A prospective cost analysis following operative treatment of unstable ankle fractures

30 patients followed for 1 year

Mohit Bhandari[1], Sheila Sprague[1], Olufemi R Ayeni[3], Beate P Hanson[2] and Jaydeep K Moro[3]

[1]Department of Clinical Epidemiology and Biostatistics, McMaster University, McMaster University Medical Centre,1200 Main Street West, Room 2C3, Hamilton, Ontario, L8N 3Z5, Canada, [2]AO Clinical Investigation and Documentation, Davos, Switzerland, [3]Division of Orthopaedic Surgery, McMaster University, Hamilton, Ontario
Correspondence: MB bhandari@sympatico.ca
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Background **Ankle fractures remain one of the commonest injuries requiring operation. Quality of life and the overall costs associated with the treatment of such injuries are rarely reported. We did a pilot study to determine the cost of treating patients operatively with unstable ankle fractures and to measure the patients' quality of life (utility scores) over time.**

Patients and methods **30 patients (17 men) were eligible and included in the study. They were on the average 52 (18–81) years old. All patients had type B Weber fractures (OTA 44B).**

Results **The mean utility score from the Health Utilities Index immediately after surgery was 0.4. At 12 months follow-up, this score had increased to 0.78. The cost was, on average, USD 2,143 per patient.**

Interpretation **Our findings indicate that patients operated on for ankle fractures had significant gains in health at an acceptable cost. These results provide data for studies of larger sample size.**

Ankle fractures remain one of the commonest injuries requiring operations. Although many Weber Type B ankle fractures are considered benign with a good prognosis, evidence from observational studies suggests that up to quarter of such patients may have less satisfactory outcomes (Mak et al. 1985, Phillips et al. 1985, Mont et al. 1992).

Although a few studies have evaluated health-related quality of life (HRQL) following ankle fractures (Ponzer et al. 1999, Obremskey et al. 2002), no reports have included costs and utility scores on patients with operatively-treated ankle fractures. Assessing patients' quality of life and costs after operations is important to ensure that health care dolars are being used efficiently to promote strategies that lead to clinically important patient outcomes. The Health Utilities Index (HUI) is a generic approach to the measurement of health status and assessment of HRQL and provides a comprehensive framework within which to measure health status and calculate HRQL scores. The HUI has two components: one that assesses health status, the second, which assigns value to 8 attributes (vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain) (Kaplan 1998, Feeny et al. 1999). Utility measures are ideally suited to examine quality of life over time, and for equating cost with quality of life (Guyatt et al. 1993, Feeny et al. 1996). Utility is the preference or worth assigned to a particular health status ranging from 0 (death) to 1 (perfect health). The HUI has been widely used and well validated in many patient populations and the scoring formula for the HUI is well grounded in theory and based on preference data from community surveys.

Given the lack of existing information as regards HRQL and the economic effect of treating frac-

tures of the ankle, we did a prospective observational cohort study of patients operated on for unstable ankle fractures with the following objectives: (1) to determine the cost of treating patients with unstable ankle fractures and (2) to measure patients' utility scores over time.

Methods

We did a 12-month prospective observational study to determine the costs of operating on patients with unstable ankle fractures who were otherwise healthy. This study received approval from our local ethics review board (Approval #19-1835). This study included patients who met the following criteria: 1) age above 18 years; 2) isolated injury to the ankle; 3) unstable ankle fracture (OTA 44B, Weber Type B) requiring operative fixation; and 4) patient consent.

Over the 6-month period between July through December 1999, 310 patients were screened at two university-affiliated hospitals in the same city, of which 64 patients with ankle injuries were eligible for participation in this study. The use of criteria for these patients eliminated 34, which left 30 patients for the study. Patients were excluded for the following reasons: multiple fractures (24); reluctance to participate (7); and inability to communicate in English (3). We followed all 30 patients for 12 months, and checked emergency department logs, operating room logs, and ward admission lists every other day for potentially eligible patients. An independent investigator did periodic random checks of the logs to ensure that all eligible patients had really been included in the study.

Utility is the preference or worth assigned to a particular health status on an interval scale ranging from 0 (death) to 1 (perfect health). Since there has been limited research on the patients quality of life and utility in orthopaedics, the health utility was calculated from the Health Utilities Index Mark 2/3 (HUI) (Furlong et al. 2001). The HUI consists of 7 attributes of health status with 3 to 5 levels per attribute. (Torrance et a1. 1995, Furlong et al. 2001). These levels range from highly impaired to normal. The HUI mark 3 has 8 attributes (vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain) with 5–6 levels per attribute. A multiplicative multi-attribute utility function and single-attribute utility functions for HUI mark 3 have recently been published (Furlong et al. 2001). Questionnaires that provide sufficient information to describe the health status of a subject at a point in time in both the HUI2 and HUI3 systems have been developed and validated in a combined instrument (Furlong et al. 2001). We determined the quality of life in the immediate post-operative period (—i.e., within 48 hours of surgery), at 3 months, 6 months, and 12 months. At each follow-up, a study investigator, who was blinded to other baseline demographic information about the patient, administered the questionnaire.

We collected information on medical resources used by the patient at each follow-up visit. The viewpoints of the primary payer, the Canadian Ministry of Health, were adopted in this study as the basis for the economic evaluation. Although some guidelines recommend a comprehensive societal basis, including out-of-pocket expenses and lost productivity of patients, family members and other caregivers (Guyatt et al. 1993), this information was not obtained. Costs were reported in 2002 Canadian dollars (CAD), which were then converted to US dollars. The exchange rate at the time of the study was USD 1 = CAD 1.58 (November 2002).

Hospital costs were obtained from an Ontario Schedule of Benefits (Ontario Ministry of Health 2002). All the resources used by the patient while in hospital were recorded on special forms designed for this study. On leaving the hospital, each patient was given a diary to record community care. The participants were instructed to register only items related to the treatment of their ankle fracture, including follow-up visits to the fracture clinic, the orthopaedic surgeon, and other specialists, diagnostic tests, and home care. Any complications following discharge such as visits to the emergency room, re-admission to hospital and re-operations, were noted. The cost of outpatient physiotherapy was not included in the analysis, as the patients or their insurance plans paid for most of the outpatient physiotherapy not the Ministry of Health. Outpatient medication costs were also excluded from this analysis because the majority of medications are paid by insurance companies or by the patient. The participant was asked to read

Table 1. Baseline characteristics of the study cohorts in 30 patients

Age	52	(range 18–81)
Male	17	
Diabetes	2	
Peripheral vascular disease	1	
Work status (at time of injury)		
Full time	14	
Part-time	4	
Company-paid sick leave	3	
Workman's compensation	1	
Homemaker	5	
Days of work missed	19	(SD 14, range 1–94)
Mechanism of injury		
Fall	20	
Twist	5	
MVA	3	
Crush	2	
Smoking history		
Smokers	14	
Pack per year	31	(SD 26, range 2–99)
Alcohol consumption		
Drink alcohol	13	
Drinks/week	6.7	(SD 18, range 2–75)
Time from injury to surgery, hours	41	(SD 37, range 5–144)
Number of patients delayed more than 12 hours	25	
Days in hospital	4.1	(SD 2.6, range 1–9)

SD standard deviation

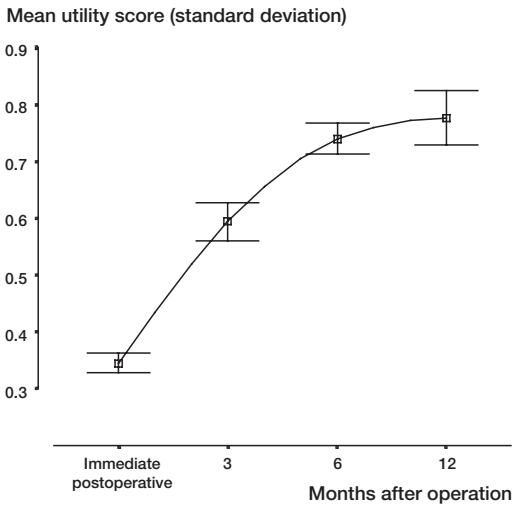
from their diary any resources that were utilized via a phone interview every month by a research assistant.

Continuous variables were presented as means with standard deviations. Single factor analysis of variance was done to evaluate differences in utility scores over time. Post-hoc tests of significance were adjusted by a Bonferroni method. Specifying an alpha level = 0.05, a beta = 0.20 (study power = 80), we required a sample of at least 30 patients to ensure detection of a 1/2 standard deviation improvement in Health Utility scores.

Results

Baseline characteristics of study cohort

The patients were on the average 52 (18–81) years old of whom 17/30 were males (Table 1). They all had closed injuries with type B Weber fractures (OTA 44B), which were fixed with a lateral one-third semi-tubular plate and interfragmentary



Mean Health Utility Index scores over time (30 patients). significant improvements in scores occurred immediately after surgery ($p < 0.05$).

Table 2. Comparison of Health Utility Index scores across disease states

Health state	Utility score
Perfect health	1.0
Population norms (Canada)	0.93
Recent angina	0.89
Ankle fracture (O.R.I.F)	0.78
Arthritis	0.77
Stroke	0.54
Mild Alzheimer's	0.39
Severe Alzheimer's	0.06
Dead	0

screw fixation. Medial malleolar screw fixation was done in 25 patients. A review of the postoperative radiographs showed anatomic reduction with stable fixation in all patients.

Health utility scores

They all felt that they had improved in all domains of the HUI and overall utility over the 12-month follow-up period (Figure). The mean utility score immediately after surgery was 0.34 and at the 12-month follow-up examination, the mean utility score was 0.78. Patients with ankle fractures fared better than those with other diseases (Table 2).

Cost analysis

The total cost of treating 30 patients with unstable

Table 3. Cost comparison

Author	Country	Intervention	Cost per patient (USD) [a]
Ankle fracture			
Current study	Canada	operative fixation	1,801
James et al. (2001)	UK	operative fixation	3,333
Tibial fracture			
Toivanen et al. (2000)	Finland	casting	4,307
		intramedullary nail	5,065
Downing et al. (1997)	UK	casting	2,197
		intramedullary nail	3,680
Sprague et al. (2002)	Canada	plate fixation	4,266
Femoral fracture			
Nork and Hoffinger (1998)	USA	casting (pediatric shaft fracture)	13,569
Wiktorowicz et al. (2001)	Canada	operative fixation (adult hip fracture)	16,789
Distal radius			
Kakarlapudi et al. (2000)	UK	non-operative	505

[a] All currencies were converted to USD for comparison

ankle fractures was USD 64,300 or USD 2,143 per patient. The total in-hospital costs for the 30 patients were USD 54,016 (or USD 1,801 per patient). The total outpatient costs for the 30 patients were USD 9,977 (or USD 333 per patient). No patient had a deep infection, non-union, malunion, or hardware failure during the follow-up period. However, 5 patients returned to the emergency department for minor complaints (3–15 days after discharge): Swollen ankles (2); repeated falls, without a fracture (1); problems requiring reapplication of the cast (2). No patient required readmission to hospital for matters related to the initial fracture of the ankle. The cost of the emergency room visits for these 5 patients totals USD 307 (or USD 10 per patient per visit).

The cost of treating ankle fractures was less than that of the treatment of tibial shaft, pediatric femoral shaft, and adult hip fractures (Table 3).

Discussion

Patients in the present series achieved significant gains in quality of life (HUI) from discharge at an average direct cost of USD 1,801 per patient. The incidence of ankle fractures averages about 110 per 100,000 (Court-Brown et al. 1998). Thus, expected costs of treatment of ankle fractures in Canada (population 32 million) are USD 8 million a year.

We have found no other reports or patient utility scores following ankle fractures. The advantages of utility measurement include the ability to compare directly the cost-effectiveness of various interventions across different patient populations. The HUI Mark 2 (HUI2) and Mark 3 (HUI3) classification and scoring systems can be used to estimate multi-attribute utility functions. The HUI has been utilized in many clinical studies for a wide variety of conditions in a large number of countries (Furlong et al. 2001). The Health utilities index has also been shown to be a reliable, responsive and valid measure in numerous clinical studies (Furlong et al. 2001). The widespread use of HUI facilitates the interpretation of results and permits comparisons. For instance, utility scores one year after operative fixation of ankle fractures are better, than in patients with arthritis, stroke and Alzheimer's disease and only slightly lower than population norms (Table 2) (Grootendorst et al. 2000, Neumann et al. 2000).

The direct costs associated with operations on ankle fractures in the current study were similar to those of another study. James et al. (2001), in a retrospective analysis of patients in the United Kingdom with ankle fractures treated early (< 24 hrs) and late (> 24 hrs), found a direct cost of USD 3,396 associated with operative fixation of fractures. Our data suggest that the overall costs associated with the operations on ankle fractures

are one half of those in the United Kingdom. The reason for this difference remains unclear.

Although operations on ankle fractures are not risk-free, they cost far less than the management of tibial shaft fractures and hip fractures (Sprague and Bhandari 2002, Toivanen et al. 2000). Toivanen et al. (2000) did a retrospective cost analysis of tibial fracture management. The direct costs (treatment, hospitalization, and outpatient services, and complications) of casting or intramedullary nailing of tibial shaft fractures were USD 4,307 and USD 5,065, respectively.

As compared to the costs of treating fractures of the hip, the overall costs of treating patients with ankle fractures are low. Wiktorowicz and colleagues (2001) did a 1 -year prospective cohort study of the costs of treating hip fractures in the elderly. Among the 504 study participants, the mean cost of managing them was USD 16,789 (95% CI: 15,547–18–310). On the basis of their data, these investigators estimated that the care of patients with hip fractures in Canada would approach 411 million dollars.

There are only a few reports on patients' quality of life following ankle fractures. Obremskey and colleagues (2002) compared SF-36 scores in 20 patients who had undergone operations on ankle fractures (Weber types B and C) at 4 months and 20 months. As in our study, their patients improved significantly in all domains, except their general health, which remained normal from baseline. We found that their improvement had leveled off by 6 months after the operation, beyond which no further improvement in their quality of life was noted. Ponzer and colleagues (1999) reported similar findings among patients in Sweden: at 2 years, those patients with ankle fractures showed significantly greater reductions in physical function and mental health than Swedish population norms.

This study provides the first prospective description of utility measures and costs associated with treatment of ankle fractures. These results are strengthened by prospective data collection, careful documentation of in-hospital and outpatient costs by the use of patient diaries. To be most effective, future studies should use the Health Utilities Index in various other fracture management regimens to provide a basis for direct comparisons. Moreover, with the ever-increasing need and popularity of economic analyses, the HUI is required to facilitate direct comparisons of cost-effectiveness of studies.

In conclusion, patients with fractures of the ankle requiring operative fixation can be expected to show improvement in health-related quality of life up to one year following surgery at an acceptable health care cost. Our results provide data for studies of larger sample size.

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