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Supplementary material

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Supplementary Table 1. Comparison of case-mix parameters utilised by major healthcare systems to segment their respective populations

	Description of case-mix classification system						
	CMG+		MS-DRG		DRG	HRG4+
	Canadian Institute for Health Information (Canada)		Centers for Medicare and Medicaid Services (United States)		Independent Hospital Pricing Authority (Australia)	National Health Service (United Kingdom)
Age category	Age at admission; separate groupings for newborns/neonates, paediatric, and adult populations		DRG split based on age groups for a small number of MS-DRGs. Groups apply to neonates and paediatric populations; in adults, use is diagnosis-specific due to effects on severity coding		DRG split based on age-group (eg, cellulitis age >59 or <60 years)	Different HRG4+ groupings by age among patients with the same primary diagnosis and procedures
	Newborn / Neonates	A – Newborn B – 0 to 7 days C – 8 to 28 days	Neonates	Ages <29 days at admission		
	Paediatric	F – 29 to 364 days G – 1 to 7 years H – 8 to 17 years	Paediatric	Ages <17 years at admission		
	Adults	R – 18 to 59 years S – 60 to 79 years T – ≥80 years	Adult	Diagnosis-dependent		

Admission diagnosis	ICD-10-CA diagnosis codes, based on the diagnosis deemed most responsible for the greatest portion of the patient's LOS	Principal diagnosis (and up to 24 additional diagnoses) documented using Medicare codes, based on ICD-10-CM definitions	Principal diagnosis documented using ICD-10-AM codes (Australia)	Primary diagnosis documented using ICD-10
Clinical category classification	MCC, based on ICD-10-CA diagnosis codes	MDC, 25 mutually exclusive categories based on ICD-10-CM codes corresponding to organ systems or medical specialties	N/A	N/A
Co-morbidity level factor	0 = No significant Co-morbidity 1 = 1.25 to <1.5 times more resource intensive 2 = 1.5 to <2 times more resource intensive 3 = 2 to <3 times more resource intensive 4 = 3 or more times more resource intensive NA = Co-morbidity level not applicable	Bundled with co-morbidities; distinction between cases with and without complications. Secondary diagnoses are categorised into CCs and MCCs. CC/MCC status is mutually exclusive. Hospital-acquired conditions are often not CC/MCCs (eg, foreign body left during procedure)	N/A	Bundled with complications; CC score based on summation of all secondary diagnoses' CC values, corresponding to levels of CC split (ie, co-morbidity)

Intervention factors	16 FIs that reliably predict patients likely to consume significant resources*	Pre-MDCs: resource-intensive procedures grouped separately before MDC assignment. Based on procedure rather than diagnosis. Up to 25 procedures considered per hospital stay; based on ICD-10-PCS definitions	Non-operative procedures (eg, allied health interventions, transfusions, biopsies, lumbar punctures, CT, MRI, cardiac catheterisation)	Intervention splits based on prescribed procedures (eg, Liver Failure Disorders without Interventions vs Liver Failure Disorders with Single Intervention)
IE factor	Considers multiple intervention events further predicting resource consumption. An IE is defined as a trip to the operating/surgical room, regardless of the number of interventions, if at least one intervention was significant (ie, on the Intervention Partition list)	Operating room status: only one operating procedure required to qualify for a surgical DRG. Based on surgical hierarchy; patients are assigned to a single class corresponding to the highest-level procedure performed	Surgical partition based on procedures performed in operating theatre	See procedure-based features (Diagnosis-qualified and Subsidiary procedure–qualified) below
Out-of-hospital intervention factor	Applicable only to the Circulatory System MCC; incorporates interventions outside the admitting hospital (eg, pacemaker implantation, cardiac catheterisation, PCI)	N/A	N/A	N/A
Hospital LOS	N/A	N/A	DRG split based on patient	HRG4+ derivation split

			LOS (eg, >4 days or ≤4 days)	based on patient LOS
Complications	N/A	Bundled with co-morbidities; distinction between cases with and without complications. Secondary diagnoses categorised into CCs and MCCs. Hospital-acquired conditions often not CC/MCCs	DRG split based on disease complications (eg, wound infection, urinary retention, acute blood loss, postoperative problems, adverse drug effects, surgical complications)	Bundled with co-morbidities; CC score based on secondary diagnoses' CC values. Score corresponds to CC split level
Discharge status	N/A	DRG split based on discharge status (alive vs deceased)	DRG split based on discharge destination [eg, mode of separation = discharge/transfer to acute hospital (01); death (08)]	N/A
Procedure-based (diagnosis-qualified)	N/A	N/A	N/A	Split based on dominant procedure, even among patients with different primary diagnoses
Procedure-based (subsidiary procedure–qualified)	N/A	N/A	N/A	Split based on subsidiary procedure codes (eg, indicating approach or site, including laterality; eg, right-sided or bilateral

operation)

Abbreviations: CC = Complications and Co-morbidity; CMG+ = Case Mix Groups+; CT = computed tomography; DRG = Diagnosis Related Group; FI = flagged interventions; HRG4+ = Healthcare Resource Groups; ICD-10-AM = International Statistical Classification of Diseases and Health Related Problems, Tenth Revision, Australian Modification; ICD-10-CA = International Statistical Classification of Diseases and Health Related Problems, Tenth Revision, Canadian Modification; ICD-10-CM = International Classification of Diseases, Tenth Revision, Clinical Modification; ICD-10-PCS = International Classification of Diseases, Tenth Revision Procedure Coding System; IE = intervention event; LOS = length of stay; MCC = Major Complications and Co-morbidity; MDC = Major Diagnostic Category; MRI = magnetic resonance imaging; MS-DRG = Medicare Severity Diagnosis Related Groups; N/A = not applicable; PCI = percutaneous coronary intervention

* Flagged interventions: non-invasive biopsy; cardioversion; cell saver; chemotherapy; dialysis; per-orifice endoscopy; feeding tubes (percutaneous endoscopic gastrostomy tubes); cardiac resuscitation; mechanical ventilation >96 hours; mechanical ventilation <96 hours; paracentesis; parenteral nutrition; pleurocentesis; radiotherapy; tracheostomy; vascular access device

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Supplementary Table 2. Mapping table of Major Clinical Categories, Case Mix Groups, and International Classification of Diseases codes

MCC	CMG	ICD-10 code*
Burns	Extensive burn/non-extensive burn	T20.0, T25.0, T21.0, T23.0, T24.0, T22.0
Diseases and disorders of the blood and lymphatic system	Acute leukaemia except myeloid	C91.0
	Acute lymphadenitis	L04.2, L04.0, L04.3, L04.9
	Acute myeloid leukaemia	C92.0
	Agranulocytosis	D70
	Aplastic anaemia	D61.9, D61.3, D60.9, D60.0, D60.1, D61.1
	Coagulation defect	D66, D68.6, D68.9, D68.5, D68.4, D68.8, D65, D68.2, D67, D68.1
	Hemoglobinopathy	D56.1, D56.8, D56.0, D56.9, D56.3
	Lymphoma	C86.0, C85.9, C77.0, C77.4, C84.0, C82.9, C88.0, C86.5, C83.7, C81.2, C81.9, C77.9, C77.8, C85.1, C77.3, C77.5, C77.2, C81.0, C88.9, C86.2, C84.8, C88.4, C86.3, C84.7, C82.9
	Malignant neoplasm of other site	C80.9, C48.0, C37, C79.9, C80.0, C79.8, C26.1, C76.7, C48.8, C809
	Multiple myeloma	C90.0, C90.1, D47.9, C90.2
	Non-malignant neoplasm of other site	D47.2, D15.0, D48.7, D36.9, D18.0, D18.1, D15.7, D48.3, D48.9, D47.9, D36.7, D20.0, D19.9
	Other anaemia	D59.6, D64.9, D64.8, D59.1, D58.9, D50.9, D50.0, D52.9, D51.9, D59.5, D51.0, D51.8, D55.0, D50.8, D62, D52.0, D58.1, D53.1, D53.9, D51.3, D59.0, D59.9, D64.3, D59.4, D58.0
	Other disease/disorder of blood/lymphatic system	R77.0, R72, I89.8, R59.0, I88.9, D75.9, D72.9, R59.9, D72.1, D75.1, Z03.1, R59.1, D89.9, D72.8, D74.9, R23.3, D89.1, Q85.8, E32.8, T80.9, D71, D73.4, I89.9, D84.9, D89.3, I88.8, D75.8, R16.1, D76.3, D73.9, D73.1, D84.1, E32.9, R71, D73.3, D80.8,

		D73.5, R76.8, D89.2, D89.0, D80.1, D76.1
	Other leukaemia	C91.1, C92.1, C93.1, D47.3, C95.9, C91.4, C94.6, D46.9, D47.4, D47.1, D45, D47.5, D46.2, C96.6, C95.7, D46.4, D46.1
	Purpura/other haemorrhagic disorder	D69.0, D69.3, D69.5, D69.6, D69.4, D69.2, D69.1, D59.5, D51.0, D51.8
Diseases and disorders of the circulatory system	Hypertensive disease except benign hypertension	I10
	Angina (except unstable)/chest pain with coronary angiogram	R07.4, I20.1, I20.9
	Angina (except unstable)/chest pain without coronary angiogram	I20.9, R07.4, R07.3, I20.1
	Arrhythmia with coronary angiogram	I49.0, I47.2, I48, I47.9, I45.6, I44.2, I49.1, I49.8, I47.1, I44.1, I49.3, I49.5, I44.3
	Arrhythmia without coronary angiogram	R00.1, I48, I44.3, I47.1, I49.8, I45.9, I47.2, I44.7, I49.3, R00.2, I45.1, I44.1, I49.5, I45.5, R00.0, I49.4, I44.2, I45.6, I49.1, I44.0, I45.2, I49.0, I45.8, I45.3, I47.9, I49.2, I49.9, I47.0
	Benign hypertension	I15.0, I15.9, I15.1, I15.8
	Cardiac valve disease, except endocarditis	I35.9, I35.0, I05.9, I05.0, I34.1, I34.0, I36.1, I35.1, I35.2, I34.9, I34.2, I37.1, I36.9, I06.2, I06.0, I05.1, I08.0, I05.2, I07.1, I07.9, I51.1, T82.0, I34.8, I37.0, I06.1, I06.9, I07.2, I08.1, I05.8, I08.2
	Congenital cardiac disorder	Q23.0, Q21.1, Q23.1, Q25.3, Q21.0, Q25.1, Q24.9, Q24.5, Q25.4, Q20.8, Q25.6, Q25.0, Q21.3, Q22.8, Q24.6, Q22.5, Q21.8, Q24.3, Q28.9, Q20.3, Q28.8, Q21.2, Q26.4
	Deep vein thrombophlebitis	I80.2
	Embolism/thrombosis except deep vein thrombophlebitis	I74.9, I74.2, I74.3, I74.5, I82.2, I82.9, I74.0, I74.8, I74.1
	Endocarditis	I38, I33.0
	Heart failure with coronary angiogram	I50.1, I50.9

	Heart failure without coronary angiogram	I50.1, I50.0, I50.9, I26.0
	Hypertensive disease except benign hypertension	I13.9, I13.0, I13.1, I11.9, I11.0, I10, I13.2
	Myocardial infarction/shock/arrest with coronary angiogram	I21.1, I21.4, I46.0, I21.0, I46.1, I21.2, I21.9, I46.9
	Myocardial infarction/shock/arrest without coronary angiogram	I21.0, I21.2, I21.4, I46.9, R57.0, I46.0, I21.1, I21.9
	Other/miscellaneous cardiac disorder	R94.3, I30.9, I42.6, I28.0, T82.8, T82.5, C38.0, D15.1, I31.9, I42.7, I09.9, I31.1, I27.9, I42.0, Z45.0, I42.2, I42.1, I95.9, I95.2, T82.7, I25.5, I51.7, I51.4, I95.1, T82.9, I31.3, I27.0, I27.2, R01.1, I40.9, I42.8, I97.8, I64, I51.3, I23.8, I42.9, I51.8, T82.1, I42.5, R03.0, I31.2, R03.1, R93.1, I23.2, I09.2, I51.9, I25.3, Z03.5, I40.0, I28.1, I97.1, I27.1, I09.1, I95.8, I95.0, Z03.4
	Other/miscellaneous vascular disease	I71.4, I72.9, I72.0, I72.3, I72.8, Q27.9, I71.9, I71.2, I77.0, Q27.3, I70.0, I87.2, I71.0, I72.4, R02, I78.0, M31.7, I80.3, I80.8, I72.1, T81.7, I73.0, I71.3, I77.1, I87.1, I77.6, I80.9, I83.1, I83.0, I83.9, I83.2, I72.5, T82.3, I70.9, I99, M31.9, T82.4, I87.9, I71.5, I71.1, I80.0, I78.9, I71.8, I71.6, I77.2, I77.9, A41.0
	Peripheral vascular disease	I70.21, I70.2, I73.9, I73.1, I73.8
	Pulmonary embolism	I26.9
	Syncope	R55
	Unstable angina/atherosclerotic heart disease with coronary angiogram	I25.9, I25.8, I25.1, I24.8, I24.9, I20.0, I25.4
	Unstable angina/atherosclerotic heart disease without coronary angiogram	I24.9, I25.1, I20.0, I25.9, I24.8, I25.6, I24.1, I25.4
Diseases and disorders of the digestive	Complicated ulcer	K26.1, K25.1, K27.1, K26.5, K25.5, K31.5, K31.1, K22.7, K27.5, K28.5, K28.1, Q43.0
	Digestive malignancy	C21.1, C21.0, C18.1, C18.2, C18.0, C18.9, C18.6, C17.0, C18.3,

system		C17.2, C17.1, C15.9, C15.2, C15.0, C15.1, C48.2, C16.3, C19, C20, C18.7, C18.5, C16.9, C16.2, C16.0, C16.6, C16.5, C16.4, C18.4, C78.6, C18.8, C15.8, C17.9, C16.8, C16.1, D00.1, C78.8, C78.4, C76.2, D01.9, C21.8, C78.5, C48.1, C26.8, Z85.0
	Esophagitis/gastritis/miscellaneous digestive disease	K22.0, K29.1, K29.4, K29.5, K22.2, K22.9, K29.8, K29.7, K58.9, K58.0, K22.8, K21.9, K20, K31.8, K59.8, A18.3, B78.7, K22.5, K91.1, K59.9, K29.9, K22.3, K91.2, K29.0, B37.8, B78.9, K90.4, K22.4, K21.0, K90.9, K31.9, K29.6, K31.6
	Gastrointestinal haemorrhage	K26.2, K25.0, K27.0, K62.5, I85.0, K25.4, K27.4, K92.2, K26.0, K26.4, K92.0, K22.6, K92.1, P54.3, K22.1, K25.2, K28.0, K31.8, K27.2, K26.6, K28.4
	Gastrointestinal obstruction	K56.6, K56.3, K56.7, K56.4, K56.5, K56.0, K56.2, K56.1, K91.3
	Inflammatory bowel disease	K50.9, K51.9, K51.8, K51.0, K50.1, K51.2, K50.0
	Non-severe enteritis	A04.9, K52.9, A09.9, A09.0, K57.3, K57.9, A08.1, A04.4, A02.0, A05.3, K52.8, A08.4, K57.1, A08.0, A04.5, A03.0, A08.3, A00.9, A03.9, K59.9
	Other gastrointestinal disorder	K65.0, K35.8, K35.2, K35.3, D12.5, K60.2, K60.3, K62.8, K62.0, K62.4, K91.8, K60.5, Z43.3, Z43.2, D12.1, D13.0, D12.8, K61.0, K65.8, K91.4, I86.4, K62.1, T85.5, K43.9, K63.9, K36, K63.2, K63.5, D12.6, K38.9, K66.9, K62.9, K63.8, K31.7, T18.5, T18.9, T18.1, D37.1, D37.2, D37.4, K66.1, K46.9, K44.9, K40.4, K66.0, K46.0, N32.1, K43.0, K61.3, D48.4, K38.8, I85.9, K42.9, K63.1, K65.9, K66.8, K62.7, K61.1, K62.3, K62.6, N82.3, K40.9, K40.3, K41.3, K42.0, D13.1, D37.7, K63.3, K41.9, K62.2, K28.9, Z43.1, K60.1, Q45.9, D13.2, Q40.3, K92.8, D37.5, D13.3, K37, K44.1, K41.4, T18.2, K45.8, D12.2, D12.4, D12.3, N82.4, T18.3, K92.9, N82.2, T18.4, K43.1, K42.1, D12.0, K59.3, K60.4, D37.9, K63.0,

		P92.9, K61, K60.0, I85.5, K32.1
	Severe enteritis	K55.2, K57.2, K52.1, K55.0, A04.8, A04.7, K52.0, K55.9, K55.8, K55.1, K57.8, K57.4, K57.0
	Symptom or sign of digestive system	R19.0, R10.4, R10.1, R10.3, R19.3, R18, R19.4, K59.0, R14, K30, R13, R19.8, I88.0, R11, R93.5, R12, R93.3, K91.0, R85.9, R15, R19.5
	Uncomplicated ulcer	K26.3, K25.3, K27.3, K26.7, K25.7, K27.7, K26.9, K22.1, K25.9, K27.9, K28.7, K28.3
	Croup	J05.0
Diseases and disorders of the ear, nose, mouth and throat	Disease of oral cavity/salivary gland/jaw	K11.3, K08.1, K04.7, K08.2, K14.9, K09.2, K02.9, K08.9, K04.8, K09.0, K13.7, K01.0, K13.2, K10.8, K05.6, K05.1, K13.4, K01.1, K13.0, K12.2, K12.3, K10.2, K14.8, K11.2, K05.2, K11.5, K11.8, K14.0, K08.8, K12.1, K07.6, K02.1, K10.9, K11.9, K06.9, K00.6, K06.8, K09.8, K12.0, K00.1, K10.0, K04.4, K05.0, K04.5, K09.9, K07.9, K07.0, K11.6, K08.3, K06.2, K06.1, K07.4, K09.1, K05.4, K05.3, K03.8, K05.5, K11.7, K14.6
	Disequilibrium/hearing loss	H81.1, H90.2, H90.1, H91.9, R42, H92.2, H83.0, H81.0, H90.6, H81.3, H90.5, H93.1, H81.4, H81.2, H83.2, H83.1, H90.8, H90.4, H91.2, H93.3, H92.0, H92.1, H91.1, H81.8
	Ear/nose/throat malignancy	C06.0, C04.9, C04.8, C05.0, C32.0, C32.1, C03.1, C31.0, C06.8, C30.0, C11.9, C07, C12, C05.1, C08.0, C02.1, C02.9, C01, C02.0, C09.9, C30.1, C31.1, C76.0, C13.8, C32.9, C32.2, C04.1, C31.8, C10.9, C06.2, C31.3, C02.8, C09.0, C09.1, C03.0, C05.8, C13.9, C02.4, C10.3, C05.9, C13.0, C10.8, C14.8, C00.1, C05.2, C14.0, C10.2, C02.2, C31.9, C10.1, C13.2, C08.9, C08.1, C00.0, C03.9, C00.3, C06.9, C10.0, C13.1
	Epiglottitis	J05.1

	Epistaxis	R04.0
	Influenza/acute upper respiratory infection	J06.0, J06.9, J11.1, J10.1, J09
	Miscellaneous ear/nose/throat disorder	M95.0, H61.3, H60.3, J04.0, J00, H60.5, J30.4, D14.1, D14.0, D10.3, J38.0, J33.0, H73.0, M95.1, H71, H70.1, H60.8, J34.1, J34.2, J38.7, J34.8, J39.2, J39.8, J38.3, H61.9, H70.9, G47.8, T18.0, T17.2, R49.0, G47.1, J34.3, G47.0, J33.9, J38.4, B37.0, H80.9, D10.1, J39.0, D11.0, D37.0, H72.1, D11.9, H74.4, J33.8, J38.1, Q18.1, G47.9, R06.5, J38.6, R07.0, H74.0, J38.2, D38.0, J39.1, H70.0, H61.0, H73.8, D10.2, Q18.0, D00.0, H60.1, Q30.0, J37.0, H73.1, J31.1, Q16.3, H61.8, T16, B08.5, D16.5, H80.0, H72.2, J95.5, H60.0, H95.0, J31.0, J30.0, Q31.0, D10.6, D10.9, H61.1, H60.2, Q18.5, H72.9, H60.4, D10.7, D10.5, D02.0, J39.9, T17.3, Q35.9, R68.2, T75.3, H80.1, R49.8, Q38.7, H61.2, J34.0, B00.2, T17.1, R49.1, H68.1, J30.3, T28.5, J39.3, T17.0
	Otitis media with/without ventilation tube	H65.3, H65.2, H66.3, H66.1, H66.9, H66.0, H66.2, H66.4, H65.4
	Sinusitis	J01.1, J01.0, J01.9, J32.2, J32.0, J32.9, J32.3, J32.1, J32.4, J01.2, J01.3
	Sleep apnoea	G47.3
	Tonsillitis/pharyngitis	J02.9, J03.9, J35.0, J35.1, J35.8, J36, J31.2, J35.3, J03.0, J02.0, J35.9, L35.8, LJ35.8
Diseases and disorders of the endocrine system, nutrition and metabolism	Dehydration	E86
	Diabetes	E14.9, E14.6, E14.2, E14.1, E11.2, E10.9, E10.6, E10.1, E10.0, E11.9, E11.4, E11.3, E11.8, E11.5, E11.6, E11.0, E11.7, E11.1, E10.2, E14.5, E14.3, R73.0, E10.4, E14.4, E10.3, E14.0, F20.0
	Disease/disorder of adrenal/pituitary gland	E22.0, E27.2, D35.0, D44.1, E27.8, D35.2, C74.9, E26.0, E27.4, E24.0, E24.9, E27.9, E23.7, E24.2, C79.7, E23.0, E22.2, Q89.2, D44.9, D44.3, E27.1, E23.2, E34.9, E26.9, E23.6, E89.3, D44.8,

		E26.1, E34.8, E26.8, E34.0, E22.1, C75.8, E27.3, E24.3
	Disease/disorder of pancreas	E16.0, E16.2, D13.7, E15, E16.1, D35.8
	Disease/disorder of thyroid/parathyroid	E03.9, D34, E04.1, E21.5, E07.9, E05.0, E04.9, E21.3, E05.9, E04.2, E07.8, D35.1, E21.0, E89.0, E21.1, E06.1, D44.0, E06.9, E05.2, E06.0, E06.3, E03.1, E04.0, E03.2, E89.2, E03.8, E05.8, E20.9, D44.2, E06.5, E20.1
	Disorder of fluid/electrolyte balance	R79.9, R79.8, E87.7, E87.5, D73.1, E87.6, E87.1, E87.2, E87.8, E87.0, E86, R77.1, R29.0, R63.1
	Disorder of metabolism	E72.2, E83.5, E78.5, E83.4, E88.2, E80.1, E78.0, E74.0, E72.5, E83.1, E88.8, E88.1, E78.2, E78.1, E83.3, E88.9, E72.0, E88.0, E88.3, E80.2, E83.0
	Disorder related to nutrition	R63.4, R63.3, E61.1, E65, E66.8, E66.9, E53.9, E53.8, E51.2, R63.0, R63.6, E46, E66.2, E55.9, E63.1, E63.9
	Malignant neoplasm of thyroid/parathyroid	C75.0, C73
Diseases and disorders of the eye	Inflammation of orbit	H05.0, H05.1
	Major ophthalmology disorder	H49.2, G45.3, H47.0, H34.8, H18.1, H34.1, H16.3, H18.8, H18.2, H16.0, H49.8, H35.3, H30.0, H18.5, B02.3, H16.9, H16.8, H16.2, H49.9, H49.0, H35.2, H34.2, H35.0, H49.3, H49.1, C69.3, C69.6, H18.9, H35.8, H30.8, H35.6, H30.9, C69.5, H35.4, H47.2, H18.3, H18.7, C69.9, B00.5, H47.3, H35.5, C69.0, H16.1
	Other ophthalmology disorder	H40.2, H10.3, H04.0, H46, H40.0, H27.0, D23.1, D31.5, H53.8, T26.4, C44.1, H26.9, H26.2, H00.1, H31.3, H04.4, H02.0, Q10.0, H17.9, H26.0, H02.8, H04.3, H53.2, H43.9, H02.1, H44.0, H04.2, H50.0, H05.2, S05.9, H57.1, H57.9, H02.5, H44.7, T15.0, T15.9, H40.9, H40.4, H40.5, H00.0, H25.2, H02.7, H21.0, H50.3, H51.2, S01.1, H40.1, D22.1, H52.1, H26.8, H33.0, H02.2, H27.1, H43.8, H44.8, H11.0, H02.4, H57.0, H33.5, H33.3, H05.5, S05.3, H25.9,

		H04.5, H11.3, H53.1, S05.0, H57.8, H33.4, H26.1, H20.9, H53.9, H53.4, H54.9, H43.3, H43.1, H20.0, H15.0, D31.6, G24.5, H44.5, H54.0, H10.9, S00.1, H44.2, H31.9, H02.9, H21.9, H04.9, H27.9, H05.9, H50.1, T15.1, H50.2, H44.6, H54.5, H54.6, T85.2, H40.8, H44.1, H25.0, H59.9, H21.5, H33.1, H11.2, S05.8, H20.8, H17.0, H26.4, D31.2, H11.4, H05.3, H59.8, H55, H52.7, H25.1, H50.9, H04.1, H54.4, T85.3, H44.4, H05.8, D31.0, D31.9, H01.0, Q10.5, T81.3, S05.1, Q14.2, H50.4, H11.9, H31.0, H50.6, H51.8, H33.2, S00.2, Q14.0, H05.4, H51.0, H50.5, H11.1, H15.1, S05.2, H52.2, H10.5, H17.1, H01.1, S05.4, H31.4, D09.2, H52.5, D31.1, H10.4, C43.1, H43.0, Q12.9, H21.1, H10.1, H21.3, H10.0, Q12.0, Q12.2
	Disorder of fertility	E28.2
Diseases and disorders of the female reproductive system	Disorder of menstruation/endometriosis/non-inflammatory disorder of female reproductive system	R10.2, N80.0, N85.1, N83.2, N87.9, N88.2, N80.1, N85.8, N93.8, N94.6, N85.0, N84.0, Q50.4, T19.8, N93.9, N92.0, N83.9, N88.8, N94.8, N95.0, N92.4, N83.5, N85.6, N89.8, T83.4, N89.1, N87.1, N90.4, T19.2, N90.8, N92.1, N92.6, N95.9, Q50.5, N80.3, N95.8, N90.3, Z30.5, N83.8, N87.0, N84.1, N90.7, N89.3, N80.9, N89.7, N83.6, T83.3, N95.1, N93.0, N89.0, N84.2, N90.1, N83.1, N85.7, N94.9, N94.2, N92.5, N90.5, I86.3, N89.5, N84.3, N87.2
	Fibroid/prolapse/fistula/other disorder	N81.2, D27, D26.9, N81.1, N81.6, N39.3, N81.9, D25.1, D25.9, D39.1, N99.3, D25.0, D25.2, N81.4, N81.3, N82.0, N82.1, D26.0, D39.7, N82.9
	Inflammatory disorder of female reproductive system	N75.1, N76.4, N73.0, N71.9, N75.0, N73.1, N71.1, N73.9, A60.0, N70.1, T83.6, N73.6, N95.2, N70.9, N76.0, A57, A51.9, A56.1, N76.5, N76.6, L29.2, A60.9, B37.4, B37.3, N72, A64, N71.0, N76.8
	Malignant neoplasm of female reproductive system,	C54.9, C53.9, C53.0, C53.1, C57.0, C51.0, D06.9, D07.1, D06.0,

	except ovary	C51.9, D07.2, C52, D07.3, C51.1, C79.6, C51.2, C54.1
	Malignant neoplasm of ovary	C56
Diseases and disorders of the hepatobiliary system and pancreas	Cirrhosis/alcoholic hepatitis	K70.1, K72.0, K70.9, K70.3, K70.0, K70.4, K74.3, K73.9, K74.6, K72.9, K71.9, K70.2, K72.1, K74.0, K74.5, K74.4
	Disorder of biliary tract	K81.9, K81.0, K83.0, K83.1, K80.2, K80.5, K81.1, K83.8, K82.8, K80.0, K82.2, K82.3, K83.5, K83.9, K82.9, K82.1, K82.4, K80.4, K80.1, K83.2, K85.9
	Disorder of pancreas except malignancy	K85.9, K85.2, D13.6, K85.1, K86.1, K86.2, K86.9, K86.8, K86.3, K85.8, Q45.3, K86.0
	Failure/rejection of liver/pancreas/duodenum transplant	T86.4
	Hepatobiliary/pancreatic malignancy	C24.1, C24.9, C23, C22.1, C22.9, C25.9, C25.1, C25.0, C25.2, C78.7, C24.0, C22.0, C25.4, C24.8, C25.8, D01.5, C25.3
	Liver disease except cirrhosis/malignancy	R94.5, B17.9, B16.9, B17.1, K75.4, D13.5, B18.2, B18.1, K76.9, D13.4, R17, K76.0, K76.8, B19.9, B17.2, K75.9, R16.0, K75.0, D37.6, Q44.6, I81, K76.1, E80.7, R16.2, K76.7, K76.6, B15.9, B66.1, K75.3, K75.8, B17.8, I82.0, B18.9, R93.2, E80.4, A06.4, B16.2
Diseases and disorders of the kidney, urinary tract and male reproductive system	Disease/disorder of male reproductive system	N48.2, N41.2, N49.2, N45.9, N46, N42.1, N48.9, N43.0, N50.8, N49.8, N43.3, D17.6, N47, N48.5, L29.1, D40.1, Q53.1, Q53.9, N41.0, N48.1, D29.1, N48.8, N50.1, N48.6, N43.1, N45.0, N41.9, I86.1, N42.9, Q55.6, N48.0, Q54.1, N48.3, D29.3, P83.5, N43.4, N41.1, N50.9, D40.0, N49.0, Q54.9
	Kidney disease	N00.9, N05.7, N25.9, N05.9, N02.8, N05.2, N05.3, N05.0, N25.1, N14.2, N04.9, N04.0, Q61.3, N25.8, N05.5, N05.8, N04.5, N04.2, N01.7, N02.9, N00.7, Q61.9, N04.1, Q61.2, N01.9, N03.1, N03.9, N05.1, N04.8, N00.8
	Lower urinary tract infection	N30.9, N30.4, N39.0, A18.1, N30.0, N34.0, N30.1, N34.1, N34.2

	Malignant neoplasm of male reproductive system	C60.1, C60.9, C61, C60.0, C63.2, C62.9, C62.0, C63.7, C63.1, C60.2, G95.2
	Malignant neoplasm of urinary system	C64, C65, C66, C67.9, C67.2, C67.5, C67.4, C67.0, C67.8, D09.1, C79.1, C76.3, C67.6, C68.0, C67.3, C67.1, D09.0, C68.8, C67.7, C68.9, C79.0
	Other disorder of kidney/ureter	N28.9, Q63.0, N26, Q63.1, I70.1, N28.1, N28.8, D41.0, I82.3, Q60.0, D41.2, R94.4, I72.2, D30.0, Z52.4, D30.2, D41.1, N25.0, D30.1, Q61.0
	Other disorder of urinary system	Z46.6, N32.8, T83.0, G83.4, N32.9, N36.0, T19.0, Q64.4, T83.5, N36.8, N31.9, D41.4, N32.2, T83.1, N36.2, N39.8, T83.2, N39.4, N32.4, N31.8, N32.3, T19.1, N99.5, N39.1, N36.3, D41.3, N39.9, Q64.7, R36, N36.9, D30.4, D30.3, N99.8, N36.1
	Renal failure	N17.9, N17.0, N19, N18.9, N18.3, N18.4, N18.5, I12.9, I12.0, N17.1, D59.3, N17.2, Z49.2
	Symptom or sign of urinary system	R33, R82.0, R30.0, R35, R31, R80, R32, R39.8, R93.4, R82.8, R82.9, R34, R39.1, R82.7
	Upper urinary tract infection	N10, N15.1, N12, N13.6, N11.9, N15.9
	Urinary obstruction with percutaneous drainage	N35.9, N13.4, N13.9, N13.5, N99.1, N13.3, N40, N21.0, N32.0
	Urinary obstruction without percutaneous drainage	N40, N32.0, N21.0, N35.9, N21.1, N20.1, N13.3, N13.2, N13.4, N13.5, N13.9, N23, N20.0, N20.9, N21.9, N13.1, N99.1, N35.0, N13.7, N13.8, N42.0
Diseases and disorders of the musculoskeletal system and connective tissue	Back pain/strain	M54.99, M54.59, M54.56, S33.5, M54.22, S13.4, M54.38, M99.95, M99.31, M54.64, S39.0, M99.11, M99.42, M54.47, M99.32, M99.21, M99.41, M99.43
	Inflammatory and reactive arthropathy	M13.99, M06.19, M10.99, M10.09, M13.09, M11.29, M02.99, M06.99, M05.99, M12.57, M13.97, M12.26, M05.39, M10.49, M13.89, M06.09, M12.59, M02.39, M06.49, M13.17, M13.00,

	M11.99, M10.39, M10.29, M06.90, M13.14, M13.03, M02.92, M11.26, M11.27, M13.04, M13.91, M11.89, M12.27, M12.81, M13.19, M11.96, M12.89
Musculoskeletal malignant neoplasm	C49.4, C49.0, C49.2, C49.5, C49.3, C40.2, C41.4, C79.5, C41.9, C49.9, C49.1, C41.0, C49.8, C40.0, C76.5, C41.1, C41.3, C41.2
Orthopaedic aftercare	Z47.0, Z47.8, T84.8, T84.0, T84.4, T84.5, T87.4, T84.7, T84.3, Z47.9, T87.6, T87.5, T84.9
Osteoarthritis	M19.89, M15.4, M15.9, M19.99, M19.97, M19.92, M16.9, M17.9, M19.94, M18.1, M19.07, M19.04, M17.1, M16.1, M19.02, M19.09, M19.27, M19.29, M17.5, M19.23, M16.3, M19.13, M19.03, M16.7, M19.91, M19.14, M19.19, M18.9, M19.84, M18.0, M18.3, M15.0, M19.12, M19.01, M19.21, M19.24
Osteomyelitis/septic arthritis	M86.17, M86.14, M86.96, M86.69, M86.67, M86.99, M86.94, M00.99, M00.94, M00.97, M00.95, M00.96, M00.91, M46.28, M86.27, M86.19, M86.55, M86.46, M86.45, M86.64, M86.66, M86.95, M86.97, M00.92, M00.93, M86.29, M86.89, M00.98, M86.24, M86.15, M86.49, M46.22, M86.12, M86.47, M86.23, M86.22, M86.93, M86.16, M86.65, M86.63
Other musculoskeletal disorder	E85.9, M85.59, M87.95, M87.97, D16.3, D16.7, D16.0, D21.9, D21.4, D21.3, D21.1, D16.2, D16.4, D21.2, M85.69, M89.89, E85.4, D16.9, T79.6, M84.29, M89.99, D16.1, M92.7, M31.0, M84.09, M84.19, M92.5, M89.59, M83.99, M87.99, M89.66, M81.99, M87.38, L40.5, M87.39, M85.49, M84.35, M89.88, M31.1, A18.0, M31.3, M87.29, D21.0, M31.5, M93.1, D21.5, D21.6, M31.4, M46.39, M85.89, M81.09, M84.39, D16.6, M89.67, M85.09, E85.2, M92.2, M87.96, M88.99, M89.97,

	M84.37, M87.92, L87.1, M84.31, M81.89
Other soft tissue disorder	M62.29, M62.99, M79.79, M65.19, M60.09, M60.99, M72.27, M60.05, M79.59, M62.89, M79.99, M79.89, M72.04, M72.99, M71.19, M62.19, M65.09, M62.86, M72.49, M60.28, M61.99, M61.59
Other syndrome/deformity	M95.2, Q67.0, T94.1, R93.7, M96.0, Q69.2, M96.6, T91.1, T91.8, Q87.4, Q78.4, M96.8, T92.5, M95.9, M96.1, T93.2, Q66.8, R26.2, M62.59, Q77.4, T93.1, R93.6, M62.49, Q78.2
Pain/stiffness, except back	M79.67, M79.65, M79.64, M25.55, M25.59, M25.51, M25.57, M25.54, M25.56, M25.52, M79.60, M79.19, M79.69, M25.67, M25.69, M25.66, M25.62, M25.53, M79.62, M79.63, M25.50, M79.18, M25.63, M25.64, M25.61, M25.58, N79.67, N79.63, N79.64, N25.55
Pathological fracture	M84.49, M84.45, M84.42, M84.41, M84.48, M84.46, M84.43, M48.59, M80.55, M80.99, M80.98, M80.95, M80.91, M80.90, M80.92, M80.09
Strain/sprain/joint/tendon disorder	M76.67, M20.6, M21.57, M21.47, M21.06, M20.1, M20.3, M21.67, S83.4, S83.2, M75.0, M25.97, M24.19, M71.26, M20.5, M71.39, M70.04, M65.99, M75.1, Q65.8, Q66.3, M24.54, M94.09, M23.36, M23.25, M23.33, M23.22, M23.29, M23.35, M23.32, M21.95, M23.16, M23.19, M21.33, M25.47, M25.41, M21.37, M67.4, M25.09, M25.06, M20.2, M25.89, M25.45, S83.7, M25.37, M23.91, M23.97, M25.46, M23.49, M20.0, M77.47, M66.46, M66.23, M66.59, M23.23, M23.51, M93.2, M24.31, M76.77, M25.86, M70.46, M24.41, M66.31, M66.06, M75.8, M75.4, M23.64, M66.29, M66.39, S93.4, S93.6, S53.4, S73.1, S83.6, S43.4, S63.5, M65.81, S83.5, M77.12, M65.87,

	M65.83, M76.86, S86.0, M65.34, M21.12, M21.94, M23.26, M71.99, M70.32, M70.56, M75.3, M21.54, Q66.6, M24.52, M24.59, M67.1, M65.43, M23.21, M23.15, M94.99, M67.9, M25.01, M25.02, M20.4, M25.39, M25.32, M23.93, M70.75, M22.3, M24.07, M24.09, S63.7, Q66.2, M62.69, M24.38, M66.33, M66.45, M70.22, M25.79, M24.39, M23.63, S43.5, S63.6, S93.5, M75.5, Q66.0, M77.99, M75.2, S63.3, M70.65, M21.79, M24.14, M65.29, M24.56, M24.53, M23.24, M25.42, T14.6, M23.99, M76.56, M76.15, M22.1, M23.61, M77.97, M21.09, M24.42, M22.2, M23.39, M22.4, M24.57, M25.91, M77.02, M25.34, M25.31, M24.75, M24.01, Q66.5, M24.49, M75.9, S43.7, S63.4, M23.04, M77.57, M67.3, M76.36, M25.84, M21.19, M24.55, M23.03, M22.9, M77.92, M94.89, M66.24, T13.2, M25.43, M24.64, M25.35, M25.49, M66.47, M77.94, M77.37, M21.86, M65.89, M22.0, M25.81, M23.54
Systemic connective tissue disorder	M35.9, M30.1, M33.1, M35.4, M35.1, M35.3, M33.2, M34.9, M35.0, M32.9, M32.1, M35.2, M34.8, M30.0, M34.1
Vertebral/disc disease	M43.19, M45.9, M48.19, M53.99, M48.02, M47.82, M47.12, Q76.4, M50.2, M51.2, D48.1, M41.29, M46.59, S16, M50.0, M51.0, M46.49, M51.8, M54.16, M47.86, M48.96, M54.17, Q76.2, M47.87, M54.14, M53.89, M48.82, M54.19, M41.99, M48.09, M48.06, M48.07, M48.04, M46.99, M43.16, M43.09, M47.99, M47.29, M50.1, M48.92, M54.13, M50.3, M51.3, M51.9, M43.29, M53.92, M54.18, M47.19, M47.14, M48.89, M53.38, M40.29, M53.26, M47.84, D48.0, M53.82, M40.24, M43.41, M46.18, M53.29, M47.16, M43.62, M54.15, M43.31, M50.8, M41.59, M46.89

	Status epilepticus/seizure disorder, except status epilepticus	G40.9, G40.1, G40.3, G40.2
	Cerebrovascular disorder	I65.2, I67.1, Q28.2, M31.6, I69.1, I69.8, I67.5, I65.0, I67.8, I69.2, I69.0, I67.9, I67.0, I67.4, Q28.3, I67.2, I66.0, I65.3, I69.3, I65.1, I67.7
	Haemorrhagic event of central nervous system	I62.0, I62.1, I61.9, I62.9, I60.9, I61.5
	Infection/inflammation of central nervous system except meningitis	A52.2, G06.0, B69.0, G04.9, B02.2, B00.4, G08, A81.0, A83.0, B91, A32.1, A52.1, A52.3, B01.1, B45.1, G06.1, A17.8, B02.0, A86, A88.1
	Ischemic event of central nervous system	I63.5, I63.4, I63.2
	Meningitis except viral	G03.9, A17.0, G03.8, G00.2, G00.1, G00.9, G00.8, G03.0
	Migraine/other headache	G43.1, G43.0, R51, G43.9, F07.2, G44.2, G43.8, G44.0, G43.3, G44.3, G44.8
Diseases and disorders of the nervous system	Multiple sclerosis/demyelinating disorder	G37.2, G37.8, G36.0, G37.3, G37.9, G35
	Neoplasm of central nervous system	D33.3, D32.0, D33.2, D36.1, D32.1, C71.6, C71.1, C71.4, C71.3, C71.2, C71.7, C70.0, C71.0, D44.7, C79.3, D43.2, D42.9, D43.9, D35.4, D35.6, R90.0, D43.4, D44.5, D35.5, C71.5, C79.4, D48.2, C71.8, C72.0, D33.4, D43.1, C72.5
	Neuromuscular disorder	G80.9, G72.0, G72.3, G71.0, G70.0, G72.9, G80.1, G71.3, G71.1, G71.9, G80.8, G72.4, G80.3, G71.2, G72.2, G72.1
	Neuropathy/polyneuropathy	G62.1, G61.0, G60.9, G62.9, G62.2, G62.0, G60.0, G61.9, G62.8
	Other degenerative disease of nervous system	G12.2, G11.9, G31.9, G25.5, G31.8, G25.9, G24.8, G25.3, G24.0, G25.1, G11.1, G10, G24.9, G25.0, G24.4, G14, G25.8, G12.9, G23.8, G24.3, G11.4, G25.2, G24.1
	Other disorder of central nervous system	Q07.0, G96.0, G91.0, G93.9, G93.4, G91.9, G90.3, G95.9, Q85.0, G91.2, G93.8, G97.8, G95.2, G93.6, G45.4, G93.0, G90.9, Q04.9, G93.1, G93.2, G97.2, G91.1, G98, G95.1, G95.0, T85.0, Q06.4,

		G95.8, G96.8, G90.2, G90.4, Q85.1, G92, G96.1, Q03.0, Q04.6, T90.9, Q03.1
	Other disorder of nerve	G51.0, M54.12, G54.0, G56.0, G57.3, G56.2, G52.9, H47.4, G51.3, M79.28, G57.6, G54.4, G58.7, G58.9, G54.9, G56.3, G50.0, G52.3, G51.9, G52.1, G57.0, M79.29, H47.1, G50.8, G50.1, G56.4, G52.7, G58.8, G54.2, G57.2, G57.1, G57.5, M89.00, G54.3, G54.6, H47.7
	Other dysfunction of central nervous system	R93.0, R25.8, R26.8, R26.0, R47.1, R47.0, R29.8, G81.9, R40.2, R25.2, R20.8, R20.2, G82.5, G81.1, G82.1, R25.1, G82.2, R27.0, G82.0, G82.3, R20.3, F95.9, G83.8, R40.0, R47.8, R20.1, R94.0, R43.2, G83.3, G82.4, G83.2, R25.3
	Parkinson’s disease/other parkinsonian disorder	G20, G21.1, G21.0, G21.9, G23.1, G21.2, G21.4, G23.2
	Seizure disorder, except status epilepticus	R56.8
	Status epilepticus	G40.3, G41.0, G40.2, G40.1, G40.9, G41.1
	Transient ischemic attack	G45.0, G45.9
	Unspecified stroke	I64
	Viral meningitis	B01.0, B00.3, A87.9, B02.1
Diseases and disorders of the respiratory system	Aspiration pneumonia	J69.0, J69.1, J69.8
	Asthma	J45.9, J46, J45.0
	Bacterial disease of respiratory system	A48.1, A31.0, A42.0, A37.0, A37.9
	Bacterial pneumonia	J14, J15.0, J15.7, J15.5, J15.6, J15.4, J15.3, J15.1, J15.2, J13, J15.8
	Bronchiectasis	J47
	Chronic obstructive pulmonary disease	J44.8, J44.9, J43.9, J42
	Disease of pleura	J94.0, J94.2, J94.8, J90, J92.9, J94.1
	Infectious/parasitic disease of respiratory system	B44.0, B90.9, B45.0, B44.1, B59, B37.1

	Malignant neoplasm of respiratory system	C38.1, C34.9, C34.8, C34.3, C34.0, C34.2, C34.1, C76.1, C78.2, C78.0, C38.3, C38.4, C38.2, C38.8, C78.1, C33, C78.3
	Other lung disease	J85.2, J85.3, J81, J80, J86.9, J85.0, J84.9, J86.0, J64, J84.1, J62.8, J85.1, J60, J82, D86.9, J70.1, J61, J70.0, J68.3, J68.0
	Other respiratory diagnosis	D14.3, D15.2, J98.4, J98.5, J98.2, Q34.1, D38.3, J98.6, J98.1, J98.8, D38.2, D38.1, Z43.0, J98.0, D38.4, Z03.0, T17.8, S23.4, D38.6, Q33.0, T17.5, D19.0, S43.6, T17.9, D17.4, T27.1, M95.4
	Pneumothorax	J93.9, J93.1, J93.0
	Postprocedural respiratory disorder	J95.8, J95.0, J95.9
	Respiratory failure	J96.0, R09.2, J96.9, J96.1
	Respiratory tuberculosis	A16.2, A16.9, A15.9, A15.3, A15.0, A15.1, A16.5, A15.2
	Symptom or sign of respiratory system	R91, R09.3, R04.2, R09.8, R05, R06.0, R06.6, R06.4, R06.8, R09.1, R04.8, R06.1, R06.2, R04.9, R09.0
	Upper/lower respiratory infection	J20.9, J20.4, J20.5, J40, J21.0, J20.6, J04.1, J21.8, J21.9, J20.1, J21.1
	Viral/unspecified pneumonia	J18.8, J11.0, J18.9, J12.8, J12.2, J12.1, J12.9, J12.0, J12.3, K31.8, D50.8, Z43.0
Diseases and disorders of the skin, subcutaneous tissue and breast	Abscess	L02.9, L02.3, L02.2, L02.1, L02.0, L05.0, L02.4, L02.8
	Cellulitis	L03.9, L03.0, L03.3, L03.2, L03.1, L03.8
	Decubitus ulcer/ulcer of lower limb NEC	L97, L98.4, L89.9, L89.3, L89.1, L89.2, L89.0
	Malignant neoplasm of breast	C50.9, C50.1, C50.3, C50.5, C50.2, C50.4, C50.8, D05.9, C50.0, C50.6
	Malignant neoplasm of skin	C44.4, C44.3, C44.2, C44.7, C44.5, C44.6, C44.9, C43.7, C43.5, C79.2, C44.8, C43.9, C43.6, C43.4, C44.0, C46.0, C43.3, C43.0, D04.5, D04.3, D04.7
	Non-malignant breast disorder	N61, N64.8, N64.5, N63, N64.4, R92, D24, N60.0, N64.1, N62, N64.2, N64.9, N60.1, N64.3

	Other disease/disorder of skin/subcutaneous tissue	L53.9, B02.9, Z42.8, L23.3, L50.0, D17.5, R22.3, L20.9, D23.7, R22.4, D48.6, R22.0, L12.0, L92.9, R22.2, L84, R22.1, A63.0, L25.9, L30.9, B36.9, L98.9, L27.0, L51.9, L52, L26, L90.5, L27.1, R21, L73.2, L50.9, M79.46, L50.1, D17.9, L91.0, L98.8, D17.3, L08.9, R22.9, I89.1, I89.0, D22.9, D48.5, M79.39, B88.9, L12.9, L10.0, L81.9, L05.9, B07, L30.1, I97.2, L40.9, L40.1, L88, L98.0, L72.1, R23.8, L51.1, B35.9, L95.9, L80, L53.8, L23.9, D23.2, D23.9, L60.0, L13.9, L60.8, L50.3, Q82.8, L60.9, L73.9, L56.1, A46, A18.4, L40.8, D22.3, L92.3, L92.0, B00.9, L43.0, L01.0, L24.9, L95.0, L51.2, B87.9, L10.9, L10.2, L81.7, L42, L40.3, L71.9, B86, L25.1, L27.2, B43.2, L55.9, B35.3, B35.4, L70.9, L98.2, A06.7, L20.8, L12.1, D23.3, L94.2, D23.5, B00.0, B00.1, L93.0, D23.4, L29.9, L29.8, L82, L57.0, L30.8, R22.7, L28.1, L50.6, B88.8, L24.5, D17.0, L21.9, L25.0, L91.8, L85.8, L28.0, B35.1, L40.0, B35.6, B35.0, L59.8, A31.1, L22, L74.9, L92.2, L43.9, L28.2, L00, L85.3, M79.35, L71.0, D22.2, L60.2, L93.1, L40.4, B85.1, L94.0, I78.1, B35.2, L08.0, L85.0, L60.1, D23.6
	Trauma of skin/subcutaneous tissue/breast	T14.0, S60.8, S90.8, T13.0, T00.3, S40.7, S20.4, S30.8, S40.8, T00.2, S70.8, T85.4, T93.0, S90.9, S00.9, S80.9, S50.9, S61.1, S70.7, S80.7, S60.9, S50.8, T00.0, T00.1, S10.9, S00.8, T09.0, S00.5, T11.0, S30.9, S40.9, S10.0, T00.6, T95.8, S00.4, S70.9, S10.1, S00.3
Mental diseases and disorders	Dementia/electroconvulsive therapy for mental health disorder	F03, G30.0, F01.9, G30.9, G30.1, F03.04, F03.03, F03.02, F01.3, F01.1, F01.0, F01.04, F01.03, F01.93, F01.14, F01.01, F03.01, F01.2, F01.02, F01.33, F01.94, F01.92, G30.8, F01.10
	Anxiety disorder	F41.9, F41.1, F41.2, F41.0, F41.3, F40.9, F40.0

Bipolar disorder	F31.9, F31.2, F31.1, F31.0, F31.3, F31.6, F31.7, F30.9, F30.0, F30.2, F30.1
Bipolar disorder, severe depression	F31.5, F31.4
Childhood/adolescent developmental disorder	F98.2, F79.9, F72.9, F72.1, F79.8, F70.9, F70.1, F71.9, F71.0, F71.1, F72.0, F70.0, F80.9, F73.1, F72.8, F94.0, F71.8, F81.8
Depressive episode	F32.9, F34.1, F32.1, F33.4, F32.3, F32.0, F32.30, F32.2, F33.9, F32.11, F33.1, F33.0, F32.01, F33.3
Disorder of adult personality behaviour	F60.3, F60.31, F60.2, F60.0, F60.9
Eating disorder	F50.5
Miscellaneous mental disorder	Q90.9, F63.9, F99, Z03.2, F54, F51.3, F55.9, F59, F51.0, F64.0, R44.0, F52.2, Z13.3, R54, F63.0, R48.2, Z00.4
Mood [affective] disorder	F39, F34.9
Obsessive compulsive disorder	F42.1, F42.9
Organic mental disorder	F05.9, F04, F06.7, F07.0, F06.2, F06.3, F07.9, F09, F06.9, F06.0, F06.4, F05.1, F05.0, F06.8, F06.71
Schizophrenia/schizoaffective disorder	F20.2, F20.1, F20.0, F20.00, F20.5, F25.2, F25.9, F25.0, F20.9, F20.03, F20.02, F25.1, F25.00, F20.3, F20.05, F20.6, F25.10, F20.8
Schizotypal/delusional disorder	F23.8, F22.0, F29, F23.91, F23.2, F23.9, F23.20, F23.3, F21, F23.0
Somatoform/dissociative disorder	F44.5, F45.3, F45.2, F45.0, F45.9, F45.1, F44.9, F45.4, F44.8, F44.4, F44.2
Stress reaction/adjustment disorder	F43.0, F43.01, F43.2, F43.25, F43.8, F43.20, F43.23, F43.00
Substance abuse with acute intoxication	F10.0, F19.0, F13.0, F10.03, F11.0, F14.0, F19.00, F11.01, F11.00, F13.03, F10.01, F18.0, F11.05
Substance abuse with other state	F10.1, F10.6, F10.2, F10.9, F10.3, F19.2, F19.1, F19.9, F19.3, F11.1, F11.2, F11.3, F13.31, F13.1, F13.8, F10.25, F19.8, F15.1,

		F13.9, F11.9, F13.24, F13.30, F13.2, F10.22, F16.1, F11.8, F11.31, F19.31, F10.24, F14.1, F13.26, F13.21, F11.22, F11.30
	Substance abuse with residual/late onset/psychotic disorder	F10.73, F11.5, F19.50, F10.50, F10.5, F19.5, F16.5, F10.52, F19.56, F13.5
	Substance abuse with withdrawal and delirium	F10.4, F10.41, F10.40, F19.4, F13.40, F13.41, F11.40
Misc. CMG and ungroupable data	Diagnosis not generally hospitalised	Z01.2, Z43.9, Z04.9, Z09.9, Z02.8, Z00.5, Z12.2, Z22.5, Z71.8, Z13.9, Z13.8, Z01.0, Z51.6, Z01.6, Z01.4, Z71.1, Z48.0, Z12.8, Z12.1, Z22.8, Z08.9, R78.7, Z13.6, Z01.5
	Ungroupable	Z95.0, Z93.3, Z91.1, Z02.0, Z80.9, Z93.1, Z72.1, Z94.1, Z95.2, Z86.4, Z92.3, Z86.0, Z87.3, Z92.4, Z86.6, Z93.2, Z94.0, Z94.4, Z89.5, Z89.4, Z94.2, I25.2, Z85.8, Z85.0, Z85.5, Z85.3, Z85.1, Z85.4, Z85.7, Z00.0, Z98.8, Z98.1, Z99.2, Z87.4, Z60.9, Z91.5, Z93.0, Z95.9, Z88.1, Z87.1, Z94.7, Z86.3, Z86.1, Z89.7, Z89.6, Z85.2, Z85.6, Z96.8, Z00.6, Z98.2, Z93.4, Z52.0, Z72.0, Z95.4, Z97.5, Z01.7, Z85.9, Z86.5, Z65.9, Z93.6, Z89.0, Z91.8, Z80.0, Z94.9, Z96.6, Z72.4, Z60.5, R65.1, Z80.3, Z88.9, Z95.5, Z87.2
Multisystem or unspecified site infections	Chickenpox/herpes zoster/cytomegaloviral disease	B25.9, B25.8, B02.7, B02.8, B01.9
	Fever	R50.2, R50.9
	Other infectious/parasitic disease	A49.9, A31.9, A49.1, A49.8, B49, A48.0, A49.2, A49.0, A19.9, B47.0, M72.69, A43.9, T79.3, A53.9, A77.9, A18.8, B37.9, A28.1, B45.7, A48.8, B50.9, A05.1, A30.9, A27.9, A01.4, B48.4, A79.9, A75.3, B37.7, A18.2, A01.0, B51.9, B44.9, B99, A24.4, A01.1, A75.9, A23.9, B48.8, A32.7, A02.9, B65.9, A49.3, A54.9, B47.9, A01.2, A78, B58.9, A52.8, A19.2, A51.4, A36.9, B46.5, A53.0, Z21, B54, A42.9, A48.3, A02.2, B60.1
	Other/unspecified sepsis	A41.9, A41.5, A39.9, A41.1, A02.1, A40.0, R57.2, A41.4, A41.2, A40.9, A40.3, R57.9, A40.1, A41.3, A40.8, A40.2, B25.9

Other reasons for hospitalisation	Other/unspecified viral illness	B34.0, B27.9, B34.9, B34.8, B09, B34.1, B33.8, B08.4, B05.9, B26.9, A70, A92.8, J11.8, A74.8, B34.3, Bb34.0
	Sepsis due to staphylococcus aureus/pseudomonas/enterococcus	A41.0, A41.5
	Cancelled intervention	Z53.9, Z53.2
	Follow-up treatment/examination	Z48.8, Z09.0, Z09.4, Z08.0
	General symptom or sign	R89.6, R68.8, R41.3, R60.9, R46.8, R52.9, R64, R41.0, R23.2, R77.8, R60.1, R58, R44.3, R73.9, R68.0, R53, R45.8, R82.1, R87.6, R60.0, R45.6, R29.6, R74.0, R41.8, R89.9, R45.1, R41.2, R52.2, R46.4, R93.8, R52.1, R94.8, R45.4, R52.0, R99, R74.9, R46.0, R69, R45.2, R45.0
	Multiple/unspecified congenital anomaly	Q87.8
	Observation/evaluation	Z03.8, Z03.6, Z03.3
	Other factor causing hospitalisation	Z52.3, Z44.8, Z76.3, Z45.8, Z40.9, Z63.8, Z46.3, Z52.6, Z29.0, Z63.4, Z76.5, Z74.9, Z29.8, Z40.0, Z59.7, Z45.2, Z74.1, Z60.2, P54.6, Z74.2, Z04.8, Z59.3, Z59.4, Z51.9
	Palliative care	Z51.5
	Rehabilitation	Z50.8, Z50.5, Z50.9, Z50.0
Pregnancy and childbirth	Abortive diagnosis with abortive or non-major obstetric/gynaecologic intervention and fetal anomaly/abortive diagnosis with fetal anomaly treated medically/abortion diagnosis with abortive or non-major obstetric/gynaecologic intervention/abortion diagnosis treated medically	O02.0, O03.9, O03.4, O01.9
	Ectopic pregnancy with ectopic or non-major obstetric/gynaecologic intervention/ectopic pregnancy treated medically	O00.1

	Intracranial injury with injury to other organ/multiple intracranial injury/single intracranial injury	S06.20, S06.40, S06.80, S06.90, S06.21, S06.41, S06.60, S06.50, S06.81
	Multiple injuries to internal organ/single injury to internal organ	S36.00, S37.00, S37.20, S36.90, S37.10, S36.80, S27.10, S27.00, S27.30, S36.10, S37.30, S27.80, S36.31, S36.30, S27.20, S36.40, S27.11, S27.01, S36.11, S37.80
	Complication of transplanted organ	T86.9, T86.1, T86.8, T86.0
	Concussion	S06.00, S06.01
	Fracture of femur	S72.10, S72.00, S72.40, S72.90, S72.30, S72.20, S72.31, S72.01, S72.11, S72.41, S72.21
	Fracture of patella/upper tibia/fibula	S82.00, S82.10, S82.01, S82.11
	Fracture of shoulder/upper humerus	S42.00, S42.10, S42.20, S42.01, S42.21
Significant trauma, injury, poisoning and toxic effect of drugs	Fracture of skull/facial bone	S02.30, S02.90, S02.40, S02.60, S02.80, S02.20, S02.21, S02.61, S02.01, S02.00, S02.41, S02.10, S02.11
	Fracture/dislocation of wrist/hand/ankle/foot	S63.0, S63.1, S93.3, S93.1, S62.20, S62.10, S62.30, S92.50, S62.50, S62.00, S92.10, S92.90, S92.00, S92.01, S92.20, S92.21, S92.30, S92.31, S62.80, S63.2, S62.81, S62.31, S92.51, S62.61, S92.11, S93.0, S62.60, S92.70, S92.91, S62.11, S92.9
	Fracture/dislocation/rupture of pelvis/sacrum/coccyx	S32.40, S32.80, S32.50, S32.20, S32.10, S32.70, S32.30, S32.71, S32.81, S33.2, s32.40
	Open wound/other/unspecified minor injury	S39.9, S66.8, S21.9, S11.8, S30.1, S20.2, S50.0, S60.0, S90.3, S50.1, S60.2, S70.0, S80.0, S80.1, T00.9, S40.0, S70.1, S90.1, S30.0, S97.0, T04.1, S57.0, S67.0, S97.8, S67.8, S77.0, S87.0, S87.8, S97.1, S65.5, S55.1, S61.1, S91.3, S71.7, S81.7, T75.1, T75.0, S69.9, S39.8, T67.5, T67.0, S79.9, T14.9, S99.9, S64.3, S59.9, S56.5, S66.3, S66.2, S56.2, S66.1, S56.0, S66.4, T13.9, S66.7, S96.9, S66.9, S96.1, S76.1, S65.1, T11.9, S64.4, S19.9, S84.1, S49.9, S54.0, S89.9, T14.1, S01.8, S61.0, S91.2, S11.9,

	S01.0, S01.5, S59.7, T13.1, Z04.3, S91.0, S41.8, S51.0, S01.3, S51.9, S61.9, S81.0, S81.9, S41.0, S71.1, S91.1, S41.1, T11.1, T14.4, S46.0, S31.3, S96.8, S60.1, S68.1, S68.0, S68.2, S86.8, S46.8, S90.0, S90.2, S17.9, S17.8, T75.4, S66.0, S64.1, S66.6, S86.7, S76.0, S46.1, T13.5, S86.1, S44.0, S04.5, S25.0, S29.9, S31.1, S01.2, S11.7, S21.0, S02.51, S31.0, S71.0, T01.0, S31.8, S98.1, T79.4, S38.1, T04.3, S77.1, S47, S85.1, S21.8, T67.1, S76.2, S54.3, S56.3, S46.3, S86.3, S64.9, T14.5, S04.0, S49.8, S21.2, S68.9, S09.9, S45.0, T79.7, S07.0, S57.9, T04.2, S55.0, S56.1, S46.7, S76.4, S65.0, S44.3, S45.1, S75.0, S31.2, T07, S31.4, S98.4, S34.3, T01.2, S19.7, S69.7, S02.50, S44.2, S64.2, S04.2, S54.1, T74.1, S01.7, S54.2, S46.9, S98.2, S56.4, T11.4, T70.2, T67.2, S86.2
Other fracture dislocation of leg	S82.80, S82.81, S73.0, S83.1, S82.40, S82.20, S82.60, S82.61, S82.50, S82.21, S82.51, S82.41
Other fracture/dislocation of arm/shoulder	S43.0, S43.1, S53.1, S52.50, S52.80, S52.90, S42.30, S42.40, S52.60, S52.30, S52.20, S52.00, S52.10, S52.61, S52.01, S52.70, S42.80, S42.90, S52.31, S52.21, S52.71, S42.91, S52.51, S53.0, S52.81, S42.70, S42.41, S42.31, S52.11, S52.5
Other/unspecified complication of treatment	T88.7, T88.8, T81.9, T88.6, T88.1, T98.3
Other/unspecified fracture/dislocation	S12.80, T08.0, S22.20, T02.90, T02.91, T12.0, T12.1, T09.3, T09.2, S83.0, T14.3, S03.2, S03.0, T14.20, T14.21, T03.1
Poisoning/toxic effect of drug	T78.4, T78.2, T78.3, T45.5, T43.2, T39.1, T50.9, T39.0, T42.7, T63.0, T58, T65.9, T78.0, T46.0, T49.0, T55, T44.8, T62.9, T63.4, T50.2, T63.6, T63.2, T59.7, T61.9
Post-operative complication except haemorrhage	T85.9, T81.3, T81.4, T85.6, T81.8, T85.7, T81.2, T85.8, T81.1
Post-operative haemorrhage	T81.0

Rib fracture/flail chest	S22.40, S22.30, S22.50
Significant injury/exposure to element	T68, R57.1, T66, S28.0, S15.0, S98.0, S88.0
Spinal injury	S13.1, S32.00, S14.1, S12.90, S34.1, S12.10, S24.1, S22.00, S14.3, S12.20, S12.00, S14.2, S14.0

Abbreviations: CMG = Case Mix Group; ICD-10 = International Classification of Diseases, Tenth Revision; MCC = Major Clinical Categories

* The following ICD-10 codes only appear in Hong Kong Electronic Health Records but not in Canadian Institute for Health Information documentation: I84.6, I84.5, I84.3, I84.2, I84.1, I84.0, A90, B23.1, B20.0, B24, B23.8, I84.4, A91, B20.6, B21.1, B20.8, W01

Supplementary Table 3. Clinical profiles and 28-day rehospitalisation rates of each 50-64–year-old segment's subpopulation who received no Unbiased Recursive Partitioning with Surrogate Splitting–selected service

Segment	Representative diagnosis		% Male		Age, y		% Resource-intensifying co-morbidity		% Flagged intervention*		% Chronic disease count of 2+		% 28-day rehospitali-sation		Time to rehospitalisa-tion, d (median)	
	NS group (Medoid)	FS (Medoid)	NS group	FS	NS group	FS	NS group	FS	NS group	FS	NS group	FS	NS group	FS	NS group	FS
Circulatory	Heart failure without coronary angiogram	Unstable angina or atherosclerotic heart disease without coronary angiogram	72.73	64.53	57	58	8.66	4.05	3.90	1.75	35.5	23.2	80.1	15.91	13.7	40
Digestive	Digestive malignancy	Symptom or sign of digestive system	60.76	57.2	59	58	6.08	6	9.37	4.93	17.97	2.99	89.6	20.5	11.8	31.1
Nephrology and urology	Renal failure	Malignant neoplasm of urinary system	67.36	48.1	59	58	79.08	3.67	21.76	9.83	26.36	17.44	100	30.98	7	18.3
Musculoskeletal	Inflammatory and reactive arthropathy	Inflammatory and reactive arthropathy	46.28	46.93	58	58	3.19	1.88	7.98	1.79	19.15	9.91	80.9	13.03	12.6	39.2

Segment	Representative diagnosis		% Male		Age, y		% Resource-intensifying co-morbidity		% Flagged intervention*		% Chronic disease count of 2+		% 28-day rehospitalisation		Time to rehospitalisation, d (median)	
	NS group (Medoid)	FS (Medoid)	NS group	FS	NS group	FS	NS group	FS	NS group	FS	NS group	FS	NS group	FS	NS group	FS
Respiratory	Chronic obstructive pulmonary disease	Chronic obstructive pulmonary disease	73.23	63.67	60	59	5.2	4.92	7.06	5.03	33.83	21.22	90.3	25.92	11.9	27.1
Multisystem	Fever	Other or unspecified sepsis	57.82	53.68	58	58	12.93	10.05	10.2	6.12	28.57	15.5	83.7	22.78	13.2	28
Other reasons for hospitalisation	Disequilibrium or hearing loss	General symptom or sign	58.6	52	59	58	3.76	2.79	5.38	2	18.82	10.13	84.4	13.06	10.8	35.3

Abbreviations: FS = full segment; NS group = No Service group

* Flagged Intervention Group 3: cardioversion, chemotherapy, dialysis, cell saver, cardiac resuscitation, paracentesis, pleurocentesis, radiotherapy, non-invasive biopsy, or per orifice endoscopy

Supplement Table 4. Clinical profiles and 28-day rehospitalisation rates of each ≥65–year-old segment's subpopulation who received no Unbiased Recursive Partitioning with Surrogate Splitting–selected service

Segment	Representative diagnosis		% Male		Age, y		% Resource-intensifying co-morbidity		% Flagged intervention*		% Chronic disease count of 2+		% 28-day rehospitalisation		Time to rehospitalisation, d (median)	
	NS group (Medoid)	FS (Medoid)	NS group	FS	NS group	FS	NS group	FS	NS group	FS	NS group	FS	NS group	FS	NS group	FS
Circulatory	Heart failure without coronary angiogram	Arrhythmia with coronary angiogram	56.54	51.94	81	79	9.02	7.53	0.3	1.78	58.83	44.28	85.6	23.66	11.8	35.6
Digestive	Symptom or sign of digestive system	Symptom or sign of digestive system	52.73	53.45	79	76	4.91	9.45	4.35	3.37	42.22	30.89	84.29	21.69	12.9	35.8
Nephrology and urology	Renal failure	Malignant neoplasm of male reproductive system	60.23	55.88	69	76	5.62	6.31	39.24	7.31	43.16	37.59	99.26	30.36	6	48.9
Musculoskeletal	Back pain or strain	Orthopaedic aftercare	49.16	43.17	80	77	3.36	2.81	0.48	0.77	35.49	26.6	86.09	17.43	12.9	38
Respiratory	Chronic obstructive	Chronic obstructive	73.31	67.84	79	79	4.51	6.25	3.43	3.99	57.7	45.82	81.50	27.8	14.9	33.2

Segment	Representative diagnosis		% Male		Age, y		% Resource-intensifying co-morbidity		% Flagged intervention*		% Chronic disease count of 2+		% 28-day rehospitalisation		Time to rehospitalisation, d (median)	
	NS group (Medoid)	FS (Medoid)	NS group	FS	NS group	FS	NS group	FS	NS group	FS	NS group	FS	NS group	FS	NS group	FS
	pulmonary disease	pulmonary disease														
Multisystem	Other anaemia	Sepsis due to *Staphylococcus aureus*, *Pseudomonas*, or *Enterococcus*	52.14	49.53	80	77	15.43	11.85	2.14	3.4	42	33.41	76.58	19.17	14.2	75.9
Other reasons for hospitalisation	Disequilibrium or hearing loss	General symptom or sign	47.74	45.08	81	78	8.6%	7	1.02	0.95	41.02	29.28	74.72	13.69	12.9	126
Mental health	Dementia	Dementia	48.84	46.07	81	80	9.76	7.9	2.33	1.47	48.84	30.84	79.1	15.23	14.5	46.1

Abbreviations: FS = full segment; NS group = No Service group

* Flagged Intervention Group 3: cardioversion, chemotherapy, dialysis, cell saver, cardiac resuscitation, paracentesis, pleurocentesis, radiotherapy, non-invasive biopsy, or per orifice endoscopy

Supplementary Table 5. Feature pool to which Unbiased Recursive Partitioning with Surrogate Splitting was applied

	Features developed	Description
Demographics	Age Sex	Both scale (in years) and categorical Male/female
Patient clinical profiles derived from each patient's primary and secondary diagnoses	Case-mix group	Derived from diagnostic and procedural codes according to ICD-10-CM
	Major clinical categories	Clinical categories reflecting clinically homogeneous taxa of diagnoses, as judged by a panel of clinical leaders
	Multimorbidity	Both scale and categorical: 0—No significant co-morbidity 1—1.25 to <1.5 times more resource intensive 2—1.5 to <2 times more resource intensive 3—2 to <3 times more resource intensive 4—3 or more times more resource intensive NA—Co-morbidity level not applicable
Acute care utilisation: interventions received, whether OT or ICU was utilised during the index care episode, specialty and ward assignment, and acute care LOS	FI Group 1	Presence of invasive ventilation ≥96 hours; or extracorporeal membrane oxygenation
	FI Group 2	Presence of feeding tube; invasive ventilation <96 hours; parenteral nutrition; tracheostomy; or vascular access device
	FI Group 3	Presence of cardioversion; chemotherapy; dialysis; cell saver; cardiac resuscitation; paracentesis; pleurocentesis; radiotherapy; non-invasive biopsy; or per orifice endoscopy
	FI Group 4	FI Group 1 and any intervention in FI Group 2
	FI Group 5	FI Group 1 and any intervention in FI Group 3
	FI Group 6	At least one intervention from FI Group 2 plus at least one from FI Group 3
	FI Group 7	FI Group 1 and at least one intervention from FI Group 2 plus at least one from FI Group 3
	Intervention events	Frequency and presence/absence of ICU or OT admissions
	Acute care LOS	In hours
History of acute care utilisation	Previous 1-year cumulative LOS	In days
	Previous 6-month emergency room visits	Number of times
Acute discharge arrangements	Discharge status	Discharged home with follow-up care prescribed; Discharged home;

		Transferred to same hospital's non-acute ward; Transferred to another hospital's acute ward; Transferred to another hospital's non-acute ward; Discharged against medical advice
PAC inpatient care utilisation	Convalescent	Yes/No; number of hours between acute discharge and attendance
	Infirmary	Yes/No; number of hours between acute discharge and attendance
	Other non-acute ward	Yes/No; number of hours between acute discharge and attendance
PAC day-patient ward care utilisation	Acute	Yes/No; number of hours between acute discharge and attendance
	Convalescent	Yes/No; number of hours between acute discharge and attendance
	Infirmary	Yes/No; number of hours between acute discharge and attendance
	Other non-acute ward	Yes/No; number of hours between acute discharge and attendance
PAC outpatient care utilisation	Specialist outpatient clinic (ambulatory care)	Yes/No; number of hours between acute discharge and attendance
	Multidisciplinary transitional care programme	Yes/No; number of hours between acute discharge and attendance
	PAC non-ward follow-up at hospital	Yes/No; number of hours between acute discharge and attendance
	End-of-life programme	Yes/No; number of hours between acute discharge and attendance
	Primary care service	Yes/No; number of hours between acute discharge and attendance
	Other community nursing service (nursing transitional care programme)	Yes/No; number of hours between acute discharge and attendance
PAC emergency care utilisation	Emergency medicine ward	Yes/No; number of hours between acute discharge and attendance

Abbreviations: FI = flagged intervention; ICD-10-CM = International Classification of Diseases, Tenth Revision, Clinical Modification; ICU = intensive care unit; LOS = length of stay; OT = operating theatre; PAC = post–acute care

Appendix. Supplementary methods

Data and features

The present study included records of community-dwelling patients within a municipal public healthcare system in Hong Kong (patients admitted from residential care homes were excluded). The cohort comprised individuals aged 50 to 64 years (n=69 138) and 65 years or older (n=128 667) who were admitted between 1 January 2015 and 31 December 2019, and whose primary diagnoses were assigned International Classification of Diseases, Tenth Revision (ICD-10) diagnostic codes falling under various Major Clinical Categories (MCCs).[1] The ICD-10 diagnostic codes, corresponding procedure codes, and patient demographics (sex and age) formed the basis for constructing 218 Case Mix Groups (CMGs)[1] across 20 MCCs. Please see online supplementary Table 2 for the mapping among MCCs, CMGs, and ICD codes.

Case Mix Groups classify patients according to clinical principles and can standardise the acute care length of stay (LOS) within each CMG. Although patients within the same CMG share homogeneous diagnostic and procedural profiles, their acute care resource utilisation may vary depending on clinical complexity. Clinical complexity is operationally defined by the Canadian Institute for Health Information (CIHI) Population Grouper Methodology[1] as including resource-intensifying co-morbidity pairs, cost-intensive interventions, trips to operating theatres and intensive care units, and out-of-hospital operations. The CIHI Population Grouper Methodology estimates acute care utilisation for individual CMGs using regression models that incorporate complexity measures. In this study, the comprehensive list of clinical and service utilisation parameters[1] used by the Canadian public health system to derive CMGs from its inpatient population was adopted as the population-segmenting parameters.

Analytic models: unsupervised and supervised machine learning

An unsupervised machine learning algorithm for partitioning around medoids, ie, Clustering Large Applications, was applied to identify ‘typical patients’ (the medoids) from populations of community-dwelling patients aged 50 to 64 years and ≥65 years. The Calinski-Harabasz Index was used to determine the optimal number of segments, based on which the population was partitioned. Individual patients were then assigned to segments according to their similarity to the segment medoids.

Specifically, Clustering Large Applications was first applied to the original datasets to randomly create multiple subsets. Second, based on the number of population segments (k) that yielded the highest Calinski-Harabasz Index, the algorithm was applied to each subset to identify the corresponding k medoids—representing the most typical exemplars of patients (ie, the 'typical patient' in each segment, with respect to every dimension of the parameterised population). In the present study, the population was parameterised using clinical and acute care utilisation indicators derived from the CIHI case-mixing framework.[1] Third, using these CIHI indicators, the algorithm measured the dissimilarity between each patient and each medoid, assigning each patient to the segment whose typical patient they most closely resembled.

Furthermore, to identify patients with the greatest unmet needs relative to others sharing similar clinical status and acute care utilisation patterns, a 28-day rehospitalisation outcome-supervised machine learning algorithm was applied. This model further partitioned each homogeneous clinical and acute service utilisation segment into subpopulations that were also homogeneous in post–acute care (PAC) utilisation with respect to 28-day rehospitalisation outcomes. Given the high dimensionality and interdependence of the clinical and service utilisation features—and their unique and combined effects on 28-day rehospitalisation—machine learning models were preferred over conventional linear models in this study.

In particular, a non-regression model–based optimal classification tree with an Unbiased Recursive Partitioning and Surrogate Splitting (URPSS) mechanism[2] was implemented. Using 28-day rehospitalisation as the supervised outcome, URPSS sequentially selected features in an order reflecting the magnitude of their respective marginal contributions to rehospitalisation outcomes relative to all remaining features in the pool (see online supplementary Table 5 for the feature pool to which URPSS was applied). A greater magnitude of a selected service's marginal contribution to the 28-day rehospitalisation outcome led to its earlier selection by URPSS to split the sample of records. Each selected feature (a parent node) divided the remaining records within the segment into two subsets (offspring nodes). The split-stopping criteria of URPSS optimised tree depth by terminating when the conditional inference of any remaining features in the pool made no additional marginal contribution to the outcome.

A key feature of URPSS is that the two offspring nodes derived from the same parent node statistically significantly differ in their outcomes. Consequently, the final subpopulations within each segment that remained unsplit from the sequential partitioning (ie, offspring nodes that did not become parent nodes) comprised patients who were homogeneous—both among themselves and within the broader segment—in terms of clinical and acute care utilisation, but who had received none of the PAC services that the algorithm considered of high importance to rehospitalisation outcomes.

These final unsplit subpopulations within each segment were subsequently labelled as 'NS groups'.

Accordingly, we hypothesised that, for each segment, the NS group would consistently be the subpopulation with the highest 28-day rehospitalisation rate among all subpopulations partitioned from its corresponding segment, even after adjusting for the conditional inference of all clinical and acute care utilisation features. Potential differences between the two age populations were also explored. For each NS group, its medoid was identified to characterise the typical patient profile.

In this study, co-morbid diagnoses received during index hospitalisations were coded separately from historical chronic illnesses diagnosed before the index hospitalisation. Co-morbidities during index hospitalisation were parameterised using CIHI's resource-intensifying weights[1] to reflect the presence of co-morbid diagnoses that at least doubled acute care resource utilisation compared with others sharing the same CMGs. Additionally, historical diagnoses of chronic illnesses prior to index hospitalisation were parameterised as the presence or absence of six specific chronic illnesses associated with the greatest risk of short-term rehospitalisation.[3]

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