

Supplementary Material

Table S1: Parameters of the Gradient Tree Boosting algorithm. In this study, we used the freely available gradient tree boosting algorithm implemented in the R package XGBoost with the following parameters chosen via manual tuning:

Parameter	Value	Variable name in R package XGBoost ²³
Number rounds	1,000	nrounds
Maximum depth of each tree	5	max_depth
Factor scaling the contribution of each tree	0.01	eta
Minimum loss reduction required to make a further partition on a leaf node of the tree	1	gamma
Maximum gradient delta step for tree weight estimation	1	max_delta_step
Minimum sum of instance weigh in a child	5	min_child_weight
Subsample ratio of the training instance	0.5	subsample
Subsample ratio of columns when constructing each tree	0.6	colsample_bytree

Table S2: Conversion of continuous variables into categorical variables (cutting points)

Name of the feature	Number of levels	Cutting points
LOS (hours)	6	12, 24, 48, 72, 168
Age (years)	5	25, 45, 65, 85
Cumulative LOS (hours)	3	0, 168
Days from last admission	3	30, 365
Number of pathology tests	6	0, 25, 50, 100, 200
Number of pathology panels	5	0, 1, 5, 10
Hours since last surgery	4	(no surgery), 6, 48
Hours since last panel	5	(no panel), 0, 6, 24
Admission type	3	(Medical), Minor Surgery*, Surgery**

*: Minor Surgery is defined as surgeries with not more than 1 hour duration.
 **: Surgery is defined as surgeries with more than 1 hour duration.

Table S3: Characteristics of patients and their hospital admissions for the study population							
Feature	Statistics						
	25 th -Perc.	Median	Mean	75 th -Perc.	STD	Reference value	
Age (years)	34.0	52.0	51.9	68.0	20.1	<=25 years	
Cumulative LOS in the past year (hours)	0	0	85.1	5.9	343.5	0 hours	
Days since last admission	237.8	365.5	290.2	365.5	127.5	>365 days (no admission)	
Number of pathology tests	3.0	37.0	83.5	70.0	226.0	0	
Number of pathology panels	2.0	8.0	10.1	13.0	11.1	0	
Hours since last surgery	0	0	22.4	5.0	74.6	(no surgery)	
Length of stay (hours)	6.8	22.6	74.3	74.4	166.6	<=12 hours	
Gender (%)	Male			Female			
	57			43			Male
Day of Week Admission (%)	Mon	Tue	Wed	Thu	Fri	Sat	Sun
	17.1	17.1	16.3	17.3	14.1	9.0	8.8
Day of Week Discharge (%)	Mon	Tue	Wed	Thu	Fri	Sat	Sun
	15.5	17.0	16.7	17.6	16.7	9.1	7.1
Time of Day Admission (%)	00:00-07:59		08:00-15:59		16:00-23:59		
	25.9		47.4		26.5		
Time of Day Discharge (%)	00:00-07:59		08:00-15:59		16:00-23:59		
	4.9		64.1		30.9		
Marital Code (%)	Married	Never Married	Widow	Divorced/separated	Unknown		
	39.3	40.2	6.8	6.3	7.2		Married
Episode of care type (%)	Acute care	Palliative care	Rehabilitation care				
	99.2	0.4	0.2				Acute care
Source of referral (%)	Emergency Department					61.7	Others
	Outpatients					9.3	
	Other Hospital					1.8	
	Other Medical Practitioner other than Private Psychiatric Practice					24.6	
	Hospital in same AHS					0.4	
	Private Psychiatric Practice					0.0	
Admission type	Medical					61.2	Medical
	Minor Surgery					19.6	
	Surgery					19.2	
Triage Code (%)	Resuscitation					3.5	Ref=No ED
	Emergency					13.8	
	Urgent					35.0	
	Semi-urgent					8.5	
	Non-urgent					0.3	
	No ED					38.7	
Arrival mode (%)	Community/Public Transport					17.7	Not from ED
	Police/Correctional Services Vehicle					1.1	
	Private Car					12.7	
	Ambulance Service					29.5	
	Air Ambulance					0.0	
	Not from ED					38.7	
	Unknown					0.1	
Payment status (%)	Medicare card holder and public patient					69.1	other or missing
	Medicare card holder and private patient					18.3	
	Overseas visitor					7.6	
	Veterans affairs					1.5	
	Prisoner					0.0	
	Trial patient					0.0	
	Other or missing					3.3	

Ward type	Emergency/Mobile Unit	33.7	Others
	Day Procedure	19.0	
	Cardiology	8.2	
	Cardiothoracic Surgery and Transplant	6.1	
	Orthopaedics, Urology, Rheumatology and Plastics	5.7	
	Neurosurgery, neurology, vascular medicine, vascular surgery, stroke unit	5.6	
	Oncology, haematology, bone marrow transplant, immunology, nephrology, rheumatology, HIV, clinical pharmacology, drugs & alcohol	5.1	
	Psychiatric emergency care centre	2.3	
	Gastroenterology, Colorectal surgery, GIT	6.9	
	Mental Health	1.8	
	ICU	1.1	
	Geriatrics	2.5	
	Others	1.9	
Procedure blocks	Allied Health Intervention	9.1	No procedure
	Haemodialysis	4.9	
	Computerised tomography of brain	4.8	
	Coronary angiography	3.0	
	Panendoscopy with excision	2.3	
	Computerised tomography of abdomen and pelvis	1.7	
	Administration of blood and blood products	1.6	
	No procedure	27.1	
	Others	45.1	

Table S4: Categories of primary diagnosis in our cohort, ICD10			
Cardiac murmurs and other cardiac sounds	4.21%	Gastritis and duodenitis	1.31%
Abdominal and pelvic pain	2.30%	Other forms of heart disease	1.29%
Ischaemic heart diseases (I20)	2.23%	Mental and behavioural disorders due to use of alcohol	1.27%
Syncope and collapse	1.86%	Acute appendicitis	1.17%
Transient cerebral ischaemic attacks and related syndromes	1.55%	“Others”	81.4%
Ischaemic heart diseases (I25)	1.35%		

Table S5: Comorbidity groups in our cohort (Reference value= no comorbidity)			
Comorbidity groups	Percentages	Comorbidity groups	Percentages
Congestive heart failure (%)	3.6	AIDS/HIV (%)	1.2
Cardiac arrhythmia (%)	10.1	Lymphoma (%)	0.8
Valvular disease (%)	2.6	Metastatic cancer (%)	2.3
Pulmonary circulation disorders (%)	1.3	Solid tumor without metastasis (%)	5.1
Peripheral vascular disorders (%)	2.0	Rheumatoid arthritis/collagen (%)	1.4
Hypertension Uncomplicated (%)	21.0	Coagulopathy (%)	1.2
Hypertension Complicated (%)	0.1	Obesity (%)	2.0
Paralysis (%)	0.6	Weight loss (%)	0.0
Other neurological disorders (%)	3.3	Fluid and electrolyte disorders (%)	5.3
Chronic pulmonary disease (%)	6.5	Blood loss anemia (%)	0.0
Diabetes uncomplicated (%)	2.9	Deficiency anemia (%)	1.5
Diabetes complicated (%)	5.8	Alcohol abuse (%)	7.2
Hypothyroidism (%)	1.7	Drug abuse (%)	4.3
Renal failure (%)	3.4	Psychoses (%)	2.8
Liver disease (%)	2.0	Depression (%)	6.6
Peptic ulcer disease excluding bleeding (%)	0.7		

Table S6: Pathology variables identified by the hospital laboratory in our cohort (Reference value=missing)									
Panel	Pathology tests	Normal (%)	Abnormal (%)	Missed (%)	Panel	Pathology tests	Normal (%)	Abnormal (%)	Missed (%)
Panel 1: Full Blood count (FBC)	Haemoglobin White Blood Cell RBC Red Cell Distribution Width Mean Corpuscular Hemoglobin Concentration Hematocrit test Mean Corpuscular Volume Mean Corpuscular Hemoglobin Platelets Meosinophils Monocytes Basophils Lymphocytes Neutrophils	11.5	58.9	29.5	Panel9: International Normalised Ratio (INR)	International Normalised Ratio	55.2	15.1	29.7
Panel2: Urea Electrolyte and creatinine (UEC)	Creatinine Urea Sodium Potassium Chloride Bicarbonate Estimate Glomerular Filtration Rate	31.7	38.6	29.7	Panel10: Troponin I	Troponin I	61.9	8.4	29.7
Panel3: Liver Function Test (LFT)	Albumin Total Protein Aspartate Aminotransferase Gamma Glutamyl Transferase Alanine Aminotransferase Total Bilirubin Alkaline Phosphatase	22.3	38.9	38.6	Panel11: Lipase	Lipase	65.5	4.8	29.7
Panel4: CA/MG/PHOS	Calcium Magnesium Inorganic Phosphate	38.6	14.1	47.2	Panel12: Transferrin saturation	Transferrin saturation	67.7	2.5	29.7
Panel5: C-Reactive Protein (CRP)	C-Reactive Protein	69.5	0.9	29.5	Panel13: Faecal Occult Blood	Faecal Occult Blood	52.0	18.2	29.7
Panel6: Activated Partial Thromboplastin Time (APTT)	Activated Partial Thromboplastin Time	42.2	28.3	29.5	Panel14: Blood Alcohol Concentration	Blood Alcohol Concentration	59.0	10.7	30.3
Panel7: Glucose	Glucose	52.2	18.2	29.5	Panel15: GPScreen	GPScreen	53.6	7.7	38.7
Panel8: Prothrombin Time (PT)	Prothrombin Time	61.0	9.3	29.7	Panel16: Free thyroxine	Free thyroxine	51.1	9.6	38.9

Table S7: Calibration performance: Observed and expected rates for selected scores can be found in this table.

7-days				30-days				60-days			
S*	Number Admission	Readmission rate		S*	Number Admission	Readmission rate		S*	Number Admission	Readmission rate	
		Observed	Expected			Observed	Expected			Observed	Expected
-3	115	0.0%	0.6%	0	185	1.1%	1.8%	-3	2	0.0%	1.5%
-2	144	0.7%	0.7%	1	187	1.6%	2.0%	-2	9	0.0%	1.7%
-1	366	0.0%	0.8%	2	693	1.4%	2.3%	-1	116	0.9%	1.9%
0	641	0.6%	0.9%	3	1049	2.3%	2.6%	0	135	2.2%	2.2%
1	299	0.7%	1.0%	4	346	3.5%	3.0%	1	85	1.2%	2.5%
2	383	0.8%	1.2%	5	555	2.9%	3.4%	2	458	1.7%	2.8%
3	524	0.8%	1.3%	6	657	3.7%	3.8%	3	867	2.7%	3.2%
4	322	2.2%	1.5%	7	1011	4.6%	4.3%	4	684	3.4%	3.6%
5	381	0.5%	1.7%	8	1084	5.4%	4.9%	5	592	3.9%	4.1%
6	470	1.3%	2.0%	9	1072	6.3%	5.6%	6	534	4.1%	4.7%
7	636	3.1%	2.3%	10	893	5.8%	6.3%	7	709	6.6%	5.3%
8	803	1.6%	2.6%	11	707	6.6%	7.2%	8	801	6.1%	6.0%
9	947	3.5%	3.0%	12	552	9.1%	8.1%	9	893	7.4%	6.8%
10	1003	3.4%	3.4%	13	432	9.7%	9.2%	10	707	8.5%	7.6%
11	1069	3.4%	3.8%	14	355	14.6%	10.3%	11	584	10.3%	8.6%
12	929	5.3%	4.4%	15	300	14.0%	11.6%	12	471	11.3%	9.7%
13	733	6.0%	5.0%	16	220	9.5%	13.1%	13	446	12.1%	10.8%
14	565	5.3%	5.7%	17	157	16.6%	14.6%	14	421	15.7%	12.2%
15	424	5.7%	6.5%	18	150	16.0%	16.4%	15	338	16.0%	13.6%
16	277	5.8%	7.3%	19	116	12.9%	18.3%	16	281	16.4%	15.2%
17	204	6.9%	8.3%	20	101	21.8%	20.4%	17	257	19.8%	17.0%
18	159	7.5%	9.4%	21	80	26.3%	22.6%	18	195	17.9%	18.9%
19	141	8.5%	10.7%	22	70	28.6%	25.0%	19	178	20.8%	20.9%
20	98	12.2%	12.0%	23	61	23.0%	27.6%	20	156	22.4%	23.2%
21	73	20.5%	13.6%	24	41	29.3%	30.3%	21	121	24.8%	25.6%
22	49	12.2%	15.2%	25	44	34.1%	33.2%	22	124	29.0%	28.1%
23	44	27.3%	17.1%	26	28	32.1%	36.2%	23	106	27.4%	30.8%
24	34	14.7%	19.1%	27	17	29.4%	39.3%	24	87	32.2%	33.6%
25	20	10.0%	21.3%	28	13	46.2%	42.5%	25	67	35.8%	36.6%
26	19	26.3%	23.7%	29	14	35.7%	45.8%	26	70	37.1%	39.6%
27	13	23.1%	26.3%	30	10	50.0%	49.1%	27	59	37.3%	42.8%
28	2	0.0%	29.0%	31	5	40.0%	52.5%	28	53	47.2%	46.0%
29	5	20.0%	31.9%	32	1	0.0%	55.8%	29	39	46.2%	49.2%
30	7	28.6%	34.9%	34	3	33.3%	62.2%	30	18	55.6%	52.5%
31	5	0.0%	38.1%	35	1	0.0%	65.3%	31	16	56.3%	55.7%
34	1	0.0%	48.1%					32	10	50.0%	58.9%
								33	6	50.0%	62.0%
								34	6	16.7%	65.0%
								35	1	0.0%	67.9%
								36	1	100.0%	70.6%
								40	1	100.0%	80.2%

S*=Score

Table S8: Sensitivity, specificity and PPV for different cut-off scores

<i>RETURN7</i>					<i>RETURN30</i>					<i>RETURN60</i>				
cut-off score	10	12	20	30	cut-off score	10	12	20	30	cut-off score	10	11	20	30
SEN	77.9%	61.5%	14.7%	0.5%	SEN	65.7%	52.9%	17.7%	1.0%	SEN	75.5%	70.0%	27.9%	2.8%
SPE	51.7%	69.2%	97.3%	99.9%	SPE	63.0%	77.4%	96.6%	99.9%	SPE	58.4%	65.1%	93.4%	99.7%
PPV	5.7%	6.9%	17.0%	15.4%	PPV	11.6%	14.8%	28.0%	40.0%	PPV	17.0%	18.5%	32.2%	50.8%