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REVIEW

Costs and consequences of acupuncture as a treatment for chronic pain: A systematic review of economic evaluations conducted alongside randomised controlled trials

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KEYWORDS
Acupuncture;
Chronic pain;
Economic evaluation;
Randomised controlled trial;
Systematic review

Summary
Background: The economic burden that chronic pain conditions impose on individuals and society is significant. Acupuncture appears to be a clinically effective treatment for some chronic pain conditions. Given the need for policy decisions to be informed by economic evaluations, the objective of this systematic review was to synthesise data from economic evaluations to determine whether acupuncture for the treatment of chronic pain conditions is good value for money.
Methods: A literature search was conducted using health and economics databases, with additional hand-searching. Economic evaluations conducted alongside randomised controlled trials were eligible.
Results: Eight economic evaluations were included in this review, seven cost-utility analyses and one cost-effectiveness analysis. Conditions treated included low back pain, neck pain, dysmenorrhoea, migraine and headache, and osteoarthritis. From the seven cost-utility analyses, acupuncture was found to be clinically effective but cost more. The cost per quality adjusted life year (QALY) gained ranged from £2527 to £14,976 per QALY, below the commonly quoted threshold used by the UK National Institute for Health and Clinical Excellence of £20,000 to £30,000. The one cost-effectiveness study indicated that there might be both clinical benefits and cost savings associated with acupuncture for migraine. There was heterogeneity across the eight trials in terms of professional who provided the acupuncture, style of acupuncture, and country of origin.
Conclusion: The cost per QALY gained in all seven cost-utility studies was found to be below typical thresholds of willingness to pay. Acupuncture appears to be a cost-effective intervention for some chronic pain conditions.

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Introduction

The economic impact of chronic pain for both individuals and society is considerable. Musculoskeletal disorders are the leading cause of absence from work, account for 2% of the European Gross Domestic Product, and are the most common cause of early retirement and disability.[1] The estimated annual total cost of pain in the US is more than US$ 100 billion per year in health care expenses, compensation and litigation.[2]

Despite creating considerable demands on health care systems, chronic pain is often still poorly managed.[3,4] Medication is not fully effective, with side effects that increase with compound analgesics and opioids.[5] The use of non-steroidal anti-inflammatories and non-opiate analgesic medication for chronic pain control is associated with a significant impact on primary care workload, and poor efficacy is the trigger for almost as many consultations as poor tolerability.[6]

As a treatment option, the evidence base for the clinical effectiveness of acupuncture is growing. Systematic reviews have increasingly showed acupuncture to be effective for short-term pain relief compared to sham controls in low back pain,[7,8] chronic osteoarthritis of the knee,[9–12] and headache.[13] Over a longer term at 6 to 12 months, these differences remained statistically significant for knee pain[11,12] and chronic headache.[13,14] For low back pain in the longer term the data are inconsistent; one review finding a statistically significant effect of pain relief maintained at 6 to 12 months,[8] while another was inconclusive.[7]

In countries where acupuncture is not integrated into the public health care system, it is often purchased privately by patients and may be covered by private or employer-based health insurance plans. In April 2006, German health authorities decided to reimburse acupuncture for chronic low back pain and chronic osteoarthritis of the knee in social health insurance funds.[15] In the UK, the National Institute for Health and Clinical Excellence (NICE) recommended that GPs offer patients with persistent low back pain a course of acupuncture comprising a maximum of 10 sessions over a period of up to 12 weeks.[16]

The aim of this review is to identify, synthesise and interpret the findings of current economic research on acupuncture for chronic pain in order to inform policy decision making in health care and in practice. Our focus is on economic evaluations conducted alongside randomised controlled trials on the basis that this review will provide robust data on cost-effectiveness.

Methods

Search strategies

Based on an unpublished review protocol, systematic literature searches were conducted to identify relevant published evidence during January 2010 and were limited to English language only. Searches were conducted from inception in the following health bibliographic databases: AMED (Allied and Complementary Medicine), MEDLINE, EMBASE; and specific health economic databases: Health Economics Evaluation Database (HEED) and NHS Economic Evaluation Database (NHS EED). Relevant systematic reviews, reference lists of studies eligible for inclusion and key journals were hand searched, including Journal of Chinese Medicine, European Journal of Integrative Medicine, and American Acupuncturist. Experts in the field were contacted to identify additional published or unpublished studies not found in the main search. Predefined methodological search filters for health economics and randomised controlled trials were combined with a general filter for pain and acupuncture. Medical subject headings (MeSH) containing the words, economics, economic evaluation, cost effectiveness analysis, cost benefit analysis, cost utility analysis, cost, health economics and pharmacoeconomics were exploded. Relevant free text words, cost consequences, cost analysis, were searched in multiple posting ''mp'' and search truncation ''$'' in ''mp'' was used in terms such as cost benefit$, cost utilit$, cost$, health economic$. The acupuncture filter included the terms acupuncture, acupuncture therapy, auricular therapy and electroacupuncture and acupoint, because these have been demonstrated to be effective in

locating a high number of relevant articles.[17] All identified titles and abstracts from the searches were screened (by EA) for relevance. Full papers and manuscripts in English were obtained, and their potential relevance assessed using the predefined set of inclusion/exclusion criteria.

Inclusion criteria

Studies were included in this review if they were: randomised trials including a full economic evaluation of acupuncture with a control group (standard care, usual care, waiting list, do nothing); with a study population of human participants with chronic pain at the start of the study but no restriction by age, gender, ethnic group or nationality; acupuncture treatments involving insertion of needles into the skin; and reporting both the costs and effectiveness of the intervention. Studies were excluded if they did not involve needle insertion, for example acupressure, or laser-acupuncture, or compared two acupuncture techniques or compared acupuncture with another active therapy other than usual or standard care.

Methods of quality assessment

The quality assessment of the economic evaluations included in this review used the 35 — item check list used by the British Medical Journal to evaluate the quality of the economic evaluations of submitted articles. All 35 items were graded accordingly with predefined criteria ''yes'', ''no'', ''NC'' and ''NA'' for each individual study; where ''yes'' indicates that the item was taken into account or covered, ''no'' the item was not addressed, ''NC'' (not clear) it is not possible to determine if the item was included in the study and ''NA'' (not applicable) the item is not relevant.

Data extraction and synthesis

Relevant data from the studies were extracted (by EA), recorded and tabulated using data extraction forms created for this purpose. The main characteristics and results of the studies were captured in data extraction forms. Data fields for all studies included information on: first author; clinical type study; price year; country; setting; condition; population; intervention and control; clinical outcomes; follow up; economic evaluation type; cost measurement; effectiveness measurement; results; authors' conclusions; and comments on the study including confounders and potential sources of bias. The quantitative research study results were not pooled in a statistical meta-analysis as there are methodological complications in conducting meta-analyses in economic evaluations.[18] The data and findings are presented in a narrative form and synthesised with elements of interpretation and integration of studies.

Results

Study selection

Overall, 148 citations were retrieved from electronic databases, and after the removal of duplicates, 99 unique citations were identified, see flow chart (Fig. 1). Titles and abstracts of all articles identified by the search were reviewed. The reasons for exclusion are identified in Fig. 1. At this stage, seven trials met the eligibility criteria for inclusion.[19–25] Specialised journals and reference lists, including reference to published systematic reviews, were hand-searched to identify any study that was not retrieved through the database search. This search yielded one additional citation.[26]

Fig. 2 summarises the included economic studies. Three studies (one in Germany, one in Italy and one in UK) considered acupuncture for headache,[23,25,26] and two examined acupuncture for low back pain[19,22] (one in Germany and one in UK). The other three papers were based on studies conducted in Germany, and considered acupuncture for neck pain,[21] dysmenorrhoea[24] and osteoarthritis.[20] Seven studies used a cost-utility approach[19–25] and there was one cost-effectiveness analysis.[26] All eight of the studies used a broad societal viewpoint. In the two studies carried out in the UK,[19,25] the National Health Service (NHS) perspective was also considered.

Quality assessment

The most common limitations we identified were: competing alternatives were not clearly described; details of subjects from whom valuations were obtained were not given; relevance of productivity changes to the study question were rarely discussed; quantities and resource use were not reported separately from their unit costs; currency was reported and price data rarely was recorded, details of price adjustments for inflation or currency conversion were not given. These limitations may affect both the external and internal generalisability.

Resource use data and source of unit costs

Resource use, cost data and source of valuations differs across studies, as shown in Table 1. To measure resource use, all the German studies drew on data maintained by the national health insurance funds' databases, while data related to clinical outcomes, such as SF-36, were collected from patients' self reports in the trial [20–24]. Resource use data in the three remaining studies[19,25,26] were captured from trial-based events such as patient and staff reports at different points in time and during follow up. Medical records from general practice databases and hospital records were also used.[19,25] Unit costs for all items except acupuncture sessions in the German trials [20–24] were obtained from the social health insurance funds' databases. Acupuncture was not routinely reimbursed by the social health insurance funds, so a payment rate of €35 for each acupuncture session was assumed for each of those studies. In the UK, cost valuation was largely based on standard costs published in national sources.[19,25] For private expenditure (other health care visits, non-prescription medication), data was reported by patients in the trials. One study did not state the sources of unit costs.[26]

Table 1 Summary of studies presenting the resource use, source of unit cost and cost description.

Author	Cost measurement	Costs included in the analysis
(Liguori et al., 2000) Migraine Italy	Resource use data: related to therapy, side effects and total days of absence work were taken from trial reported data in monthly time sheets Source of unit costs: not reported	Direct costs: National Health Service (costs: medical examinations acupuncture treatments, specific material; administrative; nursing personnel and general management). Patient costs charges: acupuncture and medical examinations Indirect costs: absence from work
(Ratcliffe et al., 2006) Low back pain United Kingdom	Resource use data: trial based data. Patient self completed questionnaires and general practitioners (GP) notes Source of unit costs: Personal Social Services Research Unit, National Health Service (NHS) Reference costs, British National Formulary, acupuncture Practitioners' fee made by the York Health Authority, costs reported by patients (private treatments, over counter drugs). Wage valuation: Office for National Statistics new earning survey (daily average rate/adjusted for gender and age)	Direct costs: acupuncture consultation, National Health Service (NHS) visits (hospital: inpatient, outpatient, pain clinic, general practitioner (GP) consultation, physiotherapy and other National Health Service (NHS) practitioner) private treatments, over the counter and prescription drugs Indirect costs: time off work sick (lost productivity)
(Reinhold et al., 2008) Osteoarthritis pain Germany	Resource use: data maintained by the national health insurance funds databases Source of unit costs: social health insurance funds databases. Acupuncture session: determined arbitrary by the authors. Wage valuation: not reported	Direct costs: acupuncture treatment, physician's visits, hospital stays (patient private expenditure not considered) and prescription drugs (patients co-payments included) Indirect costs: lost workdays
(Willich et al., 2006) Chronic neck pain Germany	Resource use: data maintained by the national health insurance funds databases Source of unit costs: social health insurance funds databases. Acupuncture session: determined arbitrary by the authors. Wage valuation: not reported	Direct costs: acupuncture treatment (inc. needles and consumables), physician's visits, hospital stays (patient private expenditure not considered) and medication (patients co-payments included) Indirect costs: work incapacity
(Witt et al., 2006) Low back pain Germany	Resource use: data maintained by the national health insurance funds databases Source of unit costs: social health insurance funds databases. Acupuncture session: determined arbitrary by the authors. Wage valuation: not reported	Direct costs: acupuncture treatment, physician's visits, hospital stays and medication Indirect costs: number of sick leave days
(Witt et al., 2008) Dysmenorrhea Germany	Resource use: data maintained by the national health insurance funds databases Source of unit costs: social health insurance funds databases. Acupuncture session: determined arbitrary by the authors. Wage valuation: not reported	Direct costs: acupuncture treatment, physician's visits, hospital stays and medication Indirect costs: number of sick leave days
(Witt et al., 2008) Headache Germany	Resource use: data maintained by the national health insurance funds databases Source of unit costs: social health insurance funds databases. Acupuncture session: determined arbitrary by the authors. Wage valuation: not reported	Direct costs: acupuncture treatment (including needles and consumables), physician's visits, hospital stays (patient private expenditure not considered) and prescription drugs (patients co-payments included) Indirect costs: lost workdays
(Wonderling et al., 2004) Headache United Kingdom	Resource use: trial based data reported by patients and general practice databases Source of unit costs: trial data reported by patients (private costs, non-National Health Service (NHS) healthcare). Personal Social Services Research unit (acupuncture and standard National Health Service (NHS) costs). British National Formulary (prescription drugs). Wage Valuation: lost productivity costs Office for National Statistics	Direct costs: acupuncture treatment (study, non study-National Health Service (NHS) and private) (excluded costs: needles and other consumables), National Health Service (NHS) visits (general practitioner (GP), outpatient, counsellor and psychotherapist, physiotherapy, chiropractor or osteopath, medical herbalist, homoeopath, hypnotherapist, relaxation therapy), other costs (private health care visits and over the counter medication) Indirect costs: day off sick

Table 2 Summary of total cost comparisons for all studies in a common currency (£).

Study	Condition	Perspective	Mean total costs (£)		*P*	Var. costs
			Intervention (SD)/(95%CI)	Control (SD)/(95%CI)		
(Liguori et al., 2000)	Migraine	Total	1,074,180.55[a]	1,534,155.33[a]		↓ −574.85
Italy		NHS	−3111.76[a]	141,500.48[a]		
(Ratcliffe et al., 2006)UK	Low back pain	NHS	471.10 (SD 341.61)	322.24 (SD 426.50)	0.05	↑ AcC (214.01)
(Reinhold et al., 2008)	Osteoarthritis pain	Overall	1010.57 (CI 813.81—1207.34)	616.56 (CI 418.57—814.53)	0.006	↑ AcC (312.37)
Germany		Osteoarthritis related	463.95 (CI 383.78—544.15)	47.06 (CI 0—127.75)	0.001	↑ AcC (312.37)
(Willich et al., 2006)	Chronic neck pain	Overall	776.73 (SD 1313.21)	543.88 (SD 1255.61)	0.001	↑ AcC (303.60)
Germany		Neck pain related	370.83 (SD 458.90)	97.18 (SD 620.07)	0.001	↑ AcC (303.60)
(Witt et al., 2006)	Low back pain	Overall	891.66 (SD 1292.21)	656.59 (SD 1450.88)	0.001	↑ AcC (307.96)
Germany		Back pain related	467.58 (SD 732.61)	211.41 (SD 894.13)	0.001	↑ AcC (307.96)
(Witt et al., 2008)	Dysmenorrhea	Overall	559.49 (SD 620.99)	341.91 (SD 990.06)	0.001	↑ AcC (306.82)
Germany		Dysmenorrhea related	392.44 (SD 336.70)	25.14 (SD 63.82)	0.001	↑ AcC (306.82)
(Witt et al., 2008)	Headache	Overall	719.62 (CI 663.72—775.52)	442.56 (CI 385.89—499.25)	0.001	↑ AcC (306.86)
Germany		Headache related	344.28 (CI 335.49—353.08)	39.02 (CI 30.10—47.93)	0.001	↑ AcC (306.86)
(Wonderling et al., 2004)	Headache	NHS[b]	289.65 (SD 165.86)	88.65 (SD 130.28)		↑ AcC (198.97)[c]
UK		NHS and patients[b]	403.40 (SD 356.69)	217.20 (SD 486.00)		↑ AcC (198.97)[c]

P values reported equal to 0.001 are equivalent to $P \leq 0.001$, AcC — cost associated to accupuncture sessions. ↑ Increase in costs and ↓ decrease in costs. The exchange rate of €1 equivalent to £0.839239 applied to all studies that reported results in € (01 June 2010 — source www.xe.com). The exchange rate of 1 ITL (Italian liras, obsolete currency) equivalent to £0.000431566 (01 June 2010 — source www.xe.com).

[a] (Liguori et al., 2000) — projected costs (in thousands of liras) for an estimated 800.000 patients suffering from migraine per year. (ITL −1,332,000 cost saving per patient per year).

[b] Data reported only for a reduced sample of patients (for whom SF-36 and QALYs (quality adjusted life-years) could be calculated: acupuncture arm $n = 136$, control arm $n = 119$).

[c] Costs determined for the total sample of parients included in the RCT (acupuncture arm $n = 177$, control arm $n = 157$). Costs are only those for acupuncture, study £198.97; acupuncture, other NHS (National Health Service) £17.76 and acupuncture, private £10.48 are not included.

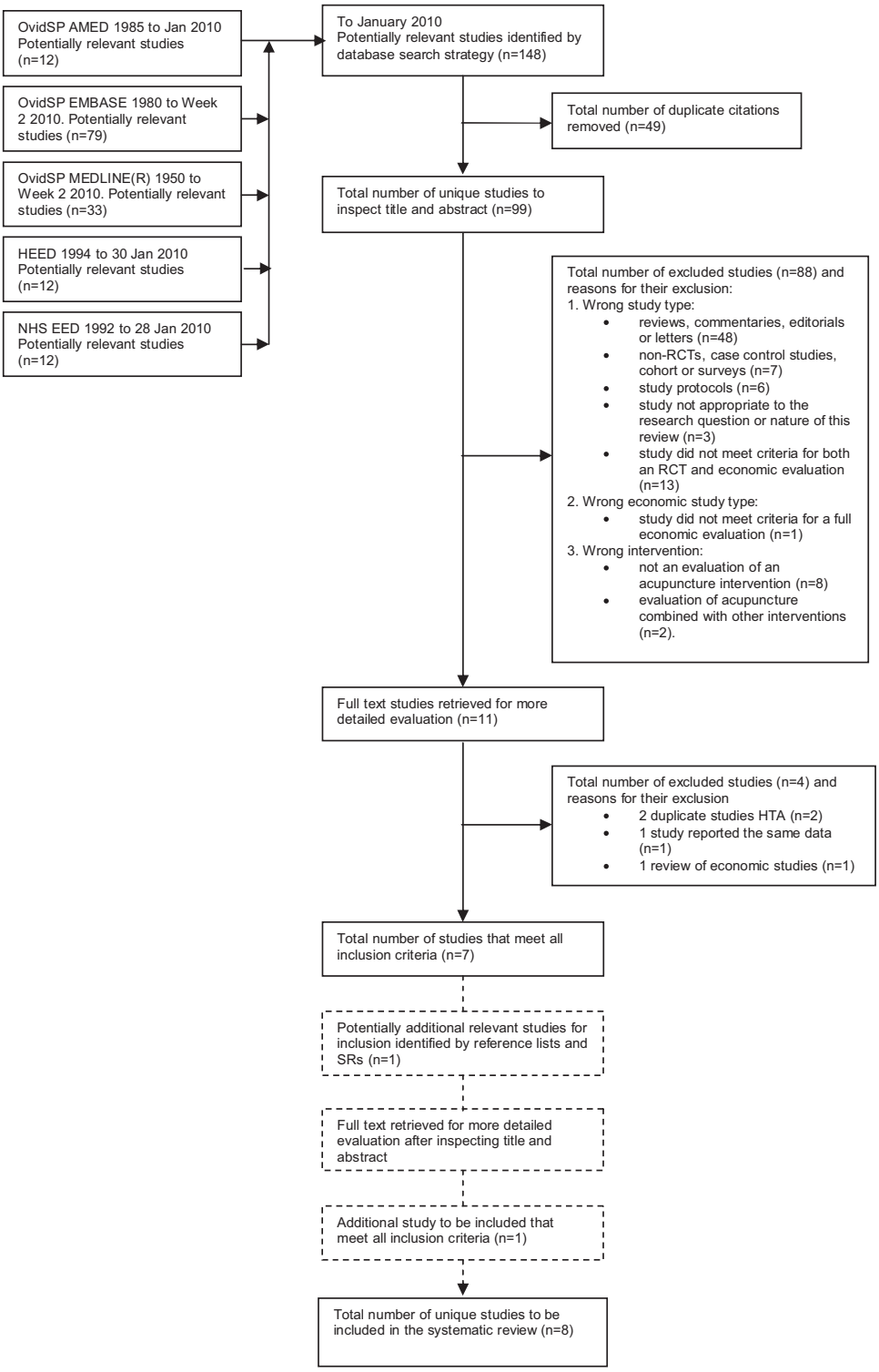

Figure 1 Flowchart of studies reviewed.

Cost and cost-utility comparisons between treatment arms

Table 2 shows cost comparisons including both direct and indirect costs. The differences in costs attributed solely to the cost of acupuncture treatments between interventions is also presented, allowing for meaningful comparisons to be made determining the relative impact of acupuncture interventions on cost differences between groups. Only the costs for the overall analysis were considered for the German ARC studies[20–24] and the costs that fall entirely to the National Health Service (NHS) for the UK studies.[19,25]

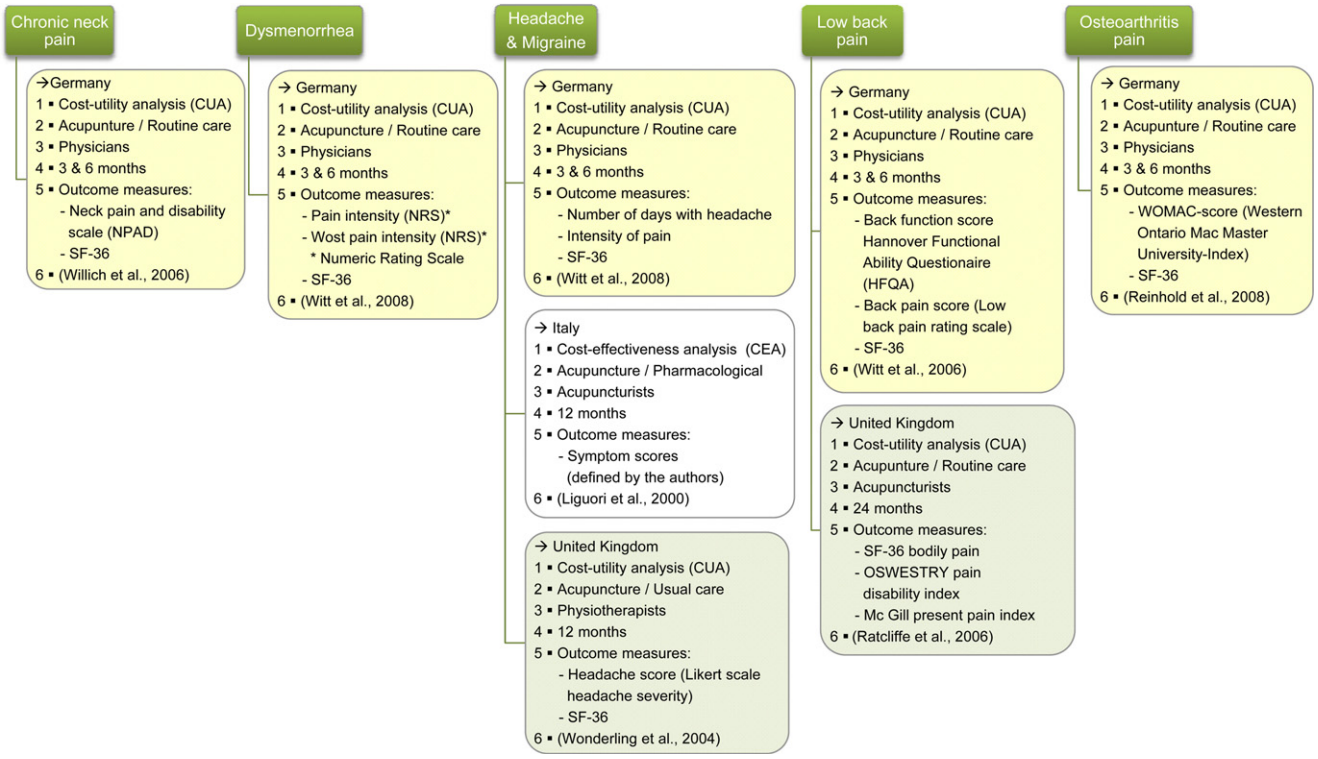

Figure 2 Summary characteristics of included economic evaluations by chronic pain condition. Notes to Fig. 2: (1) type of economic evaluation (CUA — cost-utility analysis/CEA — cost-effectiveness analysis); (2) intervention acupuncture/control; (3) professional that delivered the intervention; (4) follow-up [German studies: 3 months economic evaluation and 6 months clinical effectiveness]; (5) outcome measures; (6) name author and year.

The Italian study[26] assessing acupuncture for migraine reports that acupuncture is cost-saving, while the other trials find the costs in the acupuncture arms are higher. In part this is due to the costs of the acupuncture which range from £198.97[25] to £312.37 (€372.21).[20] Costs of individual acupuncture sessions range from £24[19] to £43[25] per session.

Fig. 3 shows the value of productivity losses in terms of cost per working day owing to health incapacity. Liguori and colleagues reported a total number of work days lost per year because of migraine of 1120 in the acupuncture group and 1404 in the control group.[26]

Ligouri and colleagues found acupuncture to be cost-saving compared with the alternative, and as acupuncture also improved pain scores this was viewed as dominant.[26] In the cost-utility studies,[19–25] SF-36 values were converted to SF-6D using the algorithm developed by Brazier et al. and QALYs were calculated using the area under the curve method. Table 3 summarises the incremental costs, QALYs gained and incremental cost per QALY gained for the studies that performed a cost-utility analysis.

Cost-effectiveness thresholds

Table 4 presents the incremental cost-effectiveness ratio per QALY gained, the range of cost-effectiveness thresholds

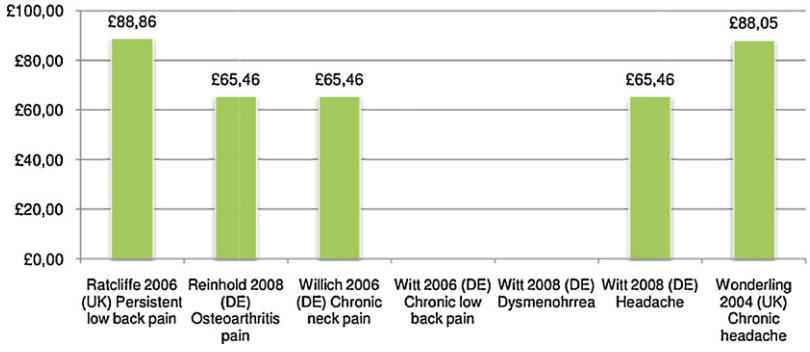

Figure 3 Indirect costs comparisons between studies, estimated cost for lost working day (£). Legend of Fig. 3: exchange rate €1 equivalent to £0.839239 (01 June 2010 — source www.xe.com).

Table 3 Summary results of the cost-utility studies in a common currency (£).

Studies	(Ratcliffe et al., 2006)	(Reinhold et al., 2008)	(Willich et al., 2006)	(Witt et al., 2006)	(Witt et al., 2008)	(Witt et al., 2008)	(Wonderling et al., 2004)
Condition	Low back pain	Osteoarthritis pain	Chronic neck pain	Low back pain	Dysmenorrhea	Headache	Headache
Perspective	NHS	Societal	Societal	Societal	Societal	Societal	NHS
Incremental costs	£114.50	£360.8	£246.66	Not reported	£163.99	£294.5	£205.34
QALY gain	0.027	0.0241	0.024	Not reported	Not reported	0.0301	0.021
ICER (cost/QALY)	£4241	£14,976	£10,464	£8834	£2527	£9783	£9951

QALY, quality adjusted life-years. ICER (cost/QALY), incremental cost-effectiveness ratio per QALY gained. Exchange rate €1 equivalent to £0.839239 (01 June 2010 — source www.xe.com).

suggested by each study and summarises the direction of cost-effectiveness analysis based on the threshold criteria. From these studies, only one[24] did not assess uncertainty by presenting cost-effectiveness acceptability curves. There were differences between countries in the threshold of society's willingness to pay per a QALY gained for the interventions in the review. In the German studies, the value was set arbitrarily by the authors at €50,000 (£41,962) per QALY gained; and in the UK a threshold between £20,000 and £30,000 is often quoted within NICE current guidelines. All studies in this review have an ICER that falls below the threshold of willingness to pay, below the lowest of these suggested thresholds. All studies that performed a cost-utility analysis[19–25] also conducted a sensitivity analysis, and overall, all demonstrated that firm conclusions could be drawn from the base case analysis.

Discussion

This review identified eight studies that have full economic evaluations alongside randomised controlled trials of acupuncture for the treatment of chronic pain. One study performed in Italy[26] studied patients with migraine without aura and reported that acupuncture is cost-saving as well as more effective than the pharmacological control. For the remaining studies that evaluated acupuncture for back pain,[19,22] osteoarthritis pain,[20] chronic neck pain,[21] dysmenorrhoea[24] and headache,[23,25] the incremental cost-effectiveness ratio per QALY gained was found to range from £4241 to £14,976 depending on setting and assumptions of the evaluations. The cost per QALY gained in all studies is below current thresholds of willingness to pay.

The results of this review are consistent with the only other systematic review of economic evaluations of acupuncture to have been conducted,[27] despite considerable differences in methods that include restrictions on study design, conditions under study, and acupuncture techniques (non-needling techniques were included). Our review is the first to summarise the existing knowledge base on the area of economic evaluations conducted alongside randomised controlled trials of acupuncture, and specifically for the treatment of patients with acupuncture for chronic pain conditions.

Economic evaluations following NICE guidelines only include costs related to the health care service. However, it may be useful to adopt a societal perspective, including costs to patients, family, carers and the broader economy. Only three studies had a follow-up over three months,[19,25,26] with all five German studies having a short follow-up of three months in the economic analysis. A long term follow-up may provide more reliable long-term estimates.

Owing to study resources, only the author (EA) performed the study selection, data extraction, quality assessment and analysis of results of all included studies. In addition, because of time and resource constraints only randomised controlled trials published in the English language were considered. Restricting the search to English language may have reduced the risk of introducing bias in the results. Previous research has shown that the inclusion of non-English studies in systematic reviews of acupuncture is likely to increase bias; the evidence suggests that a high proportion of positive results were found in favour of acupuncture studies

Table 4 Threshold analysis: indication and probability of cost-effectiveness of acupuncture interventions for pain.

Studies	(Ratcliffe et al., 2006)	(Reinhold et al., 2008)	(Willich et al., 2006)	(Witt et al., 2006)	(Witt et al., 2008)	(Witt et al., 2008)	(Wonderling et al., 2004)
Condition	Low back pain	Osteoarthritis pain	Chronic neck pain	Low back pain	Dysmenorrhea	Headache	Headache
Time horizon of the economic evaluation	24 months	3 months	3 months	3 months	3 months	3 months	12 months
ICER (incremental cost-effectiveness ratio per QALY gained)	Societal perspective (German studies — overall)	£14,976 (€17,845)	£10,464 (€12,469)	£8834 (€10,526)	£2527 (€3011)	£9783 (€11,657)	
	Societal perspective (German studies — diagnosis-specific)	£17,000 (€20,256)	£11,429 (€13,618)	£9626 (€11,470)	£5511 (€6567)	£10,188 (€12,140)	
	National Health Service perspective (UK studies) £4241						£9951
Threshold values per QALY gained	£20,000	£41,962 (€50,000)	£41,962 (€50,000)	£41,962 (€50,000)		£41,962 (€50,000)	£30,000
Cost acceptability curves CEAC	YES	YES-NBA	YES-NBA	YES-NBA		YES-NBA	YES-NBA
Probability of cost effectiveness	Above 90%	Not reported	Around 100%	Around 100%		Around 100%	Around 92%
Indication of cost effectiveness (I-CE) of acupuncture	Strong I-CE low back pain	Strong I-CE osteoarthritis pain	Strong I-CE chronic neck pain	Strong I-EC low back pain		Strong I-CE headache	Strong I-CE headache

Currency originally reported in € for German studies, exchange rate €1 equivalent to £0.839239 (01 June 2010 — source www.xe.com). (Reinhold et al., 2008) only reported probability values of cost-effectiveness disaggregated by condition and gender. NBA, net benefit approach to derive cost-effectiveness acceptability curves. For the German dysmenorrhea study, bootstrapped mean values for ICER (incremental cost effectiveness ratio): societal perspective (overall cost perspective) €3296 (CI 95% −1705; 9025) and (diagnosis-specific cost perspective) €7104 (CI 95% 4207; 12,672).

from East Asia and Eastern Europe.[28] In this review, we have not reported an assessment of methodological quality, but critical appraisal of the studies found all seven cost-utility studies[19–25] to have a low risk of bias. The cost-effectiveness study[26] had a potentially higher risk of bias because of incomplete information provided on allocation concealment; drop out-rate and intention-to-treat.[29]

Seven of the eight studies were cost-utility analyses, allowing comparisons across studies to be made. These studies followed accepted good quality guidelines in how to perform economic evaluations of health care interventions.[18] Important tools, such as discounting and sensitivity analysis in economic evaluation,[18] were used by the studies, strengthening the quality of the evidence presented in this review. Large-scale acupuncture studies with sample sizes greater than 3000 participants[20,21,23] provided a basis for more precise estimates. There was considerable consistency across the cost utility studies,[19–25] in terms of costs and consequences.

By contrast there was considerable heterogeneity across the professionals who provided the acupuncture, with varied backgrounds, including acupuncturists, physicians and physiotherapists. Training ranged from a minimum of 140 h to 3600 h. Health care policy decision makers should be aware of the existence of these differences when assessing acupuncture interventions. The results of the studies are country-dependent, which may limit generalisability of the review.

Conclusions

The cost per QALY gained in all seven cost-utility studies was found to be below current thresholds of willingness to pay. The results presented in this review of full economic evaluations alongside RCTs suggest that acupuncture interventions are cost-effective when compared with routine care. There was heterogeneity across the eight studies in terms of professional who provided the acupuncture, style of acupuncture, and country of origin, such that caution should be exercised when generalising the results to other contexts.

Conflict of interest

None.

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References

1. Bevan S, Quadrello T, MacGee R, Mahdon M, Vavrovsky A, Barham L. *Fit for work? Musculoskeletal disorders in the European workforce*. The Work Foundation; 2009.
2. National Institutes of Health. *NIH guide: new directions in pain research*; 1998.
3. Brennan F, Carr DB, Cousins M. Pain management: a fundamental human right. *Anesthesia and Analgesia* 2007;**105**(1):205—21.
4. Harald B, Beverly C, Vittorio V, Rob C, Derek G. Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. *European Journal of Pain* 2006;**10**(4):287—333.
5. National Center for Health Statistics. *Chartbook on trends in the health of Americans*; 2006.
6. Belsey J. Primary care workload in the management of chronic pain. A retrospective cohort study using a GP database to identify resource implications for UK primary care. *Journal of Medical Economics* 2002;**5**(1—4):39—50.
7. Furlan AD, van Tulder MW, Cherkin D, Tsukayama H, Lao L, Koes B, et al. Acupuncture and dry-needling for low back pain: an updated systematic review within the framework of the Cochrane collaboration. *Spine* 2005;**30**(April (8)):944—63.
8. Manheimer E, White A, Berman B, Forys K, Ernst E. Meta-analysis: acupuncture for low back pain. *Annals of Internal Medicine* 2005;**142**(8):651—63.
9. Bjordal JM, Johnson MI, Lopes-Martins RA, Bogen B, Chow R, Ljunggren AE. Short-term efficacy of physical interventions in osteoarthritic knee pain. A systematic review and meta-analysis of randomised placebo-controlled trials. *BMC Musculoskeletal Disorders* 2007;**8**:51.
10. Kwon YD, Pittler MH, Ernst E. Acupuncture for peripheral joint osteoarthritis: a systematic review and meta-analysis. *Rheumatology* 2006;**45**(November (11)):1331—7.
11. Manheimer E, Linde K, Lao L, Bouter LM, Berman BM. Meta-analysis: acupuncture for osteoarthritis of the knee. *Annals of Internal Medicine* 2007;**146**(June (12)):868—77.
12. White A, Foster NE, Cummings M, Barlas P. Acupuncture treatment for chronic knee pain: a systematic review. *Rheumatology* 2007;**46**(March (3)):384—90.
13. Sun Y, Gan TJ. Acupuncture for the management of chronic headache: a systematic review. *Anesthesia and Analgesia* 2008;**107**(December (6)):2038—47.
14. Davis MA, Kononowech RW, Rolin SA, Spierings EL. Acupuncture for tension-type headache: a meta-analysis of randomized, controlled trials. *Journal of Pain* 2008;**9**(August (8)):667—77.
15. Cummings M. Modellvorhaben Akupunktur — a summary of the ART, ARC and GERAC trials. *Acupuncture in Medicine* 2009;**27**(March (1)):26—30.
16. National Institute for Health and Clinical Excellence. *Low back pain: early management of persistent non-specific low back pain*. National Institute for Health and Clinical Excellence; 2009, May 27.
17. Pilkington K, Richardson J. Exploring the evidence: the challenges of searching for research on acupuncture. *Journal of Alternative and Complementary Medicine* 2004;**10**(June (3)):587—90.
18. Drummond MF, O'Brien B, Stoddart GL, et al. *Methods for the economic evaluation of health care programmes*. 2nd ed. Oxford: Oxford University Press; 1997.
19. Ratcliffe J, Thomas KJ, MacPherson H, Brazier J. A randomised controlled trial of acupuncture care for persistent low back pain: cost effectiveness analysis. *British Medical Journal* 2006;**333**(September (7569)):626—8.
20. Reinhold T, Witt CM, Jena S, Brinkhaus B, Willich SN. Quality of life and cost-effectiveness of acupuncture treatment in patients with osteoarthritis pain. *The European Journal of Health Economics* 2008;**9**:209—19.
21. Willich SN, Reinhold T, Selim D, Jena S, Brinkhaus B, Witt CM. Cost-effectiveness of acupuncture treatment in patients with chronic neck pain. *Pain* 2006;**July (125)**:107—13.
22. Witt CM, Jena S, Selim D, Brinkhaus B, Reinhold T, Wruck K, et al. Pragmatic randomized trial evaluating the clinical and economic effectiveness of acupuncture for chronic low back

pain. *American Journal of Epidemiology* 2006;**164**(September (5)):487—96.
23. Witt CM, Reinhold T, Jena S, Brinkhaus B, Willich SN. Cost-effectiveness of acupuncture treatment in patients with headache. *Cephalalgia* 2008;**28**(April (4)):334—45.
24. Witt CM, Reinhold T, Brinkhaus B, Roll S, Jena S, Willich SN. Acupuncture in patients with dysmenorrhea: a randomized study on clinical effectiveness and cost-effectiveness in usual care. *American Journal of Obstetrics and Gynecology* 2008;**198**(February (2)):166—8.
25. Wonderling D, Vickers AJ, Grieve R, McCarney R. Cost effectiveness analysis of a randomised trial of acupuncture for chronic headache in primary care. *British Medical Journal* 2004 March 27;**328**(7442):747.
26. Liguori A, Petti F, Bangrazi A, Camaioni D, Guccione G, Pitari GM, et al. Comparison of pharmacological treatment versus acupuncture treatment for migraine without aura — analysis of socio-medical parameters. *Journal of Traditional Chinese Medicine* 2000;**20**(September (3)):231—40.
27. Jabbour M, Sapko M, Miller D, Weiss L, Gross M. Economic evaluation in acupuncture: past and future. *American Acupuncturist* 2009;**49**:11—7.
28. Vickers A, Goyal N, Harland R, Rees R. Do certain countries produce only positive results? A systematic review of controlled trials. *Controlled Clinical Trials* 1998;**19**: 159—66.
29. Linde K, Allais G, Brinkhaus B, Manheimer E, Vickers A, White AR. Acupuncture for migraine prophylaxis. *Cochrane Database of Systematic Reviews* 2009;(1):CD001218.