COST-BENEFIT ANALYSIS OF HIP FRACTURE TREATMENT

MARTYN J. PARKER, JOHN W. MYLES, JOG K. ANAND, ROBERT DREWETT

From Peterborough District Hospital

We have determined the quality-adjusted-life-years and cost of such in several types of hip fracture and various treatment options. Operative treatment proved more cost-effective than other methods for displaced subcapital fractures and for extracapsular fractures. For undisplaced subcapital fractures conservative treatment was almost as cost-effective as surgery.

Clinical audit is increasingly important in assessing the relative benefits of treatment. The measurement of quality-adjusted-life-years (QALY) gives an indication of the average benefit or 'utility' of a particular treatment, and can be used in cost analysis; although it is a somewhat crude measurement the QALY does provide a basis upon which comparisons can be made.

Our aim was to determine the cost per QALY for the different methods of treatment for various types of hip fracture.

PATIENTS AND METHODS

Detailed records were kept of a consecutive series of 1400 patients treated for fracture of the neck of the femur in Peterborough. To calculate the benefit derived from a specific treatment, the base line was taken as the mortality and morbidity expected to occur if no treatment was given. This was compared with the results of specific forms of treatment assessed at one year from injury. By this time the life expectancy of patients who have had hip fractures is the same as that for the general population of the same age (Elmerson, Zetterberg and Andersson 1988).

No treatment. The results of no treatment depend on the type of fracture. Bentley (1980) predicted that between 8% and 15% of undisplaced subcapital fractures would displace on conservative treatment, while the remainder would proceed to bone union.

Even if there was uneventful union of an undisplaced subcapital fracture, the mortality at one year in our series was 30%. We estimate that with no treatment 85% of these fractures would have united, though 30% of the patients would have died within one year of the injury; 60% of patients with undisplaced subcapital fractures would therefore be alive at one year and have little or no residual disability. In our series 9% of patients had an undisplaced subcapital fracture, so 5% of all hip fractures could be anticipated to have a favourable outcome without treatment other than simple community care.

Patients with undisplaced subcapital fractures which subsequently displace and those with initially displaced subcapital fractures would fare less well with no treatment. Historical evidence of the outcome of this fracture before the introduction of surgical treatment, suggests that during the initial painful period many patients would die from pneumonia, bedsores and pulmonary emboli. By one year from injury we estimate the mortality would be 90%. A few of the fitter survivors might mobilise, with difficulty, as the fracture became less painful but others would remain confined to bed and totally dependent.

In our series, 48% had extracapsular fractures. Most of those fractures that were initially undisplaced would become displaced without treatment, but union would occur after a period of immobilisation, with shortening and external rotation of the limb. Based on the results of conservative treatment for this fracture (Hornby, Grimley Evans and Vardon 1989) and our experience of surgically treated patients at one year, we estimate a one-year mortality of 60% if the patients were left untreated. For the survivors, malunion of the fracture would be inevitable; approximately half could mobilise with considerable difficulty and disability, while the remainder would remain confined to bed.

Aggregation of these results indicates that for untreated hip fractures the one-year mortality would be 75%; 5% of patients would be able to walk with some
restriction, 10% with considerable difficulty and the remaining 10% would be confined to bed.

**Surgical treatment.** The majority of our patients were treated operatively reflecting current practice. Conservative management was used in 34 (2.4%) patients who were judged unfit for surgery, and 29 (2.1%) patients who either had an undisplaced subcapital or extracapsular fracture where conservative treatment was preferred. All displaced subcapital fractures were treated surgically, either by reduction and fixation or by hemiarthroplasty. Most extracapsular fractures had internal fixation with a dynamic hip screw. The mortality at one year was 30% for undisplaced subcapital fractures, 32% for displaced subcapital fractures and 41% for extracapsular fractures (Table I).

**Table I.** Actual and estimated survivorship at one year

<table>
<thead>
<tr>
<th>Type of fracture</th>
<th>All fractures (per cent)</th>
<th>Estimated survival if untreated (per cent)</th>
<th>Actual survival (per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undisplaced subcapital (n = 126)</td>
<td>9</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Displaced subcapital (n = 602)</td>
<td>43</td>
<td>10</td>
<td>68</td>
</tr>
<tr>
<td>Extracapsular (n = 672)</td>
<td>48</td>
<td>40</td>
<td>59</td>
</tr>
</tbody>
</table>

The survivors of this group of patients were interviewed one year from injury to record their level of activity and pain. Of these, 52% were mobile indoors without walking aids, 34% were mobile with walking aids, 10% required assistance to walk and 4% were bedridden or chairbound; 27% were able to do their own shopping and 57% were only able to leave the house with assistance; 65% lived in their own homes, 27% were in residential or nursing homes and 8% were in hospital indefinitely.

**Cost of treatment.** The cost was calculated by adding up the components of treatment such as the operation, rehabilitation, follow-up clinic visits and any further admissions, including revision surgery on the hip, within a year of the injury (Parker, Myles and Pryor 1991). The average cost for each patient was £3293.

**Life expectancy of survivors.** This can be calculated using data from central statistics (HMSO 1990). The average age of the women in our series was 80 years, with a life expectancy at one year from injury of seven years; for men the average age was 74 years with a life expectancy of eight years. The average life expectancy for a patient who survives to one year from injury is therefore 7.2 years.

**Calculation of the QALY and cost per QALY.** The benefits of treatment can be considered in two parts; first, the improvement in the quality of life in those who survive one year from injury, and second, the improvement in the quality of life of those who die within one year. Subtracted from these is the result if no treatment had been given.

We used the Rosser matrix (Williams 1987) to convert our assessment of the patients’ disability and distress into a number (Table II). This system was applied first to the average patient within our series and then to each type of fracture treated by each method.

**RESULTS**

**QALY for an average hip-fracture patient.** This figure is derived from the anticipated survival of 7.2 years in 64% of patients who survive one year from injury, and for whom we expect a Rosser matrix score for distress and disability of 0.94 after treatment. From this is subtracted the result of no treatment estimated to be a survival rate
of 25% with a Rosser score of the survivors of 0.60. The equation is as follows:

\[
\text{Years benefit} \times \\
[(\text{QALY treated} \times \% \text{pat}) - (\text{QALY no treat} \times \% \text{pat})] \\
= 7.2 \times [(0.94 \times 0.64) - (0.60 \times 0.25)] = 3.251
\]

This figure relates only to the survivors at one year; 36% of patients in our series will die within one year of injury, after an average of 81 days. During these months the quality of life will have been enhanced by the treatment which enables 80% of these patients to be discharged home. We estimate a Rosser matrix score of 0.93 for these patients, giving an extra QALY of 0.07, an overall QALY of 3.321.

Table IV: QALY and cost per QALY for a variety of procedures (from Williams 1985 with prices updated to 1988 and 1989)

<table>
<thead>
<tr>
<th>Procedure</th>
<th>QALY</th>
<th>Cost (£)</th>
<th>Cost/QALY (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemodialysis</td>
<td>5.00</td>
<td>90 230</td>
<td>18 046</td>
</tr>
<tr>
<td>Heart transplantation</td>
<td>4.50</td>
<td>29 647</td>
<td>6588</td>
</tr>
<tr>
<td>Kidney transplantation</td>
<td>5.00</td>
<td>19 335</td>
<td>3867</td>
</tr>
<tr>
<td>Coronary artery bypass graft</td>
<td>2.75</td>
<td>3674</td>
<td>1336</td>
</tr>
<tr>
<td>Total hip replacement</td>
<td>4.00</td>
<td>3867</td>
<td>967</td>
</tr>
<tr>
<td>Hip fracture treatment</td>
<td>3.32</td>
<td>3293</td>
<td>992</td>
</tr>
</tbody>
</table>

**QALY for an undisplaced subcapital fracture treated surgically.** The average age of patients with this fracture in our series was 76 years with a life expectancy, one year later, of 8.6 years. The prognosis for these fractures even if untreated is reasonable and is reflected in the higher Rosser matrix scores in the untreated patients.

\[
\text{QALY} = 8.6 \times [(0.98 \times 0.70) - (0.95 \times 0.60)] + 0.06 = 1.058
\]

**QALY for an undisplaced subcapital fracture treated conservatively.** Conservative treatment is associated with an increased incidence of nonunion (Bentley 1980). We have assumed in the calculation that a patient whose fracture failed to unite would require delayed surgical treatment. The QALY is therefore similar to that for operative treatment of this fracture.

\[
\text{QALY} = 8.6 \times [(0.97 \times 0.70) - (0.95 \times 0.60)] + 0.06 = 0.997
\]

**QALY for a displaced subcapital fracture treated surgically.** Untreated, this fracture has a high mortality and morbidity, while the prognosis after surgical treatment is considerably improved (one-year mortality, 32%). This gives a high QALY for these patients. The average age of patients with this fracture is 78 years, and the life expectancy at one year from injury is 7.4 years.

\[
\text{QALY} = 7.4 \times [(0.98 \times 0.68) - (0.60 \times 0.10)] + 0.06 = 4.547
\]

**QALY for a displaced subcapital fracture treated conservatively.** All patients with this type of fracture in our series were treated operatively. We have therefore used historical reports of conservative methods to estimate the results and cost of treatment.

\[
\text{QALY} = 7.4 \times [(0.70 \times 0.20) - (0.60 \times 0.10)] + 0 = 0.592
\]

**QALY for an extracapsular fracture treated surgically.** The average age of patients with this fracture is 80 years. The life expectancy at one year from injury is 6.5 years. The one-year mortality following injury is also high, at 41%.

\[
\text{QALY} = 6.5 \times [(0.94 \times 0.59) - (0.75 \times 0.40)] + 0.08 = 1.735
\]

**QALY for an extracapsular fracture treated conservatively.** The majority of extracapsular fractures in our series were treated surgically. We have based our calculation on the findings of Hornby et al (1989) and Pimpinelli and Cerulli (1979).

\[
\text{QALY} = 6.5 \times [(0.91 \times 0.50) - (0.75 \times 0.40)] + 0.08 = 1.088
\]

**Calculation of the cost per QALY.** Table III gives the results quoting prices for the financial year 1988 to 1989.

**DISCUSSION**

To calculate the QALY we have had to compare current treatment with the expected outcome if no treatment had been given. It is unethical to adopt a policy of no treatment for this injury and those patients who are not treated surgically are in fact managed conservatively, by traction, nursing care and analgesia. We have therefore had to estimate from historical knowledge and our own experience the expected outcome for the different types of fracture should medical and nursing care be withheld.

Comparisons of QALY's calculated by Williams (1985) and the cost per QALY benefit of various medical procedures are shown in Table IV.

To accept that health-service resources are finite demands a system for their allocation. The use of the QALY is still in its early stages, as reflected by the assumptions and estimations that are made in its determination. Although some question their value (Klein 1989; La Puma and Lawlor 1990) orthopaedic surgeons have increasingly to justify their choice of treatment and to demonstrate cost effectiveness. Initial analysis using the QALY shows that most orthopaedic procedures give good value for money and this should result in an increased proportion of health-service funds
being allocated to orthopaedics. Though we must also
argue that there will be occasions when the cheapest
treatment is not in the patient's best interest, a knowledge
of cost effectiveness is a necessity for today's orthopaedic
practice.

No benefits in any form have been received or will be received from a
commercial party related directly or indirectly to the subject of this
article.

REFERENCES

Bentley G. Treatment of nondisplaced fractures of the femoral neck.

Elmerson S, Zetterberg C, Andersson GB. Ten-year survival after
fractures of the proximal end of the femur. Gerontology 1988;
34:186-91.


Hornby R, Grinley Evans J, Vardon V. Operative or conservative
treatment for trochanteric fractures of the femur: a randomised


La Puma J, Lawlor EF. Quality-adjusted life-years: ethical implications

Parker MJ, Myles J, Pryor G. Cost analysis of different aspects of
treatment of patients following fracture of the proximal femur.

Pimpinelli G, Cerulli G. Survival and quality of recovery of patients
with pertrochanteric fractures of the femur. Ital J Orthop Trauma

Williams A. Economics of coronary artery bypass grafting. Br Med

Williams A. How should NHS priorities be determined? Hospital