RQ: Should outcome registries for open fractures be globally standardised to enhance the accuracy of prognostic models?

Section 1: Background

Open fractures are heterogeneous injuries, with outcomes influenced by mechanism of injury, anatomical site, soft-tissue damage, contamination, vascular status, associated systemic injuries, timing of treatment, fixation strategy, infection, union, reoperation, and long-term function. Accurate prognostic models require large, consistent, high-quality datasets that capture these variables in a standardized way.

The current literature demonstrates that trauma registries are valuable for describing epidemiology and associated injury patterns. However, available registries differ substantially in inclusion criteria, coding systems, captured variables, outcome definitions, and follow-up duration. Some registries include only admitted patients, exclude patients discharged from emergency departments, or omit patients who die before hospital arrival, creating selection bias. Others capture fracture location and mechanism but provide limited detail on open-fracture severity, treatment, complications, functional outcomes, or long-term recovery.

The three included studies illustrate both the strengths and limitations of existing registry-based research. Large national or institutional registries can identify rare injuries, compare adult and pediatric patterns, and detect associations between injury mechanism and associated injuries. However, incomplete Gustilo classification, lack of uniform outcome reporting, variable follow-up, and limited functional outcome data restrict their ability to generate accurate and generalizable prognostic models.

Therefore, global standardization of open-fracture outcome registries may improve data comparability, external validation, and predictive accuracy, particularly for infection, nonunion, amputation, reoperation, mortality, and functional recovery.

Section 2: Data extraction table

S.no	Author, year, country	Study design	Sample size	Study population	Groups compared	Results
1	Gottschalk et al., 2012, USA	Retrospective case series using Level I trauma registry	53 open clavicle fractures from 1645 clavicle fractures	Patients admitted with open clavicle fractures between 1995–2010	Blunt vs penetrating open clavicle fractures	Open clavicle fractures were rare, accounting for 3.2% of clavicle fractures. Associated injuries occurred in 87%. Blunt injuries had more head injuries than penetrating

S.no	Author, year, country	Study design	Sample size	Study population	Groups compared	Results
						injuries, while penetrating injuries had more great vessel injuries. Gustilo classification was documented in only 34%, demonstrating incomplete registry granularity.
2	Rubin et al., 2017, Israel	National trauma registry study	103,465 road traffic accident patients; 17,263 had upper extremity fractures; 2743 open fractures	Adult and pediatric hospitalized road traffic accident patients in the Israel National Trauma Registry, 1997–2013	Adult vs pediatric; car, motorcycle, bicycle, pedestrian injury modes	Adults had a higher risk of open upper-extremity fractures than children. The registry enabled large-scale epidemiological comparison, but excluded patients dead at scene/on arrival and those discharged from the emergency department.
3	Taitsman et al., 2006, USA	Retrospective case series from prospectively collected orthopaedic trauma registry	20 open clavicle fractures	Patients with blunt open clavicle fractures at a Level I trauma center, 1990–2002	No formal comparison group	All patients had associated injuries. Pulmonary injury occurred in 75%, head injury in 65%, spine injury in 35%, scapula fracture in 40%. Fifteen patients followed to healing had no infection or nonunion. Follow-up was incomplete in 25%, limiting outcome

S.no	Author, year, country	Study design	Sample size	Study population	Groups compared	Results
						certainty.

Section 3: Results summary

Three studies were included. All were registry-based or registry-derived observational studies addressing open fracture epidemiology, associated injuries, and outcomes.

Gottschalk et al. used a Level I trauma registry to identify 53 open clavicle fractures over 14 years. The study showed that open clavicle fractures are rare but clinically important markers of major trauma. Associated injuries were present in 87% of patients. Head injury, thoracic injury, and great vessel injury were common. The study also showed that blunt and penetrating mechanisms have different associated injury profiles. However, Gustilo-Anderson classification was documented in only 34% of cases, demonstrating a major limitation for prognostic modelling.

Rubin et al. used the Israel National Trauma Registry to analyze 103,465 hospitalized road traffic accident patients. This large registry enabled comparison between adult and pediatric open upper-extremity fracture patterns. Adults had a significantly higher risk of open upper-extremity fractures than children, and fracture distribution varied by age and mechanism. However, the registry excluded patients who died before admission and patients discharged from the emergency department, which may affect external validity.

Taitsman et al. used a prospectively collected orthopaedic trauma registry to study 20 blunt open clavicle fractures. The study captured associated injuries, treatment, union, infection, and nonunion. It showed that open clavicle fractures were strongly associated with pulmonary, cranial, spinal, facial, and shoulder-girdle injuries. Among patients followed to union, no septic complications or nonunions were reported. However, 25% had inadequate follow-up, limiting confidence in long-term outcome estimation.

Overall, the included studies demonstrate that registries are essential for studying rare open fracture patterns and associated injuries. However, heterogeneity in captured variables, missing severity classifications, inconsistent follow-up, and incomplete outcome reporting limit their ability to generate accurate prognostic models.

Section 4: Discussion

The available evidence supports the need for standardized outcome registries in open fracture care. Open fractures are uncommon in some anatomical regions but carry significant morbidity. Because single institutions often see small numbers of specific open fracture subtypes, prognostic models require large datasets generated through multicenter or national registry systems.

The included studies show the value of registry-based research. Gottschalk et al. identified 53 open clavicle fractures over 14 years, confirming that such injuries are rare but strongly associated with major trauma. Without a trauma registry, meaningful analysis of this rare injury would be difficult. Similarly, Rubin et al. used a national trauma registry to analyze over 100,000 road traffic accident patients, allowing comparison of adult and pediatric open upper-extremity fracture patterns. Taitsman et al. used a prospectively collected orthopaedic trauma registry to describe treatment outcomes and associated injuries in blunt open clavicle fractures.

However, these studies also demonstrate why global standardization is needed. The first major limitation is variable inclusion criteria. Rubin et al.'s registry excluded patients dead at the scene, dead on arrival, or discharged from the emergency department. Gottschalk et al.'s registry included admitted trauma patients and was therefore biased toward more severe injuries. Such differences affect incidence estimates, case mix, and prediction model calibration.

The second limitation is incomplete severity classification. Gottschalk et al. reported Gustilo-Anderson classification in only 34% of open clavicle fractures. Without standardized documentation of open-fracture severity, contamination, vascular injury, bone loss, soft-tissue defect, and compartment syndrome, prognostic models cannot reliably estimate infection, nonunion, amputation, or mortality risk.

The third limitation is inconsistent outcome reporting. Taitsman et al. reported union, infection, and nonunion, but 25% of patients lacked adequate follow-up. Rubin et al. primarily described epidemiology and fracture distribution but did not provide detailed long-term outcomes. Prognostic models require standardized follow-up intervals and uniform definitions of outcomes such as deep infection, fracture-related infection, nonunion, delayed union, reoperation, amputation, return to work, patient-reported outcome measures, and mortality.

The fourth issue is heterogeneity in coding systems. Registry studies often rely on ICD codes, which may identify fracture location and open status but do not adequately capture clinically important orthopaedic details. Prognostic models based only on administrative coding may therefore underperform compared with models using structured clinical variables.

A globally standardized open-fracture registry should include a minimum dataset covering patient factors, injury mechanism, fracture location, Gustilo grade, contamination type, vascular and nerve injury, soft-tissue defect, treatment timing, antibiotic administration, fixation method, soft-tissue coverage, complications, reoperations, union, amputation, mortality, and functional outcomes. Such standardization would allow pooling of international data, external validation of prognostic models, benchmarking between centers, and improved clinical decision-making.

Nevertheless, standardization should not mean uniformity without flexibility. Local trauma systems differ in resources, referral pathways, and follow-up capacity. Therefore, a tiered registry model may be most practical: a mandatory core dataset for all centers and an expanded dataset for specialist trauma centers. This approach would balance feasibility with scientific value.

Overall, the evidence from the three studies does not directly test prognostic modelling, but it strongly demonstrates that current registry data are useful yet inconsistent. The limitations identified across these studies justify a consensus recommendation in favor of global standardization of open-fracture outcome registries.

Section 5: Risk of bias of included studies

Study	Risk of bias
Gottschalk et al., 2012	Moderate–High — retrospective single-center registry study, small sample, incomplete Gustilo documentation, admission-based selection bias, limited outcome detail.
Rubin et al., 2017	Moderate — large national registry, but excludes patients dead before admission and those discharged from the emergency department; mainly epidemiological with limited long-term outcome data.
Taitsman et al., 2006	Moderate–High — small retrospective case series from a single center; 25% incomplete follow-up; treatment decisions varied by surgeon.

Section 6: Response / Recommendation

Yes. Outcome registries for open fractures should be globally standardized to improve data quality, comparability, external validation, and the accuracy of prognostic models.

Recommendation: A minimum global open-fracture registry dataset should be adopted, including injury severity, treatment variables, complications, union, infection, reoperation, amputation, mortality, and functional outcomes.

Section 7: Level / strength of evidence

LOW

Justification: The recommendation is supported by observational registry studies and retrospective case series. No randomized or prospective comparative study directly evaluates whether global registry standardization improves prognostic model accuracy. However, the available evidence consistently shows that current registries are valuable but limited by missing variables, inconsistent inclusion criteria, and incomplete outcome reporting.