

**Routine Fixation of Humeral Shaft Fractures is Cost-Effective:
Cost-Utility Analysis of 215 Patients at Five Years Following Injury**

William M. Oliver, MBBS, MRCS(ED); Samuel Molyneux, FRCS (Ortho), MSc;

Timothy O. White, MD, FRCS; Nicholas D. Clement, FRCS (Ortho);

Andrew David Duckworth, PhD, MSc

Royal Infirmary of Edinburgh, Edinburgh, UNITED KINGDOM

Purpose: The primary aim of this study was to estimate the cost-effectiveness of routine fixation for all patients with humeral shaft fractures. The secondary aim was to estimate the health economic implications of using a Radiographic Union Score for HUmeral fractures (RUSHU) <8 to facilitate selective fixation for patients at risk of nonunion.

Methods: From 2008 to 2017, 215 adult patients (mean age 57 years [range, 17-18], 61% female) with a nonoperatively managed humeral diaphyseal fracture were retrospectively identified. Union was achieved in 77% ($n = 165/215$) after initial management, with 23% ($n = 50/215$) uniting after surgery for nonunion. Costs were measured in Pounds Sterling (GBP) and based on the English National Health Service tariff or departmental procurement costs. The EuroQol 5-Dimension (EQ-5D) 3-Level Health Index was obtained via postal survey. Multiple regression was used to determine the independent influence of patient, injury, and management factors upon the EQ-5D. An incremental cost-effectiveness ratio (ICER) of $<£20,000$ (\$25,000) per quality-adjusted life year (QALY) gained was considered cost-effective.

Results: At a mean of 5.4 years (range, 1.2-11.0), the mean EQ-5D was 0.736 (95% confidence interval [CI] 0.697 to 0.775). Adjusted analysis demonstrated the EQ-5D was inferior among patients who united after nonunion surgery ($\beta = 0.103$, $P = 0.032$). Offering routine fixation to all patients in order to reduce the rate of nonunion would be associated with increased overall treatment costs of $£1,542$ /patient (\$2,000), but would confer a potential EQ-5D benefit of 0.120/patient over the 5-year period of study follow-up. The ICER of routine humeral shaft fracture fixation was $£12,850$ (\$16,000) per QALY gained. Selective fixation, based on a RUSHU <8 at 6 weeks post-injury, would be associated with reduced treatment costs of $£415$ /patient (\$500) and conferred a potential EQ-5D benefit of 0.335 per at-risk patient over the 5-year period of study follow-up.

Conclusion: Routine fixation for patients with humeral shaft fractures, in order to reduce the rate of nonunion following nonoperative management, appears to be a cost-effective intervention at 5 years post-injury. Selective fixation of patients at risk of nonunion based upon their RUSHU may confer even greater cost-effectiveness, given the potential cost savings and improvement in health-related quality of life.