

Supplementary Table 1. Most common procedures in patients admitted to ICU

Procedure	Direct ICU Admission (n [%])	Indirect ICU Admission (n [%])
L18 Emergency Replacement Of Aneurysmal	141 (11.0)	-
H33 Excision Of Rectum	132 (10.3)	65 (14.7)
H07 Other Excision Of Right Hemicolon	88 (6.9)	31 (7.0)
G52 Operations On Ulcer Of Duodenum	85 (6.6)	-
T30 Opening Of Abdomen	80 (6.2)	31 (7.0)
H01 Emergency Excision Of Appendix	-	31 (7.0)
G69 Excision Of Ileum	-	20 (4.5)

Supplementary Table 2. Factors associated with 30-day emergency reoperation.

		No 30d reoperation	30d reoperation	Univariable regression HR (95%CI) p-value	Multivariable regression HR (95%CI) p-value
n		36142 (97.2%)	1031 (2.8%)		
ICU admission status	No ICU admission	34404 (95.4%)	961 (93.2%)	0.64 (0.48, 0.87) 0.004	0.75 (0.58, 0.96) 0.025
	Direct ICU admission	1231 (3.4%)	54 (5.2%)	1 (reference)	1 (reference)
	Indirect ICU admission	427 (1.2%)	16 (1.6%)	0.86 (0.56, 1.31) 0.472	0.85 (0.57, 1.28) 0.445
Age (years)	Mean (SD); per 10 years	46.8 (20.4)	51.2 (20.7)	1.11 (1.08, 1.14) <0.001	1.02 (0.98, 1.06) 0.283
Sex	Male	21302 (58.9%)	582 (56.5%)	1 (reference)	1 (reference)
	Female	14840 (41.1%)	449 (43.5%)	1.11 (1.00, 1.23) 0.051	1.02 (0.91, 1.15) 0.725
Comorbidity count (Charlson)	0	32761 (90.6%)	867 (84.1%)	1 (reference)	1 (reference)
	1	2959 (8.2%)	137 (13.3%)	1.73 (1.54, 1.94) <0.001	0.95 (0.86, 1.04) 0.239
	2	364 (1.0%)	22 (2.1%)	2.24 (1.64, 3.05) <0.001	0.91 (0.56, 1.48) 0.699
	3+	58 (0.2%)	5 (0.5%)	3.20 (1.35, 7.59) 0.008	0.99 (0.33, 2.95) 0.982
Deprivation index quintile (SIMD)	1 Least deprived	5523 (15.6%)	167 (16.3%)	1 (reference)	1 (reference)
	2	6360 (17.9%)	185 (18.1%)	0.96 (0.69, 1.34) 0.828	0.94 (0.67, 1.32) 0.720
	3	7005 (19.8%)	185 (18.1%)	0.88 (0.72, 1.06) 0.172	0.86 (0.70, 1.06) 0.153
	4	7681 (21.7%)	227 (22.2%)	0.98 (0.83, 1.15) 0.791	0.99 (0.84, 1.16) 0.883
	5 Most deprived	8881 (25.1%)	259 (25.3%)	0.97 (0.79, 1.18) 0.739	0.99 (0.83, 1.18) 0.913
Prior elective admission	Mean (SD)	0.8 (1.6)	1.3 (2.1)	1.17 (1.15, 1.19) <0.001	1.08 (1.06, 1.11) <0.001
Prior emergency admission	Mean (SD)	0.7 (1.2)	1.1 (1.5)	1.21 (1.17, 1.26) <0.001	1.11 (1.05, 1.18) <0.001
Diagnosis	Other	28180 (78.0%)	838 (81.3%)	1 (reference)	1 (reference)
	Cancer	2138 (5.9%)	92 (8.9%)	1.44 (1.11, 1.85) 0.005	1.33 (1.04, 1.71) 0.025
	Trauma/Injury	5824 (16.1%)	101 (9.8%)	0.59 (0.53, 0.65) <0.001	0.67 (0.55, 0.83) <0.001
Procedure category	Upper digestive system	2208 (6.1%)	62 (6.0%)	0.69 (0.51, 0.93) 0.015	0.62 (0.46, 0.83) 0.001
	Lower digestive system	15269 (42.2%)	408 (39.6%)	0.65 (0.49, 0.87) 0.003	0.70 (0.53, 0.94) 0.016
	Another abdomen	4049 (11.2%)	113 (11.0%)	0.68 (0.42, 1.11) 0.121	0.68 (0.43, 1.09) 0.108
	Vascular	1674 (4.6%)	75 (7.3%)	1.08 (0.76, 1.54) 0.654	0.82 (0.54, 1.24) 0.341
	Soft tissue	8939 (24.7%)	208 (20.2%)	0.57 (0.41, 0.79) 0.001	0.72 (0.52, 1.00) 0.047
	Other	4003 (11.1%)	165 (16.0%)	1 (reference)	1 (reference)
	Minor	6734 (18.7%)	188 (18.3%)	1 (reference)	1 (reference)
Operative complexity	Intermediate	16960 (47.0%)	425 (41.4%)	0.90 (0.70, 1.16) 0.420	0.96 (0.73, 1.26) 0.777
	Major	7859 (21.8%)	240 (23.4%)	1.09 (0.71, 1.69) 0.690	1.02 (0.70, 1.50) 0.900
	Major+	1696 (4.7%)	49 (4.8%)	1.03 (0.65, 1.64) 0.890	0.88 (0.54, 1.41) 0.587
	Complex major	2809 (7.8%)	125 (12.2%)	1.58 (1.12, 2.22) 0.009	1.24 (0.85, 1.83) 0.266
	Mon-Thu	22228 (61.5%)	651 (63.1%)	1 (reference)	1 (reference)
Discharge date	Fri-Sun	13914 (38.5%)	380 (36.9%)	0.93 (0.82, 1.06) 0.309	0.97 (0.86, 1.09) 0.591
	Dec-Feb	8636 (23.9%)	279 (27.1%)	1 (reference)	1 (reference)
Season	Mar-May	9131 (25.3%)	255 (24.7%)	0.87 (0.73, 1.03) 0.099	0.85 (0.73, 1.00) 0.054
	Jun-Aug	9420 (26.1%)	268 (26.0%)	0.88 (0.78, 1.00) 0.043	0.91 (0.81, 1.01) 0.087
	Sep-Nov	8955 (24.8%)	229 (22.2%)	0.80 (0.59, 1.06) 0.124	0.79 (0.60, 1.04) 0.091

Supplementary Table 3. Factors associated with 30-day emergency readmission with complication.

		No 30d complication	30d complication	Univariable regression HR (95%CI) p-value	Multivariable regression HR (95%CI) p-value
n		36099 (97.1%)	1074 (2.9%)		
ICU admission status	No ICU admission	34392 (95.5%)	973 (90.6%)	0.51 (0.42, 0.61) <0.001	0.78 (0.66, 0.92) 0.003
	Direct ICU admission	1216 (3.4%)	69 (6.4%)	1 (reference)	1 (reference)
	Indirect ICU admission	411 (1.1%)	32 (3.0%)	1.36 (1.00, 1.83) 0.048	1.38 (1.04, 1.83) 0.026
Age (years)	Mean (SD); per 10 years	46.7 (20.4)	55.2 (20.8)	1.22 (1.19, 1.24) <0.001	1.10 (1.08, 1.12) <0.001
Sex	Male	21299 (59.0%)	585 (54.5%)	1 (reference)	1 (reference)
	Female	14800 (41.0%)	489 (45.5%)	1.20 (1.09, 1.32) <0.001	1.04 (0.93, 1.16) 0.532
Comorbidity count (Charlson)	0	32751 (90.7%)	877 (81.7%)	1 (reference)	1 (reference)
	1	2933 (8.1%)	163 (15.2%)	2.04 (1.64, 2.54) <0.001	0.97 (0.77, 1.21) 0.765
	2	359 (1.0%)	27 (2.5%)	2.73 (1.71, 4.35) <0.001	0.92 (0.57, 1.50) 0.746
	3+	56 (0.2%)	7 (0.7%)	4.43 (3.02, 6.51) <0.001	1.16 (0.77, 1.75) 0.470
Deprivation index quintile (SIMD)	1 Least deprived	5526 (15.6%)	164 (15.4%)	1 (reference)	1 (reference)
	2	6343 (17.9%)	202 (19.0%)	1.07 (0.78, 1.48) 0.669	1.09 (0.76, 1.56) 0.640
	3	6974 (19.7%)	216 (20.3%)	1.04 (0.80, 1.35) 0.746	1.07 (0.81, 1.42) 0.623
	4	7674 (21.7%)	234 (22.0%)	1.03 (0.83, 1.28) 0.814	1.06 (0.83, 1.36) 0.634
	5 Most deprived	8892 (25.1%)	248 (23.3%)	0.94 (0.76, 1.17) 0.585	1.01 (0.79, 1.28) 0.949
Prior elective admission	Mean (SD)	0.8 (1.6)	1.4 (2.1)	1.20 (1.16, 1.23) <0.001	1.04 (1.00, 1.08) 0.069
Prior emergency admission	Mean (SD)	0.7 (1.2)	1.2 (1.7)	1.30 (1.25, 1.35) <0.001	1.20 (1.17, 1.24) <0.001
Diagnosis	Other	28102 (77.8%)	916 (85.3%)	1 (reference)	1 (reference)
	Cancer	2146 (5.9%)	84 (7.8%)	1.19 (0.96, 1.49) 0.111	0.82 (0.64, 1.06) 0.126
	Trauma/Injury	5851 (16.2%)	74 (6.9%)	0.39 (0.34, 0.45) <0.001	0.44 (0.36, 0.53) <0.001
Procedure category	Upper digestive system	2169 (6.0%)	101 (9.4%)	1.41 (1.08, 1.85) 0.012	1.14 (0.80, 1.63) 0.473
	Lower digestive system	15280 (42.3%)	397 (37.0%)	0.80 (0.64, 1.00) 0.052	1.11 (0.91, 1.36) 0.316
	Other abdomen	4049 (11.2%)	113 (10.5%)	0.86 (0.73, 1.01) 0.074	0.73 (0.57, 0.93) 0.010
	Vascular	1661 (4.6%)	88 (8.2%)	1.60 (1.32, 1.95) <0.001	1.08 (0.85, 1.39) 0.520
	Soft tissue	8904 (24.7%)	243 (22.6%)	0.84 (0.73, 0.97) 0.016	1.09 (0.91, 1.30) 0.359
	Other	4036 (11.2%)	132 (12.3%)	1 (reference)	1 (reference)
	Minor	6854 (19.0%)	68 (6.4%)	1 (reference)	1 (reference)
Operative complexity	Intermediate	16891 (46.9%)	494 (46.2%)	2.92 (2.40, 3.56) <0.001	3.33 (2.76, 4.01) <0.001
	Major	7810 (21.7%)	289 (27.0%)	3.68 (2.85, 4.77) <0.001	3.62 (2.68, 4.88) <0.001
	Major+	1676 (4.7%)	69 (6.5%)	4.08 (3.24, 5.14) <0.001	3.43 (2.57, 4.58) <0.001
	Complex major	2785 (7.7%)	149 (13.9%)	5.27 (4.33, 6.43) <0.001	3.77 (2.78, 5.11) <0.001
Discharge date	Mon-Thu	22198 (61.5%)	681 (63.4%)	1(reference)	1(reference)
	Fri-Sun	13901 (38.5%)	393 (36.6%)	0.92 (0.84, 1.01) 0.090	0.98 (0.88, 1.08) 0.647
Season	Dec-Feb	8631 (23.9%)	284 (26.4%)	1(reference)	1(reference)
	Mar-May	9117 (25.3%)	269 (25.0%)	0.90 (0.74, 1.09) 0.283	0.89 (0.73, 1.09) 0.264
	Jun-Aug	9416 (26.1%)	272 (25.3%)	0.88 (0.77, 1.01) 0.068	0.91 (0.80, 1.03) 0.132
	Sep-Nov	8935 (24.8%)	249 (23.2%)	0.85 (0.75, 0.96) 0.010	0.87 (0.75, 1.01) 0.069

Supplementary Table 4. Factors associated with emergency readmission rate over 3 year follow up period.

		Mean 3year readmission rate	Univariable regression Adm RR (95%CI) p-value	Multivariable regression Adm RR (95%CI) p- value
ICU admission status	No ICU admission	0.54 (0.01)	0.44 (0.37, 0.52) <0.001	0.83 (0.73, 0.95) 0.006
	Direct ICU admission	0.95 (0.09)	1 (reference)	1 (reference)
	Indirect ICU admission	1.33 (0.18)	1.08 (0.96, 1.21) 0.196	1.05 (0.89, 1.24) 0.530
Age (years)	per 10 years	-	1.42 (1.40, 1.44) <0.001	1.19 (1.18, 1.21) <0.001
Sex	Male	0.53 (0.02)	1 (reference)	1 (reference)
	Female	0.63 (0.02)	1.18 (1.13, 1.24) <0.001	1.04 (0.98, 1.10) 0.218
Comorbidity count (Charlson)	0	0.43 (0.01)	1 (reference)	1 (reference)
	1	1.83 (0.09)	5.80 (5.48, 6.14) <0.001	1.41 (1.35, 1.48) <0.001
	2	2.00 (0.15)	8.04 (7.01, 9.22) <0.001	1.18 (0.97, 1.43) 0.104
	3+	3.05 (0.37)	15.38 (11.59, 20.43) <0.001	1.71 (1.18, 2.48) 0.004
Deprivation index quintile (SIMD)	1 Least deprived	0.49 (0.03)	1 (reference)	1 (reference)
	2	0.52 (0.02)	1.10 (1.01, 1.19) 0.030	1.07 (0.97, 1.18) 0.153
	3	0.57 (0.03)	1.22 (1.13, 1.32) <0.001	1.15 (1.10, 1.21) <0.001
	4	0.64 (0.03)	1.36 (1.20, 1.54) <0.001	1.28 (1.21, 1.36) <0.001
	5 Most deprived	0.62 (0.03)	1.41 (1.31, 1.51) <0.001	1.48 (1.37, 1.59) <0.001
Prior elective admission	Mean (SD)	-	1.47 (1.45, 1.49) <0.001	1.07 (1.05, 1.08) <0.001
Prior emergency admission	Mean (SD)	-	1.69 (1.67, 1.72) <0.001	1.46 (1.43, 1.49) <0.001
Diagnosis	Other	0.50 (0.01)	1 (reference)	1 (reference)
	Cancer	2.42 (0.13)	5.84 (5.49, 6.22) <0.001	4.87 (4.52, 5.25) <0.001
	Trauma/Injury	0.19 (0.01)	0.39 (0.36, 0.43) <0.001	0.59 (0.56, 0.63) <0.001
Procedure category	Upper digestive system	1.04 (0.08)	1.17 (1.11, 1.23) <0.001	0.95 (0.85, 1.06) 0.355
	Lower digestive system	0.40 (0.01)	0.42 (0.39, 0.45) <0.001	0.66 (0.63, 0.70) <0.001
	Other abdomen	0.39 (0.03)	0.37 (0.33, 0.42) <0.001	0.49 (0.43, 0.56) <0.001
	Vascular	1.17 (0.08)	1.52 (1.36, 1.69) <0.001	1.14 (1.04, 1.25) 0.006
	Soft tissue	0.56 (0.03)	0.49 (0.46, 0.53) <0.001	0.91 (0.83, 1.00) 0.041
	Other	0.88 (0.05)	1 (reference)	1 (reference)
Operative complexity	Minor	0.44 (0.02)	1 (reference)	1 (reference)
	Intermediate	0.44 (0.01)	0.91 (0.82, 1.02) 0.105	0.82 (0.78, 0.86) <0.001
	Major	0.70 (0.04)	1.54 (1.30, 1.82) <0.001	1.07 (0.96, 1.18) 0.231
	Major+	1.06 (0.08)	2.90 (2.49, 3.39) <0.001	1.07 (0.88, 1.30) 0.521
	Complex major	0.94 (0.05)	2.70 (2.28, 3.18) <0.001	1.11 (0.95, 1.29) 0.177
Discharge date	Mon-Thu	0.61 (0.02)	1 (reference)	1 (reference)
	Fri-Sun	0.51 (0.02)	0.85 (0.79, 0.91) <0.001	1.02 (0.97, 1.06) 0.469
Season	Dec-Feb	0.60 (0.03)	1 (reference)	1 (reference)
	Mar-May	0.58 (0.02)	1.08 (1.02, 1.15) 0.008	1.03 (0.97, 1.09) 0.295
	Jun-Aug	0.55 (0.02)	0.97 (0.91, 1.03) 0.275	1.04 (1.00, 1.08) 0.043
	Sep-Nov	0.55 (0.03)	0.93 (0.88, 0.99) 0.014	0.99 (0.95, 1.04) 0.778

Additional supplementary material

Expanded methods section

This project was scrutinised by the Privacy Advisory Committee for issues relating to information governance, disclosivity and privacy. Scotland has clear guidance on principles of data linkage to ensure data are linked and analysed in an ethical and legal framework.⁽¹⁾ This guidance was developed with consultation and engagement with the Scottish public. Data linkage is undertaken centrally by Information Services Division of NHS Scotland using probabilistic matching methods. The fields used to undertake linkage include name, sex, date of birth, post code, date of death, and unique patient identifying numbers such as the Community Health Index number (a unique health care identifier in Scotland allocated to all Scottish residents). A computer algorithm is used to compare each field between two records and generate a score. This score depends on the agreement of the contents of the field and the rarity of the information. From this, the probability that the two records relate to the same person is calculated. This probability is the sum of weighted scores for each field. Records are only considered correct matches if the sum of the weighted scores is greater than a specified threshold value. Manual validation of linkages indicates that the accuracy of this method of data linkage is high.^(2,3)

General Surgical Procedures

General surgical procedures were identified using the Office of Population Censuses and Surveys (OPCS) Classification of Surgical Operations version 4.2. General surgical procedures were defined as procedures from chapters:

- Chapter G - Upper Digestive System
- Chapter H - Lower Digestive System
- Chapter J - Other Abdominal Organs, Principally Digestive
- Chapter L - Arteries and Veins
- Chapter M - Urinary
- Chapter N - Male Genital Organs
- Chapter B - Endocrine System and Breast
- Chapter S - Skin
- Chapter T - Soft Tissue
- Chapter X - Miscellaneous Operations
- Chapter Y - Subsidiary Classification of Methods of Operation

Readmission Diagnosis

Readmission diagnosis was recorded using ICD-10 system and these were grouped under broad themes by two authors (MAG, SG) and this was reviewed and adjudicated by a further two authors (NIL, EMH). Final groupings were as outlined below:

Cardiovascular/Cerebrovascular

I10-15 – hypertensive heart and renal disease
I20-25, I50 – Ischaemic heart disease – includes complications of MI
I30-32 – Pericarditis
I33, I38, I39 – Endocarditis
I40-41 – Myocarditis
I42-43 – Cardiomyopathy
I44-45 – Conduction Disorders
I46 – Cardiac Arrest
I47-49 – Arrhythmias
I50 – Heart Failure
I60 – SAH
I61 – Intracerebral Haemorrhage
I62 – Non-traumatic ICH
I63-64 – CVA

Respiratory

J00-06 – Acute URTI, incl. pharyngitis and sinusitis
J09-11 – Influenza
J12 – Viral Pneumonia
J13-15 – Bacterial Pneumonia
J16 – Pneumonia due to other organisms – chlamydial, other specified
J18 – Pneumonia – organism unspecified
J20 – Acute bronchitis
J40-47 – Chronic LRTIs

- Bronchitis, Emphysema, COPD, Asthma, Status asthmaticus, Bronchiectasis

J80 – ARDS
J81 – Pulmonary oedema (excluding cardiac causes)
J90-91 – Pleural effusion
J93 – Pneumothorax
J96 – acute respiratory failure

Gastrointestinal

K20-21 – Oesophagitis, GORD
K22 – Barret's, Oesophageal ulcer
K25-27, 29 – Peptic ulcer
K55 – Acute vascular disorders of intestine, including ischaemic bowel
K56 – Paralytic ileus

- Incl. volvulus and adhesions

K65 – peritonitis
K66 – Other disorders of peritoneum, including adhesions and haemoperitoneum
K71 – toxic liver disease, including drugs and cholestasis
K85 – Acute pancreatitis
K91 – Post-procedural disorders of digestive system

- Incl. vomiting, malabsorption, obstruction, stoma malfunction
- K92 – Other disorders of the digestive system
- Haematemesis, melena, GI haemorrhage

Renal

- N02 – Persistent haematuria
 N10 – Acute tubulo-interstitial nephritis
 N13 – Obstructive and reflex uropathy, including hydronephrosis
 N14 – drug-induced tubulo-interstitial and tubular disease
 N17 – Acute renal failure
 N18 – CKD
 N19 – Unspecified kidney failure
 N20-23 – Urolithiasis
 N30 - Cystitis
 N39 – UTI
 N99 – Post-procedural disorders of the genitourinary system
- Incl. renal failure, urethral stricture, malfunction of urostomy

Infection

- A40 – Streptococcal Infection/sepsis
- Strep A, B, D
 - Strep Pneumoniae
 - Other specified or unspecified strep infections
- A41 – Other sepsis
- Staph, Haemophilus, Anaerobes, Gram negative
 - Other specified or unspecified
- A48 – Other bacterial diseases (not elsewhere classified)
- Gas gangrene – cellulitis
 - Legionnaire's
 - Toxic Shock Syndrome
- A49 – Bacterial Infection of unspecified site
 B95 – Staphylococcus and Streptococcus as the cause of diseases classified to other chapters
 B96 – Other specified bacterial agents as the cause of diseases classified to other chapters (Klebsiella, Haemophilus, Pseudomonas, E. Coli etc)

Surgical Complications

- T81.0 – Haemorrhage and haematoma complicating a procedure
 T81.2 – Accidental puncture and laceration during a procedure, not elsewhere classified
 T81.3 – Disruption of operation wound, not elsewhere classified
 T81.4 – Infection following a procedure, not elsewhere classified – incl. wound
 T81.5 – Foreign body accidentally left in body cavity or operation wound following a procedure

T81.8 – Other complications of a procedure, not elsewhere classified – including persistent postoperative fistula

T81.9 – Unspecified complication of procedure

Thromboembolic

I80 – phlebitis and thrombophlebitis

- I80.0 – superficial vessels of lower extremities
- I80.1 – femoral vein
- I80.2 – deep vessel of lower extremities
- I80.3 – lower extremities, unspecified
- I80.8 – Other sites
- I80.9 – unspecified site

I26 – PE

Others

D50 – Iron deficiency anaemia

D59 – Acquired haemolytic anaemia

D65 – DIC

D68.3 – Haemorrhagic disorder due to circulating anticoagulants

D68.4 – Acquired coagulation factor deficiency (liver disease, Vitamin K deficiency)

D69 – Purpura and other haemorrhagic conditions

- Thrombocytopenia

D70 – Agranulocytosis (neutropenia)

D80-89 – Immunodeficiency

E10-14 – DKA

E20-35 – Disorders of other thyroid glands

- Includes hypo and hyper secretion of glands, and Addisonian Crisis

L03 – Cellulitis

L08 – Other local infections of skin and subcutaneous tissue

L50 – Allergic urticarial

M00-03 – Infective arthropathies

References

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