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Cost–utility analysis of osteopathy in primary care: results from a pragmatic randomized controlled trial

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Background. Spinal pain is common and costly to health services and society. Management guidelines have encouraged primary care referral for spinal manipulation, but the evidence base is weak. More economic evaluations alongside pragmatic trials have been recommended.

Objective. Our aim was to assess the cost–utility of a practice-based osteopathy clinic for subacute spinal pain.

Methods. A cost–utility analysis was performed alongside a pragmatic single-centre randomized controlled trial in a primary care osteopathy clinic accepting referrals from 14 neighbouring practices in North West Wales. Patients with back pain of 2–12 weeks duration were randomly allocated to treatment with osteopathy plus usual GP care or usual GP care alone. Costs were measured from a National Health Service (NHS) perspective. All primary and secondary health care interventions recorded in GP notes were collected for the study period. We calculated quality adjusted life year (QALY) gains based on EQ-5D responses from patients in the trial, and then cost per QALY ratios. Confidence intervals (CIs) were estimated using non-parametric bootstrapping.

Results. Osteopathy plus usual GP care was more effective but resulted in more health care costs than usual GP care alone. The point estimate of the incremental cost per QALY ratio was £3560 (80% CI £542–£77 100). Sensitivity analysis examining spine-related costs alone and total costs excluding outliers resulted in lower cost per QALY ratios.

Conclusion. A primary care osteopathy clinic may be a cost-effective addition to usual GP care, but this conclusion was subject to considerable random error. Rigorous multi-centre studies are needed to assess the generalizability of this approach.

Keywords. Back pain, cost–utility, neck pain, osteopathy, primary care, QALY.

Introduction

Spinal pain is common and costly to health services and society,[1–3] consuming 1–2% of the Gross National Product (GNP).[4] British and American low back pain management guidelines[5–7] have recommended that prompt referral for spinal manipulation should be funded by directing resources away from inappropriate secondary care referrals, but the cost-effectiveness of this approach has received inadequate attention.[8] Several randomized controlled trials (RCTs) of spinal manipulation have measured costs.[9–14] Some have only measured the cost of the interventions,[9–11] whilst others have measured both direct and indirect costs.[12–14] Two trials calculated incremental cost–effectiveness ratios (ICERs),[13,14] but only a recent neck pain trial tested the statistical uncertainty of this ratio.[14] This trial showed that manipulation was more effective than either physiotherapy or usual general practice care, and with lower costs. Statistical uncertainty was estimated by

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non-parametric bootstrapping,[15] and the estimates plotted on a cost-effectiveness plane.[16] They quoted negative ICERs, and plotted a cost–effectiveness acceptability curve,[17] which showed that at a ceiling ratio of zero there was still a 98% probability that manipulation was more cost-effective than usual GP care. Additional, high quality economic evaluations are needed to evaluate manipulation throughout the spine with particular care when reporting incremental cost per quality adjusted life year (QALY) ratios, and their confidence intervals (CIs).

A pragmatic RCT comparing a primary care osteopathy clinic with usual GP care for spinal pain[18] found a small but significant improvement in the primary outcome measure, the Extended Aberdeen Spine Pain Scales and the mental scale of the SF-12, in favour of osteopathy. A cost–consequences analysis of an economic evaluation alongside the trial was reported in this earlier paper. We now extend the economic evaluation into a cost–utility analysis.

Methods

Pragmatic randomized controlled trial design

This trial was conducted in North West Wales between September 1997 and March 2001. The target population was patients between 16 and 65 years old, presenting to 14 general practices with mechanical neck, upper or lower back pain of 2–12 weeks duration, whether the first episode or a recurrence. A secure method of stratified randomization was used. A sample size of 200 patients was needed to give a power of 80% for detecting a change in standardized difference of 0.4 in the primary clinical outcome measure with a significance level of 5%. All patients in the trial continued to receive treatment from their GPs, and the control group did not receive any additional intervention. The intervention group was referred to an osteopathic clinic based in Llanfairfechan Health Centre, and received three or four sessions of treatment from a GP who was also a registered osteopath (NW). A series of outcome measures were sent by postal questionnaire on entry to the study prior to randomization, after 2 months when treatment in the intervention group was complete, and finally after 6 months. These included the EuroQol EQ-5D,[19] whose health utility weights were used to calculate QALYs. PL and RM, who were not involved with the treatment of participants, extracted data from these questionnaires. Analysis was by simple intention to treat comparisons of the groups as randomized, and was carried out by NW who was involved with the treatment of participants, and validated by BH and DR who were not. The trial method has been discussed in more detail in an earlier paper.[18] A glossary of health economic terms is provided within the Appendix.

Health service costs

The study took a National Health Service (NHS) perspective, in order to inform the purchasing decisions of primary care organizations. Service utilization data were collected from practice records for the 6 months preceding and the 6 months during the trial by PL. This included primary care consultations, investigations, prescribing and out-patient consultations, and hospital stays for back pain and all other reasons. Unit costs were obtained from national sources,[20,21] and finance officers of local provider units for the year 1999/2000. No discount rate was applied to costs, as the study period for each participant was <1 year. Overheads and capital charges were included in the tariffs given out by local provider units and published reference costs. We present mean health service contact frequencies and costs for the 6 months before randomization and for the 6 months of the study period. The non-parametric bootstrap method was used for the statistical analysis, because the cost data were skewed by a small number of participants with a high use of health care services. This was performed by BH, RTE and DR, none of whom were involved with the treatment of participants, using a specially designed macro on Microsoft Excel software.

QALY estimation

QALYs were calculated for the intervention period based on EQ-5D scores at baseline, 2 and 6 months for each patient. Health utility weights were only obtained if all five EQ-5D dimensions were answered. Missing utility values were imputed using regression models. QALYs were calculated from the area under the curve of the mean EQ-5D values in each treatment group as they changed from baseline.[22] It was assumed that utility values changed in a linear fashion in between assessments.

Comparing cost with QALY

Only subjects with both QALY and cost data were included in the health economic analysis. The first step was to plot the mean differential cost and the mean differential QALY gain on the cost–effectiveness plane (in this case the cost–utility plane). This had a horizontal axis representing the difference in QALY, and a vertical axis representing the difference in costs dividing the plane into four quadrants, described by four diagonal points of the compass for convenience. The South East (SE) quadrant represented QALY gain for reduced cost, where intervention is always worthwhile; the North West (NW) quadrant QALY loss for increased cost, where intervention is never worthwhile; the North East (NE) quadrant represented a ‘trade off’ between QALY gain and increased cost; and the South West (SW) quadrant a ‘trade off’ between QALY loss and reduced cost. A cost per QALY ratio was calculated if the mean differential cost and the mean differential QALY gain were plotted within these last two ‘trade off’ quadrants. Points in mirror positions in these two quadrants represent identical cost per QALY ratios, but have opposite meanings and are not directly comparable. The intervention is 'cost-effective' in the NE quadrant, if the observed cost per QALY ratio is *less* than the economic threshold; in the SW quadrant if it is *greater* than this threshold.

Confidence intervals for the cost per QALY ratio

These were estimated using the non-parametric percentile bootstrap method.[15] A 1000 replication bootstrap was run which generated 1000 estimates of the cost per QALY ratio, which were plotted on the cost–effectiveness plane. A cost–utility acceptability curve was plotted comparing the ceiling value of the cost per QALY ratio with the cost–utility probability, from which CIs could be obtained. This analysis was repeated for costs attributed to spinal pain, and total costs excluding outliers as a sensitivity analysis. Outliers were defined as values greater than the mean cost plus 2 SDs in each treatment group.

Results

Health service activity and costs

There was no marked difference in treatment activity or health service cost between osteopathy and usual care groups over the 6 months prior to randomization (Table 1). For the study period, i.e. 6 months after randomization, total health service activity was similar between the two groups in both primary and secondary care. The unit cost for in-patient care was higher than any other cost, by an

TABLE 1 *Frequency of health service activity and costs for the 6 months before randomization*

Health care activity	Usual GP care		Osteopathy	
	Mean (SD), n = 101	Mean cost per contact	Mean (SD), n = 86	Mean cost per contact
All GP contacts	3.60 (2.84)	£15.03	3.45 (2.62)	£15.58
GP contacts for spinal pain	1.89 (1.79)	£14.74	1.62 (1.49)	£15.45
All primary health care team contacts	0.39 (0.85)	£8.80	0.37 (0.78)	£8.80
Other primary health care team contacts for spinal pain	0.03 (0.22)	£8.80	0.05 (0.21)	£8.80
All investigations	0.60 (1.11)	£44.10	0.61 (0.89)	£30.20
Spine radiographs	0.15 (0.36)	£44.10	0.10 (0.31)	£30.20
All prescriptions	5.38 (8.12)	£7.92	5.36 (8.32)	£6.61
Analgesic/non-steroidal anti-inflammatory drug prescriptions	1.41 (1.91)	£7.92	1.40 (2.08)	£6.61
All consultant contacts	0.25 (0.61)	£110.89	0.18 (0.45)	£74.32
Consultant contacts for spinal pain	0.04 (0.20)	£110.89	0.03 (0.18)	£74.32
All accident and emergency department contacts	0.07 (0.29)	£89.00	0.03 (0.18)	£89.00
Accident and emergency department contacts for spinal pain	0.02 (0.14)	£89.00	0.03 (0.18)	£89.00
All in-patient/day care episodes	0.08 (0.39)	£2202.21	0.08 (0.28)	£2202.21
In-patient/day case episodes for spinal pain	0.01 (0.10)	£2202.21	0.01 (0.11)	£2202.21
All physiotherapy contacts	0.07 (0.26)	£18.00	0.05 (0.21)	£18.00
Physiotherapy contacts for spinal pain	0.04 (0.20)	£18.00	0.02 (0.15)	£18.00
All aids and appliances	0.01 (0.10)	£12.05	0 (0)	£1.50
Aids and appliances for spinal pain	0.01 (0.10)	£12.05	0 (0)	£1.50
Health care costs				
Mean total health care costs	£290 (£918)		£257 (£430)	
Mean total health care costs excluding cases without QALY data	£220 (£363)		£271 (£436)	
Mean health care costs for spinal pain	£58 (£74)		£47 (£62)	
Mean spine-related costs excluding cases without QALY data	£52 (£71)		£45 (£64)	

Table 2 *Frequency of health service activity and costs for the 6 months after randomization*

Health care activity	Usual GP care		Osteopathy	
	Mean (SD), n = 101	Mean cost per contact	Mean (SD), n = 86	Mean cost per contact
All GP contacts	3.26 (2.69)	£15.03	3.16 (2.81)	£15.58
GP contacts for spinal pain	1.75 (2.22)	£14.74	1.49 (2.00)	£15.45
All primary health care team contacts	0.61 (1.51)	£8.80	0.66 (1.12)	£8.80
Other primary health care team contacts for spinal pain	0.02 (0.14)	£8.80	0.02 (0.15)	£8.80
All investigations	0.67 (1.10)	£29.76	0.50 (0.84)	£26.53
Spine radiographs	0.1 (0.33)	£44.10	0.06 (0.24)	£30.20
All prescriptions	5.11 (7.41)	£12.63	5.28 (8.62)	£11.60
Analgesic/non-steroidal anti-inflammatory drug prescriptions	1.3 (2.17)	£7.92	1.21 (1.9)	£6.61
All consultant contacts	0.28 (0.62)	£113.79	0.26 (0.49)	£97.55
Consultant contacts for spinal pain	0.09 (0.38)	£110.89	0.06 (0.24)	£74.32
All accident and emergency department contacts	0.05 (0.22)	£89.00	0.03 (0.18)	£89.00
Accident and emergency department contacts for spinal pain	0	£0	0.01 (0.11)	£89.00
All in-patient/day care episodes	0.1 (0.39)	£1188.67	0.05 (0.21)	£2272.80
In-patient/day case episodes for spinal pain	0	£0	0.01 (0.11)	£2202.21
All physiotherapy contacts	0.81 (1.96)	£18.00	0.38 (1.76)	£18.00
Physiotherapy contacts for spinal pain	0.73 (1.96)	£18.00	0.36 (1.73)	£18.00
All aids and appliances	0.01 (1.20)	£12.05	0.01 (0.16)	£1.50
Aids and appliances for spinal pain	0.01 (1.20)	£12.05	0.01 (0.16)	£1.50
Osteopathy contacts	N/A	N/A	2.97 (1.30)	£19.73
Health care costs				
Mean total health care costs	£307 (£687)		£328 (£564)	
Mean difference (95% CI)	£22 (–£142 to £159)			
Mean total health care costs excluding cases without QALY data	£215 (£245)		£303 (£458)	
Mean difference (95% CI)	£88 (–£3 to £239)			
Mean spine-related costs	£64 (£90)		£129 (£283)	
Mean difference (95% CI)	£65 (£32 to £155)			
Mean spine related costs excluding cases without QALY data	£66 (£101)			£142 (£316)
Mean difference (95% CI)	£76 (£29 to £230)			

order of magnitude (Table 2). The range of total health care costs was £16–£3079 in the osteopathic treatment group and £0–£5659 in the usual GP care group. The mean difference in total health care costs was £22, but there was no statistically significant difference (bootstrapped 95% CI –£142 to £159) (Table 2). A parametric confidence interval based on a normal distribution was wider (–£162 to £205), as this was over-influenced by outliers in skew distributions.

QALY calculations

As only 108 subjects had completed EQ-5D scores at baseline, 2 months and 6 months, the missing values were imputed using regression models. In these models, the dependent variable was the EQ-5D score at 2 or 6 months, with the independent variables being the baseline score and the EQ-5D score at 6 and 2 months, respectively (Table 3). Using imputed missing values, QALYs could be calculated from 146 subjects. Subjects with imputed scores were more likely to be men, have a previous episode of spinal pain, have pain in other regions of the spine apart from the lower back, and to have been referred from practices that had only recruited a few patients. They had worse baseline pain and disability, and in particular had lower mean baseline EuroQol EQ-5D scores, and a larger mean improvement in EQ-5D from baseline for the 2 and 6 month scores. This could be due to regression to the mean, or because there was more scope for improvement when the baseline score was lower. The difference in mean QALYs was 0.006 from unchanged data in favour of the osteopathy treatment group, and 0.018 when imputed missing values were included. The 95% CIs for the differential QALY included zero (Table 3).

In order to calculate cost per QALY ratios, seven subjects from the usual GP care group and three from the osteopathy group were excluded because they had no cost data, as they had either withdrawn consent or moved away from the area, making it impossible to retrieve their GP records. This left 68 subjects in each group. Based on this set of data, there was a mean QALY gain of 0.031 in the usual GP care group and of 0.056 in the osteopathy group (Table 3), and a mean total cost of £215 in the usual GP care group and £303 in the osteopathy group. The two groups still did not differ significantly in either QALY or cost. The point estimate for cost per improvement in QALY in the osteopathy group was therefore £3560.

Confidence intervals for cost per QALY

A 1000 replication bootstrap was run in order to generate a CI. The cost–utility plane (Fig. 1) showed most points (853) to be in the NE quadrant, 59 points in the SE quadrant, 80 points in the NW quadrant, and only eight points in the SW quadrant. A cost–utility acceptability curve was plotted (Fig. 2), which did not originate at zero probability when the ceiling ratio was £0, because of the proportion of bootstrap estimates that fall in the SE quadrant of the cost–utility plane. Similarly, the asymptote of the curve never reached 1.0, because of the proportion of bootstrap estimates that fall in the NW quadrant.

The median bootstrap cost–utility estimate was £3760 per QALY gained, which was similar to the mean cost–utility estimate described earlier. The 80% CI was £542–£77 100. An 85% CI included cases from the NW quadrant, where the intervention was never worthwhile. If the confidence level was increased to 90%, the interval also included cases in the SE quadrant where there were cost savings and QALY gains.

Sensitivity analyses

There were three outliers, one in the usual GP care group and two in the osteopathy group. When these were

TABLE 3 *EuroQol EQ-5D scores and QALYs with and without imputed missing values*

EuroQol EQ-5D scores	Usual care, mean EQ-5D score (SD)	Osteopathy, mean EQ-5D score (SD)	Difference in mean EQ-5D score		
Baseline score	0.497 (0.315) n = 96	0.559 (0.256) n = 82	0.062		
2 month score	0.599 (0.323) n = 70	0.695 (0.276) n = 70	0.096		
6 month score	0.665 (0.298) n = 71	0.722 (0.262) n = 61	0.056		
2 month score with imputed missing values	0.592 (0.312) n = 80	0.695 (0.267) n = 75	0.103		
6 month score with imputed missing values	0.656 (0.289) n = 80	0.717 (0.248) n = 75	0.061		
QALYs	**Usual care, mean QALY (SD)**	**Osteopathy, mean QALY (SD)**	**Difference between mean QALYs**	**Parametric 95% CI**	***P***
QALYs[a] from unchanged data	0.028 (0.102) n = 56	0.035 (0.107) n = 52	0.006	−0.033 to 0.046	0.75
QALYs with imputed missing values[b]	0.033 (0.107) n = 75	0.051 (0.103) n = 71	0.018	−0.017 to 0.052	0.31
QALYs with imputed missing values excluding cases with no cost data	0.031 (0.105) n = 68	0.056 (0.101) n = 68	0.025	−0.012 to 0.060	0.16

[a] QALY calculation: QALY = [2 month EQ-5D/4] + [6 month EQ-5D/6] − 5 × [baseline EQ-5D/12].
[b] Imputation models: 2 month EQ-5D usual GP care = 0.041 + 0.394[baseline] + 0.532[6 month EQ5D] (SE) = (0.073) (0.114) (0.114); root mean square error = 0.210.
2 month EQ-5D for osteopathy = 0.265 + 0.235[baseline] + 0.404[6 month EQ5D] (SE) = (0.127) (0.174) (0.121); root mean square error = 0.236.
6 month EQ-5D usual GP care = 0.228 + 0.17[baseline] + 0.549[2 month EQ5D] (SE) = (0.068) (0.126) (0.117); root mean square error = 0.213.
6 month EQ-5D for osteopathy = 0.301 + 0.152[baseline] + 0.458[2 month EQ5D] (SE) = (0.135) (0.187) (0.137); root mean square error = 0.251.

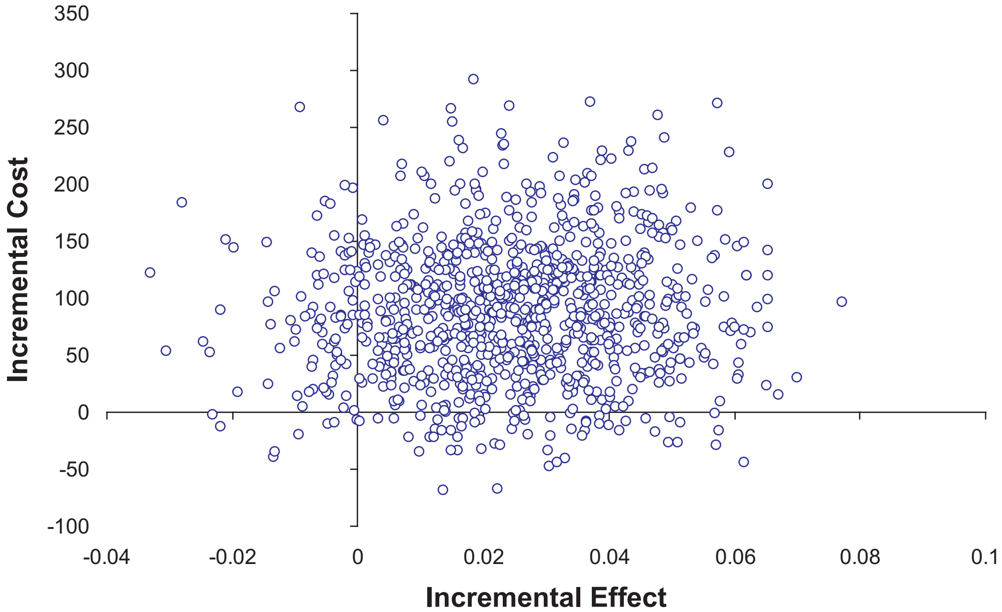

FIGURE 1 *Cost–utility plane*

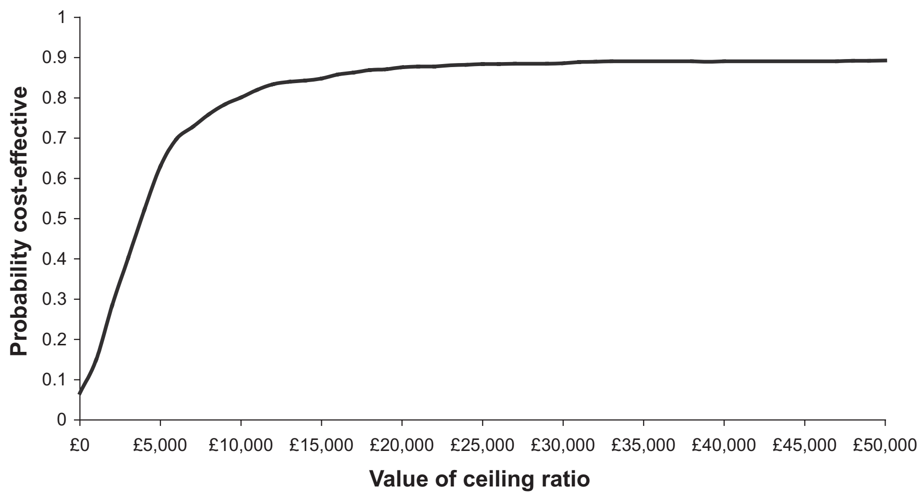

FIGURE 2 *Cost–utility acceptability curve*

removed, the median bootstrapped estimate was £1390. A large proportion of bootstrapped estimates were in the SE quadrant (QALY gain for lower cost), so it was not possible to calculate a lower confidence limit. However, the upper limit of the 80% CI was £13 400.

The spine-related mean costs were £66 in the usual GP care group and £142 in the osteopathy group (Table 2), and the median bootstrapped estimate for spine-related costs per QALY gained was £2870. The 80% CI was £998–£36 500.

Discussion

Summary of main findings

There was a relative improvement in mean QALY for the osteopathy treatment group compared with usual general practice care, and a small increase in mean health service costs. The point estimate of the cost per improvement in QALY in the osteopathy group was <£4000, which compared favourably with the implied ceiling ratio for the National Institute of Clinical Excellence (NICE) of £30 000.[23] Cost per QALY ratios were lower in the sensitivity analysis. In this group of patients, a primary care osteopathy clinic may have been a cost-effective addition to usual GP care, but this conclusion was subject to considerable random error.

Strengths and limitations of this study

The trial involved a single practitioner in a single location. This reduced the generalizability of the findings, but it was examining an innovative clinic, where the osteopath was also a general medical practitioner. It would have been difficult to recruit other centres with similar clinics, and it was important to evaluate such an innovation early in its development. A strength of this study was that costs and consequences were collected alongside a pragmatic RCT; however, like other similar studies, the sample size was calculated in terms of the primary outcome measure, and the study was relatively underpowered to evaluate health utilities and costs. General practice records for services outside primary care may be incomplete, which would under-estimate costs, but this would be common to both groups and unlikely to lead to bias.

How and why the findings agree or disagree with the existing literature

Six previous RCTs of spinal manipulation that measured costs were identified,[9–14] only one of which[14] analysed the statistical uncertainty of the economic evaluation in a similar way. In that trial, manipulation was superior to the other treatments in terms of cost and effectiveness; however, they used the raw EQ-5D scores rather than calculating QALYs for their cost–effectiveness ratios. They also quoted negative ratios, which cannot be compared with other interventions in a league table because: (i) a negative ratio can be produced if an intervention is both more costly and less effective than the control (undesirable), or less costly and more effective (highly desirable); and (ii) the magnitude of a negative ratio is meaningless because the same ratio will result from a better intervention that doubles the cost savings and doubles the effectiveness gain.[24] Similarly, their CIs were difficult to interpret because they included both positive and negative values, and their method of calculation was not presented.

Implications for future research and clinical practice

These findings need to be augmented by larger multi-centre trials, including more common forms of osteopathic provision, such as private osteopaths working in primary care premises. The steps for the calculation of cost per QALY ratios alongside RCTs need to be clarified, standardized and made more transparent. Conclusions from cost–utility analyses need to include estimates of statistical uncertainty as well as sensitivity analyses, as isolated point estimates of cost/QALY ratios can be misleading.

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Declaration

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Ethical approval: Obtained from North West Wales Local Research Ethics Committee.
Conflicts of interest: NW is a registered osteopath and provided the osteopathy service, which was funded by North Wales Health Authority.

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Appendix. Glossary of health economic terms

Cost–effectiveness analysis compares the cost of the treatments with their relative effectiveness. If the costs of the intervention are less than the control, and its effectiveness is superior, then the intervention is 'dominant' and should be accepted. If the costs of the intervention are more than the control, and its effectiveness is inferior, then the control treatment is 'dominant', and the intervention should be rejected. If, however, the intervention treatment is cheaper than the control, or less effective, or vice versa, then there is a 'trade off' and an assessment of the relative size of the difference in costs, compared with the difference in effectiveness is needed.

Cost–effectiveness plane is the graphical representation of the cost–effectiveness analysis on a four quadrant diagram (see Fig. 1)

Incremental cost–effectiveness ratio (ICER) is the ratio of the difference between costs and effectiveness when there is a 'trade off'. If either of the treatments are 'dominant', then a negative ratio will result, the interpretation of which is problematic. Sometimes this cost–effectiveness ratio can be expressed in natural units, such as cost per year of life gained, but when effectiveness is measured in terms of improvement in a patient-based outcome measure, it can be difficult to interpret.

Cost–consequences analysis is a variant of cost–effectiveness analysis that presents an array of outcomes alongside their costs, and leaves readers to draw their own conclusions about their relative importance.

Health utility is the value of a particular health state, usually expressed on a scale from 0 to 1, which can be used as weights to calculate 'quality adjusted life years' (QALYs). This can be achieved in a trial by the use of an outcome measure such as EuroQol EQ-5D.

Cost–utility analysis is analogous to cost–effectiveness analysis, but calculates a ratio of cost per change in QALY.

Non-parametric bootstrapping allows comparisons of arithmetic means without the need for assuming a normal distribution, which is useful for cost data whose distribution is typically highly skewed. Bootstrap estimates make repeated random samples with replacement of the same size as the original sample from the observed data. 'With replacement' means that any observation can be sampled more than once. The SE is estimated from the variability between the values of the statistic derived from the different bootstrap samples.

Ceiling ratio or 'economic threshold' is a cut-off value of the maximum acceptable cost–effectiveness ratio.

Cost–effectiveness acceptability curve uses the concept of a ceiling cost–effectiveness ratio, and quantifies the probability that the new intervention is cost-effective for all potential values of the ceiling ratio.