

Additional file 1. Supplementary figure and tables

Comparing Charlson, Elixhauser comorbidity indices with different weightings to predict in-hospital mortality: an analysis of national inpatient data

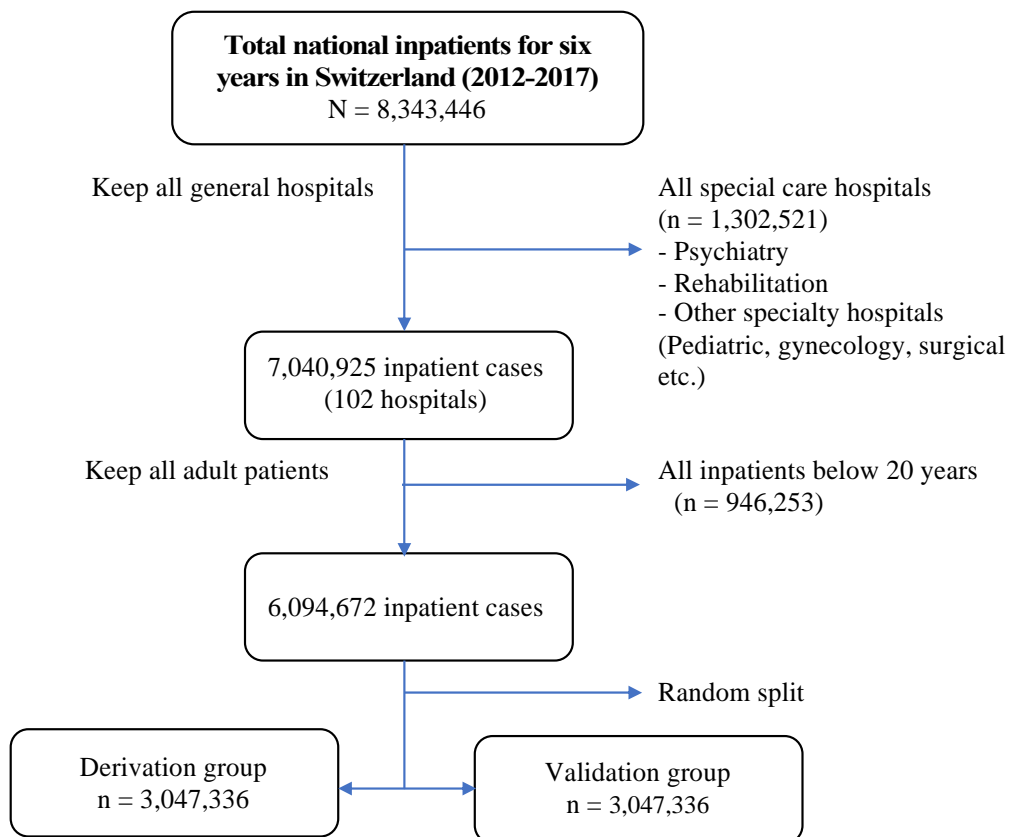


Fig. F1 Flowchart. National inpatient cases of all general hospitals for the analysis

Table S1 The ICD-10 GM codes used in comorbidity package to classify the Charlson and the Elixhauser comorbidity indices

Charlson comorbidity index	ICD-10 codes
Myocardial infarction	I21.x, I22.x, I25.2
Congestive heart failure	I09.9, I11.0, I13.0, I13.2, I25.5, I42.0, I42.5 - I42.9, I43.x, I50.x, P29.0
Peripheral vascular disease	I70.x, I71.x, I73.1, I73.8, I73.9, I77.1, I79.0, I79.2, K55.1, K55.8, K55.9, Z95.8, Z95.9
Cerebrovascular disease	G45.x, G46.x, H34.0, I60.x - I69.x
Dementia	F00.x - F03.x, F05.1, G30.x, G31.1
Chronic pulmonary disease	I27.8, I27.9, J40.x - J47.x, J60.x - J67.x, J68.4, J70.1, J70.3
Rheumatic disease	M05.x, M06.x, M31.5, M32.x - M34.x, M35.1, M35.3, M36.0
Peptic ulcer disease	K25.x - K28.x
Mild liver disease	B18.x, K70.0 - K70.3, K70.9, K71.3 - K71.5, K71.7, K73.x, K74.x, K76.0, K76.2 - K76.4, K76.8, K76.9, Z94.4
Diabetes without chronic complication	E10.0, E10.1, E10.6, E10.8, E10.9, E11.0, E11.1, E11.6, E11.8, E11.9, E12.0, E12.1, E12.6, E12.8, E12.9, E13.0, E13.1, E13.6, E13.8, E13.9, E14.0, E14.1, E14.6, E14.8, E14.9
Diabetes with chronic complication	E10.2 - E10.5, E10.7, E11.2 - E11.5, E11.7, E12.2 - E12.5, E12.7, E13.2 - E13.5, E13.7, E14.2 - E14.5, E14.7
Hemiplegia or paraplegia	G04.1, G11.4, G80.1, G80.2, G81.x, G82.x, G83.0 - G83.4, G83.9
Renal disease	I12.0, I13.1, N03.2 - N03.7, N05.2 - N05.7, N18.x, N19.x, N25.0, Z49.0 - Z49.2, Z94.0, Z99.2
Any malignancy, including lymphoma and leukaemia, except malignant neoplasm of skin	C00.x - C26.x, C30.x - C34.x, C37.x - C41.x, C43.x, C45.x - C58.x, C60.x - C76.x, C81.x - C85.x, C88.x, C90.x - C97.x
Moderate or severe liver disease	I85.0, I85.9, I86.4, I98.2, K70.4, K71.1, K72.1, K72.9, K76.5, K76.6, K76.7
Metastatic solid tumour	C77.x - C80.x
AIDS/HIV	B20.x - B22.x, B24.x
Elixhauser comorbidity index	ICD-10 codes
Congestive heart failure	I09.9, I11.0, I13.0, I13.2, I25.5, I42.0, I42.5 - I42.9, I43.x, I50.x, P29.0
Cardiac arrhythmias	I44.1 - I44.3, I45.6, I45.9, I47.x - I49.x, R00.0, R00.1, R00.8, T82.1, Z45.0, Z95.0
Valvular disease	A52.0, I05.x - I08.x, I09.1, I09.8, I34.x - I39.x, Q23.0 - Q23.3, Z95.2 - Z95.4
Pulmonary circulation disorders	I26.x, I27.x, I28.0, I28.8, I28.9

Peripheral vascular disorders	I70.x, I71.x, I73.1, I73.8, I73.9, I77.1, I79.0, I79.2, K55.1, K55.8, K55.9, Z95.8, Z95.9
Hypertension (uncomplicated)	I10.x
Hypertension (complicated)	I11.x - I13.x, I15.x
Paralysis	G04.1, G11.4, G80.1, G80.2, G81.x, G82.x, G83.0 - G83.4, G83.9
Other neurological disorders	G10.x - G13.x, G20.x - G22.x, G25.4, G25.5, G31.2, G31.8, G31.9, G32.x, G35.x - G37.x, G40.x, G41.x, G93.1, G93.4, R47.0, R56.x
Chronic pulmonary disease	I27.8, I27.9, J40.x - J47.x, J60.x - J67.x, J68.4, J70.1, J70.3
Diabetes, uncomplicated	E10.0, E10.1, E10.9, E11.0, E11.1, E11.9, E12.0, E12.1, E12.9, E13.0, E13.1, E13.9, E14.0, E14.1, E14.9
Diabetes, complicated	E10.2 - E10.8, E11.2 - E11.8, E12.2 - E12.8, E13.2 - E13.8, E14.2 - E14.8
Hypothyroidism	E00.x - E03.x, E89.0
Renal failure	I12.0, I13.1, N18.x, N19.x, N25.0, Z49.0 - Z49.2, Z94.0, Z99.2
Liver disease	B18.x, I85.x, I86.4, I98.2, K70.x, K71.1, K71.3 - K71.5, K71.7, K72.x - K74.x, K76.0, K76.2 - K76.9, Z94.4
Peptic ulcer disease, excluding bleeding	K25.7, K25.9, K26.7, K26.9, K27.7, K27.9, K28.7, K28.9
AIDS/HIV	B20.x - B22.x, B24.x
Lymphoma	C81.x - C85.x, C88.x, C96.x, C90.0, C90.2
Metastatic cancer	C77.x - C80.x
Solid tumour without metastasis	C00.x - C26.x, C30.x - C34.x, C37.x - C41.x, C43.x, C45.x - C58.x, C60.x - C76.x, C97.x
Rheumatoid arthritis/collagen vascular diseases	L94.0, L94.1, L94.3, M05.x, M06.x, M08.x, M12.0, M12.3, M30.x, M31.0 - M31.3, M32.x - M35.x, M45.x, M46.1, M46.8, M46.
Coagulopathy	D65 - D68.x, D69.1, D69.3 - D69.6
Obesity	E66.x
Weight loss	E40.x - E46.x, R63.4, R64
Fluid and electrolyte disorders	E22.2, E86.x, E87.x
Blood loss anaemia	D50.0
Deficiency anaemia	D50.8, D50.9, D51.x - D53.x
Alcohol abuse	F10, E52, G62.1, I42.6, K29.2, K70.0, K70.3, K70.9, T51.x, Z50.2, Z71.4, Z72.1
Drug abuse	F11.x - F16.x, F18.x, F19.x, Z71.5, Z72.2
Psychoses	F20.x, F22.x - F25.x, F28.x, F29.x, F30.2, F31.2, F31.5
Depression	F20.4, F31.3 - F31.5, F32.x, F33.x, F34.1, F41.2, F43.2

.x means all the sub-codes from the main ICD-10 code

Table S2 Comorbidity index of Charlson, van Walraven and population-based weights in the total study population

Parameters	Alive cohort (%)	Mortality cohort (%)	SMD
Charlson index (Charlson weights)			1.277
0	3,642,650 (61.2)	17,465 (12.2)	
1–4	1,922,213 (32.3)	72,876 (51.1)	
>=5	387,142 (6.5)	52,326 (36.7)	
Elixhauser index (van Walraven weights)			1.303
<0	376,560 (6.3)	1,216 (0.9)	
0	3,236,440 (54.4)	14,311 (10.0)	
1–4	546,349 (9.2)	9,300 (6.5)	
>=5	1,792,656 (30.1)	117,840 (82.6)	
Elixhauser index (population-based weights)			1.322
<0	1,154,573 (19.4)	4,946 (3.5)	
0	2,561,720 (43.0)	11,607 (8.1)	
1–4	426,880 (7.2)	6,121 (4.3)	
>=5	1,808,832 (30.4)	119,993 (84.1)	

Abbreviations: SMD, standardized mean difference between alive and mortality cohort

Table S3 Prevalence of Charlson comorbidities from the total population and Swiss derivation sample

Charlson comorbidities	Total population	Population-based derivation sample		
	N (%)	Alive cohort (%)	Mortality cohort (%)	SMD
	6,094,672 (100)	2,975,887 (97.7)	71,449 (2.3)	
Myocardial infarction	195,981 (3.2)	91,930 (3.1)	6,138 (8.6)	0.236
Congestive heart failure	360,599 (5.9)	163,685 (5.5)	16,333 (22.9)	0.514
Peripheral vascular disease	294,919 (4.8)	141,051 (4.7)	6,912 (9.7)	0.192
Cerebrovascular disease	254,526 (4.2)	118,841 (4.0)	8,465 (11.8)	0.294
Dementia	189,091 (3.1)	89,536 (3.0)	5,078 (7.1)	0.188
Chronic pulmonary disease	358,407 (5.9)	170,770 (5.7)	8,269 (11.6)	0.209
Rheumatic disease	83,179 (1.4)	40,366 (1.4)	1,061 (1.5)	0.011
Peptic ulcer disease	34,831 (0.6)	16,305 (0.5)	1,144 (1.6)	0.102
Mild liver disease	983,70 (1.6)	46,028 (1.5)	3,203 (4.5)	0.172
Diabetes without chronic complication	523,029 (8.6)	253,022 (8.5)	9,333 (13.1)	0.147
Diabetes with chronic complication	123,336 (2.0)	59,298 (2.0)	2,492 (3.5)	0.092
Hemiplegia or paraplegia	133,663 (2.2)	61,546 (2.1)	5,153 (7.2)	0.246
Renal disease	618,117 (10.1)	289,180 (9.7)	20,528 (28.7)	0.497
Any malignancy, including lymphoma and leukaemia, except malignant neoplasm of skin	658,483 (10.8)	302,801 (10.2)	26,900 (37.6)	0.680
Moderate or severe liver disease	29,538 (0.5)	12,442 (0.4)	2,331 (3.3)	0.213
Metastatic solid tumour	276,426 (4.5)	119,667 (4.0)	18,907 (26.5)	0.657
AIDS/HIV	4,894 (0.1)	2,300 (0.1)	85 (0.1)	0.013

Abbreviations: SMD, standardized mean difference between alive and mortality cohort; Total % exceeds 100% for each cohort, as comorbidities are mutually inclusive

Table S4 Prevalence of Elixhauser comorbidities from the total and derivation sample

Elixhauser comorbidities	Total population	Population-based derivation sample		
	N (%)	Alive cohort (%)	Mortality cohort (%)	SMD
	6,094,672 (100)	2,975,887 (97.7)	71,449 (2.3)	
Congestive heart failure	360599 (5.9)	163,685 (5.5)	16,333 (22.9)	0.514
Cardiac arrhythmias	724927 (11.9)	341,280 (11.5)	20,754 (29.0)	0.448
Valvular disease	248362 (4.1)	117,450 (3.9)	6,568 (9.2)	0.213
Pulmonary circulation disorders	116734 (1.9)	53,292 (1.8)	4,813 (6.7)	0.247
Peripheral vascular disorders	294919 (4.8)	141,051 (4.7)	6,912 (9.7)	0.192
Hypertension (uncomplicated)	1383747 (22.7)	676,609 (22.7)	15,692 (22.0)	0.019
Hypertension (complicated)	459645 (7.5)	218,656 (7.3)	11,003 (15.4)	0.256
Paralysis	133663 (2.2)	61,546 (2.1)	5,153 (7.2)	0.246
Other neurological disorders	256353 (4.2)	120,045 (4.0)	8,011 (11.2)	0.273
Chronic pulmonary disease	358407 (5.9)	170,770 (5.7)	8,269 (11.6)	0.209
Diabetes, uncomplicated	508108 (8.3)	245,817 (8.3)	9,059 (12.7)	0.145
Diabetes, complicated	137602 (2.3)	66,161 (2.2)	2,763 (3.9)	0.096
Hypothyroidism	258542 (4.2)	126,062 (4.2)	3,454 (4.8)	0.029
Renal failure	617834 (10.1)	289,047 (9.7)	20,526 (28.7)	0.497
Liver disease	111396 (1.8)	49,916 (1.7)	5,822 (8.1)	0.303
Peptic ulcer disease, excluding bleeding	12012 (0.2)	5,808 (0.2)	258 (0.4)	0.032
AIDS/HIV	4894 (0.1)	2,300 (0.1)	85 (0.1)	0.013
Lymphoma	53679 (0.9)	25,049 (0.8)	1,759 (2.5)	0.127
Metastatic cancer	276426 (4.5)	119,667 (4.0)	18,907 (26.5)	0.657
Solid tumour without metastasis	583683 (9.6)	268,298 (9.0)	24,046 (33.7)	0.631
Rheumatoid arthritis/collagen vascular diseases	97335 (1.6)	47,305 (1.6)	1,254 (1.8)	0.013
Coagulopathy	200102 (3.3)	90,551 (3.0)	9,528 (13.3)	0.382
Obesity	137896 (2.3)	68,155 (2.3)	1,011 (1.4)	0.065
Weight loss	216541 (3.6)	98,545 (3.3)	9,527 (13.3)	0.369
Fluid and electrolyte disorders	550094 (9.0)	257,618 (8.7)	17,440 (24.4)	0.434
Blood loss anaemia	40893 (0.7)	19,759 (0.7)	685 (1.0)	0.033
Deficiency anaemia	148305 (2.4)	72,290 (2.4)	1,886 (2.6)	0.013
Alcohol abuse	199964 (3.3)	96,708 (3.2)	3,086 (4.3)	0.056

Drug abuse	77640 (1.3)	38,044 (1.3)	583 (0.8)	0.045
Psychoses	59909 (1.0)	29,598 (1.0)	404 (0.6)	0.049
Depression	355765 (5.8)	173,898 (5.8)	3,715 (5.2)	0.028

Abbreviations: SMD, standardized mean difference between alive and mortality cohort; Total % exceeds 100% for each cohort, as comorbidities are mutually inclusive

Table S5 Performance measures of base, Charlson, van Walraven and population-based weights models for in-hospital mortality in total validation sample

	C statistic (95% CI)
Base model	0.754 (0.753–0.754)
Charlson weights model	0.849 (0.848–0.851)
VW weights model	0.863 (0.862–0.864)
Population-based weights model	0.866 (0.865–0.867)

Abbreviations: VW van Walraven, *CI* confidence interval

Base model: age groups, sex, hospital types

Charlson weights model: base and Charlson weights

VW weights model: base and Elixhauser/ van Walraven weights

Population-based weights model: base and Elixhauser/ Population-based weights