

Appendix 1. Codes defining patient cohorts

Only a patient's first admission to hospital for the given condition in the financial year 2014/15 was included, where the patient was discharged alive (Dismeth=1,2,3). Patient selection is further restricted to those aged 18-149, who had an "ordinary admission" (Classpat =1) rather than a day case or maternity admission, or were classed as regular day or night attenders.

1. Acute Myocardial Infarction

- a. Admission type: Emergency only (admimeth=2)
- b. Diagnosis type: As primary diagnosis in first episode

Code	Diagnosis
I210	Acute transmural myocardial infarction of anterior wall
I211	Acute transmural myocardial infarction of inferior wall
I212	Acute transmural myocardial infarction of other sites
I213	Acute transmural myocardial infarction of unspecified site
I214	Acute subendocardialmyocardial infarction
I219	Acute myocardial infarction, unspecified
I220	Subsequent myocardial infarction of anterior wall
I221	Subsequent myocardial infarction of inferior wall
I228	Subsequent myocardial infarction of other sites
I229	Subsequent myocardial infarction of unspecified site

- c. Procedure type: None specified

2. Bowel cancer surgery

- a. Admission type: Emergency and elective (admimeth = 1 or 2)
- b. Diagnosis type: As primary diagnosis in first episode

Code	Diagnosis
C180	Malignant neoplasm: Caecum
C181	Malignant neoplasm: Appendix
C182	Malignant neoplasm: Ascending colon
C183	Malignant neoplasm: Hepatic flexure
C184	Malignant neoplasm: Transverse colon
C185	Malignant neoplasm: Splenic flexure
C186	Malignant neoplasm: Descending colon
C187	Malignant neoplasm: Sigmoid colon
C19	Malignant neoplasm of rectosigmoid junction
C20	Malignant neoplasm of rectum

- c. Procedure type: primary procedure in any episode – list of procedures as advised by bowel cancer registry.¹

3. Elective hip surgery

- a. Admission type: Elective only (admimeth = 1)
- b. Diagnosis type: None specified
- c. Procedure type:
 - i. Primary procedure in first episode with following codes:

Code	Procedure description
W371	Primary total prosthetic replacement of hip joint using cement
W378	Other specified total prosthetic replacement of hip joint using cement
W379	Unspecified total prosthetic replacement of hip joint using cement
W381	Primary total prosthetic replacement of hip joint not using cement
W388	Other specified total prosthetic replacement of hip joint not using cement
W389	Unspecified total prosthetic replacement of hip joint not using cement
W391	Primary total prosthetic replacement of hip joint NEC
W398	Other specified other total prosthetic replacement of hip joint
W399	Unspecified other total prosthetic replacement of hip joint
W931	Primary hybrid prosthetic replacement of hip joint using cemented acetabular component
W938	Other specified hybrid prosthetic replacement of hip joint using cemented acetabular component
W939	Unspecified hybrid prosthetic replacement of hip joint using cemented acetabular component
W941	Primary hybrid prosthetic replacement of hip joint using cemented femoral component
W948	Other specified hybrid prosthetic replacement of hip joint using cemented femoral component
W949	Unspecified hybrid prosthetic replacement of hip joint using cemented femoral component
W951	Primary hybrid prosthetic replacement of hip joint using cement NEC
W958	Other specified hybrid prosthetic replacement of hip joint using cement
W959	Unspecified hybrid prosthetic replacement of hip joint using cement

OR

- ii. In first episode:

Primary procedure	Any subsequent procedure	Procedure description
W521	And (Z843 Or Z761 Or Z756)	Primary prosthetic replacement of articulation of bone using cement NEC
W531	And (Z843 Or Z761 Or Z756)	Primary prosthetic replacement of articulation of bone not using cement NEC
W541	And (Z843 Or Z761 Or Z756)	Primary prosthetic replacement of articulation of bone NEC
W581	And (Z843 Or Z761 Or Z756)	Primary resurfacing arthroplasty of joint

Appendix 2. Definitions of direct indicators of harm

Condition	ICD-10 codes	Source
1. Complications and adverse reactions <ul style="list-style-type: none"> Complications of surgical and medical care: <i>T80-T88 codes are post-procedural complications/disorders that are not specifically classified to a post-procedural disorder code within a body system chapter.</i> 	T80-88	Ghali et al ²
<ul style="list-style-type: none"> Drugs, medicaments and biological substances causing adverse effects in therapeutic use: <i>These are adverse effects that result from the proper use of a substance and a reaction to that drug or medicine occurs. This type of reaction can be described as: adverse effect of drug, allergic reaction, cumulative toxicity, hypersensitivity, idiosyncratic reaction, interaction of drugs, 'side effects'. The adverse effect should be recorded first, followed by the Y40-59 code naming the medication/drug that caused it</i> 	Y40-Y59	
<ul style="list-style-type: none"> Misadventures to patients during surgical and medical care: <i>When misadventure to a patient occurs during a procedure, a code from categories Y60-Y69 must be assigned in a secondary position to the code describing the misadventure caused.</i> 	Y60-Y69	
<ul style="list-style-type: none"> Medical devices associated with adverse incidents in diagnostic and therapeutic use: <i>If an adverse incident that is out of the surgeon's control occurs during a procedure, a code from categories Y70-Y82 must be assigned in a secondary position to the code describing the adverse incident caused.</i> 	Y70-82	
<ul style="list-style-type: none"> Surgical and other medical procedures as the cause of abnormal reaction of the patient, or of later complication, without mention of misadventure at the time of the procedure: <i>Where an abnormal reaction of the patient occurs after the procedure, a code from categories Y83-Y84 must be assigned.</i> 	Y83-84	
2. Sequelae of injuries of poisoning & other consequences: <i>A sequelae or "late effect" is a current condition in a patient that is caused by a previous condition which is no longer present. The code describing the current condition must be sequenced before a code from categories T90-T98.</i>	T90-T98	Blunt et al ³
3. Thrombo-embolism <ul style="list-style-type: none"> Pulmonary embolism Cerebral infarction Arterial embolism and thrombosis Phlebitis and thrombophlebitis, Portal vein thrombosis, Other venous embolism/thrombosis Air embolism, Fat embolism 	I26.0, I26.9 I63.1, I63.4 I74, I80-82 T79.0, T79.1	
4. Pneumonia <ul style="list-style-type: none"> Viral pneumonia, not elsewhere classified Pneumonia due to Streptococcus pneumoniae Pneumonia due to Haemophilus influenza Bacterial pneumonia, not elsewhere classified Pneumonia due to other infectious organisms, not elsewhere 	J12 J13 J14 J15 J16	
		Blunt et al ³ and extended following clinical

<ul style="list-style-type: none"> classified Pneumonia in diseases classified elsewhere Pneumonia, organism unspecified 	J17 J18	advice
5. Pressure sores: Decubitus ulcer and pressure area was considered indicative of suboptimal care.	L89	Blunt et al ³
6. Poisoning by drugs medicaments & biological substances: <i>Reactions to drugs and medicines that occur from their improper use must be coded with (T36-T50). Poisoning can also be described as: intoxication, overdose, therapeutic misadventure, toxic effect/toxicity, wrong dosage given or taken, wrong substance given or taken.</i>	T36-T50	Blunt et al ³
7. Urinary Tract Infections	N39	Recommended by clinicians
8. Falls <ul style="list-style-type: none"> Falls: All falls, excluding falls involving ice-skates, skis, roller-skates or skateboards; playground equipment; ladder; scaffolding, tree or cliff In-hospital falls: The codes are as above, with a fifth character of 2 which is generically "School, other institution and public administrative area" but includes a hospital. Brand et al suggest this as a way to captures in-hospital falls 	W01, W03-08, W10, W13, W17-19 With additional .2	Brand & Sundarajan ⁴
9. Fracture <ul style="list-style-type: none"> Fracture of: neck, rib(s), sternum and thoracic spine, lumbar spine and pelvis, shoulder and upper arm, forearm, wrist and hand level, femur, lower leg, foot Fractures involving multiple body regions, Fracture of: spine, upper or lower limb 	S12, S22, S32, S32, S42, S52, S62, S72, S82, S92, T02, T08, T10, T12	Brand & Sundarajan ⁴
10. Post procedural complications: Body system specific post-procedural complication <ul style="list-style-type: none"> Post-procedural endocrine and metabolic disorders, not elsewhere classified Post-procedural disorders of nervous system, not elsewhere classified Post-procedural disorders of eye and adnexa, not elsewhere classified Post-procedural disorders of ear and mastoid process, not elsewhere classified Post-procedural disorders of circulatory system, not elsewhere classified Post-procedural respiratory disorders, not elsewhere classified Post-procedural disorders of digestive system, not elsewhere classified 	E89 G97 H59 H95 I97 J95 K91	Recommended by clinical coders

<ul style="list-style-type: none"> • Post-procedural musculoskeletal disorders, not elsewhere classified 	M96	
<ul style="list-style-type: none"> • Post-procedural disorders of genitourinary system, not elsewhere classified 	N99	
<p>11. Hospital acquired infections: <i>When the responsible consultant has documented in the medical record that a condition is 'hospital acquired' code Y95.X Nosocomial condition must be assigned directly after the code for the condition that has been documented as being 'hospital acquired'</i></p>	Y95X	Recommended by clinical coders

Source: Many of the definitions listed were taken from the National Clinical Coding Standards guidance (Health and Social Care Information Centre. National Clinical Coding Standards ICD-10 4th Edition Addendum: Accurate data for quality information. 2017)

Appendix 3: Further supplementary tables

Table 3.1: Regression parameters modelling length of stay

Variable	AMI			Elective bowel surgery			Emergency bowel surgery			Hip replacement		
	Coefficient	Standard error	p-value	Coefficient	Standard error	p-value	Coefficient	Standard error	p-value	Coefficient	Standard error	p-value
Charlson score (reference value = 0)												
1	0.61	0.09	< 0.001	1.15	0.23	< 0.001	1.91	0.96	0.05	0.58	0.06	< 0.001
2	0.92	0.09	< 0.001	0.48	0.21	0.02	2.02	0.82	0.01	0.56	0.05	< 0.001
3	1.66	0.11	< 0.001	1.56	0.30	< 0.001	0.64	1.05	0.54	1.07	0.07	< 0.001
≥ 4	2.66	0.10	< 0.001	1.39	0.17	< 0.001	0.91	0.51	0.08	1.86	0.09	< 0.001
IMD quintile (reference value = 1, category 5 is most deprived)												
2	-0.14	0.09	0.13	-0.04	0.23	0.85	-1.55	0.73	0.03	-0.15	0.06	0.01
3	-0.17	0.09	0.07	-1.03	0.22	< 0.001	-1.49	0.70	0.03	-0.28	0.06	< 0.001
4	-0.35	0.10	< 0.001	-1.04	0.22	< 0.001	-1.91	0.70	0.007	-0.37	0.06	< 0.001
5	-0.37	0.10	< 0.001	-1.18	0.22	< 0.001	-2.33	0.73	0.001	-0.40	0.06	< 0.001
Age (reference category = 18 – 49)												
50 – 54	0.29	0.14	0.05	0.36	0.41	0.38	-0.97	1.15	0.4	-0.07	0.10	0.44
55 – 59	0.49	0.14	< 0.001	0.95	0.37	0.01	0.60	1.12	0.59	-0.04	0.09	0.68
60 – 64	0.81	0.14	< 0.001	0.78	0.34	0.02	1.25	1.05	0.23	0.08	0.08	0.32
65 – 69	1.07	0.13	< 0.001	0.89	0.33	0.008	1.58	1.00	0.11	0.23	0.08	0.004
70 – 74	1.43	0.14	< 0.001	1.30	0.33	< 0.001	2.35	0.99	0.02	0.59	0.08	< 0.001
75 – 79	2.05	0.14	< 0.001	1.65	0.33	< 0.001	3.01	0.95	0.002	1.15	0.08	< 0.001
80 – 84	2.12	0.14	< 0.001	2.28	0.35	< 0.001	5.16	0.98	< 0.001	2.24	0.09	< 0.001
85 – 89	2.45	0.15	< 0.001	2.57	0.41	< 0.001	3.34	1.11	0.003	3.89	0.11	< 0.001
90+	2.67	0.17	< 0.001	2.92	0.73	< 0.001	6.16	1.41	< 0.001	5.16	0.20	< 0.001

Female gender	0.20	0.07	0.003	-0.47	0.14	< 0.001	1.58	0.45	< 0.001	0.45	0.04	< 0.001
Number of emergency admissions in previous year	0.08	0.02	< 0.001	0.45	0.08	< 0.001	0.38	0.22	0.08	0.77	0.03	< 0.001
Reported harm												
Complications and adverse reactions	3.84	0.15	< 0.001	7.29	0.19	< 0.001	8.26	0.59	< 0.001	3.04	0.07	< 0.001
Sequelae	-1.82	1.14	0.11	5.75	2.79	0.04	*	*	*	0.90	0.28	0.001
Thromboembolism	4.08	0.39	< 0.001	8.88	0.75	< 0.001	10.11	1.41	< 0.001	5.31	0.30	< 0.001
Pneumonia	6.50	0.18	< 0.001	9.37	0.49	< 0.001	9.76	1.10	< 0.001	5.90	0.27	< 0.001
Pressure sores	7.61	0.34	< 0.001	12.47	0.91	< 0.001	9.21	1.56	< 0.001	6.08	0.28	< 0.001
Poisoning	1.70	1.34	0.2	3.50	5.08	0.49	-9.18	12.50	0.46	1.70	0.87	0.05
Urinary tract infections	7.41	0.17	< 0.001	9.11	0.36	< 0.001	9.05	0.87	< 0.001	3.99	0.14	< 0.001
In-hospital falls	8.90	0.50	< 0.001	15.13	1.59	< 0.001	17.92	2.43	< 0.001	4.16	0.34	< 0.001
Fractures	12.17	0.51	< 0.001	5.66	2.59	0.03	3.25	4.76	0.49	3.99	0.26	< 0.001
Post-procedural complications (body system specific)	5.71	0.56	< 0.001	8.54	0.26	< 0.001	9.17	0.90	< 0.001	1.77	0.22	< 0.001
Hospital acquired infections	11.25	0.32	< 0.001	0.43	0.62	0.48	0.90	1.42	0.52	3.85	0.34	< 0.001

* The number of reported cases of sequelae in emergency bowel surgery patients was too low

Table 3.2: List of most common primary diagnoses within each cohort including frequency and whether associated with potential harm

Primary diagnosis	AMI		Bowel surgery		Hip surgery	
	N	%	N	%	N	%
Abdominal and pelvic pain			75	5.8%		
Acute myocardial infarction	721	17.7%				
Acute renal failure			26	2.0%		
Angina pectoris	211	5.2%				
Atrial fibrillation and flutter	66	1.6%				
Cellulitis					28	2.1%
Chronic ischaemic heart disease	254	6.2%				
Complications of internal orthopaedic prosthetic devices, implants and grafts					181	13.5%
Complications of procedures, not elsewhere classified			338	26.2%	120	8.9%
Diarrhoea and gastroenteritis of presumed infectious origin			28	2.2%		
Heart failure	273	6.7%				
Malignant neoplasm of colon			31	2.4%		
Other acute ischaemic heart diseases	149	3.7%				
Other diseases of digestive system			33	2.6%		
Other disorders of urinary system			36	2.8%		
Other functional intestinal disorders			41	3.2%	32	2.4%
Other joint disorders, not elsewhere classified					71	5.3%
Other soft tissue disorders, not elsewhere classified					248	18.5%
Pain in throat and chest	594	14.6%				
Paralytic ileus and intestinal obstruction without hernia			85	6.6%		
Phlebitis and thrombophlebitis					33	2.5%
Pneumonia, organism unspecified	168	4.1%			31	2.3%
Postprocedural disorders of digestive system, not elsewhere classified			153	11.9%		
Pulmonary embolism					26	1.9%
Retention of urine					32	2.4%
Subsequent myocardial infarction	119	2.9%				
Unspecified acute lower respiratory infection	65	1.6%				
All other diagnoses	1452	35.7%	442	34.30%	542	40.30%

Not related to harm

Potentially related to harm

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References

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