97 (0.94 to 0.98)	0.98 (0.96 to 0.99)
1NM87	Excision partial, large intestine	338	0.92 (0.89 to 0.94)	0.94 (0.91 to 0.96)	0.90 (0.87 to 0.93)
1IJ50	Dilation, coronary arteries	317	0.98 (0.97 to 0.99)	0.99 (0.98 to 1.00)	0.97 (0.95 to 0.99)
1OT52	Drainage, abdominal cavity	313	0.92 (0.90 to 0.95)	0.94 (0.90 to 0.96)	0.91 (0.88 to 0.94)
1HZ53	Implantation of internal device, heart NEC	291	0.93 (0.91 to 0.95)	1.00 (0.98 to 1.00)	0.88 (0.83 to 0.91)
1SY80	Repair, muscles of the chest and abdomen	198	0.95 (0.92 to 0.97)	0.95 (0.91 to 0.98)	0.94 (0.90 to 0.97)

CCI Code	Intervention	N	K (95% CI)	Sens (95% CI)	PPV (95% CI)
1VG53	Implantation of internal device, knee joint	198	0.99 (0.99 to 1.00)	1.00 (0.98 to 1.00)	0.99 (0.96 to 1.00)
1VC74	Fixation, femur	180	0.86 (0.82 to 0.90)	0.89 (0.83 to 0.93)	0.83 (0.77 to 0.88)
1JM58	Procurement, arteries of arm NEC	167	0.94 (0.91 to 0.97)	0.98 (0.94 to 1.00)	0.90 (0.85 to 0.94)
1NK87	Excision partial, small intestine	146	0.91 (0.87 to 0.94)	0.92 (0.87 to 0.96)	0.90 (0.84 to 0.94)
1HV90	Excision total with reconstruction, aortic valve	130	0.99 (0.98 to 1.00)	0.99 (0.96 to 1.00)	0.99 (0.96 to 1.00)
1OD89	Excision total, gallbladder	129	0.97 (0.95 to 0.99)	0.98 (0.93 to 1.00)	0.96 (0.91 to 0.99)
1NK77	Bypass with exteriorization, small intestine	124	0.83 (0.78 to 0.89)	0.94 (0.87 to 0.98)	0.75 (0.66 to 0.82)
1KX53	Implantation of internal device, vein NEC	121	0.31 (0.22 to 0.41)	0.96 (0.79 to 1.00)	0.19 (0.12 to 0.27)
1NV89	Excision total, appendix	115	0.98 (0.96 to 1.00)	0.99 (0.95 to 1.00)	0.97 (0.93 to 0.99)
1RD89	Excision total, ovary with fallopian tube	103	0.99 (0.97 to 1.00)	0.99 (0.95 to 1.00)	0.98 (0.93 to 1.00)
1OT72	Release, abdominal cavity	102	0.80 (0.74 to 0.87)	0.89 (0.81 to 0.95)	0.74 (0.64 to 0.82)
1VA74	Fixation, hip joint	100	0.78 (0.71 to 0.84)	0.79 (0.69 to 0.86)	0.77 (0.68 to 0.85)
1NQ87	Excision partial, rectum	99	0.89 (0.84 to 0.94)	0.87 (0.79 to 0.93)	0.91 (0.83 to 0.96)
1NF52	Drainage, stomach	90	0.74 (0.66 to 0.82)	0.96 (0.88 to 1.00)	0.6 (0.49 to 0.70)
1RM89	Excision total, uterus and surrounding structures	85	0.97 (0.94 to 0.99)	0.93 (0.86 to 0.98)	1.00 (0.96 to 1.00)
1NK53	Implantation of internal device, small intestine	82	0.77 (0.70 to 0.84)	0.72 (0.61 to 0.80)	0.83 (0.73 to 0.90)
1NP72	Release, small and large intestine	77	0.83 (0.77 to 0.90)	0.88 (0.78 to 0.95)	0.79 (0.68 to 0.88)
1AW72	Release, spinal cord	74	0.89 (0.83 to 0.94)	1.00 (0.94 to 1.00)	0.80 (0.69 to 0.88)
1KG76	Bypass, arteries of leg NEC	67	0.87 (0.81 to 0.93)	0.87 (0.76 to 0.94)	0.88 (0.78 to 0.95)
1IC53	Implantation of internal device, thoracic [descending] aorta	66	0.88 (0.82 to 0.94)	0.98 (0.90 to 1.00)	0.80 (0.69 to 0.89)
1SC75	Fusion, spinal vertebrae	66	0.90 (0.84 to 0.95)	0.86 (0.76 to 0.93)	0.94 (0.85 to 0.98)
1HU90	Excision total with reconstruction, mitral valve	65	0.98 (0.95 to 1.00)	0.98 (0.92 to 1.00)	0.97 (0.89 to 1.00)
1AC52	Drainage, ventricles of brain	61	0.92 (0.87 to 0.97)	0.95 (0.86 to 0.99)	0.90 (0.80 to 0.96)
1NK80	Repair, small intestine	59	0.86 (0.80 to 0.93)	0.92 (0.81 to 0.98)	0.81 (0.69 to 0.90)

CCI Code	Intervention	N	K (95% CI)	Sens (95% CI)	PPV (95% CI)
1AN87	Excision partial, brain	58	0.87 (0.81 to 0.94)	0.91 (0.80 to 0.97)	0.84 (0.73 to 0.93)
1KA80	Repair, abdominal aorta	56	0.81 (0.74 to 0.89)	0.72 (0.60 to 0.82)	0.93 (0.83 to 0.98)
1IS51	Occlusion, vena cava (superior and inferior)	54	0.96 (0.92 to 1.00)	0.98 (0.90 to 1.00)	0.94 (0.85 to 0.99)
1QT87	Excision partial, prostate	54	0.98 (0.95 to 1.00)	1.00 (0.93 to 1.00)	0.96 (0.87 to 1.00)
1SZ52	Drainage, soft tissue of the chest and abdomen	54	0.70 (0.59 to 0.80)	0.89 (0.73 to 0.97)	0.57 (0.43 to 0.71)
1KV53	Implantation of internal device, artery NEC	53	0.52 (0.38 to 0.65)	0.83 (0.63 to 0.95)	0.38 (0.25 to 0.52)
1LZ19	Transfusion, circulatory system NEC	52	0.91 (0.85 to 0.97)	0.96 (0.85 to 0.99)	0.87 (0.74 to 0.94)
1VQ93	Amputation, tibia and fibula	50	0.97 (0.94 to 1.00)	0.98 (0.89 to 1.00)	0.96 (0.86 to 1.00)
1JL58	Procurement, internal mammary artery	47	0.25 (0.10 to 0.40)	0.78 (0.40 to 0.97)	0.15 (0.06 to 0.28)
1AA52	Drainage, meninges and dura mater of brain	46	0.90 (0.84 to 0.97)	0.89 (0.77 to 0.96)	0.91 (0.79 to 0.98)
1JW51	Occlusion, intracranial vessels	46	0.93 (0.87 to 0.98)	0.88 (0.76 to 0.96)	0.98 (0.88 to 1.00)
1KA76	Bypass, abdominal aorta	44	0.77 (0.67 to 0.87)	0.79 (0.63 to 0.90)	0.75 (0.60 to 0.87)

From this, the median and interquartile ranges (IQR) for the top 50 CCI Section 1 procedures are: kappa 0.92 (0.86 to 0.98), sensitivity 0.95 (0.89 to 0.99), and positive predictive value 0.91 (0.82 to 0.97). These findings imply that, with a few exceptions, the CIHI DAD is a highly reliable source of information regarding CCI Section 1 procedures, with many procedures having near-perfect sensitivity and extremely high positive predictive values.

Table 1.10 CCI Section 2 (Endoscopy and Biopsy)

CCI Code	Intervention	N	K (95% CI)	Sens (95% CI)	PPV (95% CI)
2NK70	Inspection, small intestine	491	0.84 (0.82 to 0.87)	0.85 (0.82 to 0.88)	0.86 (0.82 to 0.89)
2NM70	Inspection, large intestine	333	0.89 (0.86 to 0.91)	0.96 (0.93 to 0.98)	0.83 (0.79 to 0.87)
2GM70	Inspection, bronchus	236	0.80 (0.76 to 0.85)	0.95 (0.90 to 0.98)	0.70 (0.64 to 0.76)
2GM71	Biopsy, bronchus	229	0.84 (0.81 to 0.88)	0.82 (0.77 to 0.87)	0.88 (0.83 to 0.92)
2NF71	Biopsy, stomach	178	0.89 (0.85 to 0.92)	0.87 (0.81 to 0.91)	0.92 (0.86 to 0.95)
2PM70	Inspection, bladder	176	0.85 (0.81 to 0.90)	1.00 (0.97 to 1.00)	0.75 (0.68 to 0.81)

CCI Code	Intervention	N	K (95% CI)	Sens (95% CI)	PPV (95% CI)
2NK71	Biopsy, small intestine	125	0.77 (0.71 to 0.83)	0.86 (0.77 to 0.92)	0.71 (0.62 to 0.79)
2NM71	Biopsy, large intestine	121	0.87 (0.83 to 0.92)	0.88 (0.80 to 0.93)	0.88 (0.80 to 0.93)
2OT70	Inspection, abdominal cavity	120	0.55 (0.46 to 0.64)	1.00 (0.92 to 1.00)	0.38 (0.30 to 0.48)
2WY71	Biopsy, bone marrow	106	0.95 (0.92 to 0.98)	0.95 (0.89 to 0.98)	0.94 (0.88 to 0.98)
2NF70	Inspection, stomach	98	0.47 (0.36 to 0.57)	0.84 (0.69 to 0.94)	0.33 (0.24 to 0.43)
2OA71	Biopsy, liver	96	0.96 (0.93 to 0.99)	1.00 (0.96 to 1.00)	0.92 (0.84 to 0.96)
2GT71	Biopsy, lung	85	0.85 (0.79 to 0.91)	0.92 (0.83 to 0.97)	0.79 (0.69 to 0.87)
2OT71	Biopsy, abdominal cavity	56	0.88 (0.82 to 0.95)	0.96 (0.86 to 0.99)	0.82 (0.70 to 0.91)
2GE70	Inspection, larynx	42	0.87 (0.79 to 0.95)	0.97 (0.85 to 1.00)	0.79 (0.63 to 0.90)
2NA71	Biopsy, esophagus	42	0.88 (0.81 to 0.95)	0.88 (0.74 to 0.96)	0.88 (0.74 to 0.96)
2PC71	Biopsy, kidney	38	0.93 (0.87 to 0.99)	0.95 (0.82 to 0.99)	0.92 (0.79 to 0.98)
2NA70	Inspection, esophagus	31	0.58 (0.42 to 0.75)	0.82 (0.57 to 0.96)	0.45 (0.27 to 0.64)
2ME71	Biopsy, mediastinal lymph nodes	27	0.85 (0.75 to 0.95)	0.85 (0.66 to 0.96)	0.85 (0.66 to 0.96)
2GY70	Inspection, thoracic cavity	25	0.55 (0.36 to 0.75)	0.91 (0.59 to 1.00)	0.40 (0.21 to 0.61)
2MF71	Biopsy, intrathoracic lymph nodes	23	0.77 (0.62 to 0.92)	0.94 (0.70 to 1.00)	0.65 (0.43 to 0.84)
2NQ71	Biopsy, rectum	21	0.81 (0.68 to 0.94)	0.81 (0.58 to 0.95)	0.81 (0.58 to 0.95)
2GT70	Inspection, lung	18	0.19 (-0.04 to 0.42) (?)	0.67 (0.09 to 0.99)	0.11 (0.01 to 0.35)
2NC70	Inspection, esophagus with stomach	18	0.39 (0.17 to 0.60)	0.46 (0.19 to 0.75)	0.33 (0.13 to 0.59)
2GV71	Biopsy, pleura	16	0.97 (0.90 to 1.00)	1.00 (0.78 to 1.00)	0.94 (0.70 to 1.00)
2YT71	Biopsy, skin of arm	13	0.83 (0.67 to 0.99)	0.91 (0.59 to 1.00)	0.77 (0.46 to 0.95)

CCI Code	Intervention	N	K (95% CI)	Sens (95% CI)	PPV (95% CI)
2GW71	Biopsy, mediastinum	12	0.70 (0.48 to 0.91)	0.73 (0.39 to 0.94)	0.67 (0.35 to 0.90)
2SC71	Biopsy, spinal vertebrae	12	0.87 (0.72 to 1.00)	0.91 (0.59 to 1.00)	0.83 (0.52 to 0.98)
2AN71	Biopsy, brain	11	0.87 (0.72 to 1.00)	0.83 (0.52 to 0.98)	0.91 (0.59 to 1.00)
2GW70	Inspection, mediastinum	10	0.67 (0.39 to 0.94)	1.00 (0.48 to 1.00)	0.50 (0.19 to 0.81)
2VC71	Biopsy, femur	10	0.89 (0.74 to 1.00)	1.00 (0.63 to 1.00)	0.80 (0.44 to 0.97)
2VX71	Biopsy, soft tissue of leg	10	0.95 (0.84 to 1.00)	1.00 (0.66 to 1.00)	0.90 (0.55 to 1.00)

From this, the median and interquartile ranges (IQR) for the top 50 CCI Section 2 procedures are: kappa 0.85 (0.77 to 0.89), sensitivity 0.94 (0.81 to 1.00), and positive predictive value 0.80 (0.67 to 0.99). These findings imply that, with a few notable exceptions, the CIHI DAD is generally a reliable source of information regarding CCI Section 2 procedures. Several procedures are identified with near-perfect sensitivity.

Table 1.11 CCI Section 3 (Imaging)

CCI Code	Intervention	N	K (95% CI)	Sens (95% CI)	PPV (95% CI)
3OT20	Computerized tomography [CT], abdominal cavity	792	0.98 (0.97 to 0.98)	0.99 (0.98 to 0.99)	0.97 (0.96 to 0.98)
3IP10	X-ray, heart with coronary arteries	664	0.98 (0.97 to 0.99)	1.00 (0.99 to 1.00)	0.97 (0.95 to 0.98
3AN20	Computerized tomography [CT], brain	475	0.78 (0.76 to 0.81)	0.71 (0.67 to 0.74)	0.91 (0.88 to 0.94)
3ER20	Computerized tomography [CT], head NEC	413	0.65 (0.61 to 0.69)	0.87 (0.82 to 0.91)	0.54 (0.49 to 0.58)
3GT20	Computerized tomography [CT], lung NEC	380	0.86 (0.83 to 0.89)	0.89 (0.86 to 0.92)	0.84 (0.80 to 0.87)
3GY20	Computerized tomography [CT], thoracic cavity	252	0.82 (0.78 to 0.85)	0.80 (0.75 to 0.85)	0.85 (0.79 to 0.89)
3AN40	Magnetic resonance imaging, brain	148	0.80 (0.75 to 0.85)	0.89 (0.82 to 0.94)	0.73 (0.65 to 0.80)
3SC40	Magnetic resonance imaging [MRI], spinal vertebrae	84	0.86 (0.80 to 0.92)	0.93 (0.85 to 0.98)	0.80 (0.70 to 0.88)
3SC20	Computerized tomography [CT], spinal vertebrae	57	0.98 (0.96 to 1.00)	1.00 (0.94 to 1.00)	0.96 (0.88 to 1.00)
3ER40	Magnetic resonance imaging [MRI], head NEC	43	0.69 (0.57 to 0.82)	0.92 (0.75 to 0.99)	0.56 (0.40 to 0.71)
3FY20	Computerized tomography [CT], soft tissue of neck	37	0.95 (0.89 to 1.00)	0.95 (0.82 to 0.99)	0.95 (0.82 to 0.99)

CCI Code	Intervention	N	K (95% CI)	Sens (95% CI)	PPV (95% CI)
3OT40	Magnetic resonance imaging [MRI], abdominal cavity	26	0.84 (0.73 to 0.96)	1.00 (0.82 to 1.00)	0.73 (0.52 to 0.88)
3VZ20	Computerized tomography [CT], leg NEC	22	0.95 (0.89 to 1.00)	0.95 (0.77 to 1.00)	0.95 (0.77 to 1.00)
3WZ20	Computerized tomography [CT], musculoskeletal system NEC	19	0.68 (0.52 to 0.85)	0.64 (0.41 to 0.83)	0.74 (0.49 to 0.91)
3JX40	Magnetic resonance imaging [MRI], other vessels of head, neck and spine NEC	15	0.72 (0.52 to 0.92)	0.9 (0.55 to 1.00)	0.6 (0.32 to 0.84)
3VZ40	Magnetic resonance imaging [MRI], leg NEC	12	1.00 (1.00 to 1.00)	1.00 (0.74 to 1.00)	1.00 (0.74 to 1.00)

From this, the median and interquartile ranges (IQR) for the top 50 CCI Section 3 procedures are: kappa 0.83 (0.71 to 0.98), sensitivity 0.94 (0.78 to 1.00), and positive predictive value 0.88 (0.60 to 1.00). These findings imply that the CIHI DAD is a reliable source of information for most imaging procedures. However, certain imaging procedures, particularly CT and MRI of the head and brain, exhibit noticeably poorer coding. This particular source of miscoding presumably stems from the conceptual similarity of 'head' and 'brain' imaging, since most such procedures are likely intended to image brain tissue. These results suggest that health services researchers interested in using the CIHI DAD to identify CT or MRI of the brain should consider combining the codes for brain and head, if appropriate.

Table1.12 CCI Section 5 (Procedures related to childbirth)

CCI Code	Intervention	N	K (95% CI)	Sens (95% CI)	PPV (95% CI)
5MD50	Manually assisted vaginal delivery (vertex)	256	0.97 (0.96 to 0.99)	0.98 (0.95 to 0.99)	0.97 (0.94 to 0.99)
5MD60	Cesarean section delivery	203	0.99 (0.98 to 1.00)	0.99 (0.96 to 1.00)	1.00 (0.97 to 1.00)
5PC80	Surgical repair, postpartum	175	0.97 (0.96 to 0.99)	0.99 (0.97 to 1.00)	0.95 (0.91 to 0.98)
5AC30	Induction of labour	106	0.93 (0.89 to 0.97)	1.00 (0.96 to 1.00)	0.87 (0.79 to 0.93)
5MD54	Vacuum traction delivery	37	0.97 (0.94 to 1.00)	0.97 (0.86 to 1.00)	0.97 (0.86 to 1.00)
5MD53	Forceps traction and rotation delivery	13	0.88 (0.74 to 1.00)	0.92 (0.62 to 1.00)	0.85 (0.55 to 0.98)
5PC91	Interventions to uterus (following delivery)	11	0.91 (0.78 to 1.00)	0.91 (0.59 to 1.00)	0.91 (0.59 to 1.00)

From this, the median and interquartile ranges (IQR) for the top 50 CCI Section 5 procedures are: kappa 0.97 (0.92 to 0.98), sensitivity 0.97 (0.91 to 1.00), and positive predictive value 0.95 (0.85 to 1.00). These findings imply that the CIHI DAD is a highly reliable source of information regarding CCI Section 5 procedures. Several procedures are identified with near-perfect agreement and sensitivity.

Chapter 2—Transition Matrix for Most Responsible Diagnoses

Introduction

Health services researchers often utilize the most responsible diagnoses (MRDx) to define groups of patients, particularly in observational (cohort, case control, etc.) studies. One of the main reasons why this is done is that the MRDx is often perceived to have the highest predictive accuracy, and relying on it is thought to minimize the likelihood of misclassifying disease status. Indeed, this is substantiated by the findings of Chapter 1. However, a MRDx can be misclassified not only as a different diagnosis, but also as another diagnosis type. The extent to which this occurs has not been well studied.

We identified the 50 most common MRDx codes defined in the original record, and characterized the extent to which the reabstractor agreed with this assignment of MRDx. The results of this analysis, presented in Table 2.1, serves two purposes. First, it informs researchers of the extent to which selected MRDx in the Discharge Abstract Database (DAD) might actually represent other diagnoses or other diagnosis types. Second, it may help the Canadian Institute for Health Information (CIHI) identify areas in which erroneous diagnosis coding and typing is most likely to occur; presumably these are areas that merit particular attention for health records coders.

Table 2.1 Transition matrix for 50 leading most responsible diagnoses

Code	Original Record	Reabstracted Record	Type	Count	Complete Agreement (%)
I25	Chronic ischaemic heart disease	Chronic ischaemic heart disease	M	626	91.3
		Chronic ischaemic heart disease	1	40	5.8
			N/A*	20	2.9
I21	Acute myocardial infarction	Acute myocardial infarction	M	488	86.5
		Acute myocardial infarction	1	47	8.3
			N/A	16	2.8
		Acute myocardial infarction	2	5	0.9
		Chronic ischaemic heart disease	M	2	0.4
		Angina pectoris	M	1	0.2
		Angina pectoris	1	1	0.2
		Acute myocardial infarction	W	1	0.2
		Subsequent myocardial infarction	M	1	0.2
		Heart failure	M	1	0.2
		Pain in throat and chest	M	1	0.2
I50	Heart failure	Heart failure	M	381	85.0
		Heart failure	1	35	7.8
			N/A	18	4.0
		Heart failure	2	3	0.7
		Cardiomyopathy	M	2	0.4
		Postprocedural disorders of circulatory system, not elsewhere classified	M	2	0.4
		Heart failure	3	1	0.2
		Complications and ill-defined descriptions of heart disease	1	1	0.2
		Acute bronchitis	M	1	0.2
		Respiratory conditions due to other external agents	M	1	0.2

Code	Original Record	Reabstracted Record	Type	Count	Complete Agreement (%)
	I50 Heart Failure (cont'd)	Other interstitial pulmonary diseases	M	1	0.2
		Complications of procedures, not elsewhere classified	M	1	0.2
		Convalescence	M	1	0.2
J18	Pneumonia, organism unspecified	Pneumonia, organism unspecified	M	248	68.7
		Pneumonia, organism unspecified	1	71	19.7
			N/A	15	4.2
		Pneumonitis due to solids and liquids	M	11	3.0
		Bacterial pneumonia, not elsewhere classified	1	3	0.8
		Bacterial pneumonia, not elsewhere classified	M	2	0.6
		Pneumonitis due to solids and liquids	1	2	0.6
		Pneumonitis due to solids and liquids	2	2	0.6
		Influenza due to identified influenza virus	M	1	0.3
		Pneumonia due to Streptococcus pneumoniae	M	1	0.3
		Pneumonia due to Streptococcus pneumoniae	1	1	0.3
		Pneumonia, organism unspecified	2	1	0.3
		Pneumonia, organism unspecified	3	1	0.3
		Other chronic obstructive pulmonary disease	M	1	0.3
		Pleural effusion, not elsewhere classified	M	1	0.3
S72	Fracture of femur	Fracture of femur	M	339	95.2
		Fracture of femur	1	10	2.8
		Fracture of lumbar spine and pelvis	M	3	0.8
		Complications of internal orthopaedic prosthetic devices, implants and grafts	M	2	0.6
			N/A	1	0.3
		Osteoporosis with pathological fracture	M	1	0.3
J44	Other chronic obstructive pulmonary disease	Other chronic obstructive pulmonary disease	M	326	93.4
		Other chronic obstructive pulmonary disease	1	13	3.7
			N/A	9	2.6
		Asthma	M	1	0.3
Z51	Other medical care	Other medical care	M	184	65.7
			N/A	52	18.6
		Other medical care	1	26	9.3
		Other medical care	W	17	6.1
		Oesophagitis	M	1	0.4
J96	Respiratory failure, not elsewhere classified	Respiratory failure, not elsewhere classified	M	118	49.6
			N/A	42	17.6
		Respiratory failure, not elsewhere classified	1	42	17.6

Code	Original Record	Reabstracted Record	Type	Count	Complete Agreement (%)
	J96 Respiratory failure, not elsewhere classified (cont'd)	Postprocedural respiratory disorders, not elsewhere classified	M	13	5.5
		Respiratory failure, not elsewhere classified	2	8	3.4
		Adult respiratory distress syndrome	M	6	2.5
		Pneumonitis due to solids and liquids	1	2	0.8
		Pneumonitis due to solids and liquids	M	1	0.4
		Adult respiratory distress syndrome	1	1	0.4
		Adult respiratory distress syndrome	2	1	0.4
		Pyothorax	M	1	0.4
		Postprocedural respiratory disorders, not elsewhere classified	2	1	0.4
		Respiratory failure, not elsewhere classified	3	1	0.4
		Other symptoms and signs involving the circulatory and respiratory systems	1	1	0.4
I63	Cerebral infarction	Cerebral infarction	M	181	87.0
		Stroke, not specified as haemorrhage or infarction	M	10	4.8
		Intracerebral haemorrhage	M	4	1.9
			N/A	3	1.4
		Cerebral infarction	2	2	1.0
		Occlusion and stenosis of cerebral arteries, not resulting in cerebral infarction	M	2	1.0
		Transient cerebral ischaemic attacks and related syndromes	M	1	0.5
		Other nontraumatic intracranial haemorrhage	M	1	0.5
		Cerebral infarction	1	1	0.5
		Cerebral infarction	W	1	0.5
		Other maternal diseases classifiable elsewhere but complicating pregnancy, childbirth and the puerperium	M	1	0.5
		Care involving use of rehabilitation procedures	M	1	0.5
C34	Malignant neoplasm of bronchus and lung	Malignant neoplasm of bronchus and lung	M	139	67.8
			N/A	28	13.7
		Malignant neoplasm of bronchus and lung	3	18	8.8
		Malignant neoplasm of bronchus and lung	1	17	8.3
		Secondary malignant neoplasm of respiratory and digestive organs	M	1	0.5
		Carcinoma in situ of middle ear and respiratory system	M	1	0.5
		Personal history of malignant neoplasm	3	1	0.5
E11	Type 2 Diabetes mellitus	Type 2 Diabetes mellitus	M	127	78.4
			N/A	14	8.6
		Type 2 Diabetes mellitus	1	13	8.0

Code	Original Record	Reabstracted Record	Type	Count	Complete Agreement (%)
	E11 Type 2 Diabetes mellitus (cont'd)	Unspecified diabetes mellitus	M	4	2.5
		Type 1 Diabetes mellitus	M	2	1.2
		Type 2 Diabetes mellitus	3	2	1.2
P07	Disorders related to short gestation and low birth weight, not elsewhere classified	Disorders related to short gestation and low birth weight, not elsewhere classified	M	106	67.1
		Disorders related to short gestation and low birth weight, not elsewhere classified	1	47	29.7
			N/A	3	1.9
		Slow fetal growth and fetal malnutrition	M	1	0.6
		Feeding problems of newborn	M	1	0.6
M17	Gonarthrosis [arthrosis of knee]	Gonarthrosis [arthrosis of knee]	M	150	95.5
		Coxarthrosis [arthrosis of hip]	M	3	1.9
			N/A	2	1.3
		Gonarthrosis [arthrosis of knee]	1	2	1.3
A41	Other septicaemia	Other septicaemia	M	99	63.5
			N/A	20	12.8
		Other septicaemia	1	15	9.6
		Complications of procedures, not elsewhere classified	M	3	1.9
		Other septicaemia	2	2	1.3
		Other septicaemia	3	2	1.3
		Bacterial infection of unspecified site	1	2	1.3
		Peritonitis	M	2	1.3
		Other disorders of urinary system	M	2	1.3
		Complications of cardiac and vascular prosthetic devices, implants and grafts	M	2	1.3
		Streptococcal septicaemia	M	1	0.6
		Bacterial infection of unspecified site	M	1	0.6
		Other bacterial agents as the cause of diseases classified to other chapters	3	1	0.6
		Other disorders of urinary system	2	1	0.6
		Malaise and fatigue	M	1	0.6
		Complications following infusion, transfusion and therapeutic injection	M	1	0.6
		Complications of other internal prosthetic devices, implants and grafts	M	1	0.6
I20	Angina pectoris	Angina pectoris	M	80	51.6
		Angina pectoris	1	45	29.0
			N/A	15	9.7
		Certain current complications following acute myocardial infarction	1	4	2.6
		Angina pectoris	3	2	1.3
		Certain current complications following acute myocardial infarction	M	2	1.3
		Chronic ischaemic heart disease	M	2	1.3
		Pain in throat and chest	M	2	1.3

Code	Original Record	Reabstracted Record	Type	Count	Complete Agreement (%)
	I20 Angina pectoris (cont'd)	Acute myocardial infarction	M	1	0.6
		Pain in throat and chest	2	1	0.6
		Complications of cardiac and vascular prosthetic devices, implants and grafts	M	1	0.6
C79	Secondary malignant neoplasm of other sites	Secondary malignant neoplasm of other sites	M	119	77.3
			N/A	12	7.8
		Secondary malignant neoplasm of other sites	1	8	5.2
		Secondary malignant neoplasm of other sites	3	7	4.5
		Malignant neoplasm of other connective and soft tissue	1	1	0.6
		Malignant neoplasm of ovary	M	1	0.6
		Malignant neoplasm of brain	M	1	0.6
		Secondary malignant neoplasm of respiratory and digestive organs	M	1	0.6
		Malignant neoplasm without specification of site	1	1	0.6
		Other and unspecified types of non-Hodgkin's lymphoma	M	1	0.6
		Other diseases of pericardium	M	1	0.6
		Paralytic ileus and intestinal obstruction without hernia	M	1	0.6
C18	Malignant neoplasm of colon	Malignant neoplasm of colon	M	128	85.9
			N/A	6	4.0
		Malignant neoplasm of rectosigmoid junction	M	4	2.7
		Malignant neoplasm of colon	1	2	1.3
		Personal history of malignant neoplasm	3	2	1.3
		Malignant neoplasm of colon	3	1	0.7
		Malignant neoplasm of rectosigmoid junction	3	1	0.7
		Malignant neoplasm of rectum	M	1	0.7
		Secondary malignant neoplasm of respiratory and digestive organs	M	1	0.7
		Malignant neoplasm without specification of site	M	1	0.7
		Benign neoplasm of colon, rectum, anus and anal canal	M	1	0.7
		Neoplasm of uncertain or unknown behaviour of oral cavity and digestive organs	M	1	0.7
I64	Stroke, not specified as haemorrhage or infarction	Stroke, not specified as haemorrhage or infarction	M	96	69.1
		Cerebral infarction	M	25	18.0
			N/A	12	8.6

Code	Original Record	Reabstracted Record	Type	Count	Complete Agreement (%)
	I64 Stroke, not specified as haemorrhage or infarction (cont'd)	Stroke, not specified as haemorrhage or infarction	1	3	2.2
		Other disorders of brain	M	1	0.7
		Cerebral infarction	1	1	0.7
		Occlusion and stenosis of cerebral arteries, not resulting in cerebral infarction	M	1	0.7
C78	Secondary malignant neoplasm of respiratory and digestive organs	Secondary malignant neoplasm of respiratory and digestive organs	M	92	68.7
			N/A	23	17.2
		Secondary malignant neoplasm of respiratory and digestive organs	1	7	5.2
		Secondary malignant neoplasm of respiratory and digestive organs	3	5	3.7
		Malignant neoplasm of colon	M	2	1.5
		Malignant neoplasm of stomach	M	1	0.7
		Malignant neoplasm of bronchus and lung	M	1	0.7
		Malignant neoplasm without specification of site	M	1	0.7
		Benign neoplasm of colon, rectum, anus and anal canal	M	1	0.7
		Other medical care	M	1	0.7
T81	Complications of procedures, not elsewhere classified	Complications of procedures, not elsewhere classified	M	89	73.0
			N/A	19	15.6
		Complications of cardiac and vascular prosthetic devices, implants and grafts	M	4	3.3
		Complications of procedures, not elsewhere classified	1	2	1.6
		Complications of procedures, not elsewhere classified	2	2	1.6
		Acute myocardial infarction	M	1	0.8
		Pneumonitis due to solids and liquids	M	1	0.8
		Postprocedural disorders of digestive system, not elsewhere classified	M	1	0.8
		Postprocedural disorders of genitourinary system, not elsewhere classified	M	1	0.8
		Complications of internal orthopaedic prosthetic devices, implants and grafts	M	1	0.8
		Failure and rejection of transplanted organs and tissues	M	1	0.8
K56	Paralytic ileus and intestinal obstruction without hernia	Paralytic ileus and intestinal obstruction without hernia	M	93	78.2
			N/A	6	5.0
		Paralytic ileus and intestinal obstruction without hernia	1	6	5.0
		Other diseases of stomach and duodenum	M	3	2.5

Code	Original Record	Reabstracted Record	Type	Count	Complete Agreement (%)
	K56 Paralytic ileus and intestinal obstruction without hernia (cont'd)	Postprocedural disorders of digestive system, not elsewhere classified	M	3	2.5
		Ventral hernia	M	2	1.7
		Malignant neoplasm of colon	M	1	0.8
		Vascular disorders of intestine	M	1	0.8
		Paralytic ileus and intestinal obstruction without hernia	2	1	0.8
		Paralytic ileus and intestinal obstruction without hernia	3	1	0.8
		Other functional intestinal disorders	1	1	0.8
		Abdominal and pelvic pain	1	1	0.8
M16	Coxarthrosis [arthrosis of hip]	Coxarthrosis [arthrosis of hip]	M	109	95.6
		Gonarthrosis [arthrosis of knee]	M	2	1.8
		Other rheumatoid arthritis	M	1	0.9
		Polyarthrosis	M	1	0.9
		Congenital deformities of hip	M	1	0.9
O70	Perineal laceration during delivery	Perineal laceration during delivery	M	86	76.1
		Perineal laceration during delivery	1	22	19.5
			N/A	4	3.5
		Other obstetric trauma	M	1	0.9
Z38	Liveborn infants according to place of birth	Liveborn infants according to place of birth	M	113	100.0
N39	Other disorders of urinary system	Other disorders of urinary system	M	86	77.5
		Other disorders of urinary system	1	10	9.0
			N/A	7	6.3
		Complications of genitourinary prosthetic devices, implants and grafts	M	2	1.8
		Other septicaemia	M	1	0.9
		Tubulo-interstitial nephritis, not specified as acute or chronic	M	1	0.9
		Obstructive and reflux uropathy	1	1	0.9
		Unspecified renal failure	M	1	0.9
		Cystitis	M	1	0.9
		Other disorders of urinary system	2	1	0.9
I48	Atrial fibrillation and flutter	Atrial fibrillation and flutter	M	80	82.5
		Atrial fibrillation and flutter	1	11	11.3
			N/A	2	2.1
		Paroxysmal tachycardia	M	2	2.1
		Heart failure	M	1	1.0
		Complications of cardiac and vascular prosthetic devices, implants and grafts	M	1	1.0
I71	Aortic aneurysm and dissection	Aortic aneurysm and dissection	M	89	93.7
		Aortic aneurysm and dissection	1	4	4.2
			N/A	1	1.1
		Aortic aneurysm and dissection	2	1	1.1

Code	Original Record	Reabstracted Record	Type	Count	Complete Agreement (%)
I35	Nonrheumatic aortic valve disorders	Nonrheumatic aortic valve disorders	M	79	85.9
			N/A	5	5.4
		Nonrheumatic aortic valve disorders	1	3	3.3
		Multiple valve diseases	M	2	2.2
		Multiple valve diseases	1	2	2.2
		Congenital malformations of aortic and mitral valves	M	1	1.1
T84	Complications of internal orthopaedic prosthetic devices, implants and grafts	Complications of internal orthopaedic prosthetic devices, implants and grafts	M	83	91.2
		Complications of internal orthopaedic prosthetic devices, implants and grafts	1	4	4.4
		Complications of procedures, not elsewhere classified	M	2	2.2
			N/A	1	1.1
		Failure and rejection of transplanted organs and tissues	M	1	1.1
K57	Diverticular disease of intestine	Diverticular disease of intestine	M	77	86.5
			N/A	7	7.9
		Diverticular disease of intestine	1	5	5.6
J69	Pneumonitis due to solids and liquids	Pneumonitis due to solids and liquids	M	63	72.4
			N/A	8	9.2
		Pneumonitis due to solids and liquids	2	6	6.9
		Pneumonitis due to solids and liquids	1	5	5.7
		Bacterial pneumonia, not elsewhere classified	M	1	1.1
		Pneumonia, organism unspecified	1	1	1.1
		Postprocedural respiratory disorders, not elsewhere classified	M	1	1.1
		Respiratory failure, not elsewhere classified	M	1	1.1
		Symptoms and signs concerning food and fluid intake	M	1	1.1
N17	Acute renal failure	Acute renal failure	M	53	62.4
		Acute renal failure	3	12	14.1
		Acute renal failure	1	11	12.9
			N/A	7	8.2
		Chronic renal failure	M	1	1.2
		Postprocedural disorders of genitourinary system, not elsewhere classified	2	1	1.2
F32	Depressive episode	Depressive episode	M	64	77.1
		Recurrent depressive disorder	M	8	9.6
			N/A	3	3.6
		Other anxiety disorders	M	3	3.6
		Bipolar affective disorder	M	2	2.4
		Persistent mood [affective] disorders	M	2	2.4
		Reaction to severe stress, and adjustment disorders	M	1	1.2

Code	Original Record	Reabstracted Record	Type	Count	Complete Agreement (%)
N18	Chronic renal failure	Chronic renal failure	M	31	38.3
		Chronic renal failure	3	23	28.4
		Chronic renal failure	1	13	16.0
			N/A	9	11.1
		Acute renal failure	M	2	2.5
		Unspecified renal failure	1	2	2.5
		Care involving dialysis	M	1	1.2
F31	Bipolar affective disorder	Bipolar affective disorder	M	70	93.3
			N/A	2	2.7
		Recurrent depressive disorder	M	2	2.7
		Schizoaffective disorders	M	1	1.3
K50	Crohn's disease [regional enteritis]	Crohn's disease [regional enteritis]	M	64	85.3
			N/A	5	6.7
		Crohn's disease [regional enteritis]	1	2	2.7
		Ulcerative colitis	M	2	2.7
		Crohn's disease [regional enteritis]	3	1	1.3
		Postprocedural disorders of digestive system, not elsewhere classified	M	1	1.3
K80	Cholelithiasis	Cholelithiasis	M	58	77.3
		Cholelithiasis	1	7	9.3
			N/A	6	8.0
		Cholecystitis	M	1	1.3
		Other diseases of gallbladder	1	1	1.3
		Other diseases of biliary tract	M	1	1.3
		Acute pancreatitis	M	1	1.3
S06	Intracranial injury	Intracranial injury	M	56	74.7
			N/A	7	9.3
		Intracranial injury	1	7	9.3
		Other nontraumatic intracranial haemorrhage	M	2	2.7
		Subarachnoid haemorrhage	M	1	1.3
		Intracerebral haemorrhage	M	1	1.3
		Complications of internal orthopaedic prosthetic devices, implants and grafts	M	1	1.3
T82	Complications of cardiac and vascular prosthetic devices, implants and grafts	Complications of cardiac and vascular prosthetic devices, implants and grafts	M	57	77.0
			N/A	7	9.5
		Complications of cardiac and vascular prosthetic devices, implants and grafts	1	3	4.1
		Adjustment and management of implanted device	M	3	4.1
		Chronic ischaemic heart disease	1	1	1.4
		Acute and subacute endocarditis	M	1	1.4
		Complications of internal orthopaedic prosthetic devices, implants and grafts	M	1	1.4
		Complications of other internal prosthetic devices, implants and grafts	M	1	1.4

Code	Original Record	Reabstracted Record	Type	Count	Complete Agreement (%)
Z54	Convalescence Z54 Convalescence	Convalescence	M	55	75.3
			N/A	9	12.3
		Convalescence	1	4	5.5
		Other surgical follow-up care	M	2	2.7
		Volume depletion	M	1	1.4
		Other surgical follow-up care	1	1	1.4
		Care involving use of rehabilitation procedures	M	1	1.4
L03	Cellulitis	Cellulitis	M	52	73.2
		Cellulitis	1	5	7.0
			N/A	3	4.2
		Cellulitis	3	2	2.8
		Disorders of orbit	M	1	1.4
		Cutaneous abscess, furuncle and carbuncle	3	1	1.4
		Cellulitis	2	1	1.4
		Ulcer of lower limb, not elsewhere classified	1	1	1.4
		Gangrene, not elsewhere classified	M	1	1.4
		Open wound of lower leg	M	1	1.4
		Complications of procedures, not elsewhere classified	M	1	1.4
		Complications of internal orthopaedic prosthetic devices, implants and grafts	M	1	1.4
		Complications of other internal prosthetic devices, implants and grafts	M	1	1.4
O68	Labour and delivery complicated by fetal stress [distress]	Labour and delivery complicated by fetal stress [distress]	M	62	88.6
			N/A	5	7.1
		Labour and delivery complicated by fetal stress [distress]	1	3	4.3
K35	Acute appendicitis	Acute appendicitis	M	65	94.2
		Acute appendicitis	1	3	4.3
		Diverticular disease of intestine	M	1	1.4
F20	Schizophrenia	Schizophrenia	M	63	92.6
		Schizoaffective disorders	M	3	4.4
			N/A	1	1.5
		Acute and transient psychotic disorders	M	1	1.5
S82	Fracture of lower leg, including ankle	Fracture of lower leg, including ankle	M	67	98.5
			N/A	1	1.5
C92	Myeloid leukaemia	Myeloid leukaemia	M	51	76.1
			N/A	10	14.9
		Myeloid leukaemia	1	3	4.5
		Myeloid leukaemia	3	2	3.0
		Other medical care	M	1	1.5
K70	Alcoholic liver disease	Alcoholic liver disease	M	49	74.2
		Alcoholic liver disease	1	8	12.1

Code	Original Record	Reabstracted Record	Type	Count	Complete Agreement (%)
	K70 Alcoholic liver disease (cont'd)		N/A	7	10.6
		Hepatic failure, not elsewhere classified	M	1	1.5
		Fibrosis and cirrhosis of liver	M	1	1.5
K92	Other diseases of digestive system	Other diseases of digestive system	M	44	69.8
		Other diseases of digestive system	1	6	9.5
				5	7.9
		Diverticular disease of intestine	M	2	3.2
		Oesophageal varices	M	1	1.6
		Gastric ulcer	M	1	1.6
		Duodenal ulcer	M	1	1.6
		Peptic ulcer, site unspecified	M	1	1.6
		Gastrojejunal ulcer	M	1	1.6
		Other diseases of digestive system	2	1	1.6
E10	Type 1 Diabetes mellitus	Type 1 Diabetes mellitus	M	47	79.7
			N/A	3	5.1
		Type 1 Diabetes mellitus	1	3	5.1
		Type 2 Diabetes mellitus	M	3	5.1
		Unspecified diabetes mellitus	M	2	3.4
		Other specified diabetes mellitus	M	1	1.7
I61	Intracerebral haemorrhage	Intracerebral haemorrhage	M	50	84.7
		Cerebral infarction	M	4	6.8
		Other nontraumatic intracranial haemorrhage	M	2	3.4
			N/A	1	1.7
		Subarachnoid haemorrhage	M	1	1.7
		Intracerebral haemorrhage	2	1	1.7

* N/A indicates that the original MRDx was not coded at all by the reabstractor, either because it was not identified in the original chart or because it did not meet the criteria for significance and was purposefully not recorded.

Overall, the majority of MRDx assignments in the original record were supported by the reabstractors (unweighted average 79%), with values ranging from 100% agreement (Z38 - Liveborn infants according to place of birth) to 38% (N18 - Chronic renal failure). Of note, in more than 28% of all instances in which N18 was the originally stated MRDx, reabstraction indicated Type 3 status (i.e., nonsignificant influence on length of stay or resource use.) However, in general we feel these observations support the use of most MRDx assignments in health services research.

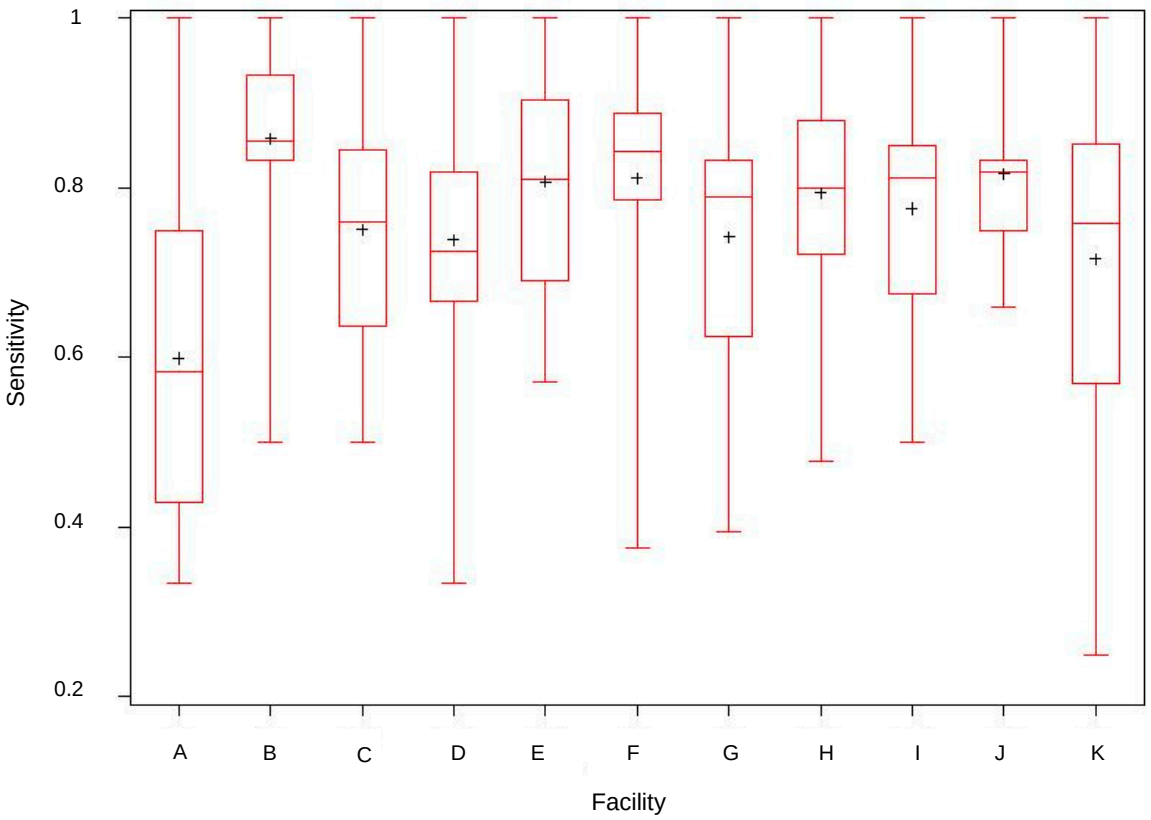
Chapter 3—Interfacility Variation in Coding

Introduction

The Ministry of Health and Long-Term Care (MOHLTC) / Canadian Institute for Health Information (CIHI) report identified significant variability in coding practices among the participating hospitals. We explored the sensitivity of coding for common comorbid diagnoses, using the mean Charlson Index for each comorbidity, by hospital.

In Figure 3.1, boxplots depict observations on the sensitivity estimates for the 16 included comorbidities of the Charlson Index. Note that HIV was excluded from this analysis because few records with a diagnosis of HIV were identified in the reabstraction study. Sensitivity is shown on the vertical axis, and hospitals (anonymized) are shown along the horizontal axis. In each boxplot, the horizontal line inside the box denotes the median, while the outer edges of each box represent the bounds of the interquartile range (i.e., the 25th and 75th percentiles). The average is shown by the '+', and the vertical lines extending above and below each box display the full range of the values for each hospital.

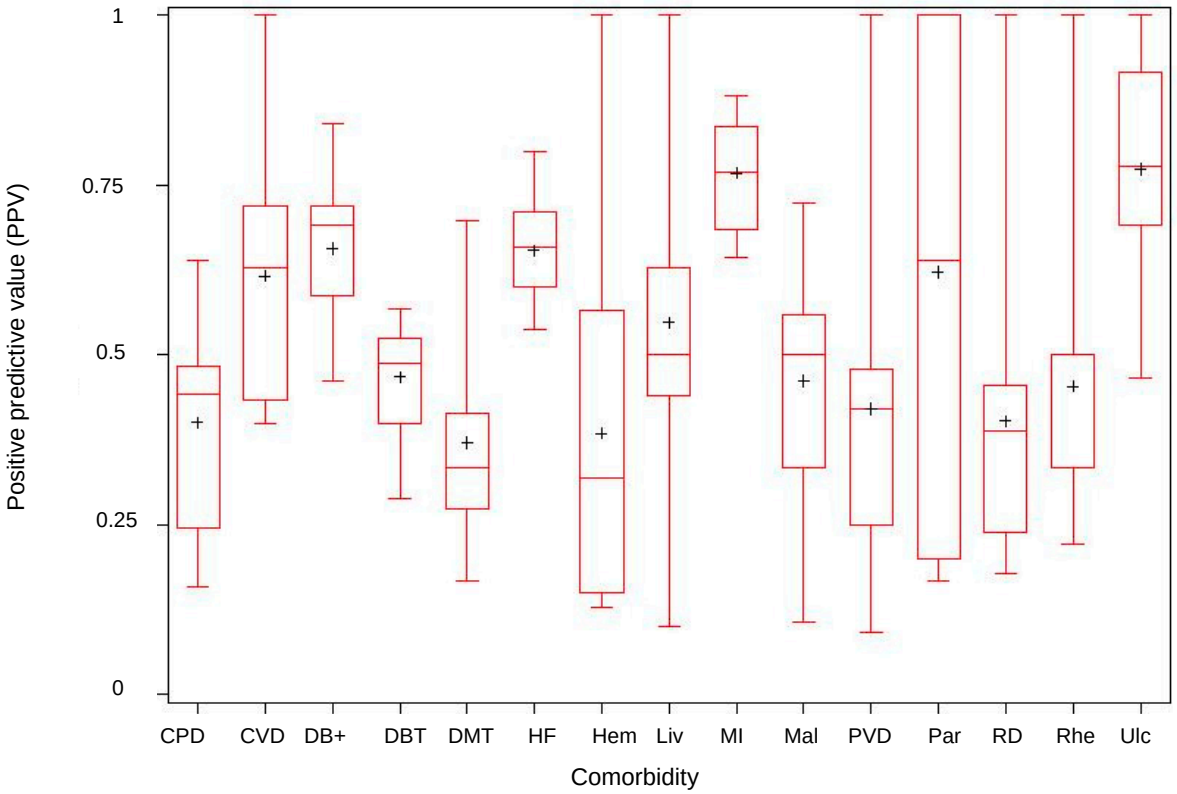
Figure 3.1 Sensitivity estimates for Charlson comorbidities, by facility



This analysis indicates that facility B has the best diagnostic sensitivity, averaged over the 16 Charlson comorbidities. Conversely, facility A is notably less sensitive than the others. Hospitals B, F, and J are among the best, as indicated by the fact that their median values tend to be high. Moreover, the boxes for each are relatively small, indicating comparatively less variability across the interquartile range of comorbidities, as compared to other hospitals.

Figure 3.2 presents boxplots for the positive predictive value (PPV) of each comorbidity. Each box represents the range of PPV values for a given comorbidity (shown on the horizontal axis), across all hospitals.

Figure 3.2 Positive predictive value estimates for Charlson comorbidities, by facility



CPD - Chronic Pulmonary Disease; CVD - Cerebrovascular Disease; DB - Diabetes with chronic complications; DBT - Diabetes; DMT - Dementia; HF - Congestive Heart Failure; Hem - Hemiplegia; Liv - Moderate or Severe Liver Disease; MI - Myocardial Infarction; Mal - Metastatic Solid Tumour; PVD - Peripheral Vascular Disease; Par - Paraplegia; RD - Renal Disease; Rhe - Rheumatologic Disease; Ulc - Peptic Ulcer Disease.

These data indicate that myocardial infarction and peptic ulcer disease are reported with the highest PPV and it appears that hospitals are consistently reporting them well. For heart failure (HF), the hospitals are still relatively consistent (the box is small), but its PPV is somewhat lower. Diabetes (discussed in detail in the Appendix) is consistently reported poorly, with a median PPV of about 0.50.

Overall, these data indicate significant variability in the coding of comorbidities that are highly relevant from a clinical and research perspective. Considerable variability was evident at the hospital level, but also at the level of individual disorders.

Summary

This report and the appendices that follow offer a detailed analysis of diagnosis- and procedure-specific agreement within the Ontario Case Costing Initiative (OCCI) dataset. The analysis yields both positive and negative findings regarding the quality of the Ontario data within the Canadian Institute for Health Information (CIHI) Discharge Abstract Database (DAD), which is routinely used for health care decision-making and health services research in Ontario.

Among the encouraging findings of this analysis is that the most responsible diagnosis (MRDx), often relied upon for health services research, generally appears to be well coded. Occasionally, however, the MRDx listed in the original record was not coded, even as another diagnosis type, by the reabstractors. The extent of this phenomenon varied according to the MRDx in question. In addition, coding for most procedures is generally good to excellent. With a few exceptions, therefore, inferences derived from the MRDx or in-hospital procedures are reaffirmed by this analysis.

However, several discouraging findings are also evident. Perhaps most troublesome is that coding of pre-admission (Type 1) and post-admission (Type 2) comorbid diagnoses is frequently very poor, with evidence of considerable 'overcoding' of common comorbidities. This threatens the conclusions of studies that rely heavily on comorbidities (rather than the MRDx), and suggests that health services researchers should avoid reliance on Type 1 and Type 2 diagnoses when possible. Policy makers should reassess the wisdom of using comorbidity information to guide health care decisions such as resource allocation. In particular, use of comorbidity information for grouping and weighting purposes should be carefully assessed when used for resource allocation purposes.

Some important interpretive cautions are warranted regarding these findings.

- The reabstraction study collected data from only the 10 hospital corporations (18 facilities) participating in the OCCI. Therefore, the generalizability of these findings to other facilities in Ontario, and to other jurisdictions in Canada, is unknown.
- The majority of analyses in this report are based upon unweighted (i.e., raw) data, both for ease of interpretation and to avoid the erroneous inference of high statistical significance from diagnosis frequencies that are, in actuality, often very small. In contrast, the OCCI was based on a stratified random sample, and therefore 'oversampled' more complex cases which are likely to exhibit greater disagreement rates than less complex cases.
- A major limitation of the OCCI dataset is that reabstractors were instructed not to reabstract Type 3 diagnoses, except for mandatory secondary conditions. This hampers the ability to study certain aspects of agreement, and in many instances, our analysis is restricted to determining percent agreement *conditional on Type 1 or Type 2 diagnosis being coded.*
- For all analyses of sensitivity, specificity, etc., we deemed the CIHI-trained reabstractor as the reference standard. However, even trained reabstractors disagree regarding a specific diagnosis, particularly when documentation in the medical record is suboptimal. Indeed, as part of the reabstraction study, approximately 800 charts were reabstracted twice to explore inter-rater agreement. Despite the intuitive assumption that agreement between trained reabstractors would be better, on average, than agreement with the original CIHI record, this was not the case for many diagnoses. As such, the reabstracted record cannot be considered as a 'gold standard'.

In summary, the findings of this analysis highlight some strengths and weaknesses of the CIHI DAD, and underscore the importance of the recommendations of the CIHI / Ministry of Health and Long-Term Care (MOHLTC) following their analysis of the OCCI reabstraction dataset. Some of these recommendations include:

1. Reviewing the current concept of diagnosis typing, with a view to determining if it can be implemented with greater consistency.

2. Implementing a strategy to improve chart documentation.

3. Conducting a review of the coding practices and processes in hospitals with particularly high and low agreement rates on selected variables, to identify best practices and identify factors contributing to the observed results.

4. Given the serious issues noted with the coding of Type 1, 2 and 3 diagnoses, grouping and weighting methodologies should use comorbid diagnoses with caution.

Appendix A. Stroke

Note: We examined the accuracy and completeness of coding for selected diagnoses of particular interest to the Institute for Clinical Evaluative Sciences (ICES) researchers using data from the reabstraction study. Throughout the appendices, we refer to the 'original' record, meaning the record as it appears in the Canadian Institute for Health Information (CIHI) inpatient Discharge Abstract Database (DAD), and to the 'reabstracted' record meaning the information coded by the reabstractor, which for analytical purposes is deemed as the reference standard.

The following conditions were selected for detailed analysis, including assessment of particular questions posed by the researchers:

1. Stroke
2. Asthma
3. Hip and knee replacement surgery
4. Parkinson's disease
5. Diabetes
6. Bowel surgery

Stroke

The ICD-10-CA diagnoses of interest for stroke are:

I60: Subarachnoid haemorrhage

I61: Intracerebral haemorrhage

I62: Other nontraumatic intracranial haemorrhage

I63: Cerebral infarction

I64: Stroke not specified as haemorrhage or infarction

G45: Transient ischemic attack

Of note, the discharge record for a stroke patient may contain more than one different stroke diagnosis, making it difficult to determine what constitutes 'agreement' between the original record and the reabstracted record. Therefore, agreement was assessed in three ways:

a) Agreement as to the most responsible diagnosis;

b) Agreement that a stroke had occurred at all; and,

c) And agreement regarding the nature of the stroke.

Additionally, agreement was assessed from two perspectives. First, we adopted the perspective of a researcher using the original CIHI discharge records to identify a cohort, and estimated how often the cohort would contain people who should not be there (i.e., people who did not actually experience a stroke). Second, we adopted the assumption of the reabstractor as the gold standard in order to ascertain how often people who have strokes (as determined by the reabstractor) are identified in the original record, thereby providing an estimate of how many actual strokes might be missing from a cohort of stroke patients.

Agreement on most responsible diagnosis

Question: When the original record contained a diagnosis of stroke of Type M, 1, 2, or W, X, or Y, did the reabstractor agree?

Because a single discharge record can contain more than one diagnosis of stroke, the reabstraction database contains more records than there were discharges. There were 895 records with a diagnosis of stroke in the original discharge database. Three of these were duplicates (they came from the same original discharge record, and contained the same diagnosis – based on the first three characters of the diagnosis – and the same diagnosis type). After removal, 892 records remained from 793 discharges, indicating that approximately 10% of the original discharge records for stroke contained more than one stroke diagnosis.

Original record containing a Type M diagnosis of stroke

In total, 511 original records contained a Type M diagnosis of stroke. There was complete agreement by the reabstractor in 81.2% (95% confidence interval [CI] 78 to 85%) of the cases. Complete agreement means that the reabstractor agreed both with the diagnosis Type M and the first three characters of the diagnosis code. The poorest agreement was for original diagnoses of I64 ('other' types of stroke), and the reabstractors indicated that this occurred because they tended to think that the strokes were due to infarction.

Agreement increases only slightly if the three haemorrhagic stroke diagnoses are combined (83% agreement, 95% CI 79% to 86%).

Table A.1 Agreement on most responsible diagnoses (MRDx) by stroke type

		Reabstracted MRDx						
		Haemorrhagic			Infarction	Other	Trans-ischemic Attack (TIA)	Non-stroke
		Subarachnoid	Intracranial	Other				
		I60	I61	I62	I63	I64	G45	
Original MRDx	I60	46 (88.5%)	1 (1.9%)					5 (9.6%)
	I61	1 (1.7%)	50 (84.8%)	2 (3.4%)	5 (8.5%)			1 (1.7%)
	I62		3 (12.0%)	19 (76.0%)	1 (4.0%)			2 (8.0%)
	I63		5 (2.4%)	1 (0.5%)	181 (87.0%)	10 (4.8%)	1 (0.5%)	10 (4.8%)
	I64				27 (19.4%)	96 (69.1%)		16 (11.5%)
	TIA				1 (3.6%)	1 (3.6%)	23 (82.1%)	3 (10.7%)

Question: When a Type M diagnosis of stroke or trans-ischemic attack (TIA) was identified in the original record, did the reabstractor agree with the diagnosis without necessarily agreeing that it was Type M?

Given disagreement on the diagnosis, there were a number of possibilities for patients originally coded as having a stroke, including:

1) The reabstractor agreed with the diagnosis, but assigned a different diagnosis type;
2) In the case of a haemorrhagic stroke, the reabstractor agreed with the haemorrhage, but not with the location;
3) The reabstractor assigned a diagnosis of TIA (or, conversely, if the original diagnosis was TIA, the reabstractor assigned a diagnosis of stroke);
4) The reabstractor agreed with the diagnosis but felt that it was a Type 3 diagnosis; or,

5) There was no agreement (i.e., the reabstractor did not agree that the patient had had a stroke or TIA).

Having a MRDx agree with a Type 3 diagnosis was placed next to last in the hierarchy, under the assumption that a diagnosis of stroke that does not affect length of stay and/or use of resources most likely represents a remote stroke. Researchers would not normally wish to include such patients in an inception cohort of strokes based on a Type M diagnosis.

Table A.2 Reabstraction results for original records with a most responsible diagnosis (MRDx) of stroke or TIA*

	Reabstraction Results						
Original MRDx	**Complete Match**	**Match on Dx, but Not on Type**	**Haem. Stroke Dx**	**Other Stroke Dx**	**TIA Dx**	**Type 3 Agreement on Dx**	**No Match**
I60	46	1 (Type 1)	1(Type M)			2	2
I61	50	1 (Type 1)	3 (Type M)	4 infarct (Type M)	0	1	0
I62	19		3 (Type M)	1 infarct (Type M)			2
I63	181	5 (one Type 1; three Type 2; 1 Type W)	6 (Type M)	10 I64 (Type M)	1 (Type M)		5
I64	96	3 (Type 1)		28 infarct (27 Type M; one Type 1)		3	9
TIA	23	2 (Type 1)		2: one infarct; one I64, both Type M			1

*The row headings indicate the first three characters of the MRDx in the original record. Table entries are counts.

From these observations, we conclude that if researchers select discharge records on the basis of a Type M diagnosis of a stroke or TIA, it will almost always (94.5%; 95% CI 92% to 96%) be true that the patient did indeed have a clinically important stroke or TIA, with strokes and TIAs correctly differentiated from one another.

Agreement on whether stroke or TIA occurred at all

Of the 793 original charts containing one or more diagnoses of stroke or TIA, the reabstractors agreed that 677 (85.4%; 95% CI 83% to 88%) of them had been correctly assigned a stroke or TIA diagnosis other than Type 3. Of the remainder, the reabstractors agreed that 48 (6.1%) had suffered a stroke or TIA, but felt that the diagnosis should have been Type 3, whereas in the original chart, six were Type M, 35 were Type 1, and seven were Type 2. For the remaining 68 charts (8.6%), reabstractors found no evidence of a stroke or TIA.

Thus, if a record is selected from the CIHI database on the basis of a stroke or TIA diagnosis that contributed to the length of stay and/or hospital resources, and/or to a service transfer (i.e., any diagnosis type other than Type 3), we estimate that in 91.4% (95% CI 89% to 93%) of cases, the reabstractor agrees that the patient did indeed suffer a stroke or TIA.

However, in some cases the reabstractor did not agree that the stroke or TIA warranted mention. An estimated 6% (48 out of 725, 95% CI 5% to 9%) should have been Type 3 diagnoses, as determined by the reabstractor.

Agreement regarding the nature of the stroke

To examine this question, we identified all patients with a diagnosis of a cerebral infarction, TIA, haemorrhagic stroke and 'other' stroke, and examined the agreement separately within each category. As a result, some people may appear in the analysis more than once (i.e., if they had more than one type of stroke in their record). Table A.3 gives the distribution of stroke types in the reabstracted charts.

Table A.3 Distribution of stroke type in reabstracted charts

Stroke Type	N (%)
TIA only	60 (7.6%)
Other stroke only	224 (28.3%)
Infarction only	294 (37.1%)
Haemorrhagic stroke only	176 (22.2%)
TIA and haemorrhagic stroke	11 (1.8%)
Haemorrhagic stroke and infarction	16 (2.0%)
Other combinations	12 (1.5%)
Total	**793**

Table A.4 shows how often the reabstractor agreed with the diagnosis found in the original record. Agreement is divided three-fold:

1. When a reabstractor assigned a diagnosis type that is mandatory to report, this is reported in the first column;
2. When a reabstractor characterized the diagnosis as Type 3, this is shown in the second column; and,
3. When a reabstractor did not provide any support for the diagnosis of stroke, this is shown in the third column.

Table A.4 Reabstraction results for original records with a diagnosis of stroke or TIA (any diagnosis type)

Type (N)	Matched by a Mandatory Diagnosis	Matched by a Type 3 Diagnosis	Not Matched
Haemorrhagic stroke (N = 207)	173 (83.6%)	10 (4.8%)	24 (11.6%)
Infarction (N = 318)	259 (81.5%)	14 (4.4%)	45 (14.2%)
Other (N = 229)	141 (61.6%)	18 (7.9%)	70 (30.6%)
TIA (N = 80)	46 (57.5%)	10 (12.5%)	24 (30.0%)

We then checked for certain kinds of miscoding in the original records. However, this was complicated by the fact that some people had diagnoses for more than one type of stroke. Therefore, it is difficult to ascertain the reason for disagreement.

Question: If the original record had a mandatory code for haemorrhagic stroke that was not validated by the reabstractor, did the reabstractor code for an infarction?

In total, 176 original records had only a diagnosis of haemorrhagic stroke. Of these, the reabstractor disagreed with 29 (16.5%). Specifically, the reabstractor felt that haemorrhagic stroke had occurred but was a Type 3 diagnosis in nine instances, and that the correct diagnosis was an infarction in six other instances.

Question: If the original record had a mandatory code for infarction that was not validated by the reabstractor, did the reabstractor code for a haemorrhagic stroke?

Of 294 original records with only a diagnosis of an infarction, 54 were not validated by the reabstractor. Of these, the reabstractor felt that the infarction had occurred but was a Type 3 diagnosis in 13 instances, and the reabstractor assigned a diagnosis of haemorrhagic stroke in five instances.

Question: If the original record contained a mandatory code for 'other stroke' that was not validated by the reabstractor, did the reabstractor assign a more specific diagnosis?

The dataset contained 224 original records with only a diagnosis of 'other stroke'. Of these, 85 (37.9%) were not validated by the reabstractor. In 35 cases, the reabstractor assigned a diagnosis of infarction, and in three cases, the reabstractor assigned both a diagnosis of infarction and a diagnosis of haemorrhage. In 18 cases, the reabstractor agreed with the diagnosis of 'other stroke', but felt that it was a Type 3 diagnosis. In two of these, the reabstractor also assigned a diagnosis of infarction that was not contained in the original record. Therefore, there were 38 instances (17.0% of 224 records) in which the reabstractor assigned a more exact code.

Type 2 (post-admission) strokes

Type 2 (post-admission) strokes were analyzed separately, as they may be of special interest in studies (e.g., complications of surgery). In the Ontario Case Costing Initiative (OCCI) dataset, there were 192 diagnoses of stroke or TIA originally labelled as Type 2, representing 184 hospital discharges. If a hospital discharge was associated with both a stroke and a TIA, it was labelled a 'stroke'. Within the 184 discharges were 156 strokes and 28 TIAs. Roughly three quarters (76.6%) of Type 2 strokes were verified by reabstractors.

Table A.5 Reabstraction results for original records with a Type 2 (post-admission) diagnosis of stroke or TIA

	Reabstracted Type 2 Diagnosis - N (%)				
	No Stroke	**Stroke Type**			**TIA**
Original Type 2 Diagnosis		**Haemorrhagic**	**Infarction**	**Other**	
Haemorrhagic stroke	9 (24.3%)	24 (64.9%)	4 (10.8%)		
Infarction	9 (12.3%)	1 (1.4%)	56 (76.7%)	6 (8.2%)	1 (1.4%)
Other stroke	7 (15.2%)		6 (13.0%)	32 (69.6%)	1 (2.2%)
TIA	18 (64.3%)				10 (35.7%)
Overall	**43 (23.4%)**				

Therefore, if we were examining stroke as a complication of surgery, for example, we anticipate that one quarter (23.4%, 95% CI 17% to 30%) of those strokes and TIAs classified as Type 2 comorbidities in the original database would be incorrectly classified, since reabstractors found no evidence of a Type 2 diagnosis of stroke or TIA. However, approximately one quarter of such events would be identified. If interest was restricted to strokes (i.e., excluding TIAs), the percentage of misclassified strokes is estimated to be 16.0% (95% CI 11% to 23%).

Question: When the reabstractor assigned a Type M, 1, 2 or W,X,Y diagnosis of stroke, did the original chart also contain a stroke diagnosis?

The dataset contains 819 reabstracted discharge records (representing 741 different hospital discharges) with a Type M, 1, 2, or W,X, or Y diagnosis of stroke or TIA. Thus, although the reabstractors were not as liberal in their coding as the original abstractors, some discharges were associated with more than one stroke/TIA diagnosis.

Type M reabstractions

The reabstractors assigned 527 Type M diagnoses of stroke or TIA. Of these, 53 (10.1%; 95% CI 8% to 13%) did not appear in the original charts as a Type M stroke/TIA. Therefore, we estimate that a cohort selected on the basis of a Type M diagnosis would miss about 10% of the desired strokes/TIAs.

The number of observations for each code are outlined in Table A.6. The counts sum to 100% across each row.

Table A.6 Original most responsible diagnosis (MRDx) in records with a reabstractor-assigned MRDx of stroke or TIA

		Original MRDx - N (%)						
		Haemorrhagic			Infarction	Other	TIA	Non-stroke
		Subarachnoid	Intractranial	Other				
		I60	I61	I62	I63	I64	G45	
Reabstracted MRDx	I60	46 (86.8%)	1 (1.9%)					6 (11.3%)
	I61	1 (1.5%)	50 (74.6%)	3 (4.5%)	5 (7.5%)			8 (11.9%)
	I62		2 (8.0%)	19 (76.0%)	1 (4.0%)			3 (12.0%)
	I63		5 (2.1%)	1 (0.4%)	181 (76.1%)	27 (11.3%)	1 (0.4%)	23 (9.7%)
	I64				10 (8.5%)	96 (81.4%)	1 (0.9%)	11 (9.3%)
	TIA				1 (3.9%)		23 (88.5%)	2 (7.7%)

These data suggest that haemorrhagic strokes are the ones most likely to be missed by using Type M diagnoses.

Overall identification of strokes and TIAs

The reabstractors assigned a stroke diagnosis to 687 discharges. Of these, 629 (91.6%) had a stroke diagnosis of one of the mandatory types (M, 1, 2, W, X or Y) in the original record. The reabstractors assigned a TIA diagnosis to 55 discharges. Of these, 45 (81.8%) had a TIA diagnosis of one of the mandatory types in the original record.

Collectively, the reabstractors assigned a diagnosis of stroke and/or TIA to 678 discharges. This is fewer than the total number of the stroke and TIA discharges counted separately, because some records contained both diagnoses. Of these, 678 (91.5%) had a diagnosis of stroke and/or TIA in the original record.

Therefore, it appears that the original records do indeed capture strokes if they occur, but that TIAs are less readily identified.

Question: How well are different types of strokes recorded?

If the reabstractor felt that a patient experienced a haemorrhagic stroke, most of the time (91.6%) this information was contained in the original record. When the reabstractors identified infarctions or 'other' stroke types, the fact of a stroke was usually recorded (~95%), but the type of stroke was incorrect about 15% of the time. If the reabstractor felt that there had been a TIA, this was recorded as a stroke in some instances, and completely missed in others. However, these observations are based on relatively few instances. These data are summarized in Table A.7.

Table A.7 Original stroke/TIA diagnosis compared to the reabstractor-assigned diagnosis

	Diagnosis in Original Record - N (%)			
Diagnosis in Reabstracted Record	**Same Type of Stroke**	**Stroke, but Not the Same Type**	**TIA**	**No Match**
Haemorrhagic stroke	174 (91.6%)	8 (4.2%)		8 (4.2%)
Infarction	259 (77.3%)	50 (14.9%)		26 (7.8%)
Other stroke	140 (76.5%)	19 (10.4%)	1 (0.6%)	23 (12.6%)
TIA	match to TIA 45 (81.8%)	match to stroke 4 (7.3%)		6 (10.9%)

Question: How well are post-admission strokes recorded?

In other words, if the patient did, in fact, have a post-admission stroke (as determined by the reabstractor), is it recorded in the original discharge record?

Of the 192 records with a Type 2 diagnosis of stroke or TIA identified by the reabstractors, stroke was not identified as a Type 2 condition in 26.6% of the records (95% CI 20% to 33%). In particular, while haemorrhagic post-admission strokes are recorded well, infarctions and 'other strokes' are not. Similarly, TIAs are not well recorded, with around one-third either missing or miscoded. Therefore, use of the DAD record to identify complications following surgery would underestimate the complication rate.

Table A.8 Original record diagnoses of post-admission stroke/TIA, in records with a reabstractor-assigned post-admission diagnosis of stroke or TIA

	Original Type 2 Diagnosis - N (%)				
	No Stroke	Stroke Type			TIA
Reabstracted Type 2 Diagnosis		**Haemorrhagic**	**Infarction**	**Other**	
Haemorrhagic stroke	5 (16.7%)	24 (80.0%)	1 (6.3%)		
Infarction	27 (29.0%)	4 (4.3%)	56 (60.2%)	6 (6.5%)	
Other stroke	16 (29.6%)		6 (11.1%)	32 59.3%)	
TIA	3 (20.0%)		1 (6.7%)	1 (6.7%)	10 (66.7%)
Overall	**51 (26.6%)**				

Appendix B. Asthma

Two questions were of particular interest to ICES researchers:

a) How well is asthma coded in the Canadian Institute for Health Information (CIHI) hospital discharge records?; and,
b) When it is miscoded, does it tend to be miscoded as chronic obstructive pulmonary disease (COPD) or as bronchiolitis?

A related issue of interest was whether miscoding was influenced by the age of the patient.

The ICD-10-CA diagnosis codes which were used were asthma (J45), COPD (J44), and bronchiolitis (J21). As with diabetes and Parkinson's disease, asthma is often a Type 3 comorbidity. Records from the 2003/04 discharge abstract were selected if they contained a diagnosis of asthma in any of the 25 diagnostic fields. If there was more than one diagnosis of asthma, the 'highest' diagnosis type was selected, using a hierarchy of most responsible diagnosis > Type 1 or Type 2 diagnosis > transfer diagnosis (Types W, X, and Y) > Type 3 diagnosis.

In 2003/04, 48.2% of the 133 discharge records with a diagnosis of asthma specified that it was the most responsible diagnosis, 20.2% contained a Type 1 or 2 diagnosis (there were very few Type 2 diagnoses: N = 37; 0.2%), and 31.7% contained only a Type 3 diagnosis.

Accuracy and completeness of asthma coding

Here again we refer to the original record (meaning the record which appears in the CIHI Discharge Abstract Database [DAD]), and to the reabstracted record (meaning the information coded by the reabstractor); the latter is the ostensible reference standard.

Question: If the original CIHI record contained a Type M or 1 diagnosis of asthma, what did the reabstractors report?

The reabstraction database contains 133 records with an original diagnosis of asthma, 53 (39.8%) with a Type M diagnosis and 80 (60.2%) with a Type 1 diagnosis. There were no service transfer diagnoses of asthma.

In 69 instances (51.9% of 133 records) the reabstractor agreed with the asthma diagnosis and assigned it a diagnosis type of either M or 1. When the reabstractor agreed with the original asthma diagnosis, of 49 original Type M diagnoses, the reabstractor assigned Type 1 rather than Type M to five (10.2%). And of 20 original Type 1 diagnoses, the reabstractor assigned Type M instead, to one record (5.0%).

In another 45 cases (33.8% of 133 records), the reabstractor did not assign an asthma diagnosis, indicating that the reason was 'significance'. In other words, although the reabstractor agreed that the patient had asthma, he or she felt that the diagnosis did not warrant a diagnosis type of M, 1, or 2. Interestingly, in all of these cases, the original record listed asthma as Type 1. In two of these 45 cases, the reabstractor assigned a diagnosis of COPD (one of them as Type M and one as Type 1). In six cases (4.5% of the 133 records), the reabstractor assigned a diagnosis of COPD instead. In none of these six cases did the reabstractor indicate asthma as an additional diagnosis.

Finally, in 13 cases (9.8% of 133 records), the reabstractor found no evidence in the original record supporting a diagnosis of asthma. These included one record in which asthma was the original most responsible diagnosis (MRDx), and 12 records in which it was listed as a Type 1 diagnosis. In none of these 13 instances did the reabstractors report either COPD or bronchiolitis.

Overall, in 114 out of 133 discharges (85.7%), the reabstractor agreed that the patient had asthma, although more than a third of the time (45 out of 114 = 39.5%) the reabstractor did not feel that the asthma contributed to the length of stay, while the original abstractor felt that it did. In eight of the 133 discharges (6.0%), the reabstractor felt that the Type M or 1 diagnosis should have been COPD rather

than asthma. There were no records in which the reabstractor thought that the diagnosis should have been bronchiolitis.

Table B.1 Reabstractor-reported diagnoses in charts with an original most responsible diagnosis (MRDx) or pre-admission diagnosis of asthma

Reabstractors' Conclusions	N	Percentage
Asthma was a Type M or 1 diagnosis	69	51.9%
COPD was the correct Type M or 1 diagnosis	6	4.5%
Evidence of asthma, but as a Type 3 diagnosis; COPD was the Type M or 1 diagnosis	2	1.5%
Evidence of asthma, but as a Type 3 diagnosis, no evidence of COPD or bronchiolitis	43	32.3%
No evidence of asthma, nor of COPD or bronchiolitis	13	9.8%
Total	**133**	**100%**

We had little data from which to draw meaningful inferences regarding the effect of age on diagnosis. The 133 records were split into four groups:

1) Those in which the reabstractor agreed that there was a Type M or 1 diagnosis of asthma;
2) Those in which the reabstractor felt that asthma was a Type 3 diagnosis (excluding two that were assigned a diagnosis of COPD by the reabstractors);
3) Those in which the reabstractor felt the correct Type M or 1 diagnosis was COPD; and,
4) Those in which the reabstractors found no evidence of asthma.

The mean age of those for whom there was agreement on the asthma diagnosis was 36 years, while the mean ages of the other three groups were 61 years (no evidence of asthma), 64 years (asthma as a Type 3 diagnosis, not Type M or 1), and 69 years (correct diagnosis was COPD). The first group (asthma is the correct diagnosis) was significantly younger than the other three groups ($p < 0.01$ for all three comparisons).

Question: If the reabstractors felt that the diagnosis was asthma, did the original chart contain a diagnosis of asthma?

The second part of the analysis examines how well asthma is captured in the original records. The reabstractors assigned a diagnosis of asthma to 76 records, calling it a Type M code in 47 cases (61.8%) and a Type 1 code in 29 cases (38.2%). This contrasts with the original records, in which the proportions were reversed (39.8%) Type M.

In most instances in which the reabstractors assigned a diagnosis of asthma, the original chart also contained an asthma diagnosis (N = 70, 91.1%, 95% confidence interval [CI] 84% to 97%).

When the original chart agreed with the asthma diagnosis, there tended to be good agreement regarding diagnosis type as well. Of the 70 charts with agreement on diagnosis, the reabstractors assigned a type of M to 45, and in 44 (97.8%) of those the original chart also had a Type M diagnosis. In the remaining chart, the original diagnosis type was 1.

Of the 70 charts with agreement on the diagnosis, the reabstractors assigned a type of 1 to 25, and in 19 (76.0%) of those 25, the original chart also had a Type 1 diagnosis; there was also one chart with an original type of 3 and five with an original type of M.

In two of the 76 charts, the original chart contained a diagnosis of COPD, but no diagnosis of asthma. In one case, the reabstractor and the original chart both had a diagnosis type of M; in the other case, both had a diagnosis type of 1. In four (5.3%) of the 76 charts, there was no diagnosis of asthma in the original charts.

Overall, these observations suggest that asthma tends to be accurately coded in the discharge abstract when it should be there, and when (according to the reabstractors) it contributes to the length of stay, this also tends to be well captured as reflected in the diagnosis type in the original record.

Table B.2 Original diagnoses in charts with a reabstractor-assigned most responsible diagnosis (MRDx) or pre-admission diagnosis of asthma

Diagnosis in Original Chart	N	Percentage
Asthma was a Type M or 1 diagnosis	70	90.8%
COPD was a Type M or 1 diagnosis	2	2.6%
Asthma was a Type 3 diagnosis	1	1.32%
Asthma was not recorded in the original chart	4	5.26%
Total	**76**	**100%**

Not surprisingly given the small number of records in which there was disagreement, we found no significant relationship between age and diagnostic agreement.

Appendix C. Hip and Knee Replacement Surgery

ICES researchers studying hip and knee replacement surgery identified the following questions as ones of particular interest:

1) Is there agreement regarding whether surgery was done, and regarding the actual joint that was replaced (hip vs. knee)?
2) Using the exclusions applied in the *Access to Health Services in Ontario: ICES Atlas*[5], do the original and the reabstracted diagnoses and admission codes exclude the same discharges?
3) Is there agreement on the revision attribute, and does this vary by year (since it was optional until 2003/04)?
4) Is there agreement on left vs. right vs. bilateral?
5) Is there agreement on cemented vs. uncemented procedures?
6) Is there agreement on the underlying diagnosis (e.g., osteoarthritis, rheumatoid arthritis, etc.)?

To address these questions, the following codes were used:

i) Hip replacement: 1.VA.53.LA-PN (open approach) and 1.VA.53.PN.PN (robotic assisted)

ii) Knee replacement: 1.VG.53

(Note: These codes were not further decomposed, in order to maintain comparability. However, true knee replacements are dual-component devices [1.VG.53.LA-PN] and tri-component devices [1.VG.53.LA-PP]. Partial knee replacements involve single-component devices [1.VG.53.LA-PM] or cement spacer [1.VG.53.LA-SL-N]. An '-N' at the end of the procedure code indicates a cemented joint, while a blank indicates uncemented; '-A' and '-K' indicate the use of a bone graft without cement, and 'Q' indicates both bone graft and cement. Also, status attribute R = revision. L-code for laterality: B = bilateral, R = right, L = left, U = unilateral unspecified.)

iii) Rheumatoid arthritis: M06 (M05 is seropositive RA, but did not appear in the hip and knee replacement data)

iv) Osteoarthritis: M16 and M17 (arthrosis of hip and knee, respectively)

Exclusions were cancer (C40.2, C40.3, C40.8, C40.9, C79.5), injury (S32.4, S72.x, S82.0, S82.1, S82.2, S82.4, S82.7 or S82.9), and external cause of injury (V01.x – V99.x, and W00.x – W19.x). Hospital admissions which were 'urgent', emergent', or 'entry from emergency' were also excluded. These are outlined in greater detail below.

Question: When the original record had a code for hip or knee replacement, did the reabstractor agree?

In total, 402 records with an original code of hip or knee replacement surgery were extracted, including eight replicates (multiple procedures on the same patient during the same hospitalization). Therefore, the analyses were performed on 394 records. Of these, 196 were coded as total hip replacements in the original chart, and 198 were coded as total or partial knee replacements.

The data set contained 192 records in which the original and the reabstractor agreed that a hip replacement had been performed, 196 in which they agreed that a knee replacement had been performed, and four original hip replacement and two original knee replacement records where the reabstractor did not agree. One of the unmatched knee replacement procedures was a single component procedure (i.e., a partial rather than full replacement).

When the reabstractor did not agree, several explanations were given. In one instance, the reabstractor felt the procedure was done on the patella; in another, the reabstractor felt it involved the pelvis. In

another case, the reabstractor felt it was a hip repair rather than a hip replacement. In one case the reabstractor felt it was a partial knee excision rather than partial knee replacement, and in the two remaining discordant cases, the reabstractor was unable to determine how the original record of a joint replacement came to be.

Thus, in 192 out of 196 original hip replacement records, the original record and the reabstracted record agreed that surgery was performed on the hip (98.0% agreement, 95% CI 94.9% to 99.4%). In 196 out of 198 original knee replacement records, the original and the reabstracted record agreed that surgery was performed on the knee (99.0% agreement, 95% CI (96.4% to 99.9%).

Hip replacement procedures

In the original records, all 196 hip replacements procedure codes were open (as opposed to robotic assisted). In 10 cases (10/196 = 5.1%), the reabstractor coded a single component replacement. This is a partial hip replacement, of the sort the *Access to Health Services in Ontario: ICES Atlas* wanted to exclude. In four cases, as noted above, the reabstractor disagreed completely with the procedure code. Therefore, if one selects a discharge record on the basis of a Canadian Classification of Health Interventions (CCI) code for total hip replacement, it is estimated that approximately 92.9% (95% CI 88% to 96%) of such records would agree upon reabstraction.

Knee procedures

The *Access to Health Services in Ontario: ICES Atlas* examined both total knee replacements (dual and tri-component devices) and partial knee replacements (single component devices and cement spacers), in order to maintain comparability with older classification systems. Of the 198 original procedures, 15 (7.6%) were single component, 43 (21.7%) were dual component, 135 (68.2%) were tri-component, and three (1.5%) were cement spacers. The remaining two (1.0%) records were not knee replacements, as noted above. Thus, using the current criteria for identifying knee replacement procedures, 196 out of 198 original charts contained the correct procedure (99.0% agreement, 95% CI 96.4% to 99.9%).

ICES researchers felt there was little interest in being able to correctly distinguish between types of prostheses using the CCI codes, because the prostheses are changing so quickly that historic information is of limited utility. However, at some future time, researchers may want to focus on just total knee replacement procedures, and will therefore want to exclude the single component prosthesis and cement spacers. In that case, as shown in Table C.2, there were 179 original charts with a total knee replacement CCI code, and of these, 97.8% were correct according to the reabstractors (95% CI 94.4% to 99.4%).

In the two tables below, the percentages add up to 100% across each line.

Table C.1 Reabstractor-reported characteristics of knee replacement surgery

		Reabstractors' Procedure Code				
		Total Knee Replacement (TKR)		Partial Knee Replacement		Non-TKR
		Dual Component	Tri-Component	Single Component	Cement Spacer	
Original Procedure Code	Dual component	28 (63.6%)	13 (29.6%)	2 (4.6%)		1 (2.3%)
	Tri-component	3 (2.2%)	131 (97.0%)	1 (0.7%)		
	Single component	3 (18.8%)	1 (6.3%)	11 (68.8%)		1 (6.3%)
	Cement spacer	1 (33.3%)			2 (66.7%)	

Table C.2 Reabstractor-reported characteristics of knee replacement surgery, collapsed into total versus partial joint replacement

		Reabstractors' Procedure Code		
		Total Knee Replacement (TKR)	**Partial Knee Replacement**	**Non-TKR**
Original Procedure Code	Total knee replacement	175 (97.8%)	3 (1.7%)	1 (0.6%)
	Partial knee replacement	5 (26.3%)	13 (68.4%)	1 (5.3%)

Overall, these results indicate that the CIHI DAD accurately identifies when these surgeries have occurred on the hip or knee. Where disagreement exists, it most often results from confusion between partial and total joint replacement.

Exclusions

In the original charts, 326 (82.7%) of the 394 hip and knee replacement patients were admitted electively; the rest were admitted on an urgent basis. Of all hip and knee replacements, 356 (90.4%) had none of the exclusion diagnoses noted above (e.g., cancer); seven (1.8%) had a diagnosis of cancer; one (0.3%) had a diagnosis of fractured acetabulum; and 30 (7.6%) had a diagnosis of fractured femur, patella, tibia or fibula.

In all, 75 of the original charts (19.0% of 394 charts) would have been excluded on the basis of type of admission and/or diagnosis. The reabstractors agreed with 71 of the 75 original exclusions, and agreed with all 319 of the inclusions. So the disagreement rate is four out of 394 charts (1.0%).

Table C.3 Inclusion/exclusion criteria for elective joint replacement procedures

		Reabstractors' Opinion		
		Include	**Exclude**	**Total**
Original Chart	Include	319	0	319
	Exclude	4	71	75
	Total	**323**	**71**	**394**

(Note: Research on hip and knee replacement procedures typically excludes surgery performed non-electively, and surgery performed on patients with certain diagnoses [cancer, fracture]. The decision to include/exclude a joint replacement procedure based on information in the original chart is compared with the decision based on *reabstractor-assigned* information.)

Using the reabstractor as the reference standard, the sensitivity of the original record is estimated as 98.8% (319 out of 323). Specificity, defined as the proportion of those who were excluded who should have been excluded, was 100% (71 out of 71). The four disagreements resulted from disagreement over admission status. The original chart and the reabstractor agreed that the four patients had none of the exclusion diagnoses. However, the original charts coded the admissions as urgent, while the reabstractors felt they were elective.

The most common reasons for exclusion (among the 71 patients for whom there was agreement) were urgent admission (N = 33, 46.5%) or an urgent admission accompanied by a diagnosis of fracture of the femur, patella, tibia or fibula (N = 28, 39.4%). Because the fractures tend to be accompanied by a non-elective admission, there is some protection against this in the sense that the original chart has to miss both the fracture and the type of admission.

Of the 71 instances where the original chart and reabstractor agreed about the exclusion of a patient, there were two disagreements: one in which there was agreement on the fracture (the original chart indicated an elective admission, while the reabstractor said it was urgent), and one in which there was agreement regarding urgency (only the original chart contained a diagnosis for fracture).

The exclusions affected mainly the hip replacements: of the 75 exclusions, based on the original charts, 60 were hip replacement patients and 15 were knee replacement patients. None of the four hip

replacement procedures which were miscoded (according to the reabstractors) were excluded, and only one of the two miscoded knee replacement procedures was excluded. In other words, if we estimated error rates using only the non-excluded charts, they would be higher, because excluding some of the charts would reduce the denominator. However, there was no reason to think that miscoding a partial hip replacement as a total hip replacement would depend on whether or not the patient had cancer, and so the error rates were not re-calculated.

Identification of revisions

Agreement on whether the procedure was a revision seemed to be independent of agreement on the nature of the procedure itself. For example, in the case coded as total knee replacement in the original chart, but as replacement of the patella by the reabstractor, there was still agreement that the procedure was a revision and that the prosthesis was cemented. However, for simplicity, we examined revisions only for comparable procedures.

Of the 186 charts in which there was agreement on a *total hip replacement:*

Table C.4 Designation of total hip replacement procedures as primary or revision

Hip Replacement		**Reabstractors' Opinion**		
		Primary	Revision	Total
Original Chart	Primary	159	4	163
	Revision	1	18	19
	Total	**160**	**22**	**182**

Sensitivity was estimated at 81.8% (95% CI 60% to 95%), and specificity at 99.4% (95% CI 96.6% to 100.0%).

Partial knee replacement (13 charts):

Table C.5 Designation of partial knee replacement procedures as primary or revision

Partial Knee Replacement		**Reabstractors' Opinion**		
		Primary	Revision	Total
Original Chart	Primary	6	1	7
	Revision	0	6	6
	Total	**6**	**7**	**13**

Sensitivity is estimated at 85.7%; specificity is estimated at 100%.

Of the 175 charts in which there was agreement on a *total knee replacement:*

Table C.6 Designation of total knee replacement procedures as primary or revision

Total Knee Replacement		**Reabstractors' Opinion**		
		Primary	Revision	Total
Original Chart	Primary	159	0	159
	Revision	5	11	16
	Total	**164**	**11**	**175**

Sensitivity was estimated at 100%; specificity at 97.0%.

Total or partial knee replacement (196 charts):

Table C.7 Designation of knee replacement procedures (total and partial) as primary or revision

Knee Replacement		**Reabstractors' Opinion**		
		Primary	Revision	Total
Original Chart	Primary	170	1	171
	Revision	5	20	25
	Total	**175**	**21**	**196**

Sensitivity is estimated at 95.2% (95% CI 76.2% to 99.9%). Specificity is estimated at 97.1% (95% CI 93.5% to 99.1%).

Agreement was also examined by year, because the coding of revisions was not mandatory in 2002/03. However, this did not influence the findings, as shown below:

Hip replacements:

Table C.8 Designation of total hip replacement procedures as primary or revision, Year 1

Hip Replacement, Year 1		Reabstractors' Opinion		
		Primary	Revision	Total
Original Chart	Primary	85	3	88
	Revision	1	11	12
	Total	**86**	**14**	**100**

Table C.9 Designation of total hip replacement procedures as primary or revision, Year 2

Hip Replacement, Year 2		Reabstractors' Opinion		
		Primary	Revision	Total
Original Chart	Primary	74	1	75
	Revision	0	7	7
	Total	**74**	**8**	**82**

(Note: Table C.8 contains data for 2002/03, when the coding of revisions was not mandatory. Table C.9 contains data for 2003/04, after coding of revisions became mandatory.)

Knee replacements (total and partial combined):

Table C.10 Designation of knee replacement procedures (total and partial) as primary or revision, Year 1

Knee Replacements, Year 1		Reabstractors' Opinion		
		Primary	Revision	Total
Original Chart	Primary	104	0	104
	Revision	5	8	13
	Total	**109**	**8**	**117**

Table C.11 Designation of knee replacement procedures (total and partial) as primary or revision, Year 2

Knee Replacements, Year 2		Reabstractors' Opinion		
		Primary	Revision	Total
Original Chart	Primary	66	1	67
	Revision	0	12	12
	Total	**66**	**13**	**79**

(Note: Table C.10 contains data for 2002/03, when the coding of revisions was not mandatory. Table C.11 contains data for 2003/04, after coding of revisions became mandatory.)

Overall, there were few revisions. Agreement was low enough for the hip replacements to be of concern if a researcher wished to estimate how long prostheses last before a revision is needed, but the 95% confidence interval is wide because of low numbers. Agreement is low enough that we will probably continue to combine the CIHI information with Ontario Health Insurance Plan (OHIP) billing information and/or with information on laterality (discussed below) in order to identify revisions.

Laterality

Laterality is important both as a check on revision coding and for determining how long joint replacements last before they require revision. If surgery was performed on the left side, and then later on the right side, the second procedure is not a revision. If, however, the first procedure had been either bilateral or on the right side, then the later procedure is indeed a revision.

For hip replacement, there was complete agreement, with the exception of one record with an invalid code ('ZZ'): three bilateral procedures, 108 procedures on the right hip, and 70 on the left hip. Based on a sample size of 181 (excluding the one record with an invalid code, the 95% CI for agreement is 98.4% to 100%).

For knee replacements, 194 of the 196 records showed agreement (99.0% agreement, 95% CI 96.4% to 99.9%). There were 12 bilateral procedures; two showed disagreement. In one case, the original record indicated 'unilateral, unspecified if right or left'; in the other case, the original record indicated a bilateral procedure. In both cases, the reabstractor felt that the right knee had been operated on. Also in both cases, the original chart showed a dual component prosthesis and the reabstractor felt it was a tri-component prosthesis. One possible explanation for this is that the charts and/or the original abstractor may not have been sufficiently attentive to this detail.

In summary, laterality appears to be recorded more accurately than revisions. Agreement was very high.

Cemented vs. uncemented procedures

The hip replacement CCI code, 1.VA.53.LA-PN, has five possible 10th characters. -N means the prosthesis was cemented. If the 10th character is blank, the procedure was uncemented. -A, and -K are uncemented procedures with bone graft (autograft and homograft, respectively). -Q is a combination of bone graft plus cement.

If we examine agreement on the use of cement and the use of a bone graft, the reabstractor disagreed with the original chart in 22 of the 182 hip replacements (12.1%; 95% CI 8% to 18%).

Table C.12 Reabstractor-reported characteristics of total hip replacement procedures

Hip Replacements		**Reabstracted Procedure Code (10th character)**			
		No Cement (blank)	**Cement (N)**	**Bone Graft (A or K)**	**Both Bone Graft and Cement (Q)**
Original Procedure Code	No cement	57 (86.4%)	3 (4.6%)	5 (7.6%)	1 (1.5%)
	Cement	4 (7.3%)	46 (83.6%)		5 (9.1%)
	Bone graft	1 (2.7%)			36 (97.3%)
	Both			3 (12.5%)	21 (87.5%)

If the attribute of interest is the use of cement, the table can be collapsed:

Table C.13 Reabstractor-reported characteristics of total hip replacement procedure

Hip Replacements		**Reabstractors' Opinion**		
		Uncemented	Cemented	Total
Original Chart	Uncemented	63	40	103
	Cemented	7	72	79
	Total	**70**	**112**	**182**

Based on the 'positive' outcome of the use of cement, sensitivity is low (64.3%, 72 out of 112, 95% CI 55% to 73%). Specificity is 90.0% (63 out of 70, 95% CI 80% to 96%).

For knee replacement procedures, the implantation of a cement spacer was removed from consideration (since this, by definition, involves cement). We combined both partial and total knee replacements, under the assumption that the determination of the use of cement is independent of the type of

prosthesis used. There were 193 records in which both the original chart and the reabstracted chart contained a CCI code for a partial or total knee replacement, excluding cement spacer. Cement was used much more frequently in knee surgery.

Table C.14 Reabstractor-reported characteristics of knee replacement procedures (total and partial)

Knee Replacements		Reabstracted Procedure Code (10th character)			
		No Cement (blank)	Cement (N)	Bone Graft (A or K)	Both Bone Graft and Cement (Q)
Original Procedure Code	No cement	17 (73.9%)	6 (26.1%)		
	Cement	2 (1.6%)	115 (92.7%)	1 (0.8%)	6 (4.8%)
	Bone graft				2 (100%)
	Both		2 (4.6%)		42 (95.5%)

Table C.15 Reabstractor-reported characteristics of knee replacement procedures (total and partial)

Knee Replacements		Reabstractor		
		Uncemented	Cemented	Total
Original Chart	Uncemented	17	8	25
	Cemented	3	165	168
	Total	**20**	**173**	**193**

Sensitivity (using cemented as the 'positive' outcome) is estimated to be 95.0% (95% CI 91% to 98%), and specificity is estimated to be 85.0% (95% CI 62% to 97%).

These data suggest that the use of cement seems to be poorly recorded for hip replacements, though accurately reported for knee replacements. The reason for this is unclear.

Diagnosis of Rheumatoid Arthritis
Only 11 charts contained a Type M or 1 diagnosis of rheumatoid arthritis (RA), and the reabstractor agreed with 10 of these (91%).

In total, 278 charts contained an original diagnosis of osteoarthritis (OA). In 262 (94.2%) charts, it was the most responsible diagnosis, in 13 (4.7%) it appeared as a Type 1 diagnosis, and in three charts (1.1%) it appeared as a service transfer diagnosis.

The reabstractors disagreed with four of the 278 diagnoses of osteoarthritis, and felt that two others should have been Type 3 diagnoses. Of the four disagreements, in one case the reabstractor felt the correct diagnosis was RA rather than OA. In another case, the reabstractor thought the correct diagnosis was 'congenital deformity of the hip'. In the remaining two cases, the reabstractor simply disagreed completely with the diagnosis. Agreement with the diagnosis of OA is therefore estimated to be 98.6%.

Consequently, there were charts in which there was no associated diagnosis of arthritis, or in which neither the original abstractor nor the reabstractor felt that it was a mandatory diagnosis. If we believe that arthritis is almost always the underlying reason for a joint replacement, this suggests that when we use the hospital discharge records to identify individuals with arthritis, we are missing up to one quarter of the diagnoses. (In the original records, 105 [26.6%] of the 394 hip and knee replacement procedures did not have an accompanying non-Type 3 diagnosis of OA or RA; in the reabstracted records, 111 [28.2%] did not have an accompanying non-Type 3 diagnosis.)

Question: When the reabstractors felt that a hip or knee replacement had been performed, how often was this recorded in the original chart?

The reabstractors identified 400 total hip replacements plus total or partial knee replacements. Of these, 378 were in the original chart and 22 (5.5%) were not. In 19 of the 22 cases where the procedure was not in the original chart, this was because the reabstractors had identified a total (dual component) hip

replacement (1.VA.53.LA-PN) and the original chart recorded a partial hip (single component) replacement (1.VA.53.LP-PM).

Of the remaining three unmatched cases, in one instance the original chart recorded an ‘excision, partial, knee’, which the reabstractor felt was a partial knee replacement. In the other two cases, the original chart recorded ‘removal of device, hip’, whereas the reabstractor felt that this had been followed by a total hip replacement.

In summary, the proportion of hip and knee replacement procedures missing from the original charts is estimated at 5.5% (95% CI 3% to 8%). The cause of disagreement was almost always disagreement between total and partial hip replacements.

Appendix D. Parkinsonism

A diagnosis of Parkinson's disease (ICD-10-CA code G20) often appears in the hospital discharge abstract as a Type 3 diagnosis—a secondary comorbidity that does not contribute to length of stay and/or resource use. Recording of Type 3 diagnoses in the discharge record is not mandatory, and because they do not contribute to the estimation of cost of care, they were not examined as part of the reabstraction project, other than to explain discrepancies between the original record and the reabstracted record.

To gain an understanding of this issue as it pertains to Parkinson's disease, we began by examining ICES' inpatient discharge database for 2003/04 (that is, the full Canadian Institute for Health Information [CIHI] inpatient database for 2003/04). There were 4,983 discharge records with one or more diagnoses of Parkinson's disease. For each record, we noted the 'highest' type of diagnosis, using the hierarchy M (most responsible diagnosis) > 1 or 2 (pre-admit and post-admit comorbidities) > W, X, or Y (service transfer diagnoses) > 0 (newborns) > 3. For example, if Parkinson's was coded as both a Type 1 and a Type 3 comorbidity, we selected the Type 1 diagnosis. Table D.1 shows that when a Parkinson's diagnosis is found in an inpatient discharge record, a sizeable proportion of the time it appears only as Type 3 diagnosis, and was therefore not included in the Ontario Case Costing Initiative (OCCI) project.

Table D.1 Diagnosis types associated with Parkinson's disease diagnoses in the 2003/04 discharge abstract database

'Highest' Diagnosis Type	% out of 4,983
M	15.5%
1 (pre-admission other than most responsible)	36.8%
2 (post-admission)	0.2%
W, X, or Y (service transfer)	0.2%
0 (newborns)	0.0%
3 (secondary)	47.4%

With this caveat, we next addressed questions from ICES researchers regarding the accuracy and completeness of coding of Parkinson's disease in the Discharge Abstract Database (DAD), as estimated from the reabstraction study.

Question: When the original record contained a diagnosis of Parkinson's disease of Type M, 1, 2, or W, X or Y, did the reabstractor agree?

The reabstraction study examined 102 original records with a diagnosis of Parkinson's disease. In 23 (22.5%) of these records, the original diagnosis type was M, in the remaining 79 (77.5%), the original diagnosis type was 1. In 43 records, the reabstractor agreed with both the diagnosis of Parkinson's disease, and also that it was either a Type M or 1 diagnosis. In three records, the reabstractor agreed with the diagnosis but felt that it was a Type 3 condition, while in an additional 50 cases the reabstractor did not code the diagnosis due to a perceived lack of significance.

In six of the records, the reabstractor disagreed with the original diagnosis. In one case, the reabstractor felt that the diagnosis should have been G211 (other drug-induced secondary Parkinsonism). In one record, the reabstractor assigned a code of G308 (Alzheimer's disease with Parkinson's). In a third record, the reabstractor assigned a code of Z501 (encountering health services for physical therapy); it is possible that the physical therapy was required due to Parkinson's disease. In the three remaining cases, the reabstractor did not provide a diagnostic code.

Table D.2 outlines the extent to which the reabstractor agreed with the original diagnosis of Parkinson's disease, and apparent reasons for discrepancies.

Table D.2 Reasons underlying discrepant coding of Parkinson's disease diagnoses identified in the original records

Original Chart Diagnosis of Parkinson's Disease	N (%)
Confirmed by the reabstractor, with a mandatory diagnosis type (M, 1, 2, W, X, Y)	43 (42.2%)
Confirmed by the reabstractor, but with a Type 3 diagnosis	3 (2.9%) **
Reabstractor assigned a non-primary Parkinson's diagnosis	3 (2.9%)*
Reabstractor did not provide a diagnosis, but stated 'significance' as reason for lack of agreement	50 (49.0%) **
Reabstractor did not provide a diagnosis, and gave some other reason for lack of agreement	3 (2.9%)*
Total	**102 (100%)**

Therefore, we estimate that 5.8% (95% CI 2.2% to 12.4%) of hospital discharges identified as related to Parkinson's disease on the basis of a Type M or 1 diagnosis of G20 are not, in fact, Parkinson's (marked with a single asterisk '*' in Table D.2). It also appears that 52.0% (95% CI 41.8 to 62.0%) of the discharge records in the CIHI database that have been assigned a mandatory diagnosis of Parkinson's disease (Type M, 1, 2, W, X or Y) are, in fact, actually Type 3 according to CIHI's coding rules (these are marked with a double asterisk '**' in Table D.2). Since Type 3 diagnoses are not mandatory, closer adherence to the CIHI coding rules would actually decrease the usefulness of DAD records as a source of information on this disease.

Question: When the reabstractor assigned a Type M, 1, 2, or W,X,Y diagnosis of Parkinsonism, did the original chart also contain a Parkinson's disease diagnosis?

Fifty reabstracted discharge records contained a diagnosis of Parkinson's disease with a diagnosis type of M or 1. Of these, 44 contained a matching diagnosis from the original record. In 43 cases, the original record also classified the diagnosis as Type M or 1; in the remaining record, it was classified as Type 3.

Of the six original charts that did not contain a G20 diagnosis, four had a diagnosis of G30.8 (Alzheimer's with Parkinson's) and one had a diagnosis of G90.3 (disorders of autonomic nervous system, multi-system degeneration). There was nothing related to a disease of the nervous system in the remaining chart.

Table D.3 Reasons underlying discrepant coding of Parkinson's disease diagnoses identified in the reabstracted records

Reabstracted Diagnosis of Parkinson's Disease	N (%)
Also found in the original record, with a mandatory diagnosis type (M, 1, 2, W, X, Y)	43 (86%)
Also found in the original record, but with a Type 3 diagnosis	1 (2%)
Original record contained a non-Parkinson's diagnosis	5 (10%)
No Parkinson's diagnosis from the original chart was included in the database, but the abstractor stated 'significance' as reason for lack of agreement	0
No Parkinson's diagnosis from the original chart was included in the database, and the reabstractor gave some other reason for lack of agreement	1 (2%)
Total	**50**

In the case where the reabstractor determined that the chart provided evidence of Parkinson's disease as a comorbid condition which contributed to the patient's length of stay and/or resource utilization, it is estimated that the original CIHI abstract contained a code for Parkinson's disease 95.0% of the time. In only a small proportion (0.6%) of those cases did the original abstractor code the disease as a Type 3 diagnosis.

An estimated 88% (95% CI 76% to 95%) of discharges that should have had a diagnosis of Parkinsonism did contain the diagnosis in the original CIHI record. Of those, 2% (95% CI 0% to 12%) originally contained the diagnosis, but coded as Type 3.

In summary, Parkinson's disease is often a Type 3 comorbidity, and as such does not influence length of stay (LOS) and/or resource intensity. These diagnoses are not taken into consideration when assigning the patient Case Mix Group (CMG) or Resource Intensity Weight (RIW), which in turn means that they do not influence hospital funding. The inclusion of such diagnoses in the discharge abstract is optional, rendering Parkinson's disease a diagnosis that is difficult to study using the reabstraction dataset.

When Parkinson's disease does appear in a discharge record as a Type M or 1 diagnosis, the reabstractors almost always (91.2%) agreed that the patient suffered from Parkinsonism. When Parkinson's disease *should* appear in a discharge record as a Type M, 1, 2, or X, Y, Z diagnosis, we estimate that it appears in 95% of the charts. In <1% of those cases, the original health records abstractor classified it as a Type 3 comorbidity, rendering it only slightly vulnerable to any policy that decreases the coding of Type 3 conditions.

The significance of these findings for ICES researchers who wish to use the DAD to identify Parkinson's disease is unclear, although one likely interpretation is that relying on DAD records to identify patients with Parkinson's disease will almost certainly result in under-detection of cases. This is because the disease often does not meet the criteria for mandatory reporting, in a database whose primary function is to estimate hospital resource utilization.

Appendix E. Diabetes

Diabetes is diagnosis for which the reabstraction study does not provide much meaningful information, because diabetes (ICD-10-CA codes E10, E11, E13 and E14), like Parkinson's disease, tends to occur as a Type 3 diagnosis in the hospital discharge records. Fortunately, at ICES most diabetic patients are identified using the Ontario Health Insurance Plan (OHIP) and/or Ontario Drug Benefit Plan (ODB), rather than relying on hospital discharge records.

To explore the coding of diabetes in the Discharge Abstract Database (DAD), we began by examining ICES' inpatient discharge database for 2003/04 (that is, the full Canadian Institute for Health Information [CIHI] inpatient database for 2003/04). For each record with one or more diagnosis of diabetes (n=2102), we noted the 'highest' type of diabetes diagnosis, using the hierarchy M (most responsible diagnosis) > 1 or 2 (pre-admit and post-admit comorbidities) > W, X, or Y (service transfer diagnoses) > 3. For example, if diabetes was coded as both a Type 1 and a Type 3 comorbidity, we selected the Type 1 diagnosis. Table E.1 shows that when a diagnosis of diabetes is found in an inpatient discharge record, it often appears only as Type 3 diagnosis and would not be identified in the Ontario Case Costing Initiative (OCCI) project.

Table E.1 Diagnosis types associated with a diagnosis of diabetes in the 2003/2004 discharge abstract database

'Highest' Diabetes Diagnosis Type	% of all Discharges (N = 2,102)
M	12.9%
1 (pre-admission other than most responsible)	44.8%
2 (post-admission)	0.4%
W, X, or Y (service transfer)	0.1%
3 (secondary)	41.8%

Next, we addressed the accuracy and completeness of diabetes coding in the discharge database, as estimated from the reabstraction study. In looking for 'matches' in the diagnosis of diabetes, we looked only at the question of whether the original and reabstracted records agreed that the patient had diabetes. For example, one of the original records recorded four diabetes diagnoses (E10222, E10223, E10322 and E10422). The reabstractor confirmed only two of those diagnoses, and this was considered a match.

Question: When the original record contained a diagnosis of diabetes of Type M, 1, 2, or W, X or Y, did the reabstractor agree?

The reabstraction study examined 2,102 original records which contained a Type M, 1, 2, or W, X or Y diagnosis of diabetes.

The reabstractor has three choices for each diagnosis found in the original chart. The reabstractor can agree with the original diagnosis, or can indicate a related (or, in some cases, unrelated) diagnosis which the reabstractor thinks is the correct diagnosis – the one which should have been entered in the original record. Or, the reabstractor can fail to assign any diagnosis. When there is disagreement between the original diagnosis and the reabstracted diagnosis (either the reabstractor enters a different diagnosis or the reabstractor doesn't provide a diagnosis at all), a reason is entered. Of interest in the case of diabetes is that the reason may be 'significance', meaning that the original diagnosis had a Type M, 1, 2, or W, X or Y, but the reabstractor felt it should have been Type 3.

Table E.2 Reasons underlying discrepant coding of diabetes diagnoses identified in the original records

Original Chart Diagnosis of Diabetes	Unweighted N (%)
Confirmed by the reabstractor, with a mandatory diagnosis type (M, 1, 2, W, X, Y)	1,435 (68.3%)
Confirmed by the reabstractor, but with a Type 3 diagnosis	25 (1.2%)**
Reabstractor assigned a non-diabetes diagnosis	2 (0.1%)*
Reabstractor did not provide a diagnosis, but stated 'significance' as reason for lack of agreement	518 (24.6%)**
Reabstractor did not provide a diagnosis, and gave some other reason for lack of agreement	122 (5.8%)*
Total	**2,102**

Therefore, we estimate that 5.9% (95% CI 4.9% to 7.0%) of hospital discharges to which we assign a diagnosis of diabetes based on the presence of a Type M, 1, 2, or W,X,Y diagnosis of E10, E11, E13 or E14, are in fact not diabetes (single asterisk '*' in Table E.2).
It also appears that 25.8% (95% CI 24.0% to 27.8%) of the discharge records in the CIHI database which have been assigned a mandatory (Type M, 1, 2, W, X or Y) diagnosis of diabetes are really Type 3 according to CIHI's coding rules (double asterisk '**' in Table E.2). Since Type 3 diagnoses are not mandatory, closer adherence to the CIHI coding rules would decrease the usefulness of the hospital discharge records as a source of information on diabetes.

Question: When the reabstractor assigned a Type M, 1, 2, or W,X,Y diagnosis of diabetes, did the original chart also contain a diabetes diagnosis?

Overall, 1647 reabstracted discharge records contained a diagnosis of diabetes with a diagnosis type of M, 1, 2, or W,X or Y. In nine instances where the reabstractor assigned a diagnosis of diabetes not found in the original record, the diagnosis from the original record was provided. These were: E743 (other disorders of intestinal carbohydrate absorption); two instances of I739 (peripheral vascular disease); two instances of N179 (acute renal failure); R730 (abnormal glucose tolerance test); two instances of R739 (hyperglycemia); and, E872 (acidosis).

Table E.3 Reasons underlying discrepant coding of diabetes diagnoses identified in the reabstracted records

Reabstracted Diagnosis of Diabetes	Unweighted
Also found in the original record, with a mandatory diagnosis type (M, 1, 2, W, X, Y)	1,433 (87.0%)*
Also found in the original record, but with a Type 3 diagnosis	75 (4.6%)*
Original record contained a non-diabetes diagnosis	9 (0.5%)
No diabetes diagnosis from the original chart was included in the database, but the abstractor stated 'significance' as reason for lack of agreement	4 (0.2%)
No diabetes diagnosis from the original chart was included in the database, and the reabstractor gave some other reason for lack of agreement	126 (7.7%)
Total	**1,647**

Thus, in the case where the reabstractor determined that the chart provided evidence of diabetes as a comorbid condition which contributed to the patient's length of stay and/or resource utilization, it is estimated that the original CIHI abstract contained a code for diabetes 91.6% of the time (single asterisk '*' in Table E.3, 95% CI 90.4% to 93.1%). However, in 5.0% of those instances (75 out of 1,508, 95% CI 4.2% to 6.5%), the original abstractor coded diabetes as a Type 3 condition, meaning that its inclusion was optional.

In summary, diabetes is often a Type 3 comorbidity – a secondary disorder which does not influence patient length of stay and/or resource intensity. These diagnoses are not taken into consideration when assigning the patient Case Mix Group (CMG) or Resource Intensity Weight (RIW) – which in turn means that they do not play a role in determining hospital funding. As far as the CIHI rules go, their inclusion in the discharge abstract is optional. That renders diabetes difficult to study using the reabstraction database.

However, a few inferences can be drawn from the OCCI dataset. First, when diabetes does appear in a discharge record as a Type M, 1, 2, or W,X,Y diagnosis, the reabstractors almost always (94.5%) agreed that the patient had diabetes. Second, when diabetes should appear in a discharge record as a Type M, 1, 2, or X, Y, Z diagnosis, it is estimated to appear in 90.6% of the charts. In 8.3% of those cases, the original abstractor classified it as a Type 3 comorbidity, making it somewhat vulnerable to any policy which decreases the coding of Type 3 conditions.

It is not clear what this means to ICES researchers who hope to use the discharge abstracts to identify people with diabetes, or to identify the frequency with which diabetes is associated with other comorbidities or with certain interventions. This is because diabetes often does not meet the criteria for mandatory reporting in a database aimed at estimating hospital resource utilization.

Appendix F. Cancer Surgery—Large Intestine

The *Access to Health Services in Ontario: ICES Atlas* examined two types of large bowel procedures: procedures to the large intestine and procedures to the rectum. The questions of interest to ICES researchers were:

1) Do the original and the reabstracted record agree that the surgery took place at all?

2) Do the original and the reabstracted record agree on the location of the surgery (large intestine vs. rectum)?

3) Given that the records agree on the location of the surgery (large intestine vs. rectum), do they agree on the exact nature of the surgery (that is, do the first five digits of the Canadian Classification of Health Interventions [CCI] code agree)?

4) Do the records agree as to whether the surgery was open vs. laparoscopic, and on whether the type of surgery was converted to open (in which case the surgery should be recorded as open surgery, with a status of 'C')?

5) Do the records agree as to whether or not there is a cancer diagnosis associated with the record?

Records were extracted from the Ontario Case Costing Initiative (OCCI) database if either the original discharge abstract and/or the reabstracted record contained one of the following procedures:

Table F.1 Procedure codes used to identify colorectal surgery

Intestine (Therapeutic Interventions on the Large Intestine)	
1NM87 (excluding 1NM87BA	Excision partial, large intestine
1NM89	Excision total, large intestine
1NM91	Excision radical, large intestine
Bowel (Therapeutic Interventions on the Rectum)	
1NQ87 (excluding 1NQ87BA)	Excision partial, rectum
1NQ89	Excision total, rectum
1NQ90	Excision total with reconstruction, rectum

We examined all of the records, regardless of whether or not they were associated with a diagnosis of cancer, on the assumption that errors in coding the intervention would be independent of diagnosis.

Question: Is there agreement between the original record and the trained reabstractor on whether surgery occurred at all?

There were 496 observations in which the original record and/or the reabstracted record contained one of the target interventions:

Table F.2 Occurrence of 'target' colorectal procedures in the original and reabstracted records

		Reabstracted Intervention is One of the Target Codes	
		No	Yes
Original Intervention is One of the Target Codes	No	0	22 (4.4%)
	Yes	33 (6.7%)	441 (88.9%)

Table F.3 presents an overall picture of this subset, and indicates that there are instances in which the original record and the reabstracted record agreed on location (intestine or rectum), but disagreed about whether the procedure was one of the procedures on the 'target' list (or, alternately, disagreed as to whether the procedure was therapeutic or diagnostic).

'Out of scope' combines instances where there was no corresponding code. In these instances, either the original record contained one of the target interventions and the reabstractor couldn't find support for

this in the chart, or the reabstractor assigned one of the target codes and there was nothing similar in the original record. These also include instances in which the reabstractor felt that whatever led to the appearance of the target code in the original record was something outside the scope of the reabstraction. In this particular analysis, the latter event arose only once, when the reabstractor felt that the code should have been 1NF13BA (control of bleeding, stomach, using endoscopic approach).

Because all of the records selected had to contain one of the target interventions, either in the original or reabstracted record, some of the cells in the table cannot contain any observations. These are marked '-' in the table below.

Table F.3 Agreement between reabstractor-reported and original colorectal procedure codes

			Reabstracted Record					
			Target Intestine	**Target Rectum**	**Other Intestine**	**Other Rectum**	**All Other Procedures**	**Out of Scope**
Original Record	Target procedures	Intestine (1NM)	301 (60.7%)	10 (2.0%)	5 (1.0%)	1 (0.2%)	10 (2.0%)	11 (2.2%)
		Rectum (1NQ)	4 (0.8%)	126 (25.4%)	0	2 (0.4%)	0	4 (0.8%)
	Other therapeutic procedures on large intestine and rectum	Intestine (1NM)	2 (0.4%)	3 (0.6%)	-	-	-	-
		Rectum (1NQ)	0	1 (0.2%)	-	-	-	-
	All other procedures		4 (0.8%)	3 (0.6%)	-	-	-	-
	Out of scope		4 (0.8%)	5 (1.0%)	-	-	-	-

Note: For the remainder of the analyses, we assume the perspective of an ICES researcher who has extracted inpatient discharge records using one of the target intervention codes in the original dataset. That is, we will examine only records which contained one of the target codes in the *original* record.

Question: Can procedures on the intestine be distinguished from procedures on the rectum?

In other words, was there agreement on the location of the intervention, conditional on finding one of the target codes in the original record?

In Table F.4, percentages add up to 100% across the rows. For example, when the original record indicated one of the target intestine codes, 92.0% of the reabstracted codes agreed that one of the target interventions had occurred, although though they may not have agreed as to *which* of the interventions it was. Therefore, if the *Access to Health Services in Ontario: ICES Atlas* combined intestine and rectal interventions, then 441 out of the 474 records would be deemed 'correct'. The estimated proportion that would be correct is 93.0% (95% confidence interval [CI] 90% to 95%).

Table F.4 Reabstractor-reported procedures identified in charts with an original colorectal procedure code

		Reabstracted Code					
		Target Intestine	**Target Rectum**	**Other Intestine**	**Other Rectum**	**Other**	**Out of Scope**
Original Target Intervention Code	Intestine	***301 (89.1%)***	***10 (3.0%)***	5 (1.5%)	1 (0.3%)	10 (3.0%)	11 (3.3%)
	Rectum	***4 (2.9%)***	***126 (92.7%)***	0	2 (1.5%)	0	4 (2.9%)

The bold-italicized cells in the table contain 441 observations. For those cells, kappa = 0.92 (95% CI 0.89, 0.96). McNemar's test has a P value of 0.11, suggesting that when there was disagreement, there was no evidence of a particular directional bias. However, the difference is not statistically significant; nor is it likely to be large enough to be clinically significant.

Question: Can the exact nature of the intervention be determined reliably?

In Table F.5, the percentages add up to 100% across each row.

Table F.5 Reabstractor-reported procedures found in charts with an original colorectal procedure code

		Reabstracted Intervention Code			
		Same Code	**Another Target Code, Same Organ**	**Another Target Code, Other Organ**	**All Others**
Original Target Intervention Code	1NM87	281 (88.4%)	3 (0.9%)	10 (3.1%) (all 1NQ87)	24 (7.6%)
	1NM89	10 (58.8%)	5 (29.4%) (all 1NM87)	0	2 (11.8%)
	1NM91	1 (33.3%)	1 (33.3%) (1NM87)	0	1 (33.3%)
	1NQ87	85 (90.4%)	2 (2.1%) (all 1NQ89)	4 (4.3%) (all 1NM87)	3 (3.2%)
	1NQ89	31 (88.6%)	2 (5.7%)	0	2 (5.7%)
	1NQ90	5 (71.4%)	1 (14.3%)	0	1 (14.3%)

When the original code was 1NM87 and the reabstractor chose 1NM87BA (this happened three times), which was an *excluded* intervention, this was counted in the 'all others' column, since although the location is correct, it is not one of the targeted interventions. Similarly, when the original code was 1NQ87 and the reabstractor chose 1NQ87BA, this was included in the 'all others' column.

Based upon these numbers, it appears that if one finds a record in the discharge abstract that reports an intestine intervention of 1NM89 or 1NM91, there is a good chance that the actual procedure (according to the reabstractor) was 1NM87. If one selects a record with a rectal intervention of 1NQ87 or 1NQ90, there is a small chance (about 2%) that the actual procedure was 1NQ89 (according to the reabstractor). Moreover, it also appears that the target intervention codes are not reliable beyond the first three characters.

Question: Can open and laparoscopic procedures be reliably differentiated?

Open and laparoscopic procedures are differentiated on the basis of the sixth character of the CCI code (the seventh character designates the technique used). Laparoscopic approaches can be performed for the following procedures: 1NM87, 1NM89 and 1NQ87.

This was examined only in those instances where the original record and the reabstracted record agreed on the first five characters of the CCI code. It is also possible to combine all of the records (in which the question open vs. laparoscopic is relevant), in order to achieve a larger sample size. This was not done, however, under the assumption that the likelihood of making a mistake depended on what the abstractors expected to see, which in turn depended on the procedure.

Table F.6 shows original records with one of the 1NM87 target codes, when the reabstractor agreed with the 1NM87 rubric. The percentages add up to 100% across each row. When the original record indicated laparoscopic surgery, the reabstractor disagreed about half the time, classifying the procedure as either open (N=9, 39.1% of the time), or as endoscopic per orifice (CCI code 1NM87BA, which is not one of the target interventions, N=2, 8.7%). If the original record indicated open surgery, the

reabstractor almost always agreed. However, these observations are based on relatively small numbers of observations and may not be generalizable.

For this table, looking only at the italicized records, McNemar's test has a P value of 0.011, indicating that where there was disagreement, it was statistically more likely to occur when the original record indicated laparoscopic surgery. That is, it appears that the original coders are preferentially coding for laparoscopic procedures. Kappa for the italicized cells in Table F.6 was 0.69 (95% CI 0.51 to 0.87).

Table F.6 Designation of colorectal procedures as laparoscopic or open procedures

1NM87		Reabstracted Record		
		INM87BA	***Laparoscopic***	***Open***
Original Record	Laparoscopic	2 (8.7%)	*12* *(52.2%)*	*9* *(39.1%)*
	Open	1 (0.4%)	*1* *(0.4%)*	*259* *(99.2%)*

For 1NM89, there were 10 records, and complete agreement that they were always performed as open surgery. For 1NM91, there was a single record, which the original coder and the reabstractor agreed was open surgery.

For 1NQ87, there were 85 records, with complete agreement: nine (10.6%) were laparoscopic and 76 (89.4%) were open.

For 1NQ89, the sixth character indicates the approach. Overall, there was agreement as to the approach in 87.1% of the records (95% CI 70% to 96%).

Table F.7 Reabstractor-reported characteristics of colorectal surgery

1NQ89		Reabstracted Record		
		Abdominal Approach	**Abdominoperineal Approach**	**Combined Approach**
Original Record	Abdominal approach	5 (62.5%)	3 (37.5%)	0
	Abdominoperineal approach	0	22 (100%)	0
	Combined approach	0	1 (100%)	0

Question: Are the status codes reliable?

This question was examined for those instances in which the original record and the reabstracted record agreed as to the first five characters of the intervention code. We restricted the analysis to records where there was agreement on the intervention because the possible status codes depend on the intervention. However, it might also make sense to look at the coding of, for example, conversion, collapsed over all of the intervention codes where conversion was possible.

Possible status codes were 'C' (converted), 'S' (staged), and 'A' (abandoned after onset). Status 'A' is available for all of the interventions, while 'C' and 'S' are available only when applicable.

For 1NM87 (Table F.8), Kappa was 0.70 (95% CI 0.45 to 0.95). McNemar's test had a P value of 0.063, suggesting that where there was disagreement, the original record was more likely than the reabstracted record to contain a code for conversion. In two of the cases where the original record indicated a status of 'conversion', the original record contained the intervention code for a laparoscopic procedure. (In one case, the reabstractor agreed that the procedure was laparoscopic, and disagreed with the conversion status; in the other case, the reabstractor agreed with the conversion status, and therefore coded an open procedure.)

It may be that the 'conversion' status should only accompany an open procedure, since conversion is otherwise not possible. The co-occurrence of a laparoscopic procedure code and status of 'conversion' suggests a lack of error checking in the software.

Table F.8 Identification of conversions during colorectal surgery

1NM87		Reabstracted Status	
		None	Conversion
Original Status	None	270 (100%)	0
	Conversion	5 (45.5%)	6 (54.6%)

For 1NQ89 (Table F.9), Kappa was -0.04, reflecting the dominance of cell A in Table F.9. Because virtually all of the records had no status code, Kappa is not a useful test here. In effect, there were too few staged procedures to formulate useful inferences from these data.

Table F.9 Identification of staging during colorectal surgery

1NQ89		Reabstracted Status	
		None	Staged
Original Status	None	28 (96.6%)	1 (3.5%)
	Staged	2 (100%)	0

There were no status indications for any of the 1NM89, 1NM91, 1NQ87 or 1NQ90 procedures (so there was, at least, total agreement that nothing untoward had happened).

Question: Was there agreement on the presence or absence of a cancer diagnosis?

The procedures were matched with their diagnostic codes. Diagnoses of cancer of the bowel were retained (C18 [colon], C19 [rectosigmoid interface], C20 [rectum], and C21 [anus]). If there was more than one cancer diagnosis associated with an intervention, a hierarchy was applied, such that a most responsible diagnosis was preferentially selected, followed by a Type 1 (pre-admission comorbidity) or Type 2 (post-admission comorbidity) diagnosis. Only if the intervention was not associated with a most responsible or Type 1 or Type 2 bowel cancer diagnosis, either in the original record and/or in the abstracted record, was a cancer diagnosis of another type (e.g., W, X or Y, which are service transfer diagnoses) retained.

Examining the discharges in which the original record contained one of the target procedures, regardless of what the reabstracted record indicated, yielded Table F.10. Kappa was 0.95 (95% CI 0.92 to 0.98). All nine instances in which the original record, but not the reabstracted record, contained a diagnosis of cancer appeared to be genuine disagreements over the diagnosis. The 'diag_code_reason' variable was never 'significance'; in other words, the reabstractor did not indicate agreement with the diagnosis, but rather disagreement that it was a mandatory diagnosis and not a Type 3 diagnosis.

Table F.10 Occurrence of cancer diagnoses in conjunction with a procedure code for colorectal surgery in the original record

		Reabstracted Diagnosis	
		Cancer Diagnosis	No Cancer Diagnosis
Original Diagnosis	Cancer diagnosis	237 (98.8%)	3 (1.3%)
	No cancer diagnosis	9 (3.9%)	225 (96.2%)

If the analysis is restricted to the 441 records where the reabstractor agreed with the original chart (i.e., that one of the target procedures had occurred), the level of agreement improves slightly—kappa is 0.96 (95% CI 0.93 to 0.99):

Table F.11 Occurrence of cancer diagnoses in conjunction with colorectal surgery for the subset of records with agreement between the original and the reabstracted record

		Reabstracted Diagnosis	
		Cancer Diagnosis	**No Cancer Diagnosis**
Original Diagnosis	Cancer diagnosis	211 (98.6%)	3 (1.4%)
	No cancer diagnosis	6 (2.6%)	221 (97.4%)

Open vs. laparoscopic approaches for bowel surgery

1. Fundoplication with a diagnosis of reflux (CCI code 1.NA.80 and diagnosis code K21).

The original charts contained 20 procedures, all of which were matched by the reabstractor. In terms of methods, the original chart and the reabstractor agreed that eight of the 20 were laparoscopic and 11 were open. They disagreed on the remaining procedure, with the original chart stating that it was open, and the reabstractor saying that it was 'combined endoscopic approach' (1.NA.80.FA).

There was considerable disagreement between the original charts and the reabstractors on a Type M or 1 diagnosis of reflux, with 137 original charts, but only 47 matched by the reabstractor. When the records with a diagnosis of reflux were merged with the records on fundoplication, there were only nine records in which the original chart and the reabstractor agreed that the surgery was performed to treat reflux (or, anyway, in which they agreed that reflux was a Type M or 1 diagnosis associated with the hospitalization). Of these, six were laparoscopic and three were open, with total agreement between the original chart and the reabstractor. (There were two more charts in which the original chart, but not the reabstractor, assigned a diagnosis of reflux, and in both cases, there was agreement that they involved an open procedure.) There were no conversions from laparoscopic to open fundoplication.

2. Hernia repair (1SY80)

There were 215 procedures in the original charts. Thirty-two of these pertain to 15 individuals who each had two (N = 13) or three (N = 2) separate procedures. Sometimes the reabstractor agreed that one of the two procedures had occurred, sometimes the reabstractor agreed that both procedures had occurred (and sometimes the reabstractor didn't think any of them had occurred). We retained all instances where the reabstractor agreed with the original chart. This means that in the final data set, seven hospital discharges appear twice.

Of the 215 original hernia repair procedures, the reabstractors agreed with 193 (89.8%). Of the 193, the original chart and the reabstractor agreed that almost all (N = 180, 93.3%) were open, and they agreed that seven (3.6%) were laparoscopic. They disagreed on six (3.1%): four were designated as laparoscopic in the original chart, and two were designated as open in the original chart.

Table F.12 Designation of hernia repair procedures as laparoscopic or open procedures

		Reabstractor		
		Open	**Laparoscopic**	**Total**
Original Chart	Open	180	2	182
	Laparoscopic	4	7	11
	Total	**184**	**9**	**193**

Treating the reabstractor as the reference standard, these data suggest that laparoscopic procedures are infrequent (nine out of 193 = 4.7%) and that about one-third of the laparoscopic procedures found in the original charts are incorrect. However, this estimate is based on a relatively small sample size, and the degree of disagreement may be higher or lower.

The hernia repair CCI code has an associated location code. When there was agreement on the procedure, the reabstractor agreed with the original location code in 85.0% of the records. Agreement was worst when the original record had a location of 0 (no attribute is applicable; in eight out of 17 cases [47.1%] the reabstractor assigned a location) or a location of B (lower abdominal region bilateral sites; in five out of 11 cases [45.5%]) the reabstractor assigned a different location). When the original record contained a location of LW (lower abdominal region unilateral sites), the reabstractor disagreed in seven out of 36 cases (19.4%). When the original record contained a location of U (unspecified or multiple or overlapping regions), the reabstractor disagreed in four out of 37 cases (10.8%). The most common location was UP (upper abdominal region), and disagreement was five out of 92 cases (5.4%).

3. Splenectomy (1.OB.89)

There were only 10 procedures in the original charts; the reabstractors agreed that all had occurred, and there was agreement that all 10 were open procedures.

4. Adrenalectomy (1.PB.89)

The reabstractors agreed that the seven procedures in the original charts had occurred. There was agreement that three were open, and three were laparoscopic. In the remaining case, the original record recorded a laparoscopic procedure, while the reabstractor felt that it was an open procedure.

5. Kidney (1.PC.89 and 1.PC.91) (total and radical excision)

The original charts contained 15 procedures, but the reabstractors agreed on only 12 of them. There was agreement as to the method: one laparoscopic and 11 open procedures.

6. Prostate (1.QT.91) (radical excision)

Of the 34 procedures in the original charts, the reabstractors agreed with 33. There was agreement that all of them were open.

7. Hysterectomy (1.RM.89)

There were 85 hysterectomies in the original data, and the reabstractors agreed with all of them. There was agreement as to the method for 84 of the 85: 16 (18.8%) were performed vaginally, 65 (76.5%) were open procedures, and three (3.5%) were laparoscopic procedures. For the last, the original chart showed a laparoscopic procedure, while the reabstractor coded an open procedure.

8. Appendectomy (1.NV.89) (total excision)

There were 115 appendectomies in the original charts; of these, reabstractors agreed with 112 (97.4%). Where there was agreement on the procedure, there was total agreement on the method: 21 (18.8%) were performed laparoscopically and 91 (81.25%) were open procedures.

This was the only procedure for which conversions were noted. The original charts noted eight conversions and the reabstractors agreed with six of them. In addition, one of the original charts noted a status of 'B' (incidental to another procedure), which the reabstractor indicated was a conversion.

Table F.13 Identification of conversions during appendectomies

		Conversion, Reabstractor		
		No	**Yes**	**Total**
Conversion, Original Chart	No	103	1	104
	Yes	2	6	8
	Total	**105**	**7**	**112**

For 78 (69.6%) of the 112 appendectomies, there was agreement that no attribute was applicable; in 21 (18.9%) there was agreement that the procedure was performed incidental to another procedure; and in six (5.4%) there was agreement that the procedure was a conversion. The original chart disagreed with the reabstracted status for the remaining seven (6.3%): two each in which the original chart indicated

'incidental to another procedure' and conversion, but the reabstractor did not specify the attribute; two in which the converse happened (i.e., the original chart did not apply an attribute, but the reabstractor felt the procedure was incidental to another procedure), and one in which the original chart indicated the appendectomy was incidental to another procedure, but the reabstractor noted a conversion.

Table F.14 Summary Table

		Reabstractor		
		Open	**Laparoscopic**	**Total**
Original Chart	**Open**	3 fundoplication 180 hernia 10 spleen 3 adrenal 11 kidney 33 prostate 65 hysterectomy 91 appendectomy **N=396**	2 hernia **N=2**	**398**
	Laparoscopic	4 hernia 1 adrenal 1 hysterectomy **N=6**	6 fundoplication 7 hernia 3 adrenal 1 kidney 3 hysterectomy 21 appendectomy **N=41**	**47**
	Total	**402**	**43**	**445**

The procedures examined were, in aggregate, rarely performed laparoscopically (< 10%). Laparoscopic methods were most common for fundoplication, adrenalectomy and appendectomy, though the confidence intervals for the first two would be quite wide, due to the low numbers of procedures.

Assuming that erroneous ascertainment of the method (open vs. laparascopic) is independent of the type of surgery, the kappa statistic for the combined table is 0.90 (95% CI 0.83, 0.97). If, however, a researcher was interested only in laparoscopic interventions, it should be noted that 12.8% of those procedures originally coded as laparoscopic were actually found to be open by reabstractors.

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