

Supplementary Information

Assessing Validity of ICD-10 Administrative Data in Coding Comorbidities

Table S 1 The data extraction and chart review procedure for three cohorts. It includes the sampling strategies, review protocol, and inter-rater reliability.

	2003 cohort	2015 cohort	2022 cohort
Locations	Four teaching hospitals in Alberta, Canada	Three teaching hospitals in Alberta, Canada	Four teaching hospitals in Alberta, Canada
Period	Patients discharged from January 1 to June 30, 2003.	Patients discharged from January 1 to June 30, 2015.	Patients discharged from January 1, 2017, to June 30, 2022.
Sampling strategy	Randomly sampled at least 1000 patients (≥ 18 years) for each hospital.	Randomly sampled at least 1000 patients (≥ 18 years) for each hospital.	Randomly sample patients (≥ 18 years) with the available document of discharge summary.
Number of patients	4,008	3,011	9,024
Sample size calculation	$\alpha = 0.05$; $power = 0.8$.	$\alpha = 0.05$; $power = 0.8$.	$\alpha = 0.05$; $power = 0.8$.
Nurse reviewers	2	6	6
Review protocol	A review guideline is decided by following the definitions of Charlson comorbidities. Reviewers went through training, agreement study, and full chart examination to complete the review.	Used review guideline for the 2003 cohort. Reviewers went through training, agreement study, and full chart examination to complete the review.	Used review guideline for the 2003 cohort. Reviewers went through training, agreement study, and full chart examination to complete the review.
Inter-rater reliability	17 conditions had Kappa > 0.81 , 10 had Kappa > 0.61 , and 4 had moderate agreement Kappa > 0.41 .	Kappa > 0.8 .	15 conditions had high Kappa > 0.72 , and 2 had moderate agreement Kappa > 0.63 . ¹
ICD coding algorithm	Quan <i>et al.</i> (2005) ²	Quan <i>et al.</i> (2005) ²	Quan <i>et al.</i> (2005) ²

Note: For the 2003 and 2015 cohorts, patients were evenly sampled from each acute care facility. In contrast, the 2022 cohort was randomly sampled without hospital stratification, resulting in a distribution ratio of 0.40, 0.27, 0.19, and 0.14 across the facilities.

Table S 2 Detailed comparison of coding accuracy metrics for comorbidities by ICD-10-CA across three cohorts (2003, 2015, 2022).

Comorbidity	2003				2015				2022			
	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Myocardial Infarction	62.0	99.3	93.0	94.7	26.3	99.8	94.0	91.1	39.8	99.3	87.6	93.1
Congestive Heart Failure	68.9	99.3	90.2	97.2	56.0	99.2	89.7	94.7	52.8	98.9	83.7	95.1
Peripheral Vascular Disease	43.9	99.0	65.2	97.5	30.0	99.2	67.2	96.5	21.0	99.2	45.1	97.5
Cerebrovascular Disease	46.9	99.2	83.2	95.5	25.3	99.7	91.9	90.9	31.3	98.7	73.2	92.9
Dementia	66.9	99.8	92.7	98.9	64.2	99.7	91.7	97.9	40.0	99.6	82.4	97.1
Chronic Pulmonary Disease	53.1	99.0	90.6	92.3	42.9	98.5	83.5	90.9	21.1	99.4	89.2	85.3
Rheumatic Disease	52.9	99.9	96.5	98.8	15.1	99.8	76.7	95.7	4.3	99.9	80.0	94.1
Peptic Ulcer Disease	39.6	99.7	76.9	98.5	1.3	99.3	46.4	67.8	3.0	99.2	46.8	81.3
Liver Disease	41.1	99.6	85.6	97.0	27.8	99.9	94.3	94.2	24.4	99.8	89.9	94.7
Diabetes	85.1	99.6	97.6	97.5	85.2	99.1	95.8	96.6	89.7	98.9	95.1	97.6
Paralysis	54.8	99.4	59.6	99.3	17.3	99.3	29.0	98.6	12.5	99.4	6.7	99.7
Renal Disease	80.0	98.1	63.7	99.2	19.9	99.9	96.6	88.3	14.6	99.9	96.3	87.9
Metastatic Cancer	80.8	99.4	86.7	99.1	64.3	99.4	83.3	98.3	74.8	98.9	80.6	98.5
Cancer	55.8	99.0	90.0	93.2	35.8	99.5	96.7	78.8	43.4	98.6	89.2	86.8
Hypertension	68.8	97.8	93.1	87.9	52.5	98.1	96.3	68.7	29.5	97.5	90.5	63.4
Psychoses	56.9	99.8	90.4	98.7	57.8	99.6	81.2	98.7	10.0	100.0	69.2	99.1
Depression	45.5	99.4	91.2	93.1	22.6	99.0	83.2	85.3	5.9	99.7	71.8	90.0

Table S 3 Prevalence comparison of 2022 cohort, +1 prior year, +3 prior years, and +5 prior years of administrative data.

Comorbidity	Chart data (%)	ICD-10 (%)			
		2022	+1 prior year	+3 prior years	+5 prior years
Myocardial Infarction	11.0	5.0	6.4	7.2	7.5
Congestive Heart Failure	9.7	6.1	8.8	9.8	10
Peripheral Vascular Disease	3.2	1.5	2.4	3	3.2
Cerebrovascular Disease	9.9	4.3	5.7	6.5	6.8
Dementia	4.7	2.3	3.3	3.7	3.8
Chronic Pulmonary Disease	17.8	4.2	6.1	6.9	7.1
Rheumatic Disease	6.2	0.3	0.5	0.8	0.9
Peptic Ulcer Disease	19.1	1.2	2.1	2.6	2.8
Liver Disease	6.9	1.9	2.6	3	3.1
Diabetes	18.9	17.8	18.8	19.2	19.3
Paralysis	0.4	0.7	1.1	1.5	1.6
Renal Disease	13.9	2.1	3.3	3.9	4.0
Metastatic Cancer	5.6	5.2	6.1	6.3	6.4
Cancer	21.0	10.2	12.6	13.7	14.2
Hypertension	44.4	14.5	21.2	25	26.6
Psychoses	1.0	0.1	0.7	0.8	0.9
Depression	10.6	0.9	2.6	3.6	3.9

Table S 4 Detailed comparison of coding accuracy metrics for comorbidities by ICD-10-CA across 2022 cohorts with 1 prior year, 3 prior years, and 5 prior years of administrative data.

Comorbidity	+1 prior year				+3 prior years				+5 prior years			
	Sens.	Specif.	PPV	NPV	Sens.	Specif.	PPV	NPV	Sens.	Specif.	PPV	NPV
Myocardial Infarction	48.8	98.7	83.2	93.3	53.3	97.9	78.8	93.4	56.8	97.8	79.2	93.8
Congestive Heart Failure	74.6	95.9	76	95.6	78.9	94.4	73	95.9	80.6	94.2	73.3	96.1
Peripheral Vascular Disease	35.9	97.9	44.7	96.9	42.7	96.8	41.6	96.9	47.8	96.5	43.0	97.1
Cerebrovascular Disease	42.5	98.1	75.1	92.5	48.8	97.8	77.1	92.7	51.6	97.6	77.0	92.9
Dementia	60.8	98.6	73.9	97.5	64.7	98.1	70.6	97.5	66.1	97.9	69.3	97.6
Chronic Pulmonary Disease	39.4	97.9	83.9	85.5	45.5	97.3	83.5	85.7	47.3	97.1	82.9	85.9
Rheumatic Disease	8.3	99.7	70	93.3	14.2	99.6	72.3	93.4	16.8	99.5	75.6	93.5
Peptic Ulcer Disease	7.5	97.7	46.6	79.7	9.0	96.7	44.1	78.7	9.5	96.3	42.8	78.3
Liver Disease	43.6	99.1	82.5	94.6	48.7	98.4	76.2	94.7	50.6	98.2	75.2	94.9
Diabetes	94.9	97.6	92.1	98.5	95.8	96.6	89.6	98.7	95.9	96.2	88.6	98.7
Paralysis	23	98.4	7.3	99.6	45.7	97.7	11.3	99.6	54.2	97.4	12.2	99.7
Renal Disease	29.2	98.8	84.8	85.5	33.3	98.4	84.6	84.4	34.5	98.2	84.4	84.3
Metastatic Cancer	85.6	98.1	79.6	98.8	86.1	97.9	77.8	98.8	86.2	97.8	76.8	98.9
Cancer	45.7	88.9	45.1	89.1	51.3	88.2	47.6	89.7	54.3	88.2	49.2	90.2
Hypertension	51.3	92.7	87.2	66.4	62.1	90.5	87.2	69.5	66.3	89.3	86.9	71.2

Psychoses	47.2	99.3	49	99.3	53.5	99.2	51.3	99.2	59.7	98.9	47.4	99.3
Depression	25.8	97.4	60.7	89.2	34.5	95.5	57	89.4	36.9	94.7	55.4	89.4

References

1. Wu, G. *et al.* Achieving high inter-rater reliability in establishing data labels: a retrospective chart review study. *BMJ Open Qual* 13, e002722 (2024).

2. Quan, H. *et al.* Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care* 43, 1130–1139 (2005).