

TABLE E-1 Potential Predictors of Short-Term Complications and Reoperations*

	Comparison Group	OR	95% CI	P Value
Pulmonary embolism				
Charlson comorbidity index		1.2	1.0 to 1.4	0.06
Hospital volume percentile, 40-79	80-100	0.8	0.4 to 1.6	0.51
Hospital volume percentile, 0-39	80-100	0.5	0.2 to 1.2	0.13
Medical center type, academic	Nonacademic	1.6	0.8 to 3.4	0.19
Location, rural	Urban (non-rural)	0.5	0.1 to 4.1	0.54
Race, black	White	0.4	0.1 to 3.3	0.42
Race, Latino	White	1.0	0.4 to 2.3	1.00
Race, Asian	White	0.4	0.1 to 3.1	0.40
Race, other	White	1.4	0.3 to 5.7	0.67
Age, 50-64 yr	<50	0.8	0.3 to 2.2	0.68
Age, 65-74 yr	<50	2.1	0.9 to 5.1	0.10
Age, ≥75 yr	<50	3.6	1.6 to 7.8	0.001
Income percentile, 0-19	80-100	2.4	1.1 to 5.6	0.04
Income percentile, 20-39	80-100	1.4	0.6 to 3.3	0.45
Income percentile, 40-59	80-100	1.6	0.8 to 3.4	0.21
Income percentile, 60-79	80-100	1.0	0.5 to 2.1	0.93
Hospital size, 0-100 beds	>300	1.3	0.4 to 3.6	0.65
Hospital size, 101-200 beds	>300	1.2	0.6 to 2.6	0.57
Hospital size, 201-300 beds	>300	1.3	0.6 to 2.8	0.53
Sex, male	Female	2.1	1.2 to 3.7	0.01
Year of surgery		1.0	0.9 to 1.1	0.62
Procedure, CRIF	ORIF	0.7	0.3 to 1.5	0.41
Procedure, IF	ORIF	1.2	0.3 to 4.9	0.83
Neurovascular injury				
Charlson comorbidity index		1.2	0.9 to 1.4	0.19
Hospital volume percentile, 40-79	80-100	1.0	0.4 to 2.6	0.99
Hospital volume percentile, 0-39	80-100	0.6	0.2 to 1.9	0.37
Medical center type, academic	Nonacademic	0.5	0.15 to 1.6	0.25
Location, rural	Urban (non-rural)	1.1	0.1 to 9.6	0.91
Race, black	White	1.2	0.2 to 8.9	0.89
Race, Latino	White	2.3	0.9 to 5.4	0.07
Race, Asian	White	1.1	0.1 to 8.2	0.93
Race, other	White	1.2	0.2 to 9.2	0.84
Age, 50-64 yr	<50	1.1	0.4 to 2.9	0.85
Age, 65-74 yr	<50	1.0	0.3 to 2.9	0.98
Age, ≥75 yr	<50	0.8	0.3 to 2.1	0.59
Income percentile, 0-19	80-100	No events	No events	No events
Income percentile, 20-39	80-100	1.4	0.5 to 3.8	0.56
Income percentile, 40-59	80-100	1.4	0.5 to 3.6	0.49
Income percentile, 60-79	80-100	1.3	0.6 to 3.0	0.56
Hospital size, 0-100 beds	>300	0.9	0.2 to 3.6	0.91
Hospital size, 101-200 beds	>300	0.7	0.3 to 1.9	0.46
Hospital size, 201-300 beds	>300	0.6	0.2 to 1.7	0.29
Sex, male	Female	0.7	0.3 to 1.6	0.46
Year of surgery		1.0	0.9 to 1.1	0.62
Procedure, CRIF	ORIF	0.5	0.1 to 1.6	0.24
Procedure, IF	ORIF	1.1	0.1 to 7.9	0.95

continued

TABLE E-1 (continued)

	Comparison Group	OR	95% CI	P Value
Mortality				
Charlson comorbidity index		1.5	1.4 to 1.6	<0.001
Hospital volume percentile, 40-79	80-100	1.0	0.7 to 1.3	0.82
Hospital volume percentile, 0-39	80-100	1.3	0.9 to 1.8	0.20
Medical center type, academic	Nonacademic	0.8	0.5 to 1.2	0.25
Location, rural	Urban (non-rural)	0.9	0.5 to 1.7	0.72
Race, black	White	1.2	0.6 to 2.3	0.58
Race, Latino	White	1.0	0.7 to 1.5	0.88
Race, Asian	White	0.6	0.3 to 1.2	0.12
Race, other	White	1.7	0.9 to 3.0	0.09
Age, 50-64 yr	<50	1.2	0.7 to 2.1	0.57
Age, 65-74 yr	<50	4.4	2.6 to 7.2	<0.001
Age, ≥75 yr	<50	10.2	6.4 to 16.2	<0.001
Income percentile, 0-19	80-100	2.0	1.4 to 2.9	<0.001
Income percentile, 20-39	80-100	1.6	1.2 to 2.3	0.004
Income percentile, 40-59	80-100	1.3	1.0 to 1.8	0.10
Income percentile, 60-79	80-100	1.3	1.0 to 1.7	0.05
Hospital size, 0-100 beds	>300	1.0	0.7 to 1.4	0.90
Hospital size, 101-200 beds	>300	0.8	0.6 to 1.1	0.13
Hospital size, 201-300 beds	>300	0.8	0.6 to 1.1	0.20
Sex, male	Female	1.7	1.3 to 2.1	<0.001
Year of surgery		1.0	1.0 to 1.0	0.78
Procedure, CRIF	ORIF	1.1	0.9 to 1.5	0.34
Procedure, IF	ORIF	1.2	0.7 to 2.2	0.47
Irrigation and debridement				
Charlson comorbidity index		1.1	0.9 to 1.2	0.28
Hospital volume percentile, 40-79	80-100	1.1	0.7 to 1.7	0.77
Hospital volume percentile, 0-39	80-100	0.9	0.5 to 1.6	0.69
Medical center type, academic	Nonacademic	2.1	1.3 to 3.3	0.002
Location, rural	Urban (non-rural)	0.7	0.2 to 3.2	0.69
Race, black	White	1.1	0.5 to 2.4	0.74
Race, Latino	White	1.4	0.9 to 2.2	0.16
Race, Asian	White	0.9	0.3 to 2.6	0.88
Race, other	White	1.9	0.9 to 4.2	0.10
Age, 50-64 yr	<50	0.8	0.5 to 1.2	0.32
Age, 65-74 yr	<50	0.5	0.3 to 1.0	0.04
Age, ≥75 yr	<50	0.5	0.3 to 0.9	0.02
Income percentile, 0-19	80-100	1.0	0.5 to 2.0	0.91
Income percentile, 20-39	80-100	1.7	1.0 to 2.9	0.03
Income percentile, 40-59	80-100	1.4	0.8 to 2.3	0.21
Income percentile, 60-79	80-100	1.2	0.8 to 1.9	0.38
Hospital size, 0-100 beds	>300	0.9	0.5 to 1.9	0.89
Hospital size, 101-200 beds	>300	0.9	0.5 to 1.6	0.78
Hospital size, 201-300 beds	>300	1.0	0.6 to 1.7	0.99
Sex, male	Female	1.5	1.0 to 2.2	0.03
Year of surgery		1.0	0.9 to 1.0	0.09
Procedure, CRIF	ORIF	1.1	0.7 to 1.7	0.65
Procedure, IF	ORIF	1.8	0.8 to 4.1	0.17

continued

TABLE E-1 (continued)

	Comparison Group	OR	95% CI	P Value
Conversion to hemiarthroplasty				
Charlson comorbidity index		1.1	1.0 to 1.2	0.05
Hospital volume percentile, 40-79	80-100	0.8	0.5 to 1.2	0.30
Hospital volume percentile, 0-39	80-100	0.8	0.5 to 1.3	0.40
Medical center type, academic	Nonacademic	0.7	0.4 to 1.2	0.16
Location, rural	Urban (non-rural)	0.9	0.4 to 2.1	0.82
Race, black	White	No events	No events	No events
Race, Latino	White	0.6	0.4 to 1.2	0.15
Race, Asian	White	0.5	0.2 to 1.5	0.21
Race, other	White	0.2	0.0 to 1.6	0.14
Age, 50-64 yr	<50	3.1	1.6 to 5.8	0.001
Age, 65-74 yr	<50	4.7	2.5 to 8.8	<0.001
Age, ≥75 yr	<50	3.4	1.8 to 6.4	<0.001
Income percentile, 0-19	80-100	1.5	0.8 to 2.6	0.17
Income percentile, 20-39	80-100	1.0	0.6 to 1.6	0.90
Income percentile, 40-59	80-100	0.8	0.5 to 1.4	0.50
Income percentile, 60-79	80-100	1.1	0.7 to 1.6	0.69
Hospital size, 0-100 beds	>300	1.1	0.6 to 2.0	0.71
Hospital size, 101-200 beds	>300	1.5	1.0 to 2.2	0.05
Hospital size, 201-300 beds	>300	0.8	0.5 to 1.3	0.40
Sex, male	Female	0.9	0.6 to 1.3	0.62
Year of surgery		1.0	1.0 to 1.0	0.95
Procedure, CRIF	ORIF	0.8	0.5 to 1.3	0.44
Procedure, IF	ORIF	0.2	0.0 to 1.6	0.13
Conversion to total shoulder arthroplasty				
Charlson comorbidity index		1.1	0.6 to 1.8	0.79
Hospital volume percentile, 40-79	80-100	0.3	0.1 to 1.5	0.14
Hospital volume percentile, 0-39	80-100	0.2	0.0 to 1.7	0.15
Medical center type, academic	Nonacademic	No events		
Location, rural	Urban (non-rural)	No events		
Race, black	White	No events		
Race, Latino	White	No events		
Race, Asian	White	No events		
Race, other	White	No events		
Age, 50-64 yr	<50	No events		
Age, 65-74 yr	<50	No events		
Age, ≥75 yr	<50	No events		
Income percentile, 0-19	80-100	No events		
Income percentile, 20-39	80-100	No events		
Income percentile, 40-59	80-100	No events		
Income percentile, 60-79	80-100	0.9	0.2 to 4.4	0.86
Hospital size, 0-100 beds	>300	1.6	0.1 to 20.4	0.71
Hospital size, 101-200 beds	>300	No events		
Hospital size, 201-300 beds	>300	1.0	0.2 to 5.6	0.99
Sex, male	Female	No events	No events	No events
Year of surgery		1.0	0.8 to 1.2	0.67
Procedure, CRIF	ORIF	No events	No events	No events
Procedure, IF	ORIF	1.3	0.2 to 6.4	0.79

continued

TABLE E-1 (continued)

	Comparison Group	OR	95% CI	P Value
Revision fixation				
Charlson comorbidity index		1.1	1.0 to 1.2	0.06
Hospital volume percentile, 40-79	80-100	0.7	0.55 to 1.0	0.03
Hospital volume percentile, 0-39	80-100	0.8	0.55 to 1.0	0.08
Medical center type, academic	Nonacademic	1.0	0.7 to 1.4	0.96
Location, rural	Urban (non-rural)	0.3	0.1 to 0.8	0.02
Race, black	White	1.0	0.5 to 1.7	0.89
Race, Latino	White	0.7	0.5 to 1.0	0.06
Race, Asian	White	0.4	0.2 to 0.9	0.03
Race, other	White	0.3	0.1 to 0.9	0.04
Age, 50-64 yr	<50	1.0	0.7 to 1.4	0.98
Age, 65-74 yr	<50	1.4	1.0 to 1.9	0.05
Age, ≥75 yr	<50	1.2	0.9 to 1.7	0.16
Income percentile, 0-19	80-100	1.0	0.6 to 1.5	0.85
Income percentile, 20-39	80-100	0.9	0.6 to 1.3	0.47
Income percentile, 40-59	80-100	0.8	0.6 to 1.1	0.24
Income percentile, 60-79	80-100	1.1	0.8 to 1.4	0.61
Hospital size, 0-100 beds	>300	1.1	0.7 to 1.6	0.76
Hospital size, 101-200 beds	>300	1.1	0.9 to 1.5	0.34
Hospital size, 201-300 beds	>300	1.1	0.8 to 1.4	0.71
Sex, male	Female	1.0	0.8 to 1.3	0.84
Year of surgery		1.0	1.0 to 1.0	0.48
Procedure, CRIF	ORIF	1.8	1.5 to 2.3	<0.001
Procedure, IF	ORIF	1.0	0.5 to 1.9	0.95

*“No events” signifies that the complication did not occur in the listed group or that it did not occur in the reference group, and the covariate was therefore dropped from the analysis.

Inclusion Criteria

Procedures

- 79.11: closed reduction of fracture with internal fixation, humerus
- 79.31: open reduction of fracture with internal fixation, humerus
- 78.52: internal fixation of bone without fracture reduction

Diagnoses

- 812.00: fracture of humerus, closed, upper end, unspecified part
- 812.01: fracture of humerus, closed, surgical neck
- 812.02: fracture of humerus, closed, anatomic neck
- 812.03: fracture of humerus, closed, greater tuberosity
- 812.09: fracture of humerus, closed, upper end, other
- 812.10: fracture of humerus, open, upper end, unspecified part
- 812.11: fracture of humerus, open, surgical neck
- 812.12: fracture of humerus, open, anatomic neck
- 812.13: fracture of humerus, open, greater tuberosity
- 812.19: fracture of humerus, open, upper end, other

Exclusion Criteria

Pathologic Fracture

- 733.11: pathologic fracture of humerus

Infection

711.01/2: pyogenic arthritis
711.41/2: arthropathy associated with other bacterial diseases
711.81/2: arthropathy associated with other infectious and parasitic diseases
711.91/2: unspecified infective arthritis
730.01/2: acute osteomyelitis
730.11/2: pyogenic osteomyelitis
730.21/2: unspecified osteomyelitis
730.31/2: periostitis
730.81/2: other infections involving bone
730.91/2: unspecified infection of bone
(xxx.x1 above indicates the shoulder region, and xxx.x2 indicates the upper arm)

Other Humeral Fracture

812.20, 812.21, 812.30, 812.31: shaft of humerus
812.40, 812.41, 812.42, 812.43, 812.44, 812.49, 812.50, 812.51, 812.52, 812.53, 812.54, 812.59: lower end of humerus

Outcomes

Procedures

Amputation

84.08: disarticulation of shoulder
84.09: interthoracoscaphular amputation

Revision

79.11: closed reduction of fracture with internal fixation, humerus
79.31: open reduction of fracture with internal fixation, humerus
78.52: internal fixation of bone without fracture reduction
78.62: removal of implanted device from bone, humerus
80.01: arthrotomy for removal of prosthesis, shoulder
81.83: other repair of shoulder, including revision

Revision to Arthroplasty

81.80: total shoulder replacement
81.81: partial shoulder replacement

Arthrodesis

81.23: arthrodesis of shoulder

Dislocation

79.71: closed reduction of dislocation of shoulder
79.81: open reduction of dislocation of shoulder

Irrigation and Debridement

86.22: excisional debridement of wound, infection, burn
86.28: nonexcisional debridement of wound, infection, burn
77.62: local excision of lesion or tissue of bone, humerus

Diagnoses

Wound Problems

998.31: disruption of internal operation wound
998.32: disruption of external operation wound
998.51: infected postoperative seroma
998.59: other postoperative infection
998.83: non-healing surgical wound

Nerve Injury

- 953.4: injury to brachial plexus
- 955.0: axillary nerve injury
- 955.1: median nerve injury
- 955.2: ulnar nerve injury
- 955.3: radial nerve injury
- 955.4: musculocutaneous nerve injury
- 955.5: cutaneous sensory nerve injury, upper limb
- 955.7: injury to other specified nerves of shoulder girdle and upper limb
- 955.8: injury to multiple nerves of shoulder girdle and upper limb
- 955.9: injury to unspecified nerve of shoulder girdle and upper limb

Vascular Injury

- 903.00: injury to axillary vessels, unspecified
- 903.01: injury to axillary artery
- 903.02: injury to axillary vein
- 903.1: injury to brachial blood vessels
- 903.2: injury to radial blood vessels
- 903.3: injury to ulnar blood vessels
- 903.8: injury to other specified blood vessels of upper extremity
- 903.9: injury to unspecified blood vessels of upper extremity

Infection

- 711.01: pyogenic arthritis
- 711.41: arthropathy associated with other bacterial diseases
- 711.81: arthropathy associated with other infectious and parasitic diseases
- 711.91: unspecified infective arthritis
- 730.01: acute osteomyelitis
- 730.11: chronic osteomyelitis
- 730.21: unspecified osteomyelitis
- 730.31: periostitis
- 730.81: other infections involving bone
- 730.91: unspecified infection of bone
- (xxx.x1 above indicates the shoulder region)

Dislocation

- 718.21: pathologic dislocation, shoulder region
- 718.31: recurrent dislocation of joint
- 831.00: unspecified dislocation of shoulder
- 831.01: anterior shoulder dislocation
- 831.02: posterior dislocation of shoulder
- 831.03: inferior dislocation of shoulder
- 831.10: unspecified dislocation of shoulder, open
- 831.11: anterior shoulder dislocation, open
- 831.12: posterior dislocation of shoulder, open
- 831.13: inferior dislocation of shoulder, open

Complications Due to Prosthetic Device

- 996.60: infection and inflammatory reaction due to unspecified device, implant, graft
- 996.66: infection/inflammation due to internal joint prosthesis
- 996.67: infection/inflammation due to other internal orthopaedic device
- 996.69: infection/inflammation due to other internal prosthetic device, implant, graft
- 996.70: other complication due to unspecified device, implant, graft
- 996.77: other complication due to internal joint prosthesis

996.78: other complication due to internal orthopaedic device
996.79: other complication due to internal prosthetic device, implant, graft
996.40: unspecified mechanical complication of internal orthopaedic device, implant, graft
996.41: mechanical loosening of prosthetic joint
996.42: dislocation of prosthetic joint
996.43: prosthetic implant joint failure
996.44: peri-prosthetic fracture around prosthetic joint
996.45: peri-prosthetic osteolysis
996.46: articular bearing surface wear of prosthetic joint
996.47: other mechanical complication of prosthetic joint implant
996.49: other mechanical complication of other internal orthopaedic device, implant, and graft
996.59: mechanical complication of other specified prosthetic device, implant, graft, NOS (not otherwise specified)
718.41: contracture of shoulder joint
719.41: pain in joint, shoulder
719.51: stiffness of joint, NOS, shoulder
728.13: postoperative heterotopic ossification

Definitions

Uncomplicated diabetes: a diagnosis of diabetes mellitus without an associated diagnosis corresponding to end-organ damage.

Complicated diabetes: a diagnosis of diabetes mellitus with an associated diagnosis corresponding to end-organ damage.

Non-teaching hospital: a hospital that does not act as a training institution for postgraduate medical education.

Teaching hospital: a hospital that acts as a training institution for postgraduate medical education.

Rural/urban hospitals: rural hospitals were identified on the basis of location and population density by the California OSHPD; all other hospitals were deemed to be urban hospitals.

Low-volume hospital: an institution in which the annual volume for shoulder fracture fixation is in the 0 to 39th percentiles.

Intermediate-volume hospital: an institution in which the annual volume for shoulder fracture fixation is in the 40th to 79th percentiles.

High-volume hospital: an institution in which the annual volume for shoulder fracture fixation is at or above the 80th percentile.

California census data were obtained from the California Department of Finance (<http://www.dof.ca.gov/research/demographic/data/>)⁶.

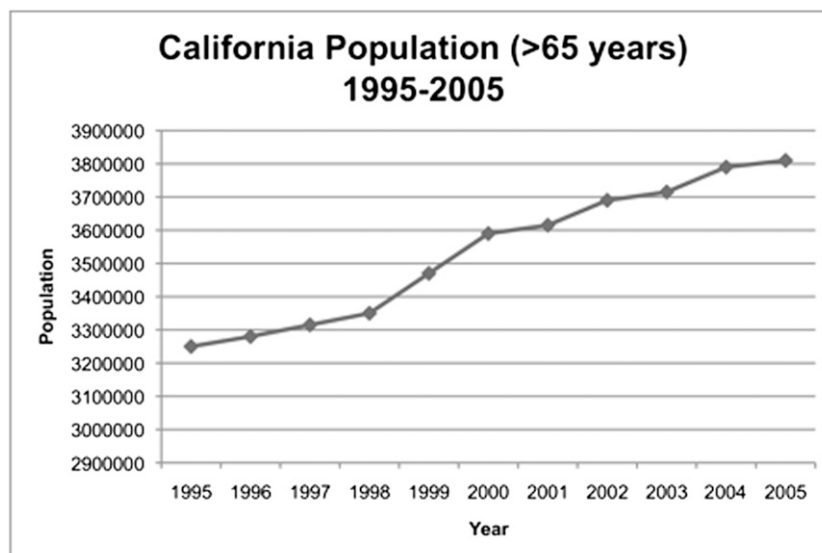


Fig. E-1

California population data for individuals at least sixty-five years of age over the study period.