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Online supplement

Predicting risk of unplanned hospital readmission in survivors of critical illness: a population-level cohort study

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Supplementary methods

Setting

The Scottish National Health Service provides comprehensive community and hospital based health care funded through general taxation and free at the point of delivery. Private health care providers comprise a small number of total activity and are not involved in delivery of emergency care. Scotland does not provide Long Term Acute Care facilities such as those found in the USA, nor has there been widespread adoption of post-ICU clinics.

Variables

Predictors: Factors were classified into three groups: demographics; indices of pre-existing patient health; and indices of critical illness severity. See Supplement for additional information relating to variables. Demographic variables comprised: sex, age at ICU admission, socioeconomic status (measured using Scottish Index of Multiple Deprivation(1)) and remoteness of residence.(2) Indices of pre-existing patient health comprised: admissions/attendances in year prior to index hospital stay (unplanned inpatient, elective/day case, new outpatient attendances, acute psychiatric admissions) and comorbidities (represented as a count and as individual comorbidities). Indices of critical illness severity comprised: ICU admission type (elective surgery, unplanned surgery, non-operative), diagnosis on ICU admission (28 categories(3)), acute physiology score (APS) at admission to ICU, Acute Physiology and Chronic Health Evaluation (APACHE) II score, organ support (mechanical ventilation, renal replacement therapy, circulatory support, maximum number of organs supported on any day during ICU stay), and length of stay variables (length of stay before, during and after ICU stay, total length of index hospital stay).

Measures of comorbidity were derived from three registries: a list of comorbidities derived from previous hospital admissions recorded in SMR01; previous cancer diagnosis from the Scottish Cancer Registry; and the comorbidities recorded in the Scottish Intensive Care Society Audit Group registry as part of severity of illness scoring. The comorbidities identified by Charlson were derived from a five year 'look-back' period from the date of the hospital admission during which the index ICU admission occurred using published International Classification of Disease version 10 coding algorithms.(4) This list was supplemented by codes relating to previous alcohol misuse and drug misuse. The comorbidities extracted from the SICSAG database were derived from those recorded at the time of ICU admission by health care staff as part of the APACHE II and the SAPS II comorbidities. This resulted in six comorbidity categories derived from the SICSSAG database: severe cardiovascular disease, severe respiratory disease, severe liver disease, end stage renal disease, immunosuppression and metastatic cancer. In order to maximise use of the two separate measures of comorbidity and reduce duplication of these measures, we combined the sources of comorbidity ascertainment to produce 19 comorbid categories. The 19 comorbidities were entered as a count of comorbidities (0, 1, 2, 3, 4, ≥ 5) in analyses.

The Scottish Index of Multiple Deprivation is an area-based ranking measure of relative deprivation across Scotland which combines seven domains of indicators of deprivation: income, employment, education, health,

access to services, crime, and housing.(1) It was used in analyses as quintiles. Remoteness of residence defined by the Scottish Office of National Statistics and were used in analyses as a four level variable.(2) An urban settlement is defined as one with greater than 10,000 people. A remote settlement is defined as one with a drive time of greater than 30 minutes to the nearest settlement with 10,000 or more people in it. A very remote settlement is defined as one with a drive time of greater than 60 minutes to the nearest settlement with 10,000 or more people in it.

All quantitative variables were analysed as categorical variables, with categories determined by frequencies.

Variable selection in the multivariable regression models differed depending on the modelling strategy. For models identifying independent predictors of readmission, variables that were closely related from a conceptual (rather than statistical) viewpoint were only entered in one form (e.g. pre-ICU, ICU and post-ICU length of stay rather than hospital length of stay). For organ support variables, individual organ support variables were entered as binary variables rather than number of days of organ support (which was related to ICU length of stay) or total number of organs supported. Count of comorbidities was entered in models rather than individual comorbidities in the primary analysis. In a sensitivity analysis, count of comorbidities was replaced by individual comorbidities. For risk prediction modelling, we allowed conceptually related variables to be candidate variables for selection e.g. count of comorbidities and individual comorbidities were eligible for selection.

References

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eTable 1 Baseline characteristics

Characteristic		N or Median	% or Quartiles	Missing N (%)
Demographics				
Sex	Female	24,466	43.7	0
Age at admission to ICU (years)	Median and Quartiles	60	45, 71	0
Scottish Index of Multiple Deprivation	First quintile (Most deprived)	14,809	26.5	31 (0.1)
	Second quintile	12,907	23.1	
	Third quintile	11,269	20.1	
	Fourth quintile	9,631	17.2	
	Fifth quintile (Least deprived)	7,328	13.1	
Remoteness of residence	Urban area	37,469	68.1	941 (1.7)
	Accessible	13,271	24.1	
	Remote	2,483	4.5	
	Very remote	1,811	3.3	
Indices of pre-existing patient health				
Admissions/attendances in year prior to index hospital stay				0
Number of unplanned inpatient admissions	0	38,429	68.7	
	1	10,582	18.9	
	2 or more	6,964	12.5	
Number of elective inpatient & daycase admissions	0	37,770	67.5	
	1	4,286	7.7	
	2 or more	13,919	24.9	
Number of new outpatient attendances	0	27,134	48.5	
	1	15,428	27.6	
	2 or more	13,413	23.9	
Number of acute psychiatric admissions	0	54,703	97.7	
	1	845	1.5	
	2 or more	427	0.8	
Comorbidities				
Number of comorbidities present	0	24,420	43.6	0
	1	17,490	31.2	
	2	8,338	14.9	
	3 or more	5,727	10.2	
Myocardial infarction	Yes	3,232	5.8	
Cardiovascular disease	Yes	3,780	6.8	
Peripheral vascular disease	Yes	2,763	4.9	
Cerebrovascular disease	Yes	2,149	3.8	
Dementia	Yes	177	0.3	
Respiratory disease	Yes	6,663	11.9	
Rheumatic disease	Yes	910	1.6	
Peptic ulcer disease	Yes	1,094	2.0	
Liver disease	No	53,401	95.4	
	Mild	966	1.7	
	Moderate or severe	1,608	2.9	
Diabetes mellitus	No	51,175	91.4	
	Yes - without chronic complication	4,122	7.4	
	Yes - with chronic complication	678	1.2	
Hemiplegia or paraplegia	Yes	390	0.7	
Renal disease	Yes	2,256	4.0	
Cancer	No	43,763	78.2	
	Yes - without metastases	10,324	18.4	
	Yes - with metastases	1,888	3.4	
Immunosuppression	Yes	1,401	2.5	

Characteristic		N or Median	% or Quartiles	Missing N (%)
Alcohol misuse	Yes	6,065	10.8	
Drug misuse	Yes	3,927	7.0	
Indices of critical illness severity				
Type of admission to ICU	Elective surgery	15,553	28.0	402 (0.7)
	Emergency surgery	13,222	23.8	
	Non-operative	26,798	48.2	
Diagnosis at admission to ICU	Trauma including head injury	1,231	2.2	0
	Cardiovascular			
	Aortic aneurysm rupture	597	1.1	
	Cardiogenic shock	211	0.4	
	Post cardiac arrest	1,200	2.1	
	Septic shock	2,805	5.0	
	Vascular surgery	1,946	3.5	
	Other CVS	5,136	9.2	
	Respiratory			
	ARDS	265	0.5	
	Asthma	649	1.2	
	COPD	390	0.7	
	Pneumonia	4,696	8.4	
	Other respiratory	4,546	8.1	
	Gastrointestinal/Liver			
	GI bleed	1,026	1.8	
	GI neoplasm	2,956	5.3	
	GI obstruction	2,007	3.6	
	GI perforation/ischaemia/ peritonitis/abscess	3,931	7.0	
	Other GI	3,000	5.4	
	Liver failure	219	0.4	
	Oesophageal variceal bleed	465	0.8	
	Pancreatitis	597	1.1	
	Nervous system			
	Intracranial bleed	1,410	2.5	
	Seizures	1,321	2.4	
	Other CNS	2,017	3.6	
	Other			
	Diabetic ketoacidosis	531	0.9	
	Renal	1,578	2.8	
	Self poisoning	2,863	5.1	
	Trauma excluding head injury	2,576	4.6	
	Miscellaneous	5,806	10.4	
CPR prior to admission to ICU	Yes	1,834	3.3	0
APACHE II score at admission to ICU	Median and Quartiles	15	11, 20	7157 (12.8)
Acute physiology score at admission to ICU	Median and Quartiles	11	8, 16	7182 (12.8)
Mechanical ventilation during ICU stay	Yes	33,447	60.2	445 (0.8)
Renal replacement therapy during ICU stay	Yes	3,925	7.1	445 (0.8)
Cardiovascular system support during ICU stay	Yes	20,101	36.2	445 (0.8)
Maximum number of organs supported on any day during ICU stay	0	17,877	32.2	445 (0.8)
	1	20,969	37.8	
	2	14,277	25.7	
	3	2,407	4.3	
Tracheostomy during ICU stay	Yes	5,304	9.6	
Length of stay prior to ICU stay (days)	Median and Quartiles	1	0, 2	445 (0.8)
Length of ICU stay (days)	Median and Quartiles	2	1, 4	0
Length of stay post ICU stay (days)	Median and Quartiles	9	4, 22	0
Length of index hospital stay (days)	Median and Quartiles	15	8, 31	0

eTable 2 Risk factors for unplanned hospital admission and unplanned hospital admission or death within 90 days of discharge from index hospital stay: univariable analyses

Risk factor		N	90d readmission N (%)	90d death without readmission N (%)	Odds ratio for 90d readmission (95% CI)	c-index	p-value	Odds ratio for 90 day readmission or death (95% CI)	c-index	p-value
Demographics										
Sex	Male	31,509	7519 (23.9)	409 (1.3)	1.00 (reference)	0.50	0.20	1.00 (reference)	0.50	0.27
	Female	24,466	5952 (24.3)	303 (1.2)	1.03 (0.99 to 1.07)			1.02 (0.98 to 1.06)		
Age at admission to ICU (years)	16 - 25	3,739	636 (17.0)	16 (0.4)	1.00 (reference)	0.52	<0.0001	1.00 (reference)	0.53	<0.0001
	26 - 35	4,310	898 (20.8)	16 (0.4)	1.28 (1.15 to 1.44)			1.27 (1.14 to 1.42)		
	36 - 45	6,364	1565 (24.6)	41 (0.6)	1.59 (1.44 to 1.76)			1.60 (1.44 to 1.77)		
	46 - 55	8,479	2161 (25.5)	69 (0.8)	1.67 (1.51 to 1.84)			1.69 (1.53 to 1.86)		
	56 - 65	11,550	2847 (24.6)	143 (1.2)	1.60 (1.45 to 1.76)			1.65 (1.51 to 1.82)		
	66 - 75	12,917	3232 (25.0)	216 (1.7)	1.63 (1.48 to 1.79)			1.72 (1.57 to 1.89)		
	76 - 85	7,572	1854 (24.5)	153 (2.0)	1.58 (1.43 to 1.75)			1.71 (1.55 to 1.88)		
	86 or older	1,044	278 (26.6)	58 (5.6)	1.77 (1.51 to 2.08)			2.25 (1.92 to 2.62)		
Scottish Index of Multiple Deprivation	First quintile (Most deprived)	14,809	3810 (25.7)	195 (1.3)	1.00 (reference)	0.52	<0.0001	1.00 (reference)	0.52	<0.0001
	Second quintile	12,907	3182 (24.7)	149 (1.2)	0.94 (0.89 to 1.00)			0.94 (0.89 to 0.99)		
	Third quintile	11,269	2645 (23.5)	155 (1.4)	0.89 (0.84 to 0.94)			0.89 (0.84 to 0.94)		
	Fourth quintile	9,631	2129 (22.1)	119 (1.2)	0.82 (0.77 to 0.87)			0.82 (0.77 to 0.87)		
	Fifth quintile (Least deprived)	7,328	1699 (23.2)	92 (1.3)	0.87 (0.82 to 0.93)			0.87 (0.82 to 0.93)		
Remoteness of residence	Urban area	37,469	9321 (24.9)	458 (1.2)	1.00 (reference)	0.52	<0.0001	1.00 (reference)	0.51	<0.0001
	Accessible	13,271	2974 (22.4)	185 (1.4)	0.87 (0.83 to 0.91)			0.88 (0.84 to 0.93)		
	Remote	2,483	516 (20.8)	35 (1.4)	0.79 (0.72 to 0.88)			0.81 (0.73 to 0.89)		
	Very remote	1,811	449 (24.8)	27 (1.5)	1.00 (0.89 to 1.11)			1.01 (0.91 to 1.12)		
Indices of pre-existing patient health										
Admissions/attendances in year prior to index hospital stay										
Number of unplanned inpatient admissions	0	38,429	7494 (19.5)	418 (1.1)	1.00 (reference)	0.60	<0.0001	1.00 (reference)	0.60	<0.0001
	1	10,582	2968 (28.0)	162 (1.5)	1.61 (1.53 to 1.69)			1.62 (1.54 to 1.70)		
	2	3,624	1296 (35.8)	65 (1.8)	2.30 (2.14 to 2.47)			2.32 (2.16 to 2.49)		
	3	1,570	681 (43.4)	35 (2.2)	3.16 (2.85 to 3.51)			3.23 (2.92 to 3.58)		

Risk factor		N	90d readmission N (%)	90d death without readmission N (%)	Odds ratio for 90d readmission (95% CI)	c-index	p-value	Odds ratio for 90 day readmission or death (95% CI)	c-index	p-value
	4	754	376 (49.9)	14 (1.9)	4.11 (3.55 to 4.75)			4.13 (3.57 to 4.78)		
	5	368	201 (54.6)	3 (0.8)	4.97 (4.04 to 6.11)			4.80 (3.90 to 5.90)		
	6 or more	648	455 (70.2)	15 (2.3)	9.72 (8.20 to 11.52)			10.18 (8.55 to 12.11)		
Number of elective inpatient & daycase admissions	0	37,770	8395 (22.2)	459 (1.2)	1.00 (reference)	0.54	<0.0001	1.00 (reference)	0.54	<0.0001
	1	4,286	1203 (28.1)	68 (1.6)	1.37 (1.27 to 1.47)			1.38 (1.28 to 1.48)		
	2	7,320	1841 (25.2)	82 (1.1)	1.18 (1.11 to 1.25)			1.16 (1.10 to 1.23)		
	3	1,877	540 (28.8)	27 (1.4)	1.41 (1.28 to 1.57)			1.41 (1.28 to 1.56)		
	4	1,963	557 (28.4)	20 (1.0)	1.39 (1.25 to 1.53)			1.36 (1.23 to 1.50)		
	5	651	211 (32.4)	8 (1.2)	1.68 (1.42 to 1.98)			1.66 (1.41 to 1.95)		
	6	596	202 (33.9)	9 (1.5)	1.79 (1.51 to 2.13)			1.79 (1.51 to 2.12)		
	7 or more	1,512	522 (34.5)	39 (2.6)	1.85 (1.66 to 2.06)			1.93 (1.73 to 2.15)		
Number of new outpatient attendances	0	27,134	5889 (21.7)	374 (1.4)	1.00 (reference)	0.54	<0.0001	1.00 (reference)	0.53	<0.0001
	1	15,428	3904 (25.3)	197 (1.3)	1.22 (1.17 to 1.28)			1.21 (1.15 to 1.26)		
	2	8,244	2219 (26.9)	91 (1.1)	1.33 (1.26 to 1.41)			1.30 (1.23 to 1.37)		
	3	3,365	909 (27.0)	32 (1.0)	1.34 (1.23 to 1.45)			1.29 (1.19 to 1.40)		
	4	1,139	350 (30.7)	13 (1.1)	1.60 (1.41 to 1.82)			1.56 (1.37 to 1.77)		
	5 or more	665	200 (30.1)	5 (0.8)	1.55 (1.31 to 1.84)			1.49 (1.26 to 1.76)		
Number of acute psychiatric admissions	0	54,703	13079 (23.9)	686 (1.3)	1.00 (reference)	0.50	<0.0001	1.00 (reference)	0.50	<0.0001
	1	845	251 (29.7)	16 (1.9)	1.34 (1.16 to 1.56)			1.37 (1.19 to 1.59)		
	2 or more	427	141 (33.0)	10 (2.3)	1.57 (1.28 to 1.92)			1.63 (1.33 to 1.99)		
Comorbidities										
Number of comorbidities present	0	24,420	4214 (17.3)	165 (0.7)	1.00 (reference)	0.60	<0.0001	1.00 (reference)	0.61	<0.0001
	1	17,490	4419 (25.3)	277 (1.6)	1.62 (1.55 to 1.70)			1.68 (1.60 to 1.76)		
	2	8,338	2582 (31.0)	144 (1.7)	2.15 (2.03 to 2.28)			2.22 (2.10 to 2.35)		
	3	3,621	1342 (37.1)	74 (2.0)	2.82 (2.62 to 3.04)			2.94 (2.73 to 3.17)		
	4	1,428	583 (40.8)	30 (2.1)	3.31 (2.96 to 3.70)			3.44 (3.08 to 3.84)		
	5 or more	678	331 (48.8)	22 (3.2)	4.57 (3.92 to 5.34)			4.97 (4.26 to 5.80)		
Myocardial infarction	No	52,743	12463 (23.6)	657 (1.2)	1.00 (reference)	0.51	<0.0001	1.00 (reference)	0.51	<0.0001
	Yes	3,232	1008 (31.2)	55 (1.7)	1.47 (1.36 to 1.58)			1.48 (1.37 to 1.60)		
Cardiovascular disease	No	52,195	12222 (23.4)	627 (1.2)	1.00 (reference)	0.52	<0.0001	1.00 (reference)	0.52	<0.0001
	Yes	3,780	1249 (33.0)	85 (2.2)	1.61 (1.50 to 1.73)			1.67 (1.56 to 1.79)		
	No	53,212	12648 (23.8)	675 (1.3)	1.00 (reference)	0.51	<0.0001	1.00 (reference)	0.51	<0.0001

Risk factor		N	90d	90d death	Odds ratio for 90d	c-index	p-value	Odds ratio for 90 day	c-index	p-value
			readmission	without						
			N (%)	N (%)	(95% CI)			(95% CI)		
Peripheral vascular disease	Yes	2,763	823 (29.8)	37 (1.3)	1.36 (1.25 to 1.48)			1.35 (1.25 to 1.47)		
Cerebrovascular disease	No	53,826	12799 (23.8)	667 (1.2)	1.00 (reference)	0.51	<0.0001	1.00 (reference)	0.51	<0.0001
	Yes	2,149	672 (31.3)	45 (2.1)	1.46 (1.33 to 1.60)			1.50 (1.37 to 1.65)		
Dementia	No	55,798	13411 (24.0)	697 (1.2)	1.00 (reference)	0.50	0.002	1.00 (reference)	0.50	<0.0001
	Yes	177	60 (33.9)	15 (8.5)	1.62 (1.19 to 2.21)			2.17 (1.61 to 2.93)		
Respiratory disease	No	49,312	11260 (22.8)	586 (1.2)	1.00 (reference)	0.53	<0.0001	1.00 (reference)	0.53	<0.0001
	Yes	6,663	2211 (33.2)	126 (1.9)	1.68 (1.59 to 1.77)			1.71 (1.62 to 1.80)		
Rheumatic disease	No	55,065	13190 (24.0)	699 (1.3)	1.00 (reference)	0.50	<0.0001	1.00 (reference)	0.50	<0.0001
	Yes	910	281 (30.9)	13 (1.4)	1.42 (1.23 to 1.63)			1.42 (1.23 to 1.63)		
Peptic ulcer disease	No	54,881	13104 (23.9)	691 (1.3)	1.00 (reference)	0.51	<0.0001	1.00 (reference)	0.51	<0.0001
	Yes	1,094	367 (33.5)	21 (1.9)	1.61 (1.42 to 1.83)			1.64 (1.44 to 1.86)		
Liver disease	No	53,401	12393 (23.2)	670 (1.3)	1.00 (reference)	0.52	<0.0001	1.00 (reference)	0.52	<0.0001
	Mild	966	372 (38.5)	20 (2.1)	2.07 (1.82 to 2.36)			2.11 (1.85 to 2.40)		
	Moderate or severe	1,608	706 (43.9)	22 (1.4)	2.59 (2.34 to 2.86)			2.56 (2.31 to 2.83)		
Diabetes mellitus	No	51,175	11806 (23.1)	621 (1.2)	1.00 (reference)	0.53	<0.0001	1.00 (reference)	0.53	<0.0001
	Yes without complication	4,122	1334 (32.4)	76 (1.8)	1.60 (1.49 to 1.71)			1.62 (1.52 to 1.73)		
	Yes - with chronic complication	678	331 (48.8)	15 (2.2)	3.18 (2.73 to 3.70)			3.25 (2.79 to 3.78)		
Hemiplegia or paraplegia	No	55,585	13337 (24.0)	705 (1.3)	1.00 (reference)	0.50	<0.0001	1.00 (reference)	0.50	<0.0001
	Yes	390	134 (34.4)	7 (1.8)	1.66 (1.34 to 2.05)			1.68 (1.36 to 2.06)		
Renal disease	No	53,719	12531 (23.3)	658 (1.2)	1.00 (reference)	0.52	<0.0001	1.00 (reference)	0.52	<0.0001
	Yes	2,256	940 (41.7)	54 (2.4)	2.35 (2.15 to 2.56)			2.42 (2.22 to 2.64)		
Cancer	No	43,763	9960 (22.8)	426 (1.0)	1.00 (reference)	0.53	<0.0001	1.00 (reference)	0.53	<0.0001
	Yes - without metastases	10,324	2892 (28.0)	188 (1.8)	1.32 (1.26 to 1.39)			1.37 (1.30 to 1.43)		
	Yes - with metastases	1,888	619 (32.8)	98 (5.2)	1.66 (1.50 to 1.83)			1.97 (1.79 to 2.17)		
Immunosuppression	No	54,574	12960 (23.7)	687 (1.3)	1.00 (reference)	0.51	<0.0001	1.00 (reference)	0.51	<0.0001
	Yes	1,401	511 (36.5)	25 (1.8)	1.85 (1.65 to 2.06)			1.86 (1.67 to 2.07)		
Alcohol misuse	No	49,910	11515 (23.1)	639 (1.3)	1.00 (reference)	0.52	<0.0001	1.00 (reference)	0.52	<0.0001
	Yes	6,065	1956 (32.3)	73 (1.2)	1.59 (1.50 to 1.68)			1.56 (1.48 to 1.65)		
Drug misuse	No	52,048	12203 (23.4)	661 (1.3)	1.00 (reference)	0.52	<0.0001	1.00 (reference)	0.52	<0.0001
	Yes	3,927	1268 (32.3)	51 (1.3)	1.56 (1.45 to 1.67)			1.54 (1.44 to 1.65)		
Indices of critical illness severity										

Risk factor		N	90d readmission N (%)	90d death without readmission N (%)	Odds ratio for 90d readmission (95% CI)	c-index	p-value	Odds ratio for 90 day readmission or death (95% CI)	c-index	p-value
Type of admission to ICU	Elective surgery	15,553	3480 (22.4)	113 (0.7)	1.00 (reference)	0.51	<0.0001	1.00 (reference)	0.52	<0.0001
	Emergency surgery	13,222	3323 (25.1)	201 (1.5)	1.16 (1.10 to 1.23)			1.21 (1.15 to 1.28)		
	Non-operative	26,798	6576 (24.5)	388 (1.4)	1.13 (1.08 to 1.18)			1.17 (1.12 to 1.22)		
Diagnosis at admission to ICU	Trauma including head injury	1,231	176 (14.3)	4 (0.3)	1.00 (reference)	0.57	<0.0001	1.00 (reference)	0.57	<0.0001
Cardiovascular	Aortic aneurysm rupture	597	113 (18.9)	5 (0.8)	1.40 (1.08 to 1.81)			1.44 (1.11 to 1.86)		
	Cardiogenic shock	211	64 (30.3)	6 (2.8)	2.61 (1.87 to 3.65)			2.90 (2.09 to 4.02)		
	Post cardiac arrest	1,200	261 (21.8)	40 (3.3)	1.67 (1.35 to 2.06)			1.95 (1.59 to 2.40)		
	Septic shock	2,805	739 (26.3)	38 (1.4)	2.14 (1.79 to 2.57)			2.24 (1.87 to 2.67)		
	Vascular surgery	1,946	384 (19.7)	16 (0.8)	1.47 (1.21 to 1.79)			1.51 (1.25 to 1.83)		
	Other CVS	5,136	1267 (24.7)	36 (0.7)	1.96 (1.65 to 2.33)			1.98 (1.67 to 2.35)		
	Respiratory	ARDS	265	80 (30.2)	3 (1.1)	2.59 (1.91 to 3.52)			2.66 (1.96 to 3.61)	
Asthma		649	171 (26.3)	1 (0.2)	2.14 (1.69 to 2.72)			2.11 (1.66 to 2.66)		
COPD		390	117 (30.0)	8 (2.1)	2.57 (1.96 to 3.36)			2.75 (2.11 to 3.59)		
Pneumonia		4,696	1066 (22.7)	62 (1.3)	1.76 (1.48 to 2.09)			1.85 (1.55 to 2.19)		
Other respiratory		4,546	1110 (24.4)	75 (1.6)	1.94 (1.63 to 2.30)			2.06 (1.73 to 2.44)		
Gastrointestinal/Liver	GI bleed	1,026	275 (26.8)	15 (1.5)	2.19 (1.78 to 2.71)			2.30 (1.87 to 2.83)		
	GI neoplasm	2,956	781 (26.4)	41 (1.4)	2.15 (1.80 to 2.58)			2.25 (1.88 to 2.69)		
	GI obstruction	2,007	529 (26.4)	51 (2.5)	2.15 (1.78 to 2.59)			2.37 (1.97 to 2.86)		
	GI perforation/ischaemia/peritonitis/abscess	3,931	1093 (27.8)	64 (1.6)	2.31 (1.94 to 2.75)			2.44 (2.05 to 2.89)		
	Other GI	3,000	839 (28.0)	28 (0.9)	2.33 (1.95 to 2.78)			2.37 (1.99 to 2.83)		
	Liver failure	219	78 (35.6)	1 (0.5)	3.32 (2.41 to 4.56)			3.29 (2.40 to 4.53)		
	Oesophageal variceal bleed	465	213 (45.8)	12 (2.6)	5.07 (3.98 to 6.46)			5.47 (4.30 to 6.97)		
	Pancreatitis	597	239 (40.0)	3 (0.5)	4.00 (3.18 to 5.03)			3.98 (3.17 to 5.00)		
Nervous system	Intracranial bleed	1,410	312 (22.1)	19 (1.3)	1.70 (1.39 to 2.09)			1.79 (1.47 to 2.19)		
	Seizures	1,321	406 (30.7)	12 (0.9)	2.66 (2.18 to 3.24)			2.70 (2.22 to 3.29)		
	Other CNS	2,017	437 (21.7)	39 (1.9)	1.66 (1.37 to 2.01)			1.80 (1.49 to 2.18)		
Other	Diabetic ketoacidosis	531	165 (31.1)	9 (1.7)	2.70 (2.12 to 3.45)			2.85 (2.24 to 3.62)		
	Renal	1,578	503 (31.9)	21 (1.3)	2.80 (2.32 to 3.40)			2.90 (2.40 to 3.51)		
	Self poisoning	2,863	516 (18.0)	26 (0.9)	1.32 (1.09 to 1.59)			1.36 (1.13 to 1.64)		
	Trauma excluding head injury	2,576	462 (17.9)	33 (1.3)	1.31 (1.08 to 1.58)			1.39 (1.15 to 1.67)		

Risk factor		N	90d	90d death	Odds ratio for 90d	c-index	p-value	Odds ratio for 90 day	c-index	p-value
			readmission	without						
			N (%)	N (%)	(95% CI)			(95% CI)		
	Miscellaneous	5,806	1075 (18.5)	44 (0.8)	1.36 (1.15 to 1.62)			1.39 (1.17 to 1.65)		
CPR prior to admission to ICU	No	54,141	13027 (24.1)	665 (1.2)	1.00 (reference)	0.50	0.88	1.00 (reference)	0.50	0.15
	Yes	1,834	444 (24.2)	47 (2.6)	1.01 (0.90 to 1.12)			1.08 (0.97 to 1.20)		
APACHE II score at admission to ICU	1 - 7	4,439	801 (18.0)	11 (0.2)	1.00 (reference)	0.55	<0.0001	1.00 (reference)	0.56	<0.0001
	8 - 10	6,394	1330 (20.8)	35 (0.5)	1.19 (1.08 to 1.31)			1.21 (1.10 to 1.34)		
	11 - 12	5,427	1233 (22.7)	28 (0.5)	1.33 (1.21 to 1.47)			1.35 (1.22 to 1.49)		
	13 - 14	5,977	1435 (24.0)	54 (0.9)	1.43 (1.30 to 1.58)			1.48 (1.35 to 1.63)		
	15 - 16	5,824	1447 (24.8)	75 (1.3)	1.50 (1.36 to 1.65)			1.58 (1.44 to 1.74)		
	17 - 18	5,202	1318 (25.3)	84 (1.6)	1.54 (1.40 to 1.70)			1.65 (1.49 to 1.82)		
	19 - 21	6,048	1649 (27.3)	114 (1.9)	1.70 (1.55 to 1.87)			1.84 (1.67 to 2.02)		
	22 - 25	5,032	1375 (27.3)	98 (1.9)	1.71 (1.55 to 1.88)			1.85 (1.68 to 2.04)		
	26 or more	4,475	1309 (29.3)	114 (2.5)	1.88 (1.70 to 2.07)			2.08 (1.89 to 2.30)		
Acute physiology score at admission to ICU	0 - 5	5,427	1096 (20.2)	33 (0.6)	1.00 (reference)	0.53	<0.0001	1.00 (reference)	0.53	<0.0001
	6 - 7	5,946	1330 (22.4)	42 (0.7)	1.14 (1.04 to 1.25)			1.14 (1.04 to 1.25)		
	8 - 9	6,919	1647 (23.8)	79 (1.1)	1.23 (1.13 to 1.35)			1.27 (1.16 to 1.38)		
	10 - 11	6,754	1650 (24.4)	82 (1.2)	1.28 (1.17 to 1.39)			1.31 (1.21 to 1.43)		
	12 - 13	5,715	1467 (25.7)	87 (1.5)	1.36 (1.25 to 1.49)			1.42 (1.30 to 1.55)		
	14 - 15	5,219	1327 (25.4)	86 (1.6)	1.35 (1.23 to 1.48)			1.41 (1.29 to 1.55)		
	16 - 18	5,239	1392 (26.6)	66 (1.3)	1.43 (1.31 to 1.56)			1.47 (1.34 to 1.60)		
	19 - 22	4,143	1034 (25.0)	82 (2.0)	1.31 (1.19 to 1.45)			1.40 (1.28 to 1.54)		
	23 or more	3,431	945 (27.5)	55 (1.6)	1.50 (1.36 to 1.66)			1.57 (1.42 to 1.73)		
Mechanical ventilation during ICU stay										
Any day	No	22,083	5273 (23.9)	264 (1.2)	1.00 (reference)	0.50	0.30	1.00 (reference)	0.50	0.17
	Yes	33,447	8116 (24.3)	443 (1.3)	1.02 (0.98 to 1.06)			1.03 (0.99 to 1.07)		
Number of days	0	22,083	5273 (23.9)	264 (1.2)	1.00 (reference)	0.51	0.051	1.00 (reference)	0.51	0.013
	1	11,615	2712 (23.3)	127 (1.1)	0.97 (0.92 to 1.02)			0.97 (0.92 to 1.02)		
	2	9,093	2261 (24.9)	130 (1.4)	1.06 (1.00 to 1.12)			1.07 (1.01 to 1.13)		
	3	2,874	747 (26.0)	42 (1.5)	1.12 (1.02 to 1.22)			1.13 (1.04 to 1.23)		
	4	1,674	425 (25.4)	30 (1.8)	1.08 (0.97 to 1.22)			1.12 (1.00 to 1.25)		
	5	1,123	259 (23.1)	16 (1.4)	0.96 (0.83 to 1.10)			0.97 (0.84 to 1.11)		
	6	952	223 (23.4)	14 (1.5)	0.98 (0.84 to 1.14)			0.99 (0.85 to 1.15)		
	7	825	206 (25.0)	12 (1.5)	1.06 (0.90 to 1.25)			1.07 (0.92 to 1.26)		

Risk factor		N	90d readmission N (%)	90d death without readmission N (%)	Odds ratio for 90d readmission (95% CI)	c-index	p-value	Odds ratio for 90 day readmission or death (95% CI)	c-index	p-value
	8	693	187 (27.0)	7 (1.0)	1.18 (0.99 to 1.40)			1.16 (0.98 to 1.38)		
	9	542	123 (22.7)	9 (1.7)	0.94 (0.76 to 1.15)			0.96 (0.79 to 1.17)		
	10	504	115 (22.8)	8 (1.6)	0.94 (0.76 to 1.16)			0.96 (0.79 to 1.18)		
	11 or more	3,552	858 (24.2)	48 (1.4)	1.02 (0.93 to 1.10)			1.02 (0.94 to 1.11)		
Renal replacement therapy during ICU stay										
Any day	No	51,605	12219 (23.7)	656 (1.3)	1.00 (reference)	0.51	<0.0001	1.00 (reference)	0.51	<0.0001
	Yes	3,925	1170 (29.8)	51 (1.3)	1.37 (1.27 to 1.47)			1.36 (1.27 to 1.46)		
Number of days	0	51,605	12219 (23.7)	656 (1.3)	1.00 (reference)	0.51	<0.0001	1.00 (reference)	0.51	<0.0001
	1	597	198 (33.2)	6 (1.0)	1.60 (1.35 to 1.90)			1.56 (1.32 to 1.85)		
	2	680	220 (32.4)	11 (1.6)	1.54 (1.31 to 1.81)			1.55 (1.32 to 1.82)		
	3	588	193 (32.8)	10 (1.7)	1.58 (1.32 to 1.87)			1.59 (1.34 to 1.88)		
	4 or more	2,060	559 (27.1)	24 (1.2)	1.20 (1.09 to 1.33)			1.19 (1.08 to 1.31)		
Cardiovascular system support during ICU stay										
Any day	No	35,429	8215 (23.2)	455 (1.3)	1.00 (reference)	0.52	<0.0001	1.00 (reference)	0.52	<0.0001
	Yes	20,101	5174 (25.7)	252 (1.3)	1.15 (1.10 to 1.20)			1.14 (1.10 to 1.19)		
Number of days	0	35,429	8215 (23.2)	455 (1.3)	1.00 (reference)	0.52	<0.0001	1.00 (reference)	0.52	<0.0001
	1	5,562	1390 (25.0)	50 (0.9)	1.10 (1.03 to 1.18)			1.08 (1.01 to 1.15)		
	2	5,759	1531 (26.6)	77 (1.3)	1.20 (1.13 to 1.28)			1.20 (1.12 to 1.27)		
	3	3,471	913 (26.3)	42 (1.2)	1.18 (1.09 to 1.28)			1.17 (1.08 to 1.27)		
	4	1,945	485 (24.9)	29 (1.5)	1.10 (0.99 to 1.22)			1.11 (1.00 to 1.23)		
	5	1,131	287 (25.4)	16 (1.4)	1.13 (0.98 to 1.29)			1.13 (0.99 to 1.29)		
	6	683	163 (23.9)	13 (1.9)	1.04 (0.87 to 1.24)			1.07 (0.90 to 1.27)		
	7 or more	1,550	405 (26.1)	25 (1.6)	1.17 (1.04 to 1.32)			1.18 (1.06 to 1.33)		
Maximum number of organs supported on any day during ICU stay	0	17,877	4070 (22.8)	202 (1.1)	1.00 (reference)	0.52	<0.0001	1.00 (reference)	0.52	<0.0001
	1	20,969	5032 (24.0)	297 (1.4)	1.07 (1.02 to 1.12)			1.09 (1.04 to 1.14)		
	2	14,277	3638 (25.5)	183 (1.3)	1.16 (1.10 to 1.22)			1.16 (1.11 to 1.22)		
	3	2,407	649 (27.0)	25 (1.0)	1.25 (1.14 to 1.38)			1.24 (1.13 to 1.36)		
Tracheostomy during ICU stay	No	50,226	12155 (24.2)	622 (1.2)	1.00 (reference)	0.50	0.13	1.00 (reference)	0.50	0.37
	Yes	5,304	1234 (23.3)	85 (1.6)	0.95 (0.89 to 1.02)			0.97 (0.91 to 1.04)		
Length of stay prior to ICU stay (days)	0	23,322	5042 (21.6)	265 (1.1)	1.00 (reference)	0.54	<0.0001	1.00 (reference)	0.55	<0.0001
	1	16,684	3857 (23.1)	142 (0.9)	1.09 (1.04 to 1.14)			1.07 (1.02 to 1.12)		
	2 - 3	6,839	1785 (26.1)	91 (1.3)	1.28 (1.20 to 1.36)			1.28 (1.21 to 1.36)		

Risk factor		N	90d	90d death	Odds ratio for 90d		c-index	p-value	Odds ratio for 90 day		c-index	p-value
			readmission	without	readmission				readmission or death			
			N (%)	N (%)	(95% CI)				(95% CI)			
	4 - 7	4,123	1120 (27.2)	63 (1.5)	1.35 (1.25 to 1.46)				1.37 (1.27 to 1.47)			
	8 or more	5,007	1667 (33.3)	151 (3.0)	1.81 (1.69 to 1.93)				1.94 (1.81 to 2.07)			
Length of ICU stay (days)	0	4,730	1043 (22.1)	52 (1.1)	1.00 (reference)		0.52	<0.0001	1.00 (reference)		0.52	<0.0001
	1	17,685	4031 (22.8)	207 (1.2)	1.04 (0.97 to 1.13)				1.05 (0.97 to 1.13)			
	2	10,409	2544 (24.4)	122 (1.2)	1.14 (1.05 to 1.24)				1.14 (1.05 to 1.24)			
	3	5,888	1519 (25.8)	90 (1.5)	1.23 (1.12 to 1.35)				1.25 (1.14 to 1.36)			
	4 - 5	6,113	1553 (25.4)	89 (1.5)	1.20 (1.10 to 1.32)				1.22 (1.12 to 1.33)			
	6 - 10	5,930	1487 (25.1)	78 (1.3)	1.18 (1.08 to 1.30)				1.19 (1.09 to 1.30)			
	11 or more	5,220	1294 (24.8)	74 (1.4)	1.17 (1.06 to 1.28)				1.18 (1.08 to 1.29)			
	Length of stay post ICU stay (days)	0 - 1	5,468	890 (16.3)	52 (1.0)	1.00 (reference)		0.56	<0.0001	1.00 (reference)		0.57
2 - 3		5,538	1060 (19.1)	34 (0.6)	1.22 (1.10 to 1.34)				1.18 (1.07 to 1.30)			
4 - 5		7,035	1488 (21.2)	40 (0.6)	1.38 (1.26 to 1.51)				1.33 (1.22 to 1.46)			
6 - 7		5,822	1313 (22.6)	46 (0.8)	1.50 (1.36 to 1.65)				1.46 (1.33 to 1.61)			
8 - 9		4,257	1011 (23.7)	43 (1.0)	1.60 (1.45 to 1.77)				1.58 (1.43 to 1.75)			
10 - 13		6,597	1750 (26.5)	64 (1.0)	1.86 (1.70 to 2.03)				1.82 (1.67 to 1.99)			
14 - 18		5,073	1406 (27.7)	73 (1.4)	1.97 (1.79 to 2.17)				1.98 (1.80 to 2.17)			
19 - 28		5,545	1621 (29.2)	90 (1.6)	2.12 (1.94 to 2.33)				2.14 (1.96 to 2.35)			
29 - 52		5,307	1549 (29.2)	104 (2.0)	2.12 (1.93 to 2.33)				2.17 (1.98 to 2.38)			
53 or more		5,333	1383 (25.9)	166 (3.1)	1.80 (1.64 to 1.98)				1.97 (1.79 to 2.16)			
Length of index hospital stay (days)	0 - 3	5,785	949 (16.4)	41 (0.7)	1.00 (reference)		0.56	<0.0001	1.00 (reference)		0.57	<0.0001
	4 - 6	5,436	1050 (19.3)	36 (0.7)	1.22 (1.11 to 1.34)				1.21 (1.10 to 1.33)			
	7 - 9	7,487	1570 (21.0)	40 (0.5)	1.35 (1.24 to 1.48)				1.33 (1.22 to 1.45)			
	10 - 12	5,694	1312 (23.0)	44 (0.8)	1.53 (1.39 to 1.67)				1.51 (1.38 to 1.66)			
	13 - 15	4,691	1200 (25.6)	44 (0.9)	1.75 (1.59 to 1.93)				1.75 (1.59 to 1.92)			
	16 - 20	5,585	1417 (25.4)	60 (1.1)	1.73 (1.58 to 1.90)				1.74 (1.59 to 1.91)			
	21 - 27	5,268	1443 (27.4)	69 (1.3)	1.92 (1.75 to 2.11)				1.95 (1.78 to 2.14)			
	28 - 39	5,233	1529 (29.2)	105 (2.0)	2.10 (1.92 to 2.31)				2.20 (2.01 to 2.41)			
	40 - 67	5,488	1589 (29.0)	107 (1.9)	2.08 (1.90 to 2.27)				2.17 (1.98 to 2.37)			
68 or more	5,308	1412 (26.6)	166 (3.1)	1.85 (1.68 to 2.03)				2.05 (1.87 to 2.24)				

eTable 3a Comparison of predictive ability of groups of patient characteristics using c-index and reclassification of outcome. Characteristics are grouped into patient demographics, indices of pre-existing patient health, and indices of critical illness severity. The reclassification of outcome is illustrated at a threshold of $\geq 20\%$ predicted probability of 90 day unplanned hospital readmission defining those predicted to have an event. The underlying classification table which has been used to calculate improved classification is provided in eTable 3b stratified by outcome.

Groups of variables in model being compared	Comparison of c-indices	Change in c-index	Improved classification of events: 90d readmissions	Improved classification of non-events: no 90d readmission
Critical illness indices vs demographics	0.603 vs 0.542	0.061	-12.1%	20.8%
Pre-existing health indices vs demographics	0.634 vs 0.542	0.092	-18.2%	31.5%
Pre-existing health vs critical illness indices	0.634 vs 0.603	0.031	-6.1%	10.7%

eTable 3b Classification tables stratified by outcome comparing groups of patient characteristics.

		Patients readmitted			Patients not readmitted		
		Critical illness indices					
		Readmission	No readmission	Total	Readmission	No readmission	Total
Demographics	Readmission	9,024	1,852	10,876	23,730	8,795	32,525
	No readmission	447	290	737	1,326	2,103	3,429
	Total	9,471	2,142	11,613	25,056	10,898	35,954
		Pre-existing health indices					
Demographics	Readmission	8,326	2,550	10,876	20,065	12,460	32,525
	No readmission	433	304	737	1,130	2,299	3,429
	Total	8,759	2,854	11,613	21,195	14,759	35,954
		Pre-existing health indices					
Critical illness indices	Readmission	7,372	2,099	9,471	16,362	8,694	25,056
	No readmission	1,387	755	2,142	4,833	6,065	10,898
	Total	8,759	2,854	11,613	21,195	14,759	35,954

Classification tables allow the reader to see how many persons are classified into those predicted to have a readmission and not to have a readmission using each group of variables. For example, the comparison of critical illness indices vs demographics (first three rows of data) demonstrates that of 11,613 patients who were readmitted, critical illness indices correctly classified 9,471 (81.6%) compared with 10,876 (93.7%) classified by demographics, which is a 12.1% decrease in correct classification. Similarly, of 35,954 patients who were not readmitted, critical illness indices correctly classified 10,898 (30.3%) compared with 3,429 (9.5%) classified by demographics, which is a 20.8% improvement in correct classification. The reclassification of outcome in these tables is illustrated at a threshold of $\geq 20\%$ predicted probability of 90 day unplanned hospital readmission defining those predicted to have an event. The proportions of improved classification would change if this threshold varied.

eTable 4 Independent risk factors for unplanned hospital admission within 90 days, unplanned hospital admission or death within 90 days, and time to first unplanned hospital admission: multivariable analysis logistic and Fine and Gray competing risks regression.

Risk factor		Predicted % with event	Adjusted odds ratio for 90d readmission (95% CI)	P value	Predicted % with event	Adjusted odds ratio for 90d readmission or death (95% CI)	P value	Adjusted hazard ratio (95% CI)	P value
Demographics									
Sex	Male	22.9	1.00 (reference)	0.74	24.2	1.00 (reference)	0.95	1.00 (reference)	0.77
	Female	23.1	1.01 (0.96 to 1.05)		24.2	1.00 (0.96 to 1.04)		1.01 (0.97 to 1.04)	
Age at admission to ICU (years)	16 - 25	21.4	1.00 (reference)	<0.001	21.8	1.00 (reference)	<0.001	1.00 (reference)	0.001
	26 - 35	23.1	1.10 (0.97 to 1.25)		23.5	1.10 (0.97 to 1.25)		1.09 (0.98 to 1.21)	
	36 - 45	24.8	1.21 (1.08 to 1.36)		25.3	1.21 (1.08 to 1.36)		1.17 (1.06 to 1.29)	
	46 - 55	24.0	1.16 (1.03 to 1.30)		24.7	1.18 (1.05 to 1.32)		1.12 (1.02 to 1.23)	
	56 - 65	22.9	1.09 (0.97 to 1.22)		24.1	1.14 (1.02 to 1.27)		1.07 (0.97 to 1.17)	
	66 - 75	22.5	1.06 (0.95 to 1.19)		24.1	1.14 (1.02 to 1.27)		1.05 (0.95 to 1.15)	
	76 - 85	21.9	1.03 (0.91 to 1.16)		23.9	1.12 (1.00 to 1.27)		1.01 (0.91 to 1.12)	
	86 or older	25.3	1.24 (1.03 to 1.50)		30.4	1.56 (1.30 to 1.87)		1.18 (1.00 to 1.38)	
Scottish Index of Multiple Deprivation	First quintile (Most deprived)	23.7	1.00 (reference)	0.058	25.1	1.00 (reference)	0.024	1.00 (reference)	0.053
	Second quintile	23.3	0.98 (0.92 to 1.04)		24.4	0.96 (0.91 to 1.02)		0.99 (0.94 to 1.04)	
	Third quintile	22.7	0.95 (0.88 to 1.01)		24.0	0.95 (0.88 to 1.01)		0.96 (0.91 to 1.02)	
	Fourth quintile	21.8	0.90 (0.84 to 0.97)		22.9	0.89 (0.83 to 0.95)		0.91 (0.86 to 0.97)	
	Fifth quintile (Least deprived)	22.9	0.96 (0.89 to 1.03)		24.1	0.95 (0.88 to 1.02)		0.96 (0.91 to 1.03)	
Remoteness of residence	Urban area	23.5	1.00 (reference)	<0.001	24.7	1.00 (reference)	0.002	1.00 (reference)	<0.001
	Accessible	22.0	0.92 (0.87 to 0.97)		23.4	0.93 (0.88 to 0.98)		0.93 (0.89 to 0.98)	
	Remote	20.2	0.82 (0.73 to 0.92)		21.4	0.83 (0.75 to 0.93)		0.84 (0.76 to 0.92)	
	Very remote	23.0	0.97 (0.86 to 1.09)		24.2	0.97 (0.87 to 1.10)		0.98 (0.88 to 1.08)	
Indices of pre-existing patient health									
Admissions/attendances in year prior to index hospital stay									
Number of unplanned inpatient admissions	0	20.4	1.00 (reference)	<0.001	21.5	1.00 (reference)	<0.001	1.00 (reference)	<0.001
	1	25.4	1.33 (1.26 to 1.41)		26.7	1.33 (1.26 to 1.41)		1.28 (1.22 to 1.35)	
	2	30.2	1.69 (1.56 to 1.84)		31.6	1.69 (1.56 to 1.83)		1.54 (1.44 to 1.64)	
	3	36.1	2.21 (1.97 to 2.49)		37.9	2.23 (1.99 to 2.50)		1.88 (1.73 to 2.06)	
	4	41.5	2.77 (2.36 to 3.26)		43.0	2.76 (2.35 to 3.24)		2.20 (1.96 to 2.46)	
	5	46.0	3.33 (2.64 to 4.20)		46.7	3.21 (2.55 to 4.05)		2.33 (2.01 to 2.70)	
	6 or more	61.3	6.19 (5.12 to 7.49)		63.7	6.43 (5.29 to 7.80)		3.47 (3.12 to 3.87)	
Number of elective inpatient & daycase admissions	0	22.5	1.00 (reference)	0.006	23.6	1.00 (reference)	<0.001	1.00 (reference)	0.007
	1	24.7	1.13 (1.04 to 1.23)		26.2	1.15 (1.06 to 1.25)		1.11 (1.03 to 1.18)	
	2	23.3	1.04 (0.97 to 1.12)		24.5	1.05 (0.98 to 1.12)		1.04 (0.98 to 1.11)	
	3	24.1	1.09 (0.97 to 1.24)		25.5	1.10 (0.98 to 1.25)		1.07 (0.97 to 1.18)	
	4	23.9	1.08 (0.96 to 1.22)		24.9	1.07 (0.95 to 1.21)		1.07 (0.97 to 1.18)	
	5	25.4	1.17 (0.97 to 1.42)		26.7	1.17 (0.97 to 1.42)		1.10 (0.95 to 1.28)	

Risk factor		Predicted % with event	Adjusted odds ratio for 90d readmission (95% CI)		p value	Predicted % with event	Adjusted odds ratio for 90d readmission or death (95% CI)		p value	Adjusted hazard ratio (95% CI)		P value
	6	28.1	1.35	(1.11 to 1.64)		29.2	1.33	(1.10 to 1.61)		1.27	(1.10 to 1.48)	
	7 or more	25.0	1.15	(1.01 to 1.30)		27.6	1.23	(1.08 to 1.40)		1.11	(1.00 to 1.23)	
Number of new outpatient attendances	0	21.8	1.00	(reference)	<0.001	23.1	1.00	(reference)	<0.001	1.00	(reference)	<0.001
	1	24.0	1.14	(1.08 to 1.20)		25.3	1.13	(1.07 to 1.19)		1.11	(1.06 to 1.16)	
	2	24.4	1.16	(1.08 to 1.25)		25.4	1.14	(1.06 to 1.22)		1.13	(1.07 to 1.20)	
	3	24.5	1.17	(1.06 to 1.29)		25.2	1.12	(1.02 to 1.24)		1.14	(1.05 to 1.23)	
	4	25.7	1.24	(1.07 to 1.45)		26.6	1.21	(1.04 to 1.40)		1.19	(1.06 to 1.35)	
	5 or more	24.8	1.19	(0.98 to 1.44)		25.1	1.12	(0.92 to 1.35)		1.15	(0.98 to 1.35)	
Number of acute psychiatric admissions	0	22.9	1.00	(reference)	0.053	24.1	1.00	(reference)	0.007	1.00	(reference)	0.081
	1	24.0	1.06	(0.89 to 1.26)		26.1	1.11	(0.94 to 1.31)		1.04	(0.91 to 1.19)	
	2 or more	28.3	1.33	(1.05 to 1.68)		31.1	1.42	(1.13 to 1.79)		1.22	(1.02 to 1.46)	
Comorbidities												
Number of comorbidities present	0	19.5	1.00	(reference)	<0.001	20.2	1.00	(reference)	<0.001	1.00	(reference)	<0.001
	1	24.3	1.33	(1.26 to 1.41)		25.8	1.37	(1.30 to 1.45)		1.28	(1.22 to 1.35)	
	2	26.6	1.50	(1.40 to 1.60)		28.1	1.54	(1.44 to 1.65)		1.42	(1.34 to 1.50)	
	3	29.9	1.77	(1.61 to 1.93)		31.6	1.82	(1.66 to 1.99)		1.60	(1.49 to 1.72)	
	4	29.7	1.75	(1.53 to 1.99)		31.5	1.81	(1.59 to 2.06)		1.58	(1.43 to 1.74)	
	5 or more	34.5	2.18	(1.82 to 2.62)		37.7	2.39	(1.99 to 2.86)		1.82	(1.60 to 2.07)	
Indices of critical illness severity												
Type of admission to ICU	Elective surgery	20.4	1.00	(reference)	<0.001	21.2	1.00	(reference)	<0.001	1.00	(reference)	<0.001
	Emergency surgery	23.5	1.20	(1.10 to 1.30)		24.7	1.23	(1.13 to 1.33)		1.15	(1.08 to 1.24)	
	Non-operative	24.0	1.23	(1.14 to 1.34)		25.5	1.28	(1.18 to 1.38)		1.19	(1.12 to 1.28)	
Diagnosis at admission to ICU	Trauma including head injury	17.2	1.00	(reference)	<0.001	17.5	1.00	(reference)	<0.001	1.00	(reference)	<0.001
Cardiovascular	Aortic aneurysm rupture	21.6	1.33	(1.00 to 1.77)		22.2	1.34	(1.01 to 1.77)		1.29	(0.99 to 1.67)	
	Cardiogenic shock	26.7	1.76	(1.22 to 2.53)		28.8	1.90	(1.33 to 2.71)		1.66	(1.22 to 2.26)	
	Post cardiac arrest	19.0	1.13	(0.86 to 1.49)		21.8	1.31	(1.00 to 1.71)		1.12	(0.88 to 1.44)	
	Septic shock	21.8	1.34	(1.10 to 1.64)		22.8	1.39	(1.14 to 1.69)		1.31	(1.09 to 1.57)	
	Vascular surgery	21.1	1.29	(1.03 to 1.62)		22.0	1.33	(1.06 to 1.66)		1.25	(1.02 to 1.52)	
	Other CVS	24.2	1.54	(1.25 to 1.89)		25.3	1.59	(1.30 to 1.95)		1.47	(1.22 to 1.76)	
Respiratory	ARDS	25.0	1.61	(1.15 to 2.24)		26.0	1.65	(1.19 to 2.30)		1.48	(1.12 to 1.95)	
	Asthma	25.2	1.62	(1.25 to 2.10)		25.7	1.62	(1.25 to 2.10)		1.48	(1.19 to 1.84)	
	COPD	26.4	1.72	(1.28 to 2.31)		28.1	1.83	(1.37 to 2.45)		1.64	(1.28 to 2.10)	
	Pneumonia	20.5	1.24	(1.02 to 1.50)		21.6	1.29	(1.07 to 1.56)		1.21	(1.02 to 1.44)	
	Other respiratory	23.1	1.45	(1.19 to 1.76)		24.7	1.54	(1.27 to 1.87)		1.36	(1.14 to 1.63)	
Gastrointestinal/Liver	GI bleed	25.2	1.62	(1.28 to 2.05)		26.0	1.65	(1.31 to 2.09)		1.53	(1.24 to 1.88)	
	GI neoplasm	25.3	1.63	(1.32 to 2.02)		26.9	1.73	(1.41 to 2.14)		1.53	(1.27 to 1.86)	

Risk factor		Predicted % with event	Adjusted odds ratio for 90d readmission (95% CI)	p value	Predicted % with event	Adjusted odds ratio for 90d readmission or death (95% CI)	p value	Adjusted hazard ratio (95% CI)	P value
	GI obstruction	24.3	1.55 (1.24 to 1.92)		26.2	1.67 (1.34 to 2.07)		1.44 (1.18 to 1.75)	
	Acute GI pathology*	25.2	1.62 (1.33 to 1.98)		26.5	1.69 (1.39 to 2.06)		1.54 (1.28 to 1.84)	
	Other GI	24.2	1.54 (1.25 to 1.89)		25.0	1.57 (1.28 to 1.92)		1.45 (1.21 to 1.75)	
	Liver failure	28.4	1.91 (1.35 to 2.71)		29.1	1.93 (1.36 to 2.73)		1.73 (1.31 to 2.27)	
	Oesophageal variceal bleed	33.5	2.42 (1.84 to 3.18)		36.0	2.64 (2.02 to 3.47)		1.95 (1.57 to 2.44)	
	Pancreatitis	38.4	3.00 (2.32 to 3.86)		38.6	2.95 (2.29 to 3.80)		2.41 (1.94 to 2.99)	
Nervous system	Intracranial bleed	23.3	1.47 (1.17 to 1.83)		24.6	1.53 (1.23 to 1.91)		1.43 (1.17 to 1.75)	
	Seizures	28.1	1.88 (1.51 to 2.34)		28.7	1.89 (1.52 to 2.34)		1.66 (1.38 to 2.01)	
	Other CNS	22.1	1.37 (1.11 to 1.69)		24.0	1.49 (1.21 to 1.83)		1.33 (1.10 to 1.61)	
Other	Diabetic ketoacidosis	25.2	1.63 (1.24 to 2.13)		26.4	1.68 (1.29 to 2.20)		1.57 (1.25 to 1.97)	
	Renal	27.7	1.84 (1.48 to 2.29)		28.8	1.90 (1.53 to 2.36)		1.71 (1.41 to 2.07)	
	Self poisoning	21.2	1.30 (1.05 to 1.60)		22.2	1.34 (1.09 to 1.65)		1.27 (1.05 to 1.53)	
	Trauma excluding head injury	20.4	1.24 (1.00 to 1.52)		21.8	1.31 (1.07 to 1.61)		1.20 (1.00 to 1.45)	
	Miscellaneous	20.9	1.27 (1.04 to 1.54)		21.8	1.31 (1.08 to 1.60)		1.23 (1.03 to 1.48)	
CPR prior to admission to ICU	No	22.9	1.00 (reference)	0.24	24.1	1.00 (reference)	0.23	1.00 (reference)	0.25
	Yes	24.8	1.11 (0.94 to 1.31)		26.1	1.11 (0.94 to 1.31)		1.09 (0.94 to 1.26)	
Acute physiology score at admission to ICU	0 - 5	21.7	1.00 (reference)	0.17	22.3	1.00 (reference)	0.035	1.00 (reference)	0.23
	6 - 7	22.3	1.04 (0.95 to 1.14)		23.0	1.04 (0.95 to 1.14)		1.05 (0.96 to 1.13)	
	8 - 9	23.0	1.08 (0.98 to 1.18)		24.0	1.10 (1.01 to 1.21)		1.06 (0.98 to 1.15)	
	10 - 11	23.1	1.09 (0.99 to 1.19)		24.3	1.11 (1.02 to 1.22)		1.08 (1.00 to 1.17)	
	12 - 13	23.5	1.11 (1.01 to 1.22)		24.9	1.15 (1.05 to 1.27)		1.09 (1.01 to 1.19)	
	14 - 15	23.1	1.09 (0.98 to 1.20)		24.7	1.14 (1.03 to 1.26)		1.08 (0.99 to 1.17)	
	16 - 18	24.2	1.15 (1.04 to 1.28)		25.4	1.18 (1.07 to 1.31)		1.13 (1.04 to 1.23)	
	19 - 22	22.5	1.05 (0.94 to 1.17)		24.5	1.13 (1.01 to 1.26)		1.05 (0.95 to 1.15)	
23 or more	24.2	1.16 (1.03 to 1.31)		25.8	1.21 (1.07 to 1.37)		1.12 (1.01 to 1.24)		
Mechanical ventilation on any day in ICU	No	23.5	1.00 (reference)	0.11	24.7	1.00 (reference)	0.15	1.00 (reference)	0.18
	Yes	22.7	0.96 (0.91 to 1.01)		23.9	0.96 (0.91 to 1.01)		0.97 (0.93 to 1.01)	
Renal replacement therapy on any day in ICU	No	22.8	1.00 (reference)	0.005	24.1	1.00 (reference)	0.028	1.00 (reference)	0.006
	Yes	25.2	1.14 (1.04 to 1.24)		25.9	1.10 (1.01 to 1.21)		1.11 (1.03 to 1.19)	
Cardiovascular system support on any day in ICU	No	22.8	1.00 (reference)	0.35	24.2	1.00 (reference)	0.98	1.00 (reference)	0.38
	Yes	23.3	1.03 (0.97 to 1.08)		24.2	1.00 (0.95 to 1.05)		1.02 (0.97 to 1.07)	
Tracheostomy during ICU stay	No	23.2	1.00 (reference)	0.006	24.4	1.00 (reference)	0.010	1.00 (reference)	0.002
	Yes	21.1	0.88 (0.81 to 0.96)		22.4	0.89 (0.82 to 0.97)		0.89 (0.82 to 0.96)	
Length of stay prior to ICU stay (days)	0	22.3	1.00 (reference)	<0.001	23.4	1.00 (reference)	<0.001	1.00 (reference)	<0.001
	1	22.7	1.02 (0.96 to 1.09)		23.7	1.02 (0.96 to 1.08)		1.03 (0.98 to 1.08)	
	2 - 3	23.3	1.06 (0.98 to 1.14)		24.3	1.05 (0.97 to 1.13)		1.06 (1.00 to 1.13)	
	4 - 7	23.4	1.06 (0.97 to 1.16)		24.5	1.06 (0.97 to 1.16)		1.07 (0.99 to 1.15)	
	8 or more	27.7	1.34 (1.23 to 1.45)		30.1	1.41 (1.30 to 1.52)		1.27 (1.19 to 1.36)	

Risk factor		Predicted % with event	Adjusted odds ratio for 90d readmission (95% CI)	p value	Predicted % with event	Adjusted odds ratio for 90d readmission or death (95% CI)	p value	Adjusted hazard ratio (95% CI)	P value
Length of ICU stay (days)	0	22.8	1.00 (reference)	0.93	23.8	1.00 (reference)	0.83	1.00 (reference)	0.93
	1	22.9	1.01 (0.91 to 1.11)		24.2	1.02 (0.93 to 1.12)		1.01 (0.93 to 1.09)	
	2	23.2	1.02 (0.92 to 1.13)		24.4	1.03 (0.93 to 1.14)		1.01 (0.93 to 1.11)	
	3	23.7	1.05 (0.94 to 1.17)		25.0	1.07 (0.95 to 1.19)		1.04 (0.94 to 1.14)	
	4 - 5	23.1	1.02 (0.91 to 1.14)		24.3	1.03 (0.92 to 1.15)		1.00 (0.91 to 1.10)	
	6 - 10	22.7	0.99 (0.88 to 1.11)		23.7	0.99 (0.89 to 1.11)		0.99 (0.90 to 1.09)	
	11 or more	22.8	1.00 (0.88 to 1.14)		24.0	1.01 (0.89 to 1.15)		1.01 (0.90 to 1.13)	
Length of stay post ICU stay (days)	0 - 1	17.2	1.00 (reference)	<0.001	18.5	1.00 (reference)	<0.001	1.00 (reference)	<0.001
	2 - 3	19.5	1.16 (1.04 to 1.30)		20.4	1.13 (1.01 to 1.26)		1.15 (1.04 to 1.27)	
	4 - 5	20.7	1.25 (1.12 to 1.40)		21.6	1.21 (1.08 to 1.35)		1.22 (1.11 to 1.34)	
	6 - 7	22.3	1.38 (1.23 to 1.55)		23.1	1.32 (1.18 to 1.48)		1.32 (1.19 to 1.45)	
	8 - 9	22.7	1.41 (1.25 to 1.60)		23.7	1.36 (1.21 to 1.54)		1.35 (1.22 to 1.50)	
	10 - 13	24.7	1.58 (1.41 to 1.76)		25.5	1.50 (1.35 to 1.68)		1.47 (1.34 to 1.62)	
	14 - 18	25.9	1.68 (1.49 to 1.88)		26.9	1.62 (1.44 to 1.81)		1.54 (1.39 to 1.70)	
	19 - 28	27.0	1.78 (1.58 to 2.00)		28.2	1.73 (1.54 to 1.94)		1.61 (1.46 to 1.77)	
	29 - 52	26.8	1.76 (1.56 to 1.98)		28.2	1.72 (1.54 to 1.94)		1.61 (1.45 to 1.78)	
53 or more	24.7	1.57 (1.40 to 1.78)		27.3	1.65 (1.46 to 1.85)		1.44 (1.30 to 1.60)		

*Acute GI pathology comprises gastrointestinal perforation/ischaemia/ peritonitis/abscess

eTable 5 Characteristics of patients in development and validation cohorts

Characteristic		Development cohort (N=33,294)		Validation cohort (N=14,273)	
		n or median	% or quartiles	n or median	% or quartiles
Demographics					
Sex	Female	14,652	44.0	6,176	43.3
Age at admission to ICU (years)	Median and Quartiles	59	43, 71	62	48, 72
Scottish Index of Multiple Deprivation	First quintile (Most deprived)	9,111	27.4	3,837	26.9
	Second quintile	7,780	23.4	3,253	22.8
	Third quintile	6,597	19.8	2,817	19.7
	Fourth quintile	5,541	16.6	2,428	17.0
	Fifth quintile (Least deprived)	4,265	12.8	1,938	13.6
Remoteness of residence	Urban area	22,771	68.4	9,917	69.5
	Accessible	7,855	23.6	3,226	22.6
	Remote	1,558	4.7	602	4.2
	Very remote	1,110	3.3	528	3.7
Indices of pre-existing patient health					
Admissions/attendances in year prior to index hospital stay					
Number of unplanned inpatient admissions	0	22,934	68.9	9,603	67.3
	1	6,087	18.3	2,864	20.1
	2	2,204	6.6	934	6.5
	3 or more	2,069	6.2	872	6.1
Number of elective inpatient & daycase admissions	0	23,803	71.5	8,987	63.0
	1	2,595	7.8	1,034	7.2
	2	3,389	10.2	2,325	16.3
	3 or more	3,507	10.5	1,927	13.5
Number of new outpatient attendances	0	17,675	53.1	6,088	42.7
	1	8,966	26.9	3,855	27.0
	2	4,160	12.5	2,537	17.8
	3 or more	2,493	7.5	1,793	12.6
Number of acute psychiatric admissions	0	32,406	97.3	14,005	98.1
	1	591	1.8	184	1.3
	2 or more	297	0.9	84	0.6
Comorbidities					
Number of comorbidities present	0	14,685	44.1	5,769	40.4
	1	10,275	30.9	4,596	32.2
	2	4,991	15.0	2,256	15.8
	3 or more	3,343	10.0	1,652	11.6
Myocardial infarction	Yes	1,616	4.9	995	7.0
Cardiovascular disease	Yes	1,922	5.8	1,036	7.3
Peripheral vascular disease	Yes	1,593	4.8	654	4.6
Cerebrovascular disease	Yes	1,270	3.8	550	3.9
Dementia	Yes	105	0.3	40	0.3
Respiratory disease	Yes	4,152	12.5	1,740	12.2
Rheumatic disease	Yes	547	1.6	228	1.6
Peptic ulcer disease	Yes	706	2.1	252	1.8
Liver disease	No	31,564	94.8	13,654	95.7
	Mild	636	1.9	234	1.6

Characteristic		Development cohort (N=33,294)		Validation cohort (N=14,273)		
		n or median	% or quartiles	n or median	% or quartiles	
Diabetes mellitus	Moderate or severe	1,094	3.3	385	2.7	
	No	30,610	91.9	12,879	90.2	
	Yes - without chronic complication	2,253	6.8	1,219	8.5	
	Yes - with chronic complication	431	1.3	175	1.2	
Hemiplegia or paraplegia	Yes	254	0.8	90	0.6	
Renal disease	Yes	1,296	3.9	661	4.6	
Cancer	No	26,295	79.0	10,773	75.5	
	Yes - without metastases	5,866	17.6	2,927	20.5	
	Yes - with metastases	1,133	3.4	573	4.0	
Immunosuppression	Yes	961	2.9	338	2.4	
Alcohol misuse	Yes	4,175	12.5	1,415	9.9	
Drug misuse	Yes	2,036	6.1	1,430	10.0	
Indices of critical illness severity						
Type of admission to ICU		Elective surgery	6,177	18.6	5,232	36.7
		Emergency surgery	8,925	26.8	2,943	20.6
		Non-operative	18,192	54.6	6,098	42.7
Diagnosis at admission to ICU	Cardiovascular	Trauma including head injury	893	2.7	237	1.7
		Aortic aneurysm rupture	444	1.3	131	0.9
		Cardiogenic shock	142	0.4	52	0.4
		Post cardiac arrest	757	2.3	354	2.5
		Septic shock	1,964	5.9	717	5.0
		Vascular surgery	1,230	3.7	434	3.0
		Other CVS	848	2.5	2,115	14.8
	Respiratory	ARDS	206	0.6	48	0.3
		Asthma	473	1.4	131	0.9
		COPD	283	0.9	83	0.6
		Pneumonia	3,360	10.1	1,054	7.4
		Other respiratory	2,393	7.2	1,636	11.5
	Gastrointestinal /Liver	GI bleed	715	2.1	186	1.3
		GI neoplasm	1,836	5.5	720	5.0
		GI obstruction	1,174	3.5	451	3.2
		GI perforation/ischaemia/ peritonitis/abscess	2,787	8.4	818	5.7
		Other GI	1,844	5.5	709	5.0
		Liver failure	160	0.5	41	0.3
		Oesophageal variceal bleed	317	1.0	90	0.6
		Pancreatitis	384	1.2	135	0.9
	Nervous system	Intracranial bleed	923	2.8	327	2.3
		Seizures	898	2.7	315	2.2
		Other CNS	1,326	4.0	498	3.5
	Other	Diabetic ketoacidosis	382	1.1	112	0.8
		Renal	989	3.0	387	2.7
		Self poisoning	1,954	5.9	655	4.6
		Trauma excluding head injury	1,582	4.8	609	4.3
Miscellaneous		3,030	9.1	1,228	8.6	
CPR prior to admission to ICU		Yes	1,222	3.7	465	3.3
APACHE II score at admission to ICU		Median and Quartiles	16	11, 20	14	10, 19
Acute physiology score at admission to ICU		Median and Quartiles	12	8, 16	10	7, 15

Characteristic		Development cohort (N=33,294)		Validation cohort (N=14,273)	
		n or median	% or quartiles	n or median	% or quartiles
Number of days with mechanical ventilation during ICU stay	0	11,693	35.1	6,076	42.6
	1	6,693	20.1	3,085	21.6
	2	5,710	17.2	2,172	15.2
	3 or more	9,198	27.6	2,940	20.6
Number of days with renal replacement therapy during ICU stay	0	30,440	91.4	13,382	93.8
	1	411	1.2	138	1.0
	2	482	1.4	174	1.2
	3 or more	1,961	5.9	579	4.1
Number of days with cardiovascular system support during ICU stay	0	21,307	64.0	8,179	57.3
	1	3,260	9.8	1,620	11.4
	2	3,404	10.2	1,680	11.8
	3 or more	5,323	16.0	2,794	19.6
Maximum number of organs supported on any day during ICU stay	0	9,304	27.9	4,617	32.3
	1	13,771	41.4	4,863	34.1
	2	8,429	25.3	4,262	29.9
	3	1,790	5.4	531	3.7
Tracheostomy during ICU stay	Yes	3,893	11.7	1,098	7.7
Length of stay prior to ICU stay (days)	Median and Quartiles	1	0, 2	1	0, 1
Length of ICU stay (days)	Median and Quartiles	2	1, 5	2	1, 5
Length of stay post ICU stay (days)	Median and Quartiles	11	5, 25	7	4, 17
Length of index hospital stay (days)	Median and Quartiles	17	8, 36	13	7, 26
Event within 90 days of discharge from index hospital stay					
Unplanned hospital admission	Yes	8,051	24.2	3,562	25.0
Unplanned hospital admission or death	Yes	8,507	25.6	3,707	26.0

The 47,567 patients with data available for all the variables being considered for the prognostic model were allocated to the development and validation cohorts based on their date of discharge from index hospital stay being on or before 17 January 2012 or after this date with the proportions in the two cohorts were 70% and 30% respectively.

eTable 6 Coefficients for variables in model predicting unplanned hospital admission within 90 days of discharge from index hospital stay and model predicting unplanned hospital admission or death within 90 days of discharge from index hospital stay in development cohort

Predictor		Outcome: 90d readmission		Outcome: 90d readmission or death	
		Coefficient	SE	Coefficient	SE
Intercept		-2.5945	0.1321	-2.6102	0.1310
Age at admission to ICU (years)	16 - 25	0	(reference)	0	(reference)
	26 - 35	0.0722	0.0739	0.0720	0.0735
	36 - 45	0.1163	0.0685	0.1268	0.0680
	46 - 55	0.0723	0.0678	0.0876	0.0673
	56 - 65	0.0447	0.0676	0.0897	0.0670
	66 - 75	-0.0165	0.0691	0.0377	0.0685
	76 - 85	-0.1129	0.0742	-0.0183	0.0732
	86 or older	0.1103	0.1152	0.2948	0.1118
Remoteness of residence	Urban area	0	(reference)	0	(reference)
	Accessible	-0.1099	0.0325	-0.0970	0.0319
	Remote	-0.1976	0.0661	-0.2064	0.0650
	Very remote	-0.0160	0.0732	-0.0212	0.0722
Admissions/attendances in year prior to index hospital stay					
Number of unplanned inpatient admissions	0	0	(reference)	0	(reference)
	1	0.2929	0.0352	0.2944	0.0347
	2	0.5315	0.0510	0.5367	0.0506
	3	0.8335	0.0716	0.8540	0.0714
	4	1.0515	0.0985	1.0658	0.0988
	5	1.2572	0.1373	1.2428	0.1382
	6 or more	1.8269	0.1144	1.8970	0.1172
Number of elective inpatient & daycase admissions	0	0	(reference)	0	(reference)
	1	0.1701	0.0502	0.1787	0.0497
	2	0.0482	0.0460	0.0480	0.0454
	3	0.0872	0.0762	0.0753	0.0754
	4	0.0141	0.0777	-0.0112	0.0770
	5	0.2347	0.1203	0.2183	0.1195
	6	0.3736	0.1255	0.3559	0.1252
	7 or more	0.0545	0.0831	0.0880	0.0820
Number of new outpatient attendances	0	0	(reference)	0	(reference)
	1	0.1297	0.0327	0.1202	0.0322
	2	0.1434	0.0434	0.1177	0.0429
	3	0.1633	0.0629	0.1186	0.0624
	4	0.2470	0.0992	0.2117	0.0983
	5 or more	-0.0269	0.1316	-0.1045	0.1310
Number of acute psychiatric admissions	0	0	(reference)	0	(reference)
	1	0.1930	0.0992	0.2704	0.0973
	2 or more	0.3377	0.1348	0.3989	0.1332
Comorbidities					
Number of comorbidities present	0	0	(reference)	0	(reference)
	1	0.2440	0.0376	0.2503	0.0371
	2	0.4283	0.0467	0.4165	0.0466
	3	0.5737	0.0629	0.5466	0.0637
	4	0.5316	0.0916	0.4847	0.0934

Predictor		Outcome: 90d readmission		Outcome: 90d readmission or death		
		Coefficient	SE	Coefficient	SE	
	5 or more	0.7664	0.1290	0.7914	0.1323	
Myocardial infarction	No	0	(reference)	0	(reference)	
	Yes	-0.1726	0.0648	-0.1712	0.0642	
Peripheral vascular disease	No	0	(reference)	0	(reference)	
	Yes	-0.1843	0.0682	-0.1846	0.0674	
Diabetes mellitus	No	0	(reference)	0	(reference)	
	Yes - without chronic complication	-0.0305	0.0547	-0.0092	0.0541	
	Yes - with chronic complication	0.4153	0.1075	0.4344	0.1090	
Renal disease	No	-	-	0	(reference)	
	Yes	-	-	0.1549	0.0680	
Cancer	No	0	(reference)	0	(reference)	
	Yes - without metastases	0.0590	0.0459	0.1138	0.0454	
	Yes - with metastases	0.2673	0.0739	0.4756	0.0724	
Type of admission to ICU	Elective surgery	0	(reference)	0	(reference)	
	Emergency surgery	0.1521	0.0510	0.1717	0.0503	
	Non-operative	0.1848	0.0530	0.2109	0.0523	
Diagnosis at admission to ICU	Trauma including head injury	0	0	(reference)	(reference)	
	Cardiovascular	Aortic aneurysm rupture	0.1566	0.1721	0.1638	0.1666
		Cardiogenic shock	0.4603	0.5552	0.2112	0.2166
		Post cardiac arrest	0.2189	0.3375	0.1307	0.1333
		Septic shock	0.1913	0.1896	0.1127	0.1136
		Vascular surgery	0.2414	0.2750	0.1305	0.1319
		Other CVS	0.4302	0.4603	0.1268	0.1279
	Respiratory	ARDS	0.3904	0.4162	0.1868	0.1884
		Asthma	0.4238	0.4326	0.1472	0.1478
		COPD	0.4625	0.5029	0.1672	0.1691
		Pneumonia	0.1425	0.1706	0.1079	0.1087
		Other respiratory	0.2175	0.2668	0.1119	0.1130
	Gastrointestinal/Liver	GI bleed	0.3453	0.3569	0.1343	0.1355
		GI neoplasm	0.3557	0.3740	0.1217	0.1228
		GI obstruction	0.3261	0.3515	0.1244	0.1257
		GI perforation/ischaemia/peritonitis/abscess	0.4035	0.4262	0.1120	0.1128
		Other GI	0.2914	0.2905	0.1167	0.1174
		Liver failure	0.3570	0.3650	0.2024	0.2029
		Oesophageal variceal bleed	0.6881	0.8162	0.1561	0.1568
		Pancreatitis	0.8827	0.8632	0.1470	0.1475
	Nervous system	Intracranial bleed	0.3235	0.3535	0.1250	0.1262
		Seizures	0.5453	0.5421	0.1237	0.1243
		Other CNS	0.2326	0.3034	0.1177	0.1191
	Other	Diabetic ketoacidosis	0.3599	0.3891	0.1564	0.1576
		Renal	0.5100	0.4810	0.1239	0.1243
		Self poisoning	0.1464	0.1757	0.1180	0.1191
		Trauma excluding head injury	0.1433	0.2129	0.1170	0.1184
		Miscellaneous	0.1139	0.1226	0.1108	0.1116
	APACHE II score at admission to ICU	1 - 7	0	(reference)	0	(reference)
		8 - 10	-0.0120	0.0657	-0.0060	0.0652
		11 - 12	0.0862	0.0678	0.0722	0.0674

Predictor		Outcome: 90d readmission		Outcome: 90d readmission or death	
		Coefficient	SE	Coefficient	SE
	13 - 14	0.0980	0.0664	0.0892	0.0659
	15 - 16	0.1202	0.0665	0.1370	0.0659
	17 - 18	0.1035	0.0681	0.1342	0.0674
	19 - 21	0.1717	0.0670	0.2026	0.0663
	22 - 25	0.1835	0.0697	0.2224	0.0689
	26 or more	0.2150	0.0729	0.2624	0.0721
Tracheostomy during ICU stay	No	0	(reference)	0	(reference)
	Yes	-0.1243	0.0458	-0.1203	0.0449
Length of stay prior to ICU stay (days)	0	0	(reference)	0	(reference)
	1	0.0561	0.0379	0.0415	0.0374
	2 - 3	0.0327	0.0454	0.0212	0.0448
	4 - 7	0.0448	0.0531	0.0292	0.0524
	8 or more	0.2700	0.0499	0.3244	0.0491
Length of stay post ICU stay (days)	0 - 1	0	(reference)	0	(reference)
	2 - 3	0.1706	0.0712	0.1347	0.0702
	4 - 5	0.2164	0.0720	0.1765	0.0709
	6 - 7	0.2747	0.0725	0.2290	0.0714
	8 - 9	0.3317	0.0758	0.2816	0.0747
	10 - 13	0.4417	0.0694	0.3829	0.0683
	14 - 18	0.5006	0.0720	0.4561	0.0708
	19 - 28	0.5881	0.0707	0.5423	0.0696
	29 - 52	0.5668	0.0718	0.5316	0.0705
53 or more	0.4634	0.0733	0.4895	0.0718	

Outcome: 90 day unplanned hospital readmission

Prognostic model was derived using backward elimination with a significance level of 0.05 for predictors to remain in the model. Thirty nine predictors were considered and the final model included the 17 predictors above after removal of following 22 predictors; sex, Scottish Index of Multiple Deprivation, comorbidities of cardiovascular disease, cerebrovascular disease, dementia, respiratory disease, rheumatic disease, peptic ulcer disease, liver disease, hemiplegia or paraplegia, renal disease, immunosuppression, alcohol misuse, and drug misuse, CPR prior to admission to ICU, acute physiology score at admission to ICU, number of days with mechanical ventilation during ICU stay, number of days with renal replacement therapy during ICU stay, number of days with cardiovascular system support during ICU stay, maximum number of organs supported on any day during ICU stay, length of ICU stay (days), length of index hospital stay (days).

Outcome: 90 day unplanned hospital readmission or death

Prognostic model was derived using backward elimination with a significance level of 0.05 for predictors to remain in the model. Thirty nine predictors were considered and the final model included the 18 predictors above after removal of following 21 predictors; sex, Scottish Index of Multiple Deprivation, comorbidities of cardiovascular disease, cerebrovascular disease, dementia, respiratory disease, rheumatic disease, peptic ulcer disease, liver disease, hemiplegia or paraplegia, immunosuppression, alcohol misuse, and drug misuse, CPR prior to admission to ICU, acute physiology score at admission to ICU, number of days with mechanical ventilation during ICU stay, number of days with renal replacement therapy during ICU stay, number of days with cardiovascular system support during ICU stay, maximum number of organs supported on any day during ICU stay, length of ICU stay (days), length of index hospital stay (days).

eTable 7 Performance of risk prediction model as a screening tool to identify patients at risk of unplanned hospital readmission with 95% confidence intervals

Threshold of predicted risk for screening positive	Number Screening Positive	% Screening Positive	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)	Positive Likelihood Ratio	Negative Likelihood Ratio
≥ 20%	7734	54.2 (53.4, 55.0)	69.3 (67.7, 70.8)	50.8 (49.9, 51.8)	31.9 (30.9, 33.0)	83.3 (82.3, 84.2)	1.41 (1.37, 1.45)	0.60 (0.57, 0.64)
≥ 30%	2806	19.7 (19.0, 20.3)	32.6 (31.1, 34.2)	84.7 (84.0, 85.3)	41.4 (39.6, 43.3)	79.1 (78.3, 79.8)	2.13 (1.99, 2.27)	0.80 (0.78, 0.82)
≥ 40%	1129	7.9 (7.5, 8.4)	16.7 (15.5, 18.0)	95.0 (94.6, 95.4)	52.7 (49.7, 55.6)	77.4 (76.7, 78.1)	3.35 (3.00, 3.74)	0.88 (0.86, 0.89)
≥ 50%	484	3.4 (3.1, 3.7)	8.6 (7.7, 9.6)	98.3 (98.1, 98.6)	63.2 (58.8, 67.5)	76.4 (75.7, 77.1)	5.17 (4.31, 6.19)	0.93 (0.92, 0.94)
≥ 60%	226	1.6 (1.4, 1.8)	4.4 (3.7, 5.1)	99.4 (99.2, 99.5)	69.0 (62.6, 75.0)	75.8 (75.0, 76.5)	6.74 (5.07, 8.86)	0.96 (0.96, 0.97)

eTable 8 Characteristics and outcomes of patients screening positive and negative using the risk prediction model illustrated at a threshold of $\geq 20\%$ and $\geq 50\%$ predicted probability of 90 day unplanned hospital readmission

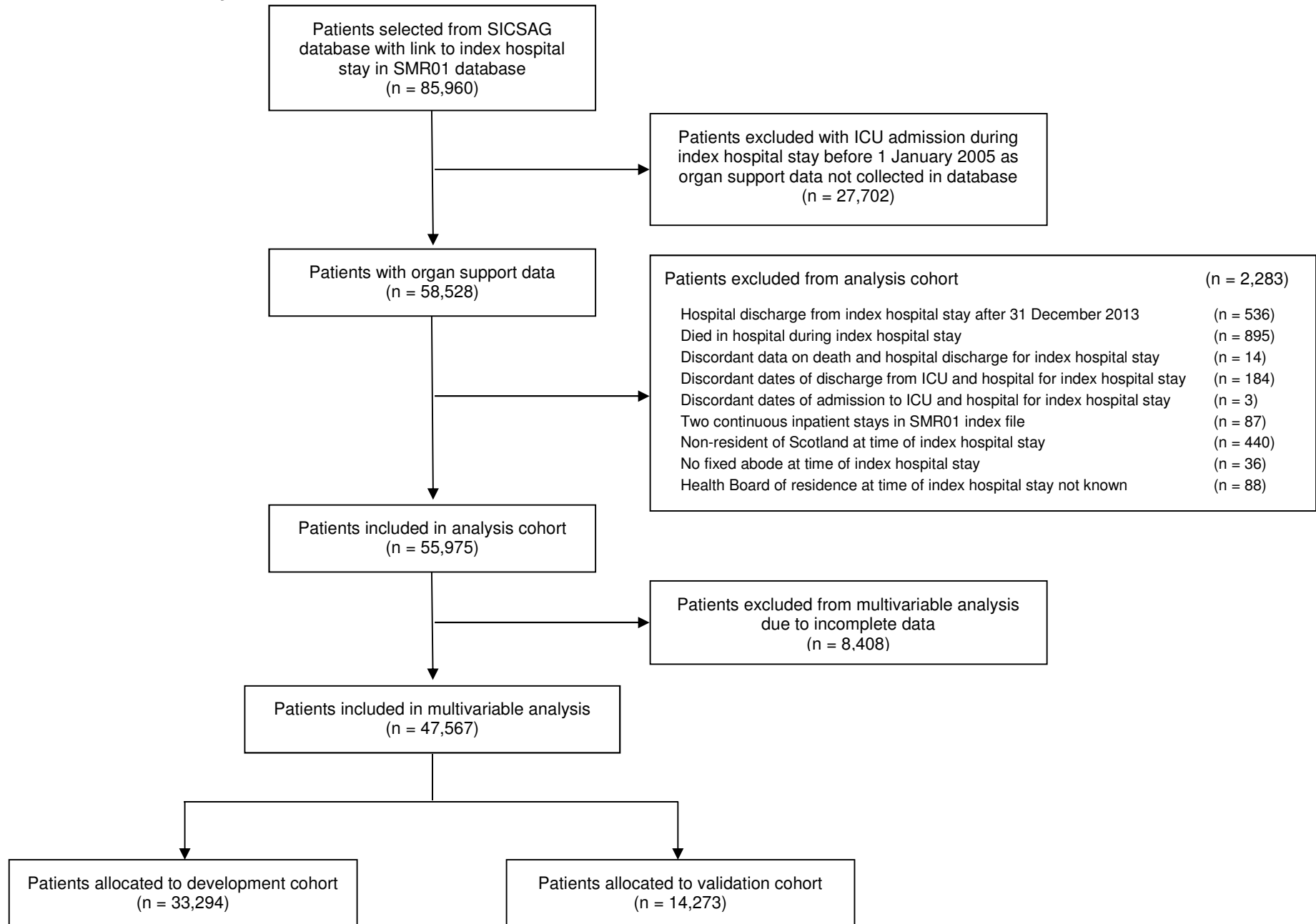
		Screen Negative Predicted probability < 0.20	Screen Positive Predicted probability ≥ 0.20	Screen Negative Predicted probability < 0.50	Screen Positive Predicted probability ≥ 0.50
Number (% of n=14,273)		6397 (44.8%)	7876 (55.2%)	13799 (96.7%)	474 (3.3%)
Age mean (SD)		55.4 (18.9)	61 (15.1)	58.6 (17.2)	55.2 (15.2)
Number of comorbidities	0	4494 (70.3%)	1275 (16.2%)	5760 (41.7%)	9 (1.9%)
	1	1633 (25.5%)	2963 (37.6%)	4539 (32.9%)	57 (12.0%)
	2	214 (3.4%)	2042 (25.9%)	2118 (15.4%)	138 (29.1%)
	3+	56 (0.9%)	1596 (20.3%)	1382 (10.0%)	270 (57.0%)
Number of previous unplanned hospital admissions in one year	0	5902 (92.3%)	3701 (47.0%)	9602 (69.6%)	1 (0.2%)
	1	460 (7.2%)	2404 (30.5%)	2850 (20.7%)	14 (3.0%)
	2	33 (0.5%)	901 (11.4%)	898 (6.5%)	36 (7.6%)
	3+	2 (0.0%)	870 (11.1%)	449 (3.3%)	423 (89.2%)
APS mean (SD)		10.4 (5.9)	12.4 (6.2)	11.4 (6.1)	14.6 (6.3)
Number of organs supported	0	2369 (37.0%)	2248 (28.5%)	4506 (32.7%)	111 (23.4%)
	1	2277 (35.6%)	2586 (32.8%)	4697 (34.0%)	166 (35.0%)
	2	1621 (25.3%)	2641 (33.5%)	4095 (29.7%)	167 (35.2%)
	3	130 (2.0%)	401 (5.1%)	501 (3.6%)	30 (6.3%)
Diagnosis on admission (5 most common specific diagnoses)	1	Pneumonia 555 (8.7%)	Acute GI pathology* 586 (7.4%)	Pneumonia 1015 (7.4%)	Pneumonia 39 (8.2%)
	2	Self-poisoning 482 (7.5%)	GI neoplasm 526 (6.7%)	Acute GI pathology* 792 (5.7%)	Seizures 35 (7.4%)
	3	Trauma ex head injury 428 (6.7%)	Pneumonia 499 (6.3%)	GI neoplasm 715 (5.2%)	Septic shock 31 (6.5%)
	4	Vascular surgery 290 (4.5%)	GI obstruction 281 (3.6%)	Septic shock 686 (5.0%)	Renal 25 (5.3%)
	5	Acute GI pathology* 232 (3.6%)	Trauma ex head injury 181 (2.3%)	Trauma ex head injury 605 (4.4%)	Self-poisoning 17 (3.6%)
ICU length of stay median (IQR)		2 (1, 4)	2 (2, 5)	2 (1, 5)	2 (1, 5)
Hospital length of stay median (IQR)		9 (5, 16)	17 (9, 33)	12 (7, 25)	22 (12, 43)
90 day readmission		1067 (16.7%)	2495 (31.7%)	3263 (23.7%)	299 (63.1%)
90 day readmission or death		1108 (17.3%)	2599 (33.0%)	3402 (24.7%)	305 (64.4%)

*Acute GI pathology comprises gastrointestinal perforation/ischaemia/ peritonitis/abscess

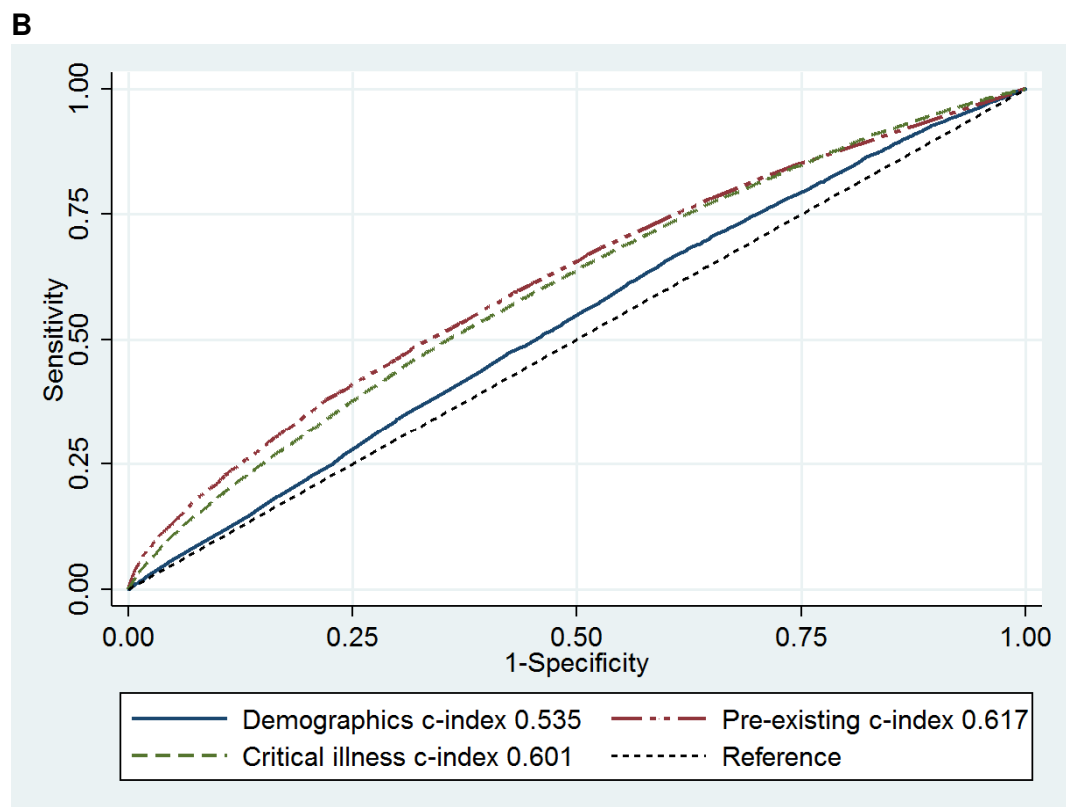
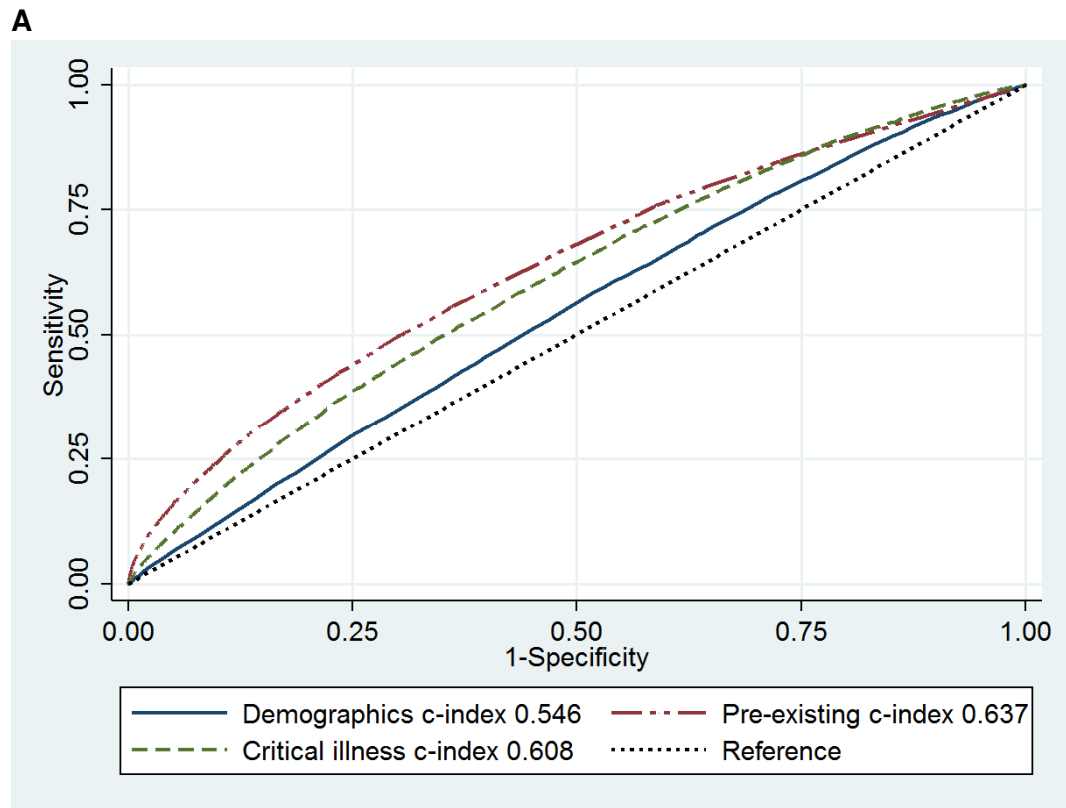
eTable 9 Comparison of c-indices from receiver operating characteristics analyses for subgroup and sensitivity analyses.

Groups of variables in model	Whole cohort			Subgroup analyses	
	90d readmission	90d readmission or death	30d readmission	90d readmission: no comorbidity	90d readmission: emergency ICU admission
Demographics	0.54 (0.54, 0.55)	0.55 (0.54, 0.55)	0.54 (0.53, 0.54)	0.55 (0.54, 0.56)	0.54 (0.54, 0.55)
Pre-existing health indices	0.63 (0.63, 0.64)	0.64 (0.63, 0.64)	0.62 (0.61, 0.62)	0.56 (0.55, 0.57)	0.65 (0.64, 0.65)
Critical illness indices	0.60 (0.60, 0.61)	0.61 (0.60, 0.61)	0.60 (0.59, 0.61)	0.62 (0.61, 0.63)	0.61 (0.60, 0.61)
All variables	0.66 (0.66, 0.67)	0.67 (0.66, 0.67)	0.65 (0.64, 0.66)	0.64 (0.63, 0.65)	0.67 (0.67, 0.68)

eFigure 1. Derivation of study cohort

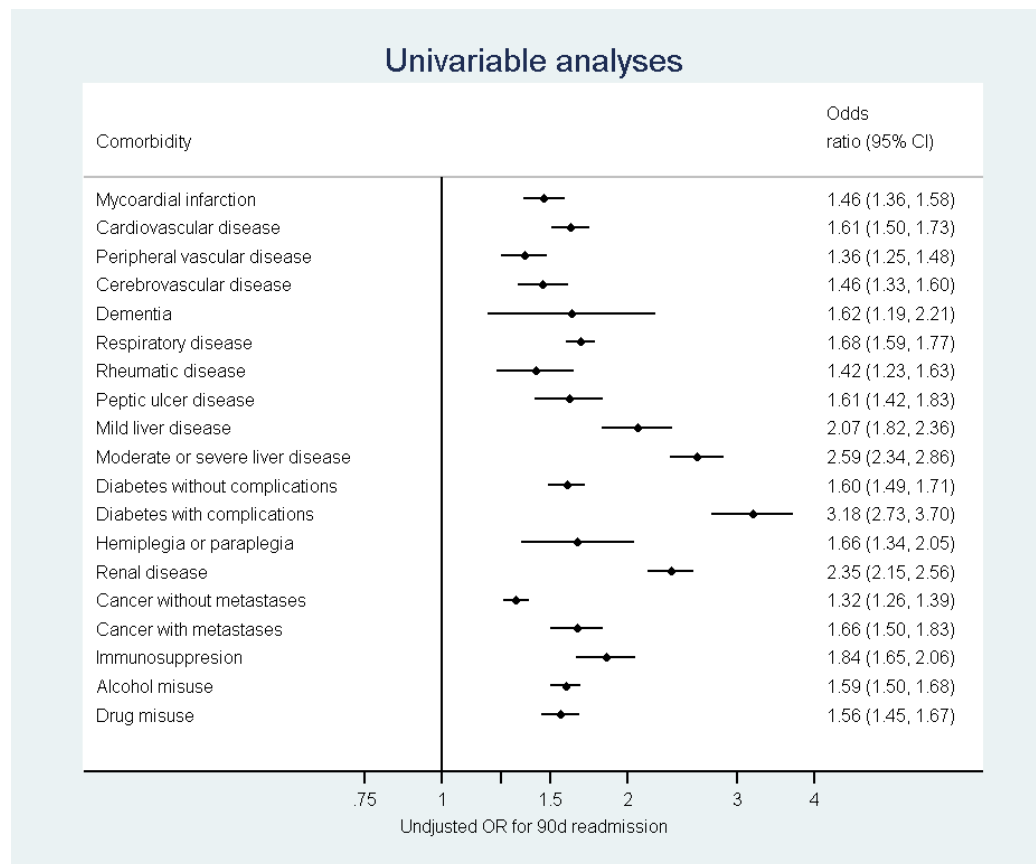


eFigure 2. Receiver operating characteristics curves illustrating discriminant ability of variables combined into three mutually exclusive groups for (A) 90-day unscheduled hospital readmission or death; (B) 30-day unscheduled hospital readmission: patient demographics, indices of pre-existing patient health, and indices of critical illness severity

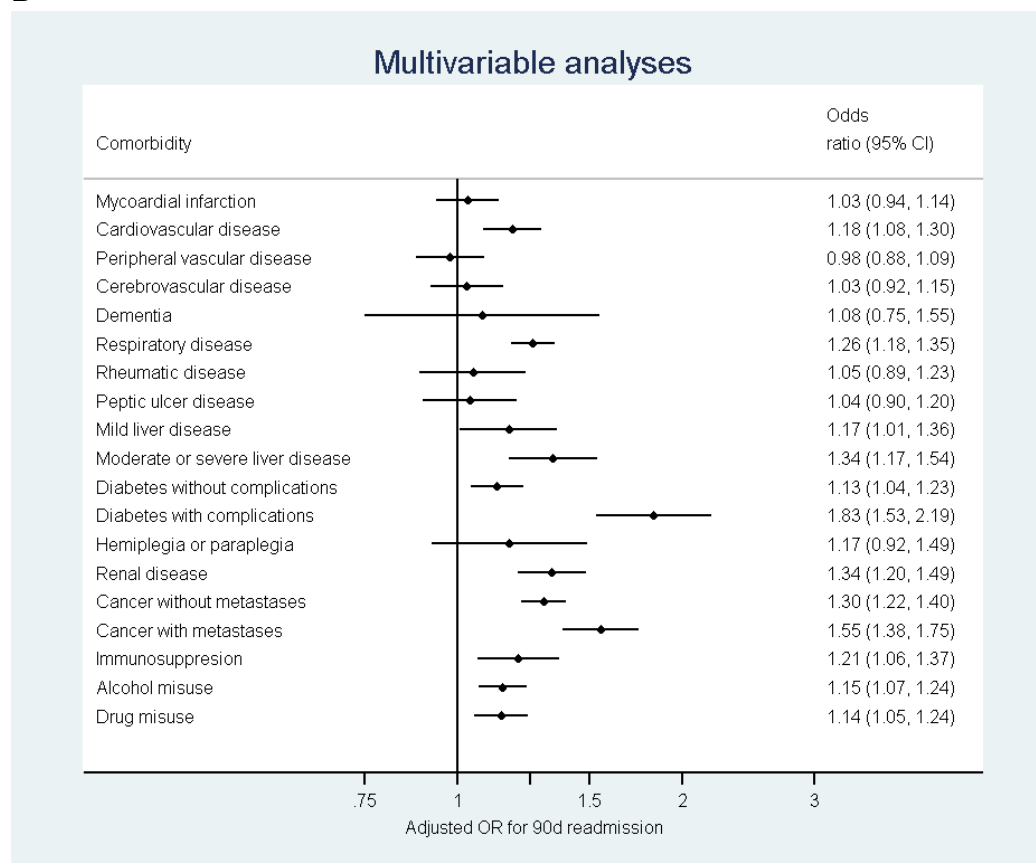


eFigure 3. Associations between comorbidities and unplanned hospital admission within 90 days of discharge from index hospital stay from logistic regression analyses: (A) univariable; (B) multivariable. Multivariable analyses include all covariates listed in eTable 3 replacing number of comorbidities with individual comorbidities.

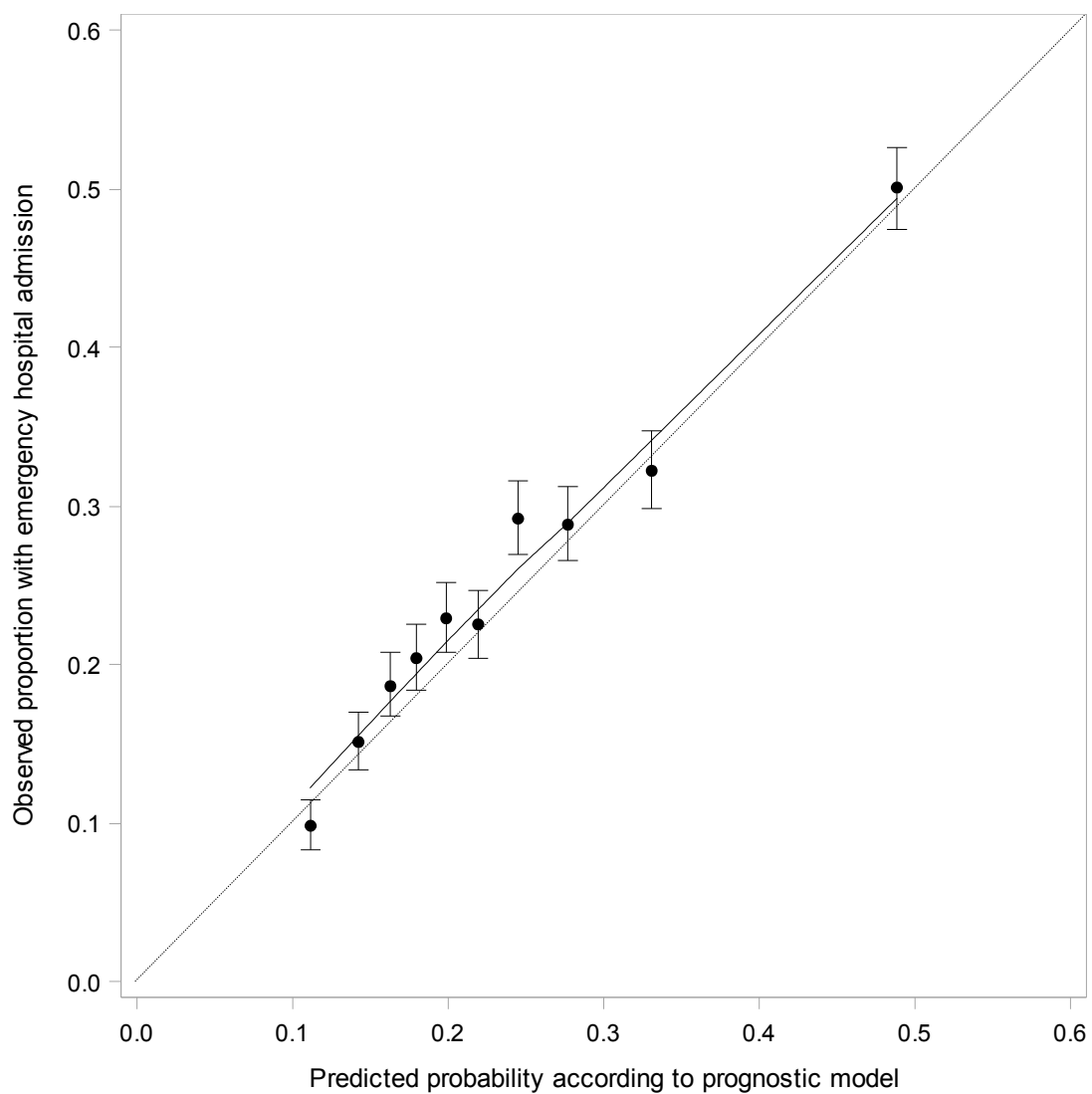
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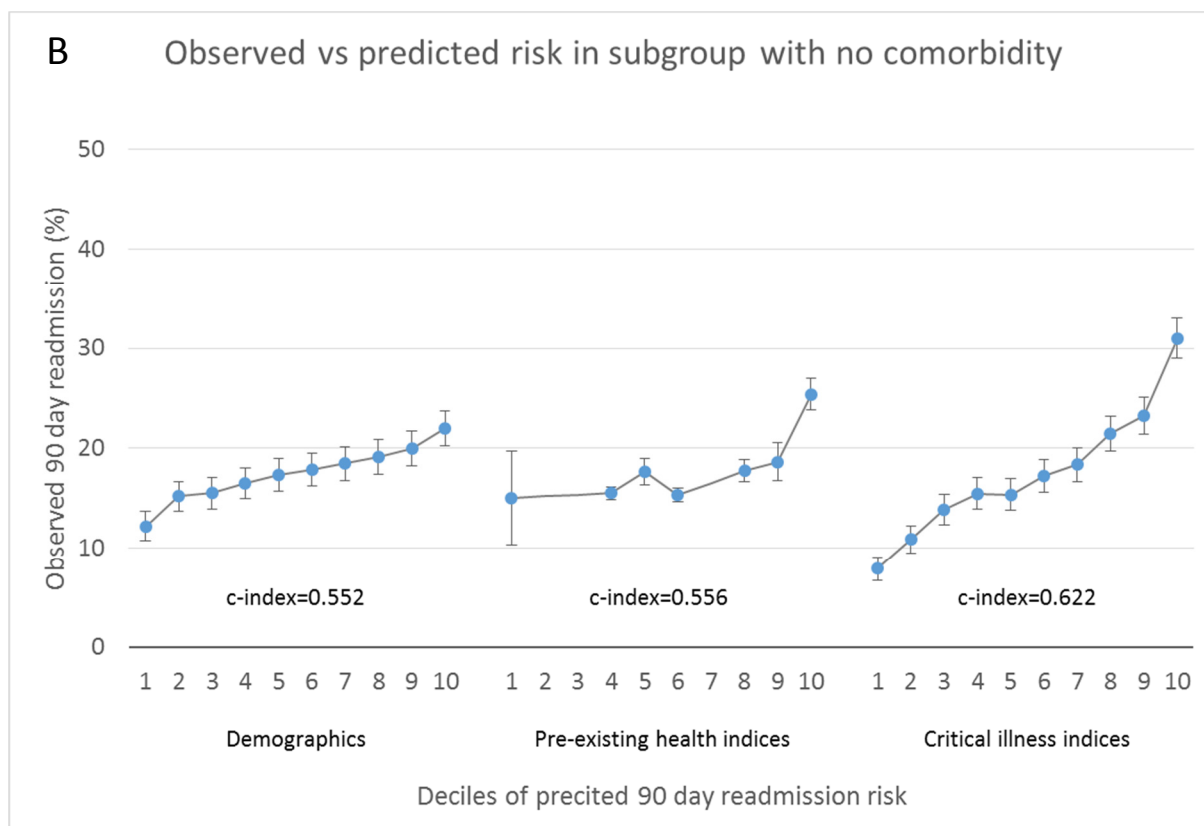
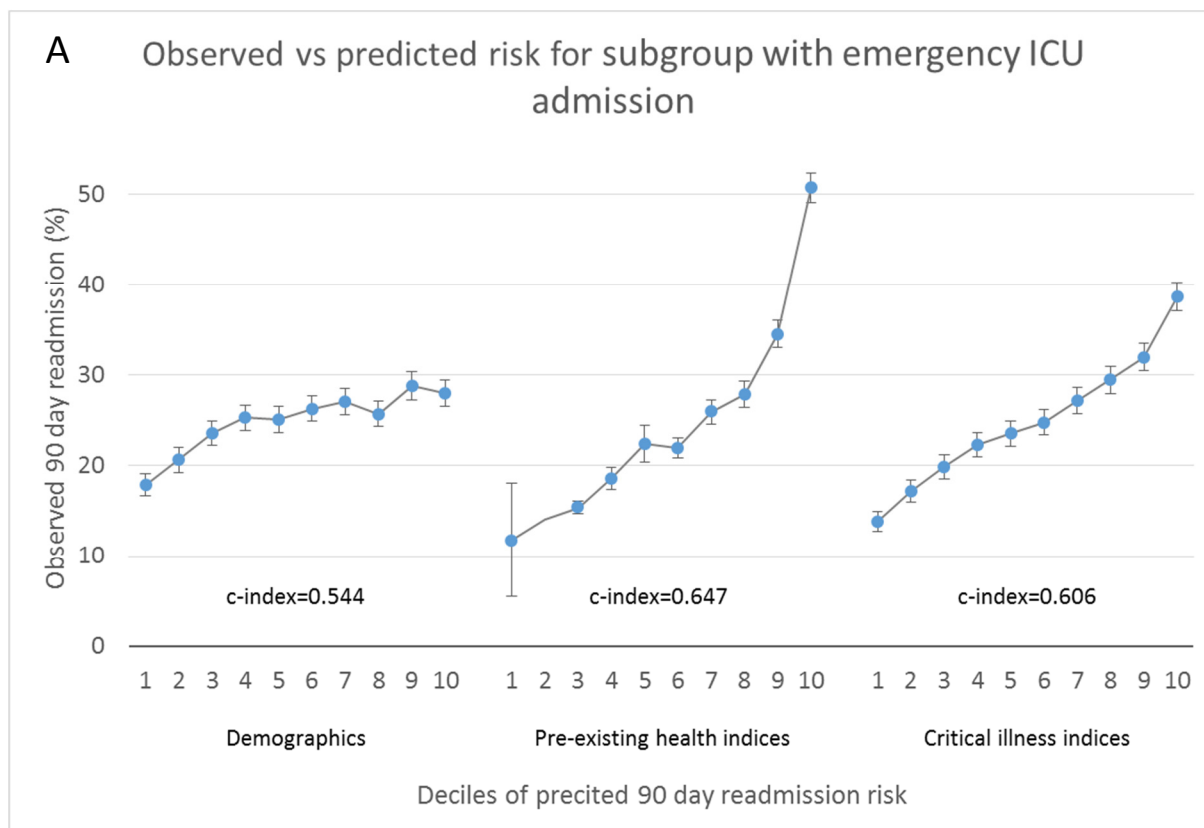
B



eFigure 4. Calibration plot for model predicting unplanned hospital readmission within 90 days of discharge from index hospital stay in the validation cohort (n=14,273)



eFigure 5. Observed risk of 90 day unscheduled hospital readmission by deciles of predicted risk in subgroups A: restricted to patients with an emergency ICU admission (n=40020, 72.0% of cohort); B: restricted to patients with no recorded comorbidity (n=24420, 43.6% of cohort). Characteristics are combined into three groups: patient demographics, indices of pre-existing patient health, and indices of critical illness severity.



eFigure 6. Receiver operating characteristics curves illustrating discriminant ability of variables combined into three mutually exclusive groups for 90-day unscheduled hospital readmission restricted to (A) patients with an emergency ICU admission; and (B) patients with no recorded comorbidity.

