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Cost-effectiveness of percutaneous fixation with Kirschner wires versus locking-plate for adult patients with a dorsally displaced fracture of the distal radius from the DRAFFT trial

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Ethical approval

This study approved by the Coventry research ethics committee under reference number 10/H1210/10. Approval was obtained from the research and development department of UHCW NHS trust.

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Cost-effectiveness of percutaneous fixation with Kirschner wires versus locking-plate for adult patients with a dorsally displaced fracture of the distal radius from the DRAFFT trial

Abstract

We present the economic evaluation from the Distal Radius Acute Fracture Fixation Trial, which compared the cost-effectiveness of K-wire fixation with locking-plate fixation for patients with a dorsally-displaced fracture of the distal radius.

The cost-effectiveness analysis (cost per QALY) was derived from a multi-centre, two-arm, parallel group, assessor-blind randomised controlled trial which took place in 18 trauma centres in the UK. Resource use data were received from 460 patients; only one patient did not provide any resource use data. The analysis includes both the Health Service perspective – cost of surgery, implants, physiotherapy etc – and the societal perspective - cost of time off work and private care.

There was small difference in health-related quality of life (QALYs gain) for patients treated with locking-plate versus K-wire fixation. At an additional cost of £714, locking-plate fixation presented an incremental cost-effectiveness ratio of £89,322 per QALY within the first 12 months of treatment. A number of sensitivity analyses were undertaken, but the incremental cost-effectiveness ratios of locking-plates fixation compared with K-wires were always more than £30,000.

The economic evaluation is driven by the choice of fixation; K-wire fixation is a 'cost saving' intervention being substantially less expensive than locking-plate fixation.

Key words: cost-effectiveness – distal radius fractures – fixation – K-wire – QALY – volar locking-plate – within-trial

JEL classification: D04 - D69 - I18

1 Introduction

Fractures of the distal radius are extremely common injuries; they are treated non-operatively if the bone fragments can be held in anatomical alignment by a plaster cast or orthotic. However, if this is not possible then surgical fixation is required. Surgery may provide functional benefits, but carries a risk of complications for the patients and considerable expense for the healthcare system; much of that expense is related to the choice of fixation.

The two most common forms of surgical treatment for dorsally displaced fractures are K-wire fixation and locking-plate fixation. In the last five years, there has been a rapid rise in the use of locking-plates despite the additional cost of the implants (Mellstrand-Navarro et al., 2014). This change in practice was predominantly based upon the results of single-centre trials which suggested that locking-plates provide improved radiological and/or functional outcomes (Karantana et al., 2013, Downing and Karantana, 2008, Rozental et al., 2009, Marcheix et al., 2010a, McFadyen et al., 2011, Hollevoet et al., 2011, Marcheix et al., 2010b).

We present the health economic evaluation from a multi-centre randomised controlled trial of K-wire fixation versus locking-plate fixation in the treatment of adult patients with a dorsally displaced fracture of the distal radius; UK DRAFFT.

2 Patients and methods

Intervention and sample

Patients were eligible for the trial if they were 18 years or over, with a dorsally displaced fracture of the distal radius, within 3 cm of the radio-carpal joint. The only other inclusion criterion was that the treating surgeon believed that the patient would benefit from surgical fixation of the fracture. Further details of the protocol are reported elsewhere (Costa et al., 2011). The primary outcome measure was the Patient Rated Wrist Evaluation (PRWE) (MacDermid et al., 1998). The clinical analysis concluded that this trial showed no difference in functional outcome between K-wires and volar locking-plates for patients with dorsally displaced fractures of the distal radius (Costa et al., 2014).

Perspective

We assessed the cost-effectiveness of locking-plate fixation versus K-wire fixation for the treatment of distal radial fractures from the NHS perspective and from a societal perspective. The NHS perspective considers only resources used within the NHS setting; the societal perspective additionally considers private costs including time-off work due to the treatment. All costs were adjusted to 2012 prices using the CCEMG-EPPI Centre Cost Converter (CCEMG-EPPI, 2013). The analysis uses the within-trial period (twelve months following the injury), discounting for the future cost and health outcome was not necessary. The currency used was the pound sterling (£).

Quality of life

Patient's health-related quality of life was assessed using the EQ-5D-3L questionnaire (Brooks et al., 2005) pre-injury, at baseline, 3, 6 and 12 months. Changes in EQ-5D scores were evaluated using two-sample t-tests to explore any important differences in the follow-up points within the time frame of the trial. In line with the NICE reference case (NICE, 2008) the primary outcome for the economic evaluation was quality-adjusted life years (QALYs). Patient responses to the EQ-5D questionnaire at each time point were converted to QALYs using the standard UK tariff values (Dolan, 1997) and "an area under the curve approach". Average QALYs between adjacent time points were calculated to generate smoothed estimates between those time points.

Resource use and valuation

The total cost of each arm of the trial was calculated combining the reported resource usage over the 12 month follow up and unit cost data along with the initial surgery cost.

Patients reported resource usage within the trial at 3, 6 and 12 months. For the 3 month data, the recall period was since discharge from hospital. For the other cases, it was since the last questionnaire was due to be completed. The questionnaires included number of further inpatient stays following the initial operation; number of outpatient, primary and community care visits, use of aids and adaptations and medication use. Patients also reported use of personal social services related to their treatment including number of weeks of frozen/hot meals on wheels, and laundry services.

Resource usage figures were converted into costs using unit cost figures from the PSSRU Costs of Health and Social Care 2012 (Curtis, 2012) and the Department of Health's Reference Costs

(Department of Health, 2013). In Appendix, Table A1 presents the summary of health care use collected and associated unit costs.

Further inpatient care following the initial operation was costed as Minimal Elbow and Lower Arm Procedures for Non-Trauma except if surgical hand complications like metal removal or debridement were reported at 6-week follow-up, where inpatient stay was costed for Trauma.

Unit costs for medications were obtained from the British National Formulary ((BNF), 2013) and the NHS Electronic Drug Tariff (Wales, 2013). Patients reported details for medications that were taken within the three budgetary periods (discharge to 3 months, 3-6 months, and 6-12 months). Total medication costs were then calculated using the average cost per dose for each product. Table A2 shows all the unit costs for the drugs that were reported in the trial.

Unit costs for aids and adaptations were taken from the website http://www.mobilitysmart.cc/, which supplies the NHS. Patients reported any equipment that they had used to protect their injury or make their daily life easier to manage. Reported aids and adaptations and unit prices are available in Table A3.

The initial fixation surgery cost was based on the initial hospital stay and the operative cost. The cost of the initial distal radial fracture fixation surgery was assessed using NHS reference costs and HRG cost for Minor Elbow and Lower Arm Procedures for Trauma. Costs for the initial operative period were identified for each patient using the average length of stay as reported in the patient records for the primary surgery. They were assumed to be £1,375.34 for a day case or £1,983.39 for overnight admission. Excess bed day costs were used when patient experienced a length of stay beyond the average reported length of stay. For example, the cost to NHS was £1,375.34 if a patient was discharged the same day, £1,983.39 if the patient was referred to overnight hospital care at least one night but no more than the average length of stay; extra bed day costs (based on a bed day cost of £278.07) were added if a patient stayed more than the average length of stay. This cost was taken to include all expenditures incurred prior to discharge, including any items provided to patients before departure. The operative costs for both locking plate and K-wire fixations were provided by the University Hospitals of Coventry and Warwickshire (UHCW) finance department, these included implant costs and consumables and are reported in Table A4.

Productivity and private costs

Cost from the societal perspective were calculated by combining loss of earnings due to work absence, private costs such as treatments within private settings and out-of-pocket expenses incurred as a result of the wrist surgery, and reported use of personal social services related to the treatment. Personal social services included number of weeks of frozen/hot meals on wheels, laundry services, and number of visits of carers and social workers. Unit costs were assigned using PSSRU and information from Centres of Personal Social Services; they are reported in Table A5.

Patients reported their time off work in days or in terms of lost income at every collection point. A human capital approach was used to generate the cost of lost productivity per day using the gross median weekly pay rate for full-time employees from the Office for National Statistics (£506, April 2012) divided by five.

Missing data

The mean total costs per patient from a NHS perspective was calculated adding the cost of inpatient stay, outpatient visit, consultations, medication, equipment, and intervention costs for all patients where response data were available. Respondents who failed to complete individual items of the EQ-5D were not allocated a utility index score. From the overall sample, missing data represented 7.07%. The complete data analysis was based on 278 patients. For those cases in which either resource usage or quality of life data was unavailable, we addressed missingness using multiple imputations via chained equations (Little and Rubin, 2002) assuming missing at random and using STATA 12. Missing cost data were predicted in terms of QALYs, treatment received, length of stay, age, gender, job status, patient's self-reported health status, PRWE score, and Disability of the Arm, Shoulder and Hand score. Missing QALYs data were predicted in terms of this same list (excluding QALYs), plus each of the cost items. In order to remove implausible data, missing cost data were constrained to be positive. A total of 10 imputations were created to stabilise the results. The reported cost-effectiveness results were synthesized based on all imputed datasets.

Cost-effectiveness analysis

The within-trial analysis aimed to determine the intervention that would maximise health outcomes within (1) the limited NHS budget and (2) within a societal perspective over the 12-month trial follow up. It adopted an intention-to-treat perspective and consisted in a cost-utility analysis examining the cost per QALY gained for all patients. Descriptive statistics of costs and EQ-5D scores were initially undertaken and parametric tests conducted to evaluate any important differences in the end points within the time frame of the trial. Incremental cost-effectiveness ratios (ICER) were then calculated dividing the average difference in cost between the two arms by the average difference in QALYs between the two arms.

The ICER represents the additional cost per one unit of outcome gained. This indicates the trade-off between total costs and effectiveness when choosing between volar locking-plate fixation and K-wire fixation. When compared against the marginal trade-off for the NHS as a whole this gives an indication of whether spending additional money on volar locking-plate fixation appears efficient. As a guideline rule, the National Institute for Health and Care Excellence considers as cost-effective an intervention with an ICER of less than £20,000 per QALY and generally states that an intervention costing more than £30,000 per QALY is not considered cost-effective.

The nonparametric bootstrapping approach with replacement was used to determine the level of sampling uncertainty around the ICER; the bootstrap consists in resampling from the original sample to create multiple random samples and generate 10,000 estimates of incremental costs and benefits. The uncertainty in the ICER was presented using cost-effectiveness acceptability curves (CEACs) illustrating the probability that each treatment is cost-effective in relation to the comparative intervention, as a function of the willingness-to-pay (Ramsay et al., 2001).

A number of univariate sensitivity analyses were conducted. To evaluate the impact of missing data, a complete case analysis was conducted where only those participants with no missing data were analysed. We then separated the analysis according to age (above or below 50 years) as age was used as a stratification factor in the trial to balance differences in bone density between younger and older patients; the two age groups are assumed to present different types of fractures (high and low energy fractures) and so the impact of the fixation was expected to differ by age. Finally, adjusted cost-effectiveness analyses were also undertaken using baseline covariates including age, gender, and EQ-5D scores.

3 Results

Trial recruitment

From January 2011 through July 2012, 461 patients were randomised (K-wire=230; locking-plate=231). One patient in the locking-plate arm of the study did not provide any quality of life data and so was excluded from the analysis.

Quality of life

Table 1 details the EQ-5D scores at pre-injury, baseline, 3, 6 and 12 months when missing values were imputed. Both groups showed increasing EQ-5D scores from baseline to the last follow-up point. The most important increase was observed between baseline and 3 month; doubling the baseline EQ-5D score in both arms. It was noted that patients at 12 months had not recovered an EQ-5D score equivalent to their pre-injury EQ-5D score. The average total QALYs over the 12 months was marginally higher in the locking-plate arm (0.742) than in the K-wire arm (0.734). There were no significant differences between EQ-5D scores at baseline for the two treatment arms.

Health care resource usage

Resource use was broadly comparable between the two treatments (Table A6). Patients were frequent users of physiotherapy outpatient visits (6.9 visits over the 12 months) and reported on average 3.6 visits in radiology and 3.6 visits in orthopaedics. Visits to the GP and nurses were infrequent. Patients reported using a wrist brace or splint. In terms of medications, we noted that paracetamol tablets were the most reported medications in the questionnaire.

Costs

The mean total NHS resource use costs were respectively £3,385 for K-wires and £4,288 for volar locking-plate and were significantly higher for volar locking-plate (+£903) (Table 2). Lost earnings and productivity losses to employers through sickness absences appeared higher in the K-wire arm, but the difference was not significant. Overall societal costs were on average £48 higher in the K-wire arm.

Cost-effectiveness and sensitivity analyses

The results suggested that volar locking-plate was more expensive than K-wires with an incremental cost of £726.46 and had higher, albeit small, QALY gains. Differences in QALY gains were 0.008 QALYs (which is equivalent to an extra three days of perfect health per year) between groups. We graphically represented the uncertainty of these estimates; Figure 1 showed that all the points were above the x-axis, indicating that the volar locking-plate was more costly, and more points were to the right of the y-axis, indicating that volar locking-plate produced more QALYs. The points in the plane lay in the area e where there is a trade-off between effect and cost: additional health benefit can be obtained but at higher cost. The ICER of locking-plate versus K-wires equalled £89,322 per QALY and under these circumstances, locking-plate could not be considered cost-effective as its ICER was above the NICE £20k-£30k per QALY range. The CEAC is presented in Figure 2 with a range of willingness-to-pay (WTP) thresholds values.

The probability of locking-plate fixation to be cost-effective was very low; at a WTP threshold of £20,000 per QALYs it was nil and only raised to 3% at a threshold of £30,000.

Within most of the sensitivity analyses undertaken here, the ICER appeared to remain above the £20k-£30k per QALY range (Table 3) even with the adjusted analysis that showed a lower incremental cost for a similar incremental QALYs gain both in the NHS and the societal perspectives. In the sample of patients aged more than 50, the evaluation suggested that patients who were treated with a locking-plate fixation gained 0.018 QALYs more than those treated with a K-wire fixation at an increased cost of £629 per patient, yielding an incremental cost-effectiveness ratio of £35,323 per QALY. In the sample of patients aged less than 50, locking-plate fixation was associated with lower benefits and higher costs than K-wires fixation, and so locking-plate fixation appeared to be dominated for this subgroup of individuals.

4 Discussion

In comparison with K-wires, locking-plate fixation did not show clinically relevant differences in QALY gain within the first 12 months from surgery. However, locking-plate fixation did present greater costs; these were largely driven by the higher cost of the initial surgery (£818.26 vs. £54.23). This incremental cost was not offset against a decrease in health care resource use or savings in lost productivity during the 12 months follow-up after discharge. The incremental cost of locking-plate fixation from an NHS perspective was £726 and £581 from a societal perspective.

The base-case analysis found an incremental QALY gain to favour locking-plate fixation but the difference was very small 0.008 (95% CI: -0.001 to 0.018) and the confidence intervals excluded QALY gain values whereby locking-plates would be a cost-effective intervention. A back-of-the-envelope-calculation yields that a net QALY gain of at least 0.036 would be required for the incremental cost of £726 to provide cost-effectiveness at a willingness-to-pay of £30,000 per QALY. The locking-plates would have had to provide very much greater QALY gains for the NHS to consider paying the extra cost of the implants. The high ICER and the low probability of locking-plate fixation to be cost-effective for a £20k-£30k willingness-to-pay threshold demonstrated that locking-plate fixation is not cost-effective. This result is robust to sensitivity analysis and stochastic bootstrapping.

The results showed that EQ-5D score was a suitable measure of health utility for this population and was sensitive to distal radius fracture and fixation as there were important changes in the score values over the follow-up points. Previous cost analyses have focused on comparing the cost of surgical fixation versus non-surgical treatment (Shauver et al., 2011a, Shauver et al., 2011b, Papaloizos et al., 2004, Schonnemann et al., 2011, Davis et al., 2006, Vinnars et al., 2007, Arora et al., 2007), they concluded that surgery had a higher initial cost, and could induce costs in relation to post-surgery complications. However, few studies have provided a comparative cost analysis of different types of surgical fixation. Shyamalan et al. (Shyamalan et al., 2009) retrospectively undertook a micro-costing analysis of percutaneous K-wire fixation for a distal radial fracture and locked volar-plate fixation for a sample of 10 patients for each treatment. They found a difference of £1,549 and 65 min theatre time between performing a percutaneous K-wire fixation procedure and a volar locked-plate procedure. The choice of implants also appeared to influence the overall cost considerably (Horriat and Marsh, 2011, Kakarlapudi et al., 2000). However, in the absence of randomised control trials comparing surgical options for the management of distal radial fractures, the cost-effectiveness of distal fracture fixations had never been fully explored. This is a particularly pertinent issue, since the current trend in surgical practice is towards the increasing use of the more expensive locking-plate fixation.

The main limitation of the trial is that it was not possible to blind either the surgeons or the patients to the study treatments. It is important to underline that we used here a ‘conservative’ estimate of the cost of initial surgery: this did not take into account the extra theatre operating time required for the locking-plate fixation: 31 min for wires and 66 min for plates. It is likely that a micro-costing analysis of the initial surgery in each arm could lead to even higher costs differences.

In conclusion, K-wire fixation is a ‘cost saving’ intervention being substantially less expensive than locking-plate fixation and locking-plates fixation showing minimal difference in health benefits.

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6 Tables and figures

Table 1 – Mean EQ-5D index scores at the baseline and follow-ups and annual QALYs of distal fracture fixation by treatment arms

	K-Wire n = 141	**Locking-plate n=137**	**Difference**
	Mean (SD)	**Mean (SD)**	**P-value of t-test**
Retrospective pre-injury	0.928 (0.170)	0.947 (0.149)	0.320
Baseline	0.354 (0.303)	0.373 (0.317)	0.611
3 months	0.725 (0.210)	0.739 (0.224)	0.591
6 months	0.787 (0.193)	0.807 (0.183)	0.366
12 months	0.842 (0.188)	0.845 (0.184)	0.918
	Mean (SD)	**Mean (SD)**	**Difference (95% CI)**
Total QALYs (non-imputed)	0.734 (0.166)	0.742 (0.159)	0.008 (-0.001, 0.018)
Total QALYs (imputed)	0.734 (0.167)	0.744 (0.156)	0.010 (0.001, 0.019)

Table 2 – Costs of resources used in relation to distal fracture fixation by treatment arms

	K-Wire n = 230	**Locking-plate n=230**	**Difference**
	Mean (SD)	**Mean (SD)**	**P-value of t-test**
NHS resource use costs*	£1524.84 (1840.14)	£1590.19 (2216.07)	0.789
Social care costs	£13.01 (105.37)	£8.18 (57.97)	0.637
Private cost	£9.74 (66.51)	£22.05 (149.05)	0.372
Cost of lost productivity	£394.26 (1704.29)	£249.16 (1128.92)	0.405
	Mean (SD)	**Mean (SD)**	**Difference (95% CI)**
Total costs (NHS PSS perspective)**	£3440 (2539)	£4154 (2203)	£714 (588, 864)
Total costs (Societal perspective)**	£3832 (3142)	£4413 (2927)	£581 (401, 761)

*The costs do not include the cost of the initial operation/care.
**The costs include the cost of the initial operation/care.

Table 3 – Incremental cost-effectiveness

Scenario	Incremental costs	Incremental QALYs	ICER (Cost per QALY)
Base case (imputed, NHS PSS perspective)	£714 (588, 864)	0.008 (-0.001, 0.018)	£89,322
Complete case (NHS PSS perspective)	£903 (392, 1414)	0.014 (-0.025, 0.053)	£64,026
Above 50 years old (NHS PSS perspective)	£629 (412, 846)	0.018 (0.007, 0.029)	£35,323
Below 50 years old (NHS PSS perspective)	£446 (172, 720)	-0.013 (-0.028, 0.003)	K-wires dominates
Base case (imputed, societal perspective)	£581 (401, 761)	0.010 (0.001, 0.019)	£58,852
Complete case (societal perspective)	£791 (60, 1521)	0.014 (-0.025, 0.053)	£56,020

Figure 1 – Cost-effectiveness plane generated from bootstrapped mean cost and QALYs differences over 12 months (NHS perspective, all patients)

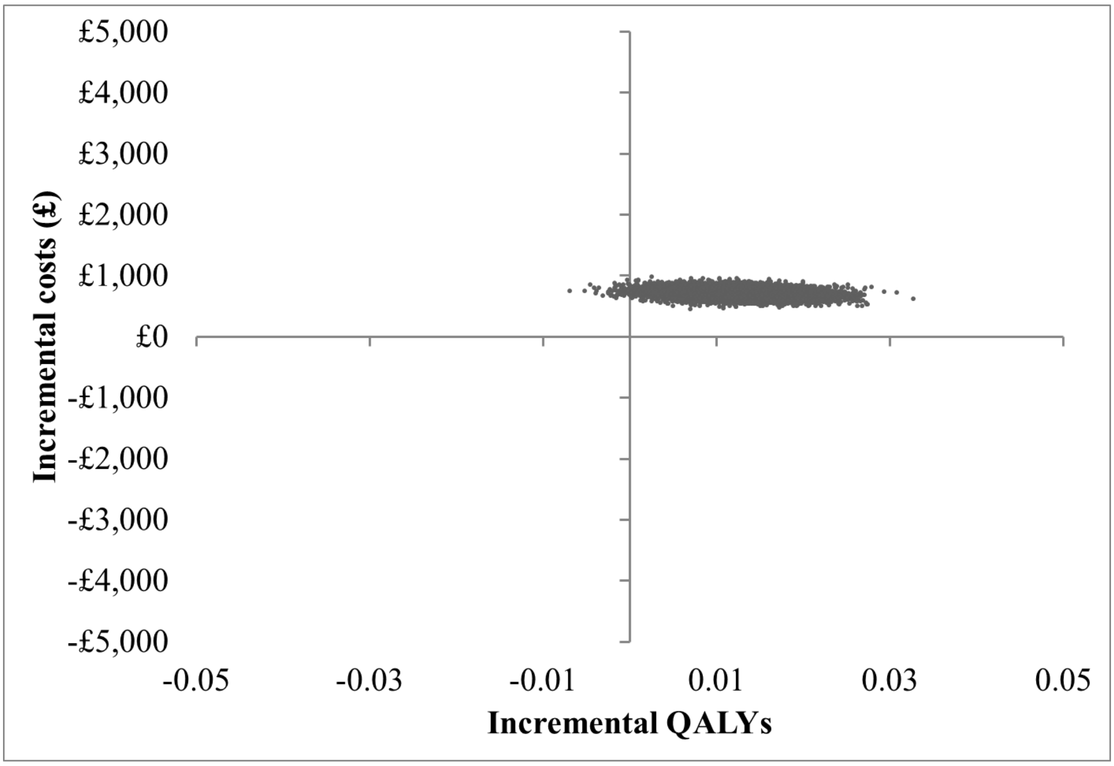
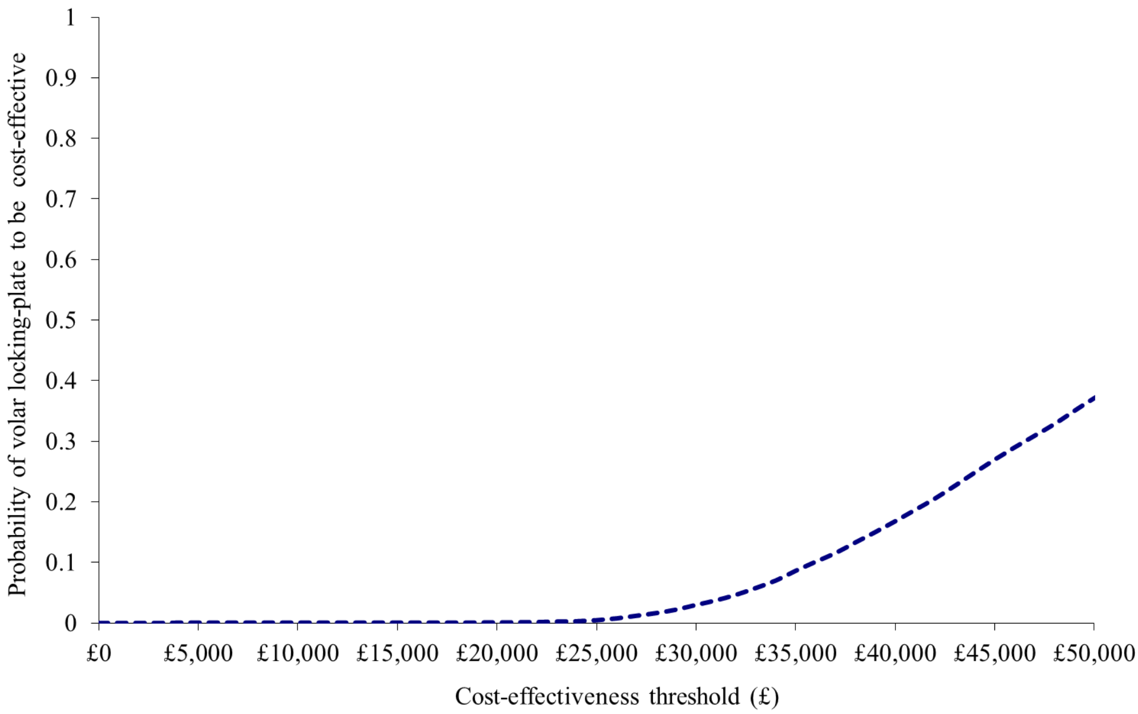


Figure 2 – Cost-effectiveness acceptability curves at 12 months (NHS perspective, all patients)



Appendix

Table A1 – Summary of patient-reported health care use and associated unit costs

Item	Unit cost (£)	Source
Subsequent Inpatient Care		
Inpatient (orthopaedics – wrist/arm)		
Cost for average LOS	£2064.71	National schedule of reference costs year 2011-2012 -
Day case	£692.04	National schedule of reference costs year 2011-2012 -
Adjustment per day ± av. LOS	£302.01	National schedule of reference costs year 2011-2012 -
Inpatient (orthopaedics – other bones)		
Cost for average LOS	£3556.04	National schedule of reference costs year 2011-2012 -
Day case	£928.36	National schedule of reference costs year 2011-2012 -
Adjustment per day ± av. LOS	£293.08	National schedule of reference costs year 2011-2012 -
Inpatient (other non-surgery)		
Cost for average LOS	£2688.10	National schedule of reference costs year 2011-2012 -
Day case	£602.61	National schedule of reference costs year 2011-2012 -
Adjustment per day ± av. LOS	£261.21	National schedule of reference costs year 2011-2012 -
Inpatient (other)		
Rehabilitation unit	£985.00	PSSRU 2012, p.114, weekly service costs per bed
Outpatient care		
Orthopaedics	£103.72	National schedule of reference costs year 2011-2012 -
Pathology	£60.74	National schedule of reference costs year 2011-2012 -
Radiology	£153.21	National schedule of reference costs year 2011-2012 -
Physiotherapy	£40.70	National schedule of reference costs year 2011-2012 -
Primary and community care		
GP surgery visit	£40.00	PSSRU2012, p.182-3, £3.40 per min, average 11.7 min
GP clinic visit	£58.00	PSSRU2012, p.182-3, £4.3 per min, 17.2 mins per visit
GP home visit	£101.00	PSSRU2012, p.182-3, £258 per hour, average 23.4 min
GP phone contact	£24.00	PSSRU2012, p.182-3, 7.1 min contact
Practice nurse surgery visit	£11.63	PSSRU2012, p.180-1, £45 per hour, average 15.5 min
Practice nurse home visit	£18.75	PSSRU2012, p.180-1, £45 per hour, average 25 min visit
Practice nurse phone contact	£3.50	PSSRU2012, p.180-1, £35 per hour, average 6 min visit
District nurse surgery visit	£10.85	PSSRU2012, p.175, £42 per hour, average 15.5 min visit
District nurse home visit	£21.83	PSSRU2012, p.175, £61 per hour, average 20 min visit
District nurse phone contact	£4.2	PSSRU2012, p.175, £42 per hour , average 6 min visit
Physiotherapist surgery visit	£15.00	PSSRU2012, p.167, £30 per hour, average 30 min per
Physiotherapist home visit	£44.16	PSSRU2010, p.151, £39 per hour, average 60 min,
Occupational therapist surgery visit	£15.00	PSSRU2012, p.167, £30 per hour , average 30 min per
Occupational therapist home visit	£44.16	PSSRU2010, p.151, £39 per hour, average 60 min visit

Table A2 – Summary of patient-reported medication use and associated unit costs

Item	Unit cost (£)	Source
ADCAL	£7.25	(from pack of 100)
ADCAL-D3	£3.84	1500 mg (from pack of 56)
Acupan	£10.54	30 mg(from pack of 90)
Adalat (Nifedipine)	£7.23	5 mg (from pack of 84)
Alendronic Acid	£1.10	70 mg(from pack of 4)
Alendronic Acid	£1.44	10 mg(from pack of 28)
Amoxicillin	£0.95	250 mg(from pack of 21)
Amitriptyline	£0.84	10 mg(from pack of 28)
Amitriptyline	£0.83	25 mg(from pack of 28)

Item	Unit cost (£)	Source
Aspirin	£0.76	75 mg(from pack of 28)
Atenolol	£0.83	100 mg (from pack of 28)
Atorvastatin	£1.89	10 ml (from pack of 28)
Bendroflumethiazide	£0.81	2.5 mg (from pack of 1)
Benlafaxine	£2.62	37.5 mg (from pack of 56)
Bisoprolol	£1.02	5 mg (from pack of 28)
Cacit	£11.81	(from pack of 76)
Calceos	£3.62	(from pack of60)
Calcichew	£4.24	(from pack of 60)
Calcium Carbonate chewable	£9.33	(from pack of 100)
Calfovit D3	£4.32	(from pack of30)
Citalopram	£1.31	10 mg (from pack of 28)
Clarithramycin	£2.52	250 mg (from pack of14)
Co-Amoxiclan	£2.34	250 mg (from pack)
Co-codamol (tablet)	£3.54	30 mg (from pack of100)
Codeine (tablet)	£2.26	30 mg (from pack of 30)
Co-Dyramol	£1.06	500 mg (from pack of 30)
Diclofenac	£1.42	50 mg (from pack of84)
Dihydrocodeine	£5.18	60 mg (from pack of 56)
Emulgel	£1.55	(from pack of 20)
Enalapril Maleate	£0.95	10 mg (from pack of 28)
Ergocalciferol	£30.34	1.25 mg (from pack of 50,000)
Eye Drops	£2.80	(from pack of 10)
Ferrous Sulphate	£1.01	(from pack of 28)
Floxacillin	£1.77	250 mg (from pack of 1)
Flucloxacillin	£2.89	500 mg (from pack of 28)
Fultium	£8.44	(from pack of 84)
Furosemide	£0.80	20 mg (from pack of 28)
Ibruprofen	£1.44	200 mg (from pack of 84)
Ibruprofen	£1.73	400 mg (from pack of 84)
Ibuprofen (gel)	£2.13	50 g (from pack of 1)
Lansoprazol	£1.20	15 mg (from pack of 28)
Lercanidipine	£4.98	10 mg (from pack of 28)
Livial Tibolone	£10.36	2.5 mg (from pack of 28)
Meloxicam	£1.54	15 mg (from pack of 30)
Meptid	£22.11	200 mg (from pack of 112)
Mirtazapine	£3.08	15 mg (from pack of 28)
Morphine	£11.21	10 mg (from pack of 1)
Naproxen	£1.25	250 mg (from pack of 28)
Naproxen	£1.65	500 mg (from pack of 28)
Nefopam	£10.54	30 mg (from pack of 90)
Nextum	£25.19	40 mg (from pack of 28)
Olanzapine	£1.17	2.5 mg (from pack of 28)
Omeprazole	£1.62	20 mg (from pack of 28)
Oramorph	£1.78	10 mg (from pack of 100)
Oxycodone	£8.70	5 ml (from pack of 50)
Oxycontin	£49.82	20 mg (from pack of 56)
Oxycontin	£74.81	30 mg (from pack of 56)
Paracetamol (tab)	£0.16	500 mg (from pack of 16)
Polyfax	£3.26	4 g (from pack of 1)
Pregabalin	£2.77	400 mg (from pack of 84)
Protelos	£25.60	2 g (from pack of 28)

Item	Unit cost (£)	Source
Risedeonate	£19.12	35 mg (from pack of 4)
Romipril (cap)	£1.39	10 mg (from pack of 28)
Solphadol	£6.74	(from pack of 100)
Tomoxifen	£5.71	10 mg (from pack of 30)
Tramadol	£1.14	50 mg (from pack of 30)
Voltrrol	£3.46	25 mg (from pack of 30)
Zopiclone	£1.30	(from pack of 28)

Table A3 – Summary of patient-reported aids and adaptation equipment use, personal social services and associated unit costs

Item	Unit cost (£)	Source
Aids and adaptation		
Wrist brace/splint	£10.00	MobilitySmart
Grab rail	£95.00	PSSRU2012, p.111, average
Dressing aids	£5.95	MobilitySmart
Long-handle shoe horns	£3.98	MobilitySmart
Bathing aids	£23.35	MobilitySmart
Kitchen aids (jar/tin openers, etc)	£21.44	MobilitySmart
Personal social services		
Frozen meals on wheels (weekly)	£41.40	Lewisham council, adult social
Hot meals on wheels (weekly)	£46.00	PSSRU2012 - p125
Laundry services (per load)	£4.30	North Yorkshire social care
Care workers/Help at home (per	£18.00	PSSRU2012, p.193 per weekday
Social workers (per visit)	£39.00	PSSRU2012, p.190 per hour

Table A4 – Summary of the initial surgery theatre cost including consumables & prosthetic devices

Description of item	Code of Item	Quantity used	Unit Price	Cost £
K-wire				
Reinforced gown XL	95224	2	3.74	7.48
Surgical Visor Masks	48247	2	1.01	2.03
Theatre Masks	48100	2	0.06	0.11
Gammex gloves	351143	1	0.68	0.68
Biogel gloves	96180	2	1.14	2.28
Non-sterile gloves	8801	5	0.02	0.11
Image Intensifier Cover	39.00.02	3	2.49	7.47
Laceration Pack	RMT9150	1	13.24	13.24
Surface Wipes	CMW01X	6	0.03	0.18
Black Bag		1	0.06	0.06
Yellow Bag	UN3291	2	0.05	0.11
Polythene Bag for Extras		1	0.02	0.02
Inco Pad	200995	2	0.13	0.26
K wire	OS292160	3	2.94	8.82
Sterilation of Drill	TSU	1	10.00	10.00
Ethicon sutures	w319	1	1.22	1.22
Mepore 9*10cm	r33334	1	0.16	0.16
Total for equipment used for K-wire surgery				54.23
Locking-plate				
Surgical Visor Masks	48247	3	1.01	3.04
Theatre Masks	48100	2	0.06	0.11
Gammex gloves	351143	1	0.68	0.68
Biogel gloves	96180	3	1.14	3.42
Non-sterile gloves	8801	6	0.02	0.14
Image Intensifier Cover	39.00.02	3	2.49	7.47
Upper Limb Pack	RMT9150	1	12.40	12.40
Surface Wipes	CMW01X	6	0.03	0.18
Black Bag		1	0.06	0.06
Yellow Bag	UN3291	2	0.05	0.11
Polythene Bag for Extras		1	0.02	0.02
Inco Pad	200995	2	0.13	0.26
DVR Plate	DVRAW(L/R)	1	384.00	384.00
Shaft Screws	CS(14)	3	27.00	81.00
Bar Screws	FP(12)	6	44.00	264.00
Sterilation of Drill	TSU	1	10.00	10.00
Ethicon sutures	w319	1	1.22	1.22
Mepore 9*10cm	r33334	1	0.16	0.16
Sterilisation of basic set	TSU	1	20.00	20.00
Sterilisation of drill	TSU	1	10.00	10.00
Sterilisation of DVR set	TSU	1	20.00	20.00
Total for equipment used for locking-plate surgery				818.26

Table A5 – Use of health care resources related to distal fracture fixation by each follow up period and treatment arm (complete case)

		K-Wire n =141	Locking-plate n =137	Difference
		Mean Usage (SD)	**Mean Usage (SD)**	**P-value of t test**
Subsequent Inpatient Care				
Orthopaedics (wrist, arm, other bones)		0.383 (1.252)	0.343 (1.320)	0.796
Rehabilitation unit		0.007 (0.084)	0 (0)	0.325
Other surgery		0.170 (0.845)	0.117 (0.385)	0.500
Outpatient care				
Orthopaedics		3.340 (4.063)	3.788 (4.633)	0.392
Pathology		0.298 (1.423)	0.358 (1.464)	0.730
Radiology		1.801 (2.723)	2.197 (2.695)	0.225
Physiotherapy		6.128 (8.255)	7.584 (11.212)	0.218
Primary and community care				
In surgery				
GPs		0.766 (2.144)	0.555 (1.212)	0.315
Practice Nurse		0.113 (0.549)	0.080 (0.322)	0.541
Physiotherapist		0.879 (2.126)	0.854 (4.420)	0.951
Occupational therapist		0.071 (0.408)	0.088 (1.025)	0.858
In clinic				
GPs		0	0.029 (0.241)	0.151
Practice Nurse		0	0.007 (0.085)	0.311
District nurse		0	0	
Physiotherapist		0.241 (0.940)	0.409 (2.102)	0.389
Occupational therapist		0.014 (0.168)	0.051 (0.426)	0.340
At home				
Practice Nurse		0.007 (0.084)	0	0.325
Physiotherapist		0.014 (0.168)	0	0.325
Occupational therapist		0.071 (0.842)	0	0.325
Aids and adaptation				
Wrist brace/splint		0.780 (1.076)	0.964 (1.239)	0.188
Grab rail		0.078 (0.464)	0.029 (0.270)	0.286
Dressing aids		0.071 (0.425)	0.109 (0.649)	0.557
Long-handle shoe horns		0.014 (0.168)	0.007 (0.085)	0.669
Bathing aids		0.021 (0.145)	0	0.087
Kitchen aids (jar/tin openers etc)		0.078 (0.687)	0.066 (0.406)	0.856
Medications				
ADCAL		0.028 (0.205)	0.007 (0.085)	0.267
ADCAL-D3	1500 mg	0.064 (0.418)	0.058 (0.482)	0.920
Acupan	30 mg	0.007 (0.084)	0	0.325
Alendronic Acid	10 mg	0.043 (0.235)	0.022 (0.147)	0.382
Alendronic Acid	70 mg	0.220 (1.043)	0.0451 (0.390)	0.077
Amitriptyline	10 mg	0.064 (0.600)	0.058 (0.683)	0.944
Amitriptyline	25 mg	0	0.029 (0.241)	0.151
Amoxicillin	250 mg	0	0.022 (0.256)	0.311
Aspirin	75 mg	0.028 (0.337)	0.073 (0.703)	0.499
Atenolol	100 mg	0	0.029 (0.342)	0.311
Atorvastatin	10 ml	0.028 (0.337)	0	0.325
Bendroflumethiazide	2.5 mg	0	0.657 (7.689)	0.311
Bisoprolol	5 mg	0.028 (0.337)	0	0.325
Cacit		0	0.007 (0.085)	0.311
Calcium Carbonate Chewable		0.028 (0.205)	0.015 (0.171)	0.544
Calceos		0.043 (0.376)	0.036 (0.307)	0.883

		K-Wire n =141	Locking-plate n =137	Difference
		Mean Usage (SD)	Mean Usage (SD)	P-value of t test
Calcichew		0.035 (0.421)	0.066 (0.571)	0.615
Calfovit D3		0.007 (0.084)	0	0.325
Citalopram	10 mg	0.028 (0.337)	0	0.325
Clarithramycin	250 mg	0.007 (0.084)	0	0.325
Co-Amoxiclan	250 mg	0	0.022 (0.256)	0.311
Co-Dyramol	500 mg	0	0.044 (0.361)	0.151
Co-codamol (tab)	30 mg	0.142 (0.661)	0.095 (0.541)	0.518
Codeine (tab)	30 mg	0.652 (3.408)	0.234 (1.208)	0.176
Diclofenac	50 mg	0.043 (0.313)	0.051 (0.390)	0.840
Dihydrocodeine	60 mg	0.121 (1.143)	0.095 (1.111)	0.850
Enalapril Maleate	10 mg	0.007 (0.084)	0	0.325
Ergocalciferol	1.25 mg	0.007 (0.084)	0	0.325
Eye Drops		0.128 (1.516)	0	0.325
Ferrous Sulphate		0	1.02 (0.851)	0.155
Floxacillin	250 mg	0.794 (9.432)	0	0.325
Flucloxacillin	500 mg	0.014 (0.168)	0.015 (0.171)	0.984
Fultium		0.014 (0.168)	0	0.325
Furosemide	20 mg	0.028 (0.337)	0	0.325
Ibruprofen	200 mg	0.092 (0.477)	0.102 (0.633)	0.882
Ibruprofen	400 mg	0.007 (0.084)	0.022 (0.190)	0.400
Ibuprofen (gel)	50 g	0.007 (0.084)	0	0.325
Lactulose	300 ml	0	1.314 (15.378)	0.311
Lansoprazol	15 mg	0	0.029 (0.342)	0.311
Lercanidipine	10 mg	0	0.029 (0.342)	0.311
Livial	2.5 mg	0.043 (0.505)	0	0.311
Meloxicam (tab)	15 mg	0	0.022 (0.256)	0.311
Mirtazapine	15 mg	0.014 (0.168)	0.029 (0.342)	0.641
Meptid	200 mg	0	0.007 (0.085)	0.311
Morphine	10 mg	0.397 (4.716)	0.044 (0.513)	0.384
Naproxen	250 mg	0.014 (0.168)	0.015 (0.171)	0.984
Naproxen	500 mg	0	0.015 (0.171)	0.311
Nextum	40 mg	0	0.029 (0.342)	0.311
Nefopam	30 mg	0	0.015 (0.171)	0.311
Olanzapine	2.5 mg	0	0.029 (0.342)	0.311
Omeprazole	10 mg	0.007 (0.084)	0.029 (0.342)	0.457
Omeprazole	20 mg	0.035 (0.347)	0.029 (0.342)	0.880
Oramorph	10 mg	0	0.007 (0.085)	0.311
Oxycodone	5 ml	0	0.007 (0.085)	0.311
Oxycontin	20 mg	0.028 (0.337)	0	0.325
Oxycontin	30 mg	0.028 (0.337)	0	0.325
Paracetamol (tab)	500 mg	2.702 (10.11)	1.285 (4.618)	0.136
Polyfax	4 g	0.298 (3.537)	0	0.325
Protelos	2 g	0	0.029 (0.342)	0.311
Risedeonate	35 mg	0.028 (0.337)	0.058 (0.482)	0.546
Romipril (cap)	10 mg	0	0.029 (0.240)	0.311
Solphadol		0	0.022 (0.256)	0.311
Tomoxifen	10 mg	0	0.022 (0.180)	0.311
Tramadol	50 mg	0.262 (1.850)	0.212 (1.160)	0.785
Voltrol	25 mg	0	0.029 (0.208)	0.097
Zopiclone		0	0.007 (0.085)	0.311