

Additional file 1

Table S1 Content of national registries used for data extraction in this study

Country	Data source	Study period	Outpatient information included	Emergency room information included	Inpatient information included	International Statistical Classification of Diseases	Classification of surgical procedures
Denmark	The Danish National Patient Registry (DNPR)	1998-2018*	Yes	Yes	Yes	ICD-10	NOMESCO
	Civil Registration System (CRS)	1998-2018*					
	Statistics Denmark (SD)	1998-2018* (1 st -quarter estimates)					
England	Hospital Episode Statistics (HES)	1998-2017*	No	No	Yes (+ day case surgery)	ICD-10	OPCS-4
	The Office of National Statistics (ONS)	1998-2017* (mid-year estimates)					
Sweden	Swedish National Patient Register (SNPR)	2001-2018*	Yes	Yes	Yes	ICD-10	NOMESCO
	Official Statistics of Sweden	2001-2018* (Dec. 31 st estimates)					

Table S2 ICD-10 diagnosis and procedure codes utilized for data extraction

Denmark	Proximal humerus fracture
ICD-10 diagnosis codes combined with surgical procedure codes	S42.2* (*=S42.2A, S42.2B, S42.2C)
Plate fixation	NBJ61
Screw fixation	NBJ71
Percutaneous K-wire	NBJ41
External fixation	NBJ21
Intramedullary fixation	NBJ51
Arthroplasty	NBB0, NBB01, NBB02, NBB09, NBB1, NBB011, NBB12, NBB19, NBB20 NBB30, NBB40, NBB59

Sweden	Proximal humerus fracture
ICD-10 diagnosis codes combined with surgical procedure codes	S.42.2
Plate fixation	NBJ69
Screw fixation	NBJ79
Percutaneous K-wire	NBJ49
Intramedullary fixation	NBJ59
External fixation	NBJ29
Arthroplasty	NBB09-99

England	Proximal humerus
ICD-10 diagnosis codes combined with OPCS surgical procedure codes	Z691, Z692, Z693
Plate fixation	W201
Screw fixation	W195
Percutaneous K-wire	W242
Intramedullary fixation	W192, W193, W198, W199, W246
External fixation	W222, W258, W259
Arthroplasty	Multiple codes/ combinations - See separate table below
Other	Any Z691-3 code + PHF ICD-10 not already covered

Table S2 (continued) ICD-10 diagnosis and procedure codes utilized for data extraction(OPCS codes for HES England shoulder arthroplasty procedures)

Procedure code	Anatomy code	Type
W494		HA
W504		HA
W515		HA
W581	Z691	HA
W581	Z813	HA
W581	Z814	HA
W491		HA
W501		HA
W511		HA
O061		TSR
O071		TSR
O081		TSR
W431	Z685	TSR
W431	Z691	TSR
W431	Z814	TSR
W441	Z814	TSR
W451	Z814	TSR
W961		TSR
W971		TSR
W981		TSR
W965		RTSR
W975		RTSR
W986		RTSR
W051	Z691	EPR
W051	Z698	EPR
W051	Z699	EPR
W051	Z813	EPR
W051	Z814	EPR
W052	Z691	EPR
W052	Z698	EPR
W052	Z699	EPR
W052	Z813	EPR
W052	Z814	EPR
W053	Z691	EPR
W053	Z698	EPR
W053	Z699	EPR
W053	Z813	EPR
W053	Z814	EPR

Table S3 ICD-10 diagnosis codes for serious adverse events

Condition (Serious Adverse Events)	ICD-10 (descriptor)
Pulmonary embolism	I26 (Pulmonary embolism)
Myocardial infarction	I21 (Acute myocardial infarction) I22 (Subsequent myocardial infarction) (not used in the Danish patient registry)
Lower respiratory tract infection	J12 (Viral pneumonia, not elsewhere classified) J13 (Pneumonia due to <i>Streptococcus pneumoniae</i>) J14 (Pneumonia due to <i>Haemophilis influenzae</i>) J15 (Bacterial pneumonia, not elsewhere classified) J16 (Pneumonia due to other infectious organisms, not elsewhere classified) J18 (Pneumonia, organism unspecified) J22 (Unspecified acute lower respiratory infection) J86 (Pyothorax) J440 (Chronic obstructive pulmonary disease with acute lower respiratory infection) J851 (Abscess of lung with pneumonia) J690 (Aspiration pneumonia)
Acute kidney injury	N17 (Acute renal failure)
Urinary tract infection ^a = Additional codes used to extract data from the Swedish register (N10-N16 is provided in one indistinguishable block in the Swedish data)	N300 (Acute cystitis) N308 (Other cystitis) N309 (Cystitis, unspecified) N390 (Urinary tract infection, site not specified) ^a N10 (Acute tubulo-interstitial nephritis) ^a N11 (Chronic obstructive pyelonephritis) ^a N12 (Tubulo-interstitial nephritis) ^a N13 (Obstructive and reflux uropathy) ^a N14 (Analgesic nephropathy) ^a N15 (Renal and perinephric abscess) ^a N16 (Renal tubulo-interstitial disorders)
Cerebrovascular event	I60 (Subarachnoid haemorrhage) I61 (Intracerebral haemorrhage) I62 (Other nontraumatic intracranial haemorrhage) I63 (Cerebral infarction) I64 (Stroke, not specified as haemorrhage or infarction)

Table S4: ICD-10 codes for comorbidities in Charlson Comorbidity Index.

Conditions (Charlson Comorbidity Index)	ICD-10 (descriptor)
Congestive heart failure	I09.9, I11.0, I13.0, I13.2, I25.5, I42.0, I42.5–I42.9, I43.x, I50.x, P29.0
Dementia	F00.x–F03.x, F05.1, G30.x, G31.1
Chronic pulmonary disease	I27.8, I27.9, J40.x–J47.x, J60.x–J67.x, J68.4, J70.1, J70.3
Rheumatic disease	M05.x, M06.x, M31.5, M32.x–M34.x, M35.1, M35.3, M36.0
Mild liver disease	B18.x, K70.0–K70.3, K70.9, K71.3–K71.5, K71.7, K73.x, K74.x, K76.0, K76.2–K76.4, K76.8, K76.9, Z94.4
Hemiplegia or paraplegia	G04.1, G11.4, G80.1, G80.2, G81.x, G82.x, G83.0–G83.4, G83.9
Moderate/severe renal disease	I12.0, I13.1, N03.2–N03.7, N05.2–N05.7, N18.x, N19.x, N25.0, Z49.0–Z49.2, Z94.0, Z99.2
Diabetes mellitus with chronic complications	E10.2–E10.5, E10.7, E11.2–E11.5, E11.7, E12.2–E12.5, E12.7, E13.2–E13.5, E13.7, E14.2–E14.5, E14.7
Any malignancy, including lymphoma and leukemia, except malignant neoplasm of skin	C00.x–C26.x, C30.x–C34.x, C37.x–C41.x, C43.x, C45.x–C58.x, C60.x–C76.x, C81.x–C85.x, C88.x, C90.x–C97.x
Moderate/severe liver disease	I85.0, I85.9, I86.4, I98.2, K70.4, K71.1, K72.1, K72.9, K76.5, K76.6, K76.7
Metastatic solid tumor	C77.x–C80.x
AIDS	B20.x–B22.x, B24.x

Table S5 Predefined hierarchy for classifying surgical procedures when multiple procedures occur on the same date and primary procedure is unknown

Arthroplasty + Screw fixation = classified as Arthroplasty
Arthroplasty + K-wire = classified as Arthroplasty
Arthroplasty+ IM nail = classified as Arthroplasty
Arthroplasty + Plate fixation = classified as Arthroplasty
Ex-fix + Screw fixation = classified as Ex-fix
Ex-fix + Plate fixation = classified as Ex-fix
IM nail + Plate fixation = classified as IM nail
IM nail + K-wire = classified as IM nail
IM nail + Screw fixation = classified as IM nail
Plate fixation + Screw fixation = classified as Plate fixation
Plate fixation + K-wire = classified as Plate fixation
Screw fixation + K-wire = classified as Screw fixation

Note: IM nail = Intramedullary nail, Ex-fix = External fixation, K-wire = Kirschner wire

Table S6 Patient demographics divided by sex for surgically treated isolated proximal humerus fracture

	Male			Female		
	Denmark*	England ^a	Sweden*	Denmark*	England ^a	Sweden*
Number of cases (%)	N=2,979	N=7,748	N=4,701	N=8,474	N=17,985	N=12,190
Median age (IQR)	61.0 (50.0-71.0)	55.0 (43.6-66.7)	61.0 (49.0-71.0)	70.0 (61.0-78.0)	66.2 (56.7-75.1)	70.0 (62.0-78.0)
Surgery undertaken						
Plate	1,506 (50.6%)	3,053 (39.4%)	2,195 (46.7%)	3,941 (46.5%)	6,691 (37.2%)	5,267 (43.2%)
Screw	177 (5.9%)	467 (6.0%)	295 (6.3%)	235 (2.8%)	424 (2.4%)	308 (2.5%)
IM-nail	156 (5.2%)	1,572 (20.3%)	860 (18.3%)	303 (3.6%)	2,687 (14.9%)	2,041 (16.7%)
Ex-fix	<7*	9 (0.1%)	16 (0.3%)	12(0.1%)	26 (0.1%)	21 (0.2%)
K-wire	311 (10.4%)	396 (5.1%)	472 (10.0%)	765 (9.0%)	850 (4.7%)	1,032 (8.5%)
Arthroplasty	823 (27.6%)	2,251 (29.1%)	863 (18.4%)	3,218 (38.0%)	7,307 (40.6%)	3,521 (28.9%)
Past Medical History						
IHD	82 (2.8%)	NA	518 (11.0%)	144 (1.7%)	NA	1,165 (9.6%)
COPD	57 (1.9%)	NA	548 (11.7%)	165 (1.9%)	NA	1,964 (16.1%)
DM	116 (3.9%)	NA	203 (4.3%)	243 (2.9%)	NA	351 (2.9%)
Charlson Comorbidity Index						
0	2,675 (89.8%)	5,903 (76.2%)	2,680 (57.0%)	7,751 (91.5%)	13,092 (72.8%)	5,986 (49.1%)
1	100 (3.4%)	1,434 (18.5%)	395 (8.4%)	302 (3.6%)	3,868 (21.5%)	1,283 (10.5%)
2	138 (4.6%)	263 (3.4%)	772 (16.4%)	315 (3.7%)	727 (4.0%)	2,393 (19.6%)
3	27 (0.9%)	83 (1.1%)	311 (6.6%)	44 (0.5%)	211 (1.2%)	1,027 (8.4%)
4	19 (0.6%)	42 (0.5%)	212 (4.5%)	25 (0.3%)	63 (0.4%)	695 (5.7%)
5+	20 (0.7%)	23 (0.3%)	331 (7.0%)	37 (0.4%)	24 (0.1%)	806 (6.6%)

Note: N = number, of cases, IM-nail = intramedullary nail; Ex-Fix=external fixation, K-wire=Kirschner wire, *=using a one year look back period for Past Medical History and Charlson Comorbidity Index calculations, ^a= no time restriction in look period applied for Past Medical History and Charlson Comorbidity Index calculations, NA = not available

Table S7 Multivariable logistic regression model showing risk of mortality after surgical treatment of proximal humerus fracture, adjusted for age, sex, and CCI

	30 days mortality OR (95% CI)			90 days mortality OR (95% CI)			1 year mortality OR (95% CI)		
	Denmark	England	Sweden	Denmark	England	Sweden	Denmark	England	Sweden
Sex									
Female (<i>ref</i>)	1	1	1	1	1	1	1	1	1
Male	2.16 (1.50-3.13)	1.51 (1.12-2.04)	6.60 (3.72-11.71)	2.21 (1.71-2.85)	1.63 (1.33-2.01)	3.45 (2.50-4.76)	2.24 (1.87-2.67)	1.73 (1.52-1.97)	2.54 (2.10-3.07)
Age									
18-39y	1 (N/A)	0.27 (0.08-0.85)	0.27 (0.03-2.07)	0.09 (0.01-0.66)	0.12 (0.04-0.38)	0.11 (0.01-0.84)	0.04 (0.01-0.25)	0.23 (0.13-0.41)	0.12 (0.04-0.40)
40-59y	0.59 (0.33-1.06)	0.36 (0.21-0.62)	0.17 (0.04-0.78)	0.42 (0.28-0.65)	0.37 (0.25-0.53)	0.48 (0.27-0.87)	0.52 (0.40-0.67)	0.61 (0.50-0.75)	0.42 (0.30-0.59)
60-79y (<i>ref</i>)	1	1	1	1	1	1	1	1	1
≥80y	4.59 (3.20-6.65)	4.09 (3.07-5.44)	7.00 (3.84-12.78)	3.88 (3.02-4.99)	4.62 (3.79-5.63)	5.06 (3.61-7.11)	3.51 (2.94-4.18)	3.81 (3.29-4.42)	3.94 (3.26-4.76)
CCI									
0-1 (<i>ref</i>)	1	1	1	1	1	1	1	1	1
2-3	5.01 (2.25-7.71)	3.50 (2.48-4.95)	0.96 (0.52-1.79)	4.67 (3.40-6.41)	3.03 (2.36-3.88)	1.21 (0.83-1.73)	4.03 (3.16-5.14)	2.69 (2.27-3.19)	1.84 (1.50-2.27)
4+	8.01 (3.56-18.02)	9.98 (5.69-17.51)	0.73 (0.31-1.72)	12.50 (7.36-21.26)	7.01 (4.42-11.14)	1.56 (1.02-2.38)	12.54 (8.14-19.30)	5.74 (4.06-8.13)	2.28 (1.79-4.76)

Note: OR = odds ratio, CCI = Charlson Comorbidity Index, ref = reference, y = years, 95% CI = 95% confidence interval, N/A = not available

Table S8. Multivariable logistic regression model showing risk of serious adverse events after surgical treatment of proximal humerus fracture, adjusted for age, sex, and CCI

	Stroke within 30 days OR (95% CI)			Myocardial Infarction within 30 days OR (95% CI)			Respiratory Tract Infection within 30 days OR (95% CI)		
	Denmark	England	Sweden	Denmark	England	Sweden	Denmark	England	Sweden
Sex									
Female (<i>ref</i>)	1	1	1	1	1	1	1	1	1
Male	2.82 (1.55-5.13)	1.48 (0.66-3.33)	1.37 (1.12-1.68)	2.06 (0.97-4.41)	2.00 (0.98-4.06)	1.91 (1.55-2.34)	1.85 (1.29-2.64)	1.18 (0.83-1.68)	1.33 (1.10-1.61)
Age									
18-39y	1 (N/A)	0.34 (0.04-2.60)	0.03 (0.01-0.24)	1 (N/A)	1 (N/A)	1 (NA)	0.15 (0.02-1.10)	0.20 (0.05-0.84)	0.45 (0.25-0.82)
40-59y	0.17 (0.05-0.55)	0.08 (0.01-0.63)	0.33 (0.23-0.46)	1 (N/A)	0.36 (0.10-1.25)	0.23 (0.15-0.36)	0.59 (0.35-0.95)	0.53 (0.33-0.86)	0.85 (0.67-1.07)
60-79y (<i>ref</i>)	1	1	1	1	1	1	1	1	1
≥80y	1.22 (0.62-2.40)	0.27 (0.06-1.13)	2.03 (1.68-2.47)	1.22 (0.56-2.67)	2.98 (1.46-6.06)	1.72 (1.39-2.12)	2.19 (1.52-3.14)	2.00 (1.42-2.82)	1.68 (1.38-2.04)
CCI									
0-1 (<i>ref</i>)	1	1	1	1	1	1	1	1	1
2-3	1 (N/A)	4.75 (2.00-11.28)	1.27 (1.04-1.54)	0.55 (0.08-4.08)	4.55 (2.01-10.29)	2.08 (1.66-2.61)	2.01 (1.12-3.46)	4.01 (2.73-5.88)	1.51 (1.24-1.83)
4+	4.24 (1.00-17.95)	1 (N/A)	1.17 (0.90-1.52)	1 (N/A)	16.87 (5.66-50.24)	3.02 (2.34-3.90)	3.29 (1.19-9.15)	7.36 (3.53-15.32)	1.95 (1.55-2.45)

Note: OR = odds ratio, CCI = Charlson Comorbidity Index, ref = reference, y = years, 95% CI = 95% confidence Interval, N/A = not available

	Pulmonary Embolus within 30 days OR (95% CI)			Urinary Tract Infection within 30 days OR (95% CI)			Acute Renal Failure within 30 days OR (95% CI)		
	Denmark	England	Sweden	Denmark	England	Sweden	Denmark	England	Sweden
Sex									
Female (<i>ref</i>)	1	1	1	1	1	1	1	1	1
Male	1 (N/A)	0.93 (0.43-2.01)	1.21 (0.85-1.73)	0.97 (0.57-1.64)	0.70 (0.46-1.08)	0.91 (0.07-10.7)	2.60 (0.80-8.51)	1.25 (0.85-1.82)	1.75 (1.15-2.66)
Age									
18-39y	1 (N/A)	0.30 (0.04-2.25)	0.46 (0.16-1.29)	1 (N/A)	0.27 (0.07-1.11)	1 (NA)	1.15 (0.14-9.66)	0.11 (0.02-0.83)	1.21 (0.41-3.55)
40-59y	0.60 (0.13-2.76)	0.30 (0.10-0.86)	0.31 (0.16-0.57)	0.52 (0.24-1.14)	0.27 (0.13-0.54)	3.70 (0.31-43.40)	1 (N/A)	0.42 (0.24-0.74)	1.15 (0.66-2.01)
60-79y (<i>ref</i>)	1	1	1	1	1	1	1	1	1
≥80y	1.26 (0.43-3.70)	1.04 (0.47-2.30)	1.89 (1.35-2.64)	3.99 (2.57-6.17)	2.90 (2.08-4.05)	1 (NA)	1.13 (0.30-4.30)	2.32 (1.61-3.32)	2.24 (1.43-3.50)
CCI									
0-1 (<i>ref</i>)	1	1	1	1	1	1	1	1	1
2-3	2.8 (0.64-12.52)	0.37 (0.05-2.67)	1.12 (0.78-1.61)	2.91 (1.60-5.31)	2.48 (1.59-3.86)	1 (N/A)	1.58 (0.20-12.42)	2.90 (1.83-4.57)	2.26 (1.40-3.66)
4+	1 (N/A)	1 (N/A)	1.84 (1.24-2.74)	1 (N/A)	3.57 (1.30-9.81)	1 (N/A)	1 (N/A)	12.53 (6.74-23.32)	3.68 (2.20-6.16)

Note: OR = odds ratio, CCI = Charlson Comorbidity Index, ref = reference, y = years, 95% CI = 95% confidence interval, N/A = not available