

Risk Factors Associated with Long bone Fracture Non-Union – A US Claims Database Analysis

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OBJECTIVES

- Few contemporary long bone non-union analyses have been performed in the United States.^{1,2}
- Our Objective was to analyze non-union and infected non-union rates, and risk factors thereof, following long-bone fractures requiring surgical intervention.

METHODS

Study Design: Retrospective cohort analyses

Data Source: IBM® MarketScan® Commercial Claims and Encounters database

Study Population: All Patients with femur, tibia or humerus fractures treated in the inpatient setting and requiring surgical fracture repair, from Q4 2015 to Dec 31, 2021.

- *Index:* Defined as date of surgical intervention for fracture repair.

- *Exclusion criteria:* polytrauma, revision of prior trauma, continuous enrollment < 30 days and long-bone fracture site amputation at time of index surgery.

Study Duration: 2 years from index.

Outcomes: Non-union and infected non-union at 2 years post-index.

Variables: Patient demographic and comorbid factors, fracture location and severity of soft tissue trauma.

Statistical Analysis: Crude and adjusted rates of non-union at 1- and 2-years using Poisson regressions with log link; Risk ratio analysis for key variables; Kaplan Meier analysis for time to non-union.

References:

- Tzioupis C, Giannoudis PV. Prevalence of long bone non-unions. Injury. 2007;38(SUPPL. 2):S3
- Ekegren CL, Edwards ER, de Steiger R, Gabbe BJ. Incidence, costs and predictors of non-union, delayed union and mal-union following long bone fracture. International Journal of Environmental Research and Public Health. 2018;15(12).

RESULTS

- 31,079 Patients were identified, as shown in Table 1

Table 1: Demographic, clinical and fracture characteristics of patients with femur, tibia, and humerus fractures requiring surgical repair.

	Femur	Tibia	Humerus
N	12,770	13,504	4,805
Gender: Male (vs Female)	6,435 (50.4%)	7,026 (52.0%)	2,159 (44.9%)
Age (Mean (SD))	44.17 (19.46)	42.21 (16.03)	36.26 (22.19)
Elixhauser Index (Mean (SD))	1.61 (2.20)	1.04 (1.60)	1.16 (1.77)
Fracture Type			
Trochanteric Fracture	4,607 (36.1%)	NA	NA
Neck Fracture	6,417 (50.3%)	NA	844 (17.6%)
Shaft Fracture	4,844 (37.9%)	7,715 (57.1%)	1,933 (40.2%)
Condylar Fracture	1,120 (8.8%)	3,709 (27.5%)	1,858 (38.7%)
Other / Unspecified	987 (7.7%)	162 (1.2%)	82 (1.7%)
Pilon / Malleolus Fracture	NA	2,832 (21.0%)	NA
Proximal End Fracture	NA	2,643 (19.6%)	1,662 (34.6%)
Distal End Fracture	NA	2,770 (20.5%)	1,614 (33.6%)
Tuberosity Fracture	NA	NA	399 (8.3%)
Clinical Presentation			
Displaced Fracture	9,531 (74.6%)	12,054 (89.3%)	3,938 (82.0%)
Comminuted Fracture	2,299 (18.0%)	3,509 (26.0%)	1,283 (26.7%)
Fracture Gustilo Classification			
Closed	11,088 (86.8%)	9,857 (73.0%)	4,027 (83.8%)
Open Type I or II	1,034 (8.1%)	2,268 (16.8%)	697 (14.5%)
Open Type III	351 (2.7%)	1,315 (9.7%)	12 (0.2%)
Unknown	297 (2.3%)	64 (0.5%)	69 (1.4%)

- Nonunion was observed in more than 7% patients at 2 years post-index, as shown in Figure 1. Cumulative hazard for nonunion following femoral, tibial and humeral fracture reached 8.5% (8.0%-9.1%), 9.1% (8.6%-9.7%) and 7.2% (6.4%-8.1%), respectively.
- Infected non-union occurred in all long bone fractures but was mostly observed in patients with tibial fractures (Figure 2). Cumulative hazard for infected nonunion following femoral, tibial and humeral fracture reached 0.6% (0.4%-0.7%), 2.0% (1.7%-2.3%) and 0.9% (0.6%-1.2%), respectively.
- Risks for nonunion were increased in patients with shaft fractures and significant soft tissue trauma (Gustilo I-II and III) but were not associated with increasing comorbidities or long bone type (Figure 3).
- Risks for infected nonunion, however, were significantly higher in patients with tibia vs femoral/humeral fractures, in patients with significant soft tissue trauma (Gustilo I-II and III) and in patients with comorbidities (Figure 4).

Figure 1: Cumulative hazard for non-union, from day of discharge following surgical fracture repair, to 2-year post-surgery.

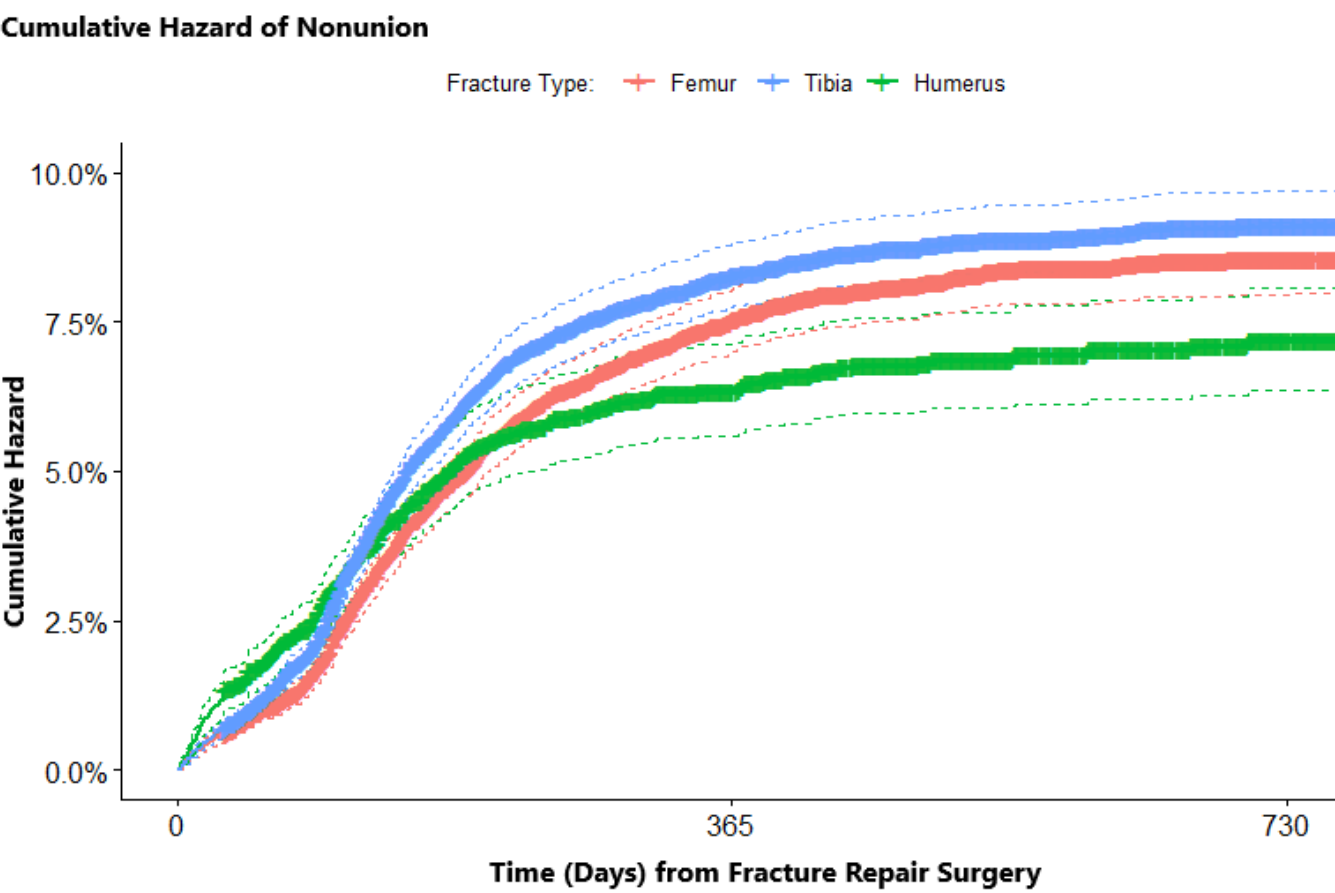


Figure 3: Risk ratios for non-union within 2 years of fracture repair surgery.

Variable		Estimate, P value
Age Group	55 To 64	Reference
	Under 19	0.34 (0.28, 0.41) <0.001
	19 To 25	0.59 (0.49, 0.70) <0.001
	26 To 34	0.81 (0.68, 0.96) 0.017
	35 To 44	1.00 (0.87, 1.14) 0.964
	45 To 54	1.11 (0.99, 1.24) 0.069
Fracture Location	Femur	Reference
	Humerus	0.92 (0.80, 1.05) 0.209
	Tibia	0.79 (0.71, 0.87) <0.001
Condylar Fracture		0.82 (0.73, 0.92) 0.001
Shaft Fracture		1.85 (1.65, 2.08) <0.001
Obesity		1.20 (1.03, 1.38) 0.016
Fracture Type	Closed	Reference
	Gustilo I-II	1.60 (1.42, 1.79) <0.001
	Gustilo III	3.00 (2.63, 3.40) <0.001
Elixhauser Comorbidity Index	0: No Comorbidities	Reference
	1 or 2	1.16 (1.04, 1.28) 0.006
	3 or 4	1.34 (1.16, 1.54) <0.001
	5 or Greater	1.36 (1.13, 1.62) <0.001
Comminuted Fractures		1.32 (1.19, 1.47) <0.001
Fractures at Multiple Sites		1.04 (0.94, 1.14) 0.462

Figure 2: Cumulative hazard for infected non-union, from day of discharge following surgical fracture repair, to 2-year post-surgery.

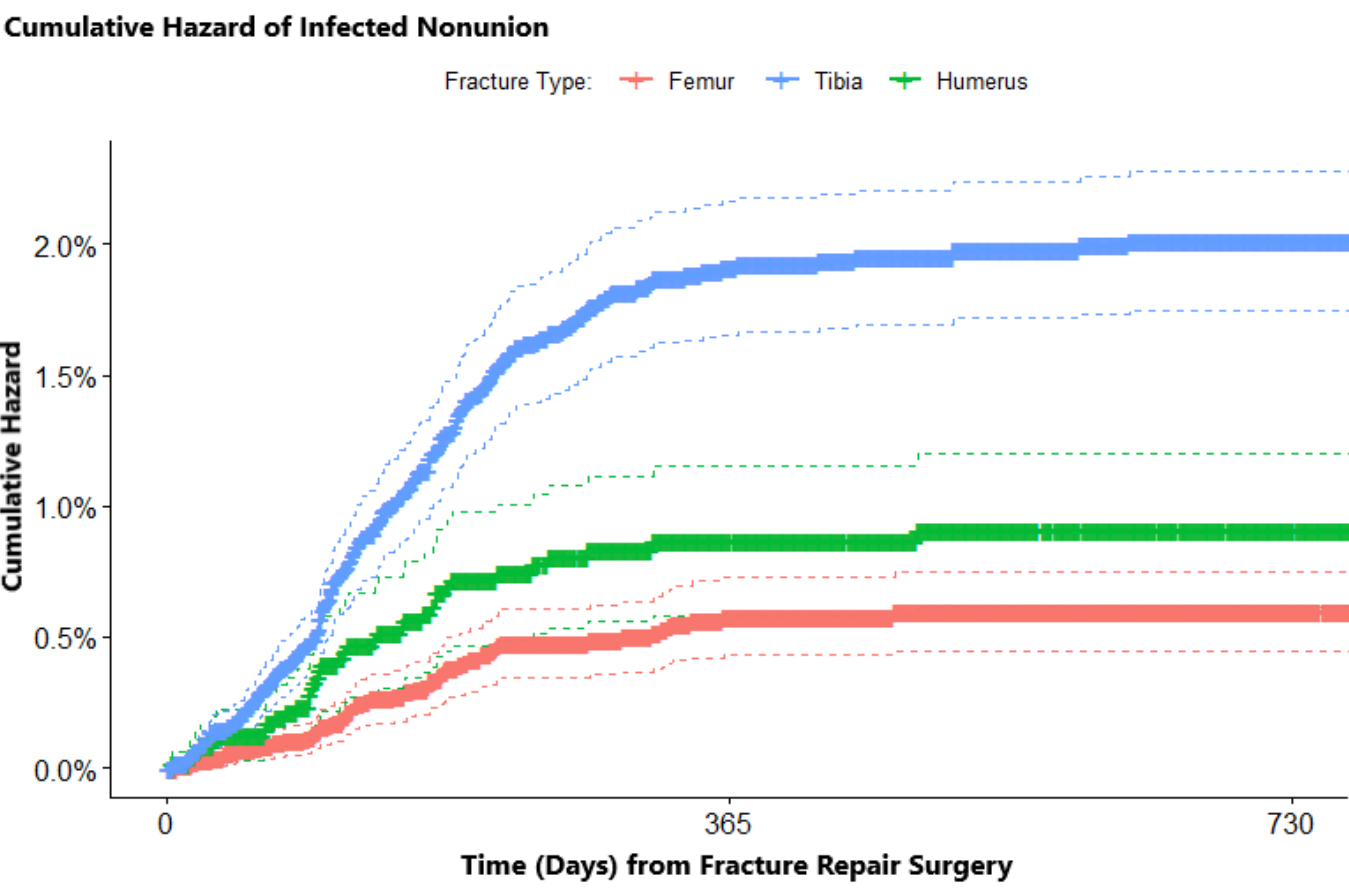


Figure 4: Risk ratios for infected non-union within 2 years of fracture repair surgery.

Variable		Estimate, P value
Age Group	55 To 64	Reference
	Under 19	0.56 (0.42, 0.74) <0.001
	19 To 25	0.72 (0.54, 0.96) 0.03
	26 To 34	0.73 (0.54, 0.98) 0.04
	35 To 44	0.87 (0.69, 1.10) 0.26
	45 To 54	1.12 (0.94, 1.33) 0.20
Fracture Location	Femur	Reference
	Humerus	1.08 (0.84, 1.39) 0.54
	Tibia	1.85 (1.57, 2.19) <0.001
Condylar Fracture		1.11 (0.93, 1.31) 0.25
Shaft Fracture		1.16 (0.96, 1.40) 0.12
Obesity		1.05 (0.85, 1.28) 0.64
Fracture Type	Closed	Reference
	Gustilo I-II	1.78 (1.48, 2.14) <0.001
	Gustilo III	4.15 (3.42, 5.01) <0.001
Elixhauser Comorbidity Index	0: No Comorbidities	Reference
	1 or 2	1.53 (1.28, 1.82) <0.001
	3 or 4	2.39 (1.91, 2.98) <0.001
	5 or Greater	4.44 (3.49, 5.61) <0.001
Comminuted Fractures		1.09 (0.91, 1.31) 0.36
Fractures at Multiple Sites		0.89 (0.76, 1.05) 0.17

CONCLUSIONS

- Patients with long-bone fractures requiring surgical repair are at significant risk of non-union.
- Risk for nonunion and infected nonunion are increased in shaft fractures and fractures with significant soft tissue damage. Risks for infected non-unions are increased in patients with comorbidities.