A systematic review of cost-effectiveness analyses alongside randomised controlled trials of acupuncture

Song-Yi Kim,1 Hyangsook Lee,1 Younbyoung Chae,1,2 Hi-Joon Park,1–3 Hyejung Lee1,2

Abstract
Objective To summarise the evidence on the cost-effectiveness of acupuncture.

Methods We identified full economic evaluations such as cost-effectiveness analysis (CEA), cost-utility analysis (CUA) and cost-benefit analysis (CBA) alongside randomised controlled trials (RCTs) that assessed the consequences and costs of acupuncture for any medical condition. Eleven electronic databases were searched up to March 2011 without language restrictions. Eligible RCTs were assessed using the Cochrane criteria for risk of bias and a modified version of the checklist for economic evaluation. The general characteristics and the results of each economic analysis such as incremental cost-effectiveness ratios (ICERs) were extracted.

Results Of 17 included studies, nine were CUAs that measured quality-adjusted life years (QALYs) and eight were CEAs that assessed effectiveness of acupuncture based on improvements in clinical symptoms. All CUAs showed that acupuncture with or without usual care was cost-effective compared with waiting list control or usual care alone, with ICERs ranging from €3011/QALY (dysmenorrhea) to €22 298/QALY (allergic rhinitis) in German studies, and from £3855/QALY (osteoarthritis) to £9951/QALY (headache) in UK studies. In the CEAs, acupuncture was beneficial at a relatively low cost in six European and Asian studies. All CUAs were well-designed with a low risk of bias, but this was not the case for CEAs.

Conclusions Overall, this review demonstrates the cost-effectiveness of acupuncture. Despite such promising results, any generalisation of these results needs to be made with caution given the diversity of diseases and the different status of acupuncture in the various countries.

INTRODUCTION

Economic evaluations can help inform decision-makers about the efficient use of healthcare resources and guide decision-making processes.1–4 Such evaluations focus on effectiveness and value rather than on efficacy. An increasing number of clinical trials are being conducted with an interest in economic value. The primary advantage of conducting economic evaluations alongside randomised controlled trials (RCTs) is that they have high internal validity.5,6

Acupuncture is a widely used and relatively safe non-pharmacological treatment for a number of conditions.7–9 However, the cost-effectiveness of acupuncture has not been fully explored. Previous reviews reported inconsistent conclusions on whether acupuncture is cost-effective due to a paucity of good data and the small number of trials.10 11 Recently, several studies have investigated the cost-effectiveness of acupuncture for chronic low back pain (LBP), headache, osteoarthritis, chronic neck pain, dysmenorrhea and allergic rhinitis.9 12–21 In these studies, acupuncture brings additional benefits but usually with additional costs by adding acupuncture to usual care.

The objective of the present study is to systematically review economic evaluations including cost-effectiveness analysis (CEA), cost-utility analysis (CUA) and cost-benefit analysis (CBA) alongside RCTs of acupuncture. The review especially addresses the following issues: (1) For which condition is acupuncture most likely to be deemed cost-effective? (2) Which type of economic analysis of acupuncture was most frequently conducted and how were the studies designed, conducted, analysed and reported? (3) Which issues should be studied in further research?

METHODS

Search strategy

A comprehensive literature search was conducted on the following electronic databases without language restrictions: PUBMED, MEDLINE (Ovid), EMBASE, The Cochrane Library, Scopus, NHS CRD databases, EBSCOhost, China National Knowledge Infrastructure (CNKI), KoreaMed, Korean studies Information Service System (KISS) and Research Information Sharing Service (RISS). The search terms used were ‘cost effectiveness’, ‘cost utility’, ‘cost benefit’ and ‘cost minimisation’, along with the terms

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‘acupuncture’, ‘electroacupuncture’, ‘auricular acupuncture’, ‘laser acupuncture’ and ‘moxibustion’. Additional searches of reference lists of papers and relevant reviews were also performed. The strategy and results of the search were reviewed by two authors (S-YK and H-JP). Details of the methods are provided in the supplementary online appendix 1.

Study selection, data extraction and data analysis
To identify all potential articles of interest and to select eligible articles, the following three-step strategy was conducted. First, publications identified as duplicates were removed. Next, articles were screened for relevance by title and abstract. In this process, protocol studies, reviews, opinions and articles which were irrelevant to acupuncture were excluded by one of the authors (S-YK). Finally, articles were further filtered to those including cost data in addition to effectiveness analysis of two or more alternatives, as our review intended to include full-text articles presenting results of CEA, CUA and CBA. Two authors (S-YK and H-JP) checked the full-text articles (abstracts were used if unavoidable) in the final process.

The included studies were all in the setting of prospective RCTs of acupuncture in patients with any medical condition. In short, the studies had to collect both components of costs and consequences directly in RCTs. Thus, studies reporting partial economic evaluations such as cost minimisation analysis, cost descriptions, cost-outcome descriptions without a comparator or cost comparisons as well as studies reporting cost estimated in other settings were excluded. Studies reporting an indirect source of consequences or cost data such as estimated potential cost savings or presumed values derived from the general population and not from the direct experimental setting were also excluded. A modelling approach was also excluded if it was not based on RCTs. Acupuncture was defined as the insertion and manipulation of needles at acupuncture points in the body. In this sense, acupuncture, electroacupuncture and auricular acupuncture were compared with sham acupuncture, medication, usual care or waiting list controls. Duplicates and studies for which only the abstracts were available were also excluded. The authors were contacted via email to obtain additional information if necessary.

Data were extracted using a predefined form. A quantitative synthesis was deemed unfeasible due to the heterogeneity of the economic evaluations. Therefore, a descriptive review followed by a summary of the findings of each study was presented. In accordance with the type of economic analysis, the included studies were grouped as CUA, CEA or CBA. The main outcome measure was the incremental cost-effectiveness ratios (ICERs). As for CUA, incremental cost per quality-adjusted life year (QALY) was extracted or measured from the published data. In our review, £30 000 per QALY in UK and €50 000 per QALY in Germany were used as the thresholds indicating good value for money based on the suggestion of the original paper. In other cases the synthesised value or the descriptive results were summarised. In some situations we deferred to the authors’ conclusions, given that these studies were performed in different clinical settings and that such cost-effectiveness analyses may not be transferable across countries. Although several studies published full details regarding their efficacy data elsewhere, this review mainly focused on data from economic evaluation reports.

Assessment of design, conduct, analysis and reporting of included studies
We examined the included studies using a modified version of Drummond’s guidelines and the Consensus on Health Economic Criteria (CHEC) list that assesses studies for the validity of their design, conduct, analysis and reporting (see supplementary online appendix 1). This checklist used a dichotomous ‘yes’ or ‘no’ response for each item. If insufficient detail for assessment was reported, the judgement was usually ‘no’. Each ‘yes’ represented 5% while ‘no’ represented 0%, thus a maximum of 100% could be obtained if the answer to all 20 items was ‘yes’.

Assessment for risk of bias
Two authors (S-YK and HL) independently assessed the included studies for any potential bias. A tool from the Cochrane Handbook for Systematic Reviews of Intervention was used to assess the risk of bias (RoB). This tool assesses six criteria: (1) adequate random sequence generation; (2) allocation concealment; (3) blinding of participants/blinding of outcome assessment; (4) incomplete outcome data; (5) selective reporting; and (6) freedom from other biases. The RoB assessment was based on the main RCT reports and protocol papers, if necessary.

RESULTS
Overview of included studies
A total of 2264 records were retrieved on 23 March 2011. First, 1157 articles were screened after overlapping articles were removed. Based on their titles and abstracts, 1010 records were excluded because they did not relate to acupuncture or were review articles. Of the 147 remaining articles, 17 met the inclusion criteria. A flow chart of the search and study inclusion is given in figure 1.

Table 1 and supplementary online appendix 2 summarises the detailed characteristics of the included studies. Six studies were conducted in Germany, four in the UK, two in China and one each in the USA, Denmark, India, Italy and Sweden. The number of participants ranged from 20 to 1753 in the intervention group and from 20 to 1696 in the control group. Most of the included studies allowed conventional medical care with the use of additional treatments as needed.

Nine studies involved CUA that measured health outcomes in terms of QALYs gained. Short Form-6 Dimensions (SF-6D), which was converted from the SF-36 values, were assessed in all CUA except in one study which instead used the EQ-5D. One study...

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showed the results of two different multi-attribute health statuses using the SF-6D and EQ-5D. All CUAAs reported ICERs to estimate economic outcomes and used bootstrapped cost-effectiveness acceptability curves (CEAC) to measure uncertainty. The other eight CEAs measured primary outcomes in ICERs or compared costs and clinical improvement between groups. There was no CBA. Eleven studies (65%) measured cost from a societal and/or a NHS perspective, but six studies did not describe the perspective of their cost analysis.

Included studies were based on short-term follow-up with a mean (SD) of 7 (6.6) months while no study used a lifetime timescale. Five studies assessed extended outcomes up to 4,15 513 18 19 or 10 years20 and discounted future benefits and costs using sensitivity analysis. No other studies needed to discount any effects or costs, except one12 that had an observation period of over 1 year. Patients received an average of 15.6 sessions of acupuncture treatment (median 10.5) during an average of 12.1 weeks (median 13.0) with the exception of three studies that measured the immediate effects of acupuncture. The overall adherence rate reported by some studies was high.12 16 17 26

Cost
Costs were measured in various ways. Most studies included the costs of acupuncture treatment, medications, physician carrying out the intervention and hospital stay as direct healthcare costs. Other costs such as the cost of adverse event management or decreased use of other medical resources due to increased well-being or disappointment over the intervention were rarely addressed. Out-of-pocket costs were only reported in four studies.12 14 20 30 Direct non-medical costs, such as the cost of the lost work time for patients’ families and the cost of transportation to and from treatment, were also rarely calculated. Regarding indirect costs from the societal perspective, the cost per day of missed work was assessed using a human capital approach12 13 15 – 20 or other processes.27 30 33 The study by Humaidan et al28 showed productivity changes due to shorter postoperative hospital stay instead of monetary value. Six studies conducted in Germany13 15 – 19 reported both the overall costs and the disease-specific costs.

Estimations of acupuncture costs showed differences across countries (see supplementary online appendix 3). The costs were £30 (UK, 1998–1999) to £43 per hour (UK, 2002–2003), £24–34 per visit (UK, 2002–2003), $45–60 per visit (USA, 1998), €35 per session (Germany, 2000–2004) and ¥40 per session (China, 2009). In two studies27 28 the cost of a physician carrying out the acupuncture treatment was not included in the acupuncture cost (£0.7 (Sweden, 2002–2003 prices); €0.2 (Denmark, 2002 prices)) since acupuncture was integrated within the routine anaesthetic procedures.
Table 1  Characteristics of the included randomised controlled trials

<table>
<thead>
<tr>
<th>Author, year, country</th>
<th>Study design (perspective)</th>
<th>Study population</th>
<th>Intervention (1=group; 2=co-intervention; 3=follow-up)</th>
<th>Outcome measurement</th>
<th>Effectiveness</th>
<th>Cost</th>
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<tbody>
<tr>
<td><strong>Low back pain (LBP)</strong></td>
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<tr>
<td>Witt, 2006, Germany16</td>
<td>Multicentre, RCT, CUA (societal)</td>
<td>11,378 patients, (aged ≥18) with chronic LBP (&gt;6 months duration)</td>
<td>1. Acupuncture (n=1,451): max 15 sessions (mean 10.3 ±3.1), 3 months -Waiting list (n=1,390) -Non-randomised cohort (n=8,537) 2. Allowed to use any additional conventional treatments as needed 3. 3 months (economic evaluation), 6 months (effectiveness)</td>
<td>SF36 -HFAQ, low back pain rating scale, side effects</td>
<td>-Acupuncture, physician visits, hospital stays, medication -Number of sick-leave days</td>
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<tr>
<td>Ratcliffe, 2006, UK12 34</td>
<td>Multicentre, RCT, CUA (NHS and societal)</td>
<td>241 patients, (aged 18–65) with persistent non-specific LBP (4–52 weeks' duration)</td>
<td>1. Acupuncture (n=160): up to 10 sessions (mean 8.1 sessions), 3 months -Usual care (n=81): pragmatic GP management 2. Allowed to use any additional conventional treatments as needed 3. 24 months (economic evaluation)</td>
<td>SF36 -Use of analgesics, ODI, McGill present pain index, safety, patient satisfaction</td>
<td>-Acupuncture, NHS visits, private health care, over the counter drugs, prescription drugs -Time off work sick (£88.86/day)</td>
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<td>Cherkin, 2001, USA26</td>
<td>Multicentre, RCT, CEA (ND)</td>
<td>262 patients (aged 20–70) with persistent LBP</td>
<td>1. Acupuncture (n=94): Up to 10 sessions (8.0±2.4 sessions), 10 weeks -Massage (n=78): Up to 10 sessions (8.3±2.3 sessions) -Self-care education (n=90) 2. Retained access to their usual medical care -Permitted basic TCM needling techniques, EA, manual manipulation of the needles, indirect moxibustion, infrared heat, cupping and exercise recommendations in acupuncture group -Proscribed the use of massage (including acupressure), herbs and treatments not considered common TCM practice in acupuncture group 3. 52 weeks (effectiveness and cost)</td>
<td>Symptom bothersomeness scale, RDQ, &gt;1 week of restricted activity and work-loss day due to LBP, SF12, satisfaction, used medication, AE</td>
<td>-Acupuncture, self-care education materials, physician visits, medication prescription, outpatient HMO back care services</td>
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<td><strong>Headache</strong></td>
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<td>Wu, 2010, China33</td>
<td>Single-centre, RCT, CEA (ND)</td>
<td>80 patients (aged 18–65) with chronic tension-type headache of wind-phlegm pattern</td>
<td>1. Acupuncture + usual care (n=20): 24 sessions, 4 weeks -Chinese herb medicine + usual care (n=20) -Acupuncture + Chinese herb medicine + usual care (n=20) -Usual care only (n=20):</td>
<td>Clinical improvement rate</td>
<td>-Acupuncture, Chinese herbal medicine -Lost working time (¥3,51/ group)</td>
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<td>Witt, 2008, Germany</td>
<td>Multicentre, RCT, CUA (societal)</td>
<td>3182 patients, (aged ≥18) with primary headache (&gt;12 months duration, at least two headaches/month)</td>
<td>1. Acupuncture (n=1613): 10–15 sessions (mean 10.5 sessions, CI 10.3 to 10.6), 3 months -Waiting list (n=1569) 2. Free to use conventional routine medical care 3. 3 months (economic evaluation), 6 months (effectiveness), 5 years (sensitivity analysis)</td>
<td>SF36</td>
<td>-Acupuncture, physician visits, hospital stays, prescription drug -Lost workdays (€78/lost workday)</td>
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<td>Wonderling, 2004, UK</td>
<td>Multicentre, RCT, CUA (NHS and societal)</td>
<td>401 patients (aged 18–65) with chronic headache disorder, predominantly migraine (average of at least two headaches/month)</td>
<td>1. Acupuncture + usual care (n=205): up to 12 sessions (mean 7.9±3.8 sessions), 3 months -Usual care (n=196) 3. 12 months (economic evaluation), 2, 5, 10 years (sensitivity analysis)</td>
<td>SF6D</td>
<td>-Acupuncture, NHS visits, prescription drugs -Day off sick (sensitivity analysis, £88.05)</td>
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<td>Liguori, 2000, Italy</td>
<td>Multicentre, RCT, CEA (societal)</td>
<td>120 patients with migraine without aura</td>
<td>1. Acupuncture (n=60): max of three courses of 10 sessions, 2/week with 1-week break between each course -Medication (n=60): medication such as flunarizine; nimodipine; dihydroergotamine; lisuride; sumatriptan; or amitriptyline (a drug called longastatine, along with TENS were applied in some cases) 3. 12 months (economic evaluation)</td>
<td>Benefit of overall symptom score in frequency and intensity of migraine episodes, days of absence from work in 1 year, Side effects</td>
<td>-Acupuncture, medical examination, specific materials (acupuncture needles, disinfectants, sterile cotton and so on), administrative costs, nursing personnel and the general management -Days of absence from work</td>
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<td>Osteoarthritis</td>
<td>Multicentre, RCT, CUA (NHS and non-NHS)</td>
<td>352 patients (aged ≥50), with knee osteoarthritis</td>
<td>1. Acupuncture (up to 6 sessions (mean 6.0±0.9 sessions) over 3 weeks) +advice and exercise programme (n=117): 6 weeks -Sham acupuncture (6 sessions over 3 weeks) +advice and exercise programme (n=119): non-penetrating blunt tip needle -Advice and exercise programme (n=116): 6 sessions over 6 weeks</td>
<td>EQ-5D</td>
<td>NHS health care (study treatment sessions, primary care contacts, outpatient attendances, others, prescribed medications), private health care</td>
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| Reinhold, 2008, Germany | Multicentre, RCT, CUA (societal) | 489 patients (aged ≥40) with an osteoarthritis-associated pain in the hip or knee (>6 months duration) | 2. No moxibustion, cupping, herbs or EA in acupuncture group  
- If already using NSAIDs, participants will be permitted to continue their stable dose  
3. 12 months (economic evaluation) | SF36 -WOMAC global score | -Acupuncture, physician visits, hospital stays, prescription drug  
-Lost workdays (€78/lost workday) |
| Chronic neck pain | Willich, 2006, Germany | Multicentre, RCT, CUA (societal) | 3451 patients, (aged ≥18) with chronic neck pain (>6 months duration) | SF36 -NPAD | -Acupuncture, physician visits, hospital stays, prescription drug  
-Patients work incapacity (€78/lost workday) |
| Pain relief during and after oocyte retrieval | Gejervall, 2005, Sweden | Single-centre, RCT, CEA (ND) | 160 women undergoing IVF | VAS for subjective pain and experiences, STAI for well-being, time consumption, IVF parameters | Acupuncture, medication, cost for aspiration needle, cost for time consumption (midwives’ salary) |
| Humaidan, 2004, Denmark | Single-centre, RCT, CEA (ND) | 200 women undergoing ovum pick-up | 1. EA + manual acupuncture (n=100), one time/at once/immediately  
- Conventional analgesia (n=100): paracervical block with premedication: 0.5 mg flunitrazepam (oral), 1 g paracetamol (rectal)  
- Paracervical block with alfentanil and lidocaine, heat therapy pillow  
3. Immediately | VAS for abdominal pain, hospitalisation period, IVF parameters | Acupuncture needles, alfentanil and NaCl (EA group) vs pre-medication, alfentanil and NaCl (analgesia group) |
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<tr>
<td><strong>Dysmenorrhoea</strong></td>
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<td>was not obtained by EA alone, patients were supplemented with intravenous alfentanil (0.25 mg)</td>
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<td>Witt, 2008, Germany</td>
<td>Multicentre, RCT, CUA (societal)</td>
<td>649 women, (aged ≥18, between menarche and menopause) with primary dysmenorrhoea from the start of the menarche or secondary dysmenorrhoea (&gt;12 months duration) with cramping pain during menstruation</td>
<td>1. Acupuncture (n=101): max 15 sessions (mean 10.5 ±3.1), 3 months</td>
<td>-SF-36</td>
<td>-Acupuncture, physician visits, hospital stays, medication</td>
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<td>-Waiting list (n=100)</td>
<td>-Non-randomised cohort (n=448)</td>
<td>Pain intensity, responder rate (&gt;33% symptom reduction), the worst pain intensity, AE</td>
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<td>2. Allowed to use any other conventional treatments as needed</td>
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<td>3. 3 months (economic evaluation), 6 months (effectiveness)</td>
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<td><strong>Postoperative nausea and vomiting</strong></td>
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<td>1. Acupuncture (n=20): 5 min before induction of anaesthesia, one time/at once/immediately</td>
<td>Incidence of nausea and vomiting, duration of stay in PACU, total hospital stay</td>
<td>Anti-emetic prophylaxis</td>
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<td>Sharma, 2007, India</td>
<td>Single-centre, RCT, CEA (ND)</td>
<td>60 patients (aged 20–60) with ASA I and II physical status scheduled for laparoscopic cholecystectomies under general anaesthesia</td>
<td>-Ondansetron injection (n=20): 4 mg 10 min after induction of anaesthesia</td>
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<td>-Acupuncture+ondansetron injection (n=20)</td>
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<td>2. Premedication: oral alprazolam (0.25 mg) before surgery, general anaesthesia (propofol 2 μg/kg, fentanyl 2 μg/kg, vecuronium 0.1 mg/kg), muscle relaxation when required, neostigmine (0.05 mg/kg), glycopyrrolate 0.01 mg/kg) at the end of surgery, diclofenac sodium (75 mg) before reversal</td>
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<td>3. Immediately</td>
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<td><strong>Dyspepsia</strong></td>
<td>Multicentre, RCT, CEA (NHS)</td>
<td>60 patients (aged &gt;16) with dyspepsia (&gt;2 weeks)</td>
<td>1. Acupuncture + GP care (n=20): mean 11 sessions (range 4–18), 6 months</td>
<td>MYMOP, GWBI, SF36</td>
<td>Acupuncture prescriptions, NHS primary care cost (consultation, drug prescriptions)</td>
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<td>Paterson, 2003, UK</td>
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<td>-Homeopathy + GP care (n=21): mean 4 sessions (range 0–8)</td>
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<td>-GP care (n=19): consultation and drug prescription</td>
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<td>3. 6 months (effectiveness and cost), 24 months (MYMOP)</td>
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Various approaches were used in the sensitivity analyses of the eight studies which used different variables for acupuncture cost and for the duration of acupuncture-related effects.\textsuperscript{12–15} 18–20 33 A sensitivity analysis of the duration of sustained effects and costs did not change the main findings. Imputation of missing data was performed using sensitivity analysis in five studies.\textsuperscript{12 14 16 17 20}

**Cost-utility analysis (CUA)**

The main outcomes of ICERs for each CUA are summarised in table 2 and the details can be found in supplementary online appendix 4. In all the CUAs, acupuncture was more effective than control but was also more costly. According to the cost-effectiveness plan in figures 2 and 3, all the results of CUAs lie at the east-northeast (ENE) quadrant. Overall, nine CUAs showed that acupuncture is cost-effective in accordance with their own criteria for decision-making.

All the included CUAs can be classified into two main categories in accordance with the country (Germany or UK) and the comparator (waiting list control or usual care). In the UK studies acupuncture was administered in addition to usual care\textsuperscript{12 20} or advice and exercise programme.\textsuperscript{14} In the results, each CUA reported an ICER of \( \varepsilon 4241/QALY \) (LBP),\textsuperscript{12} \( \varepsilon 9951/QALY \) (headache, including patients’ own costs \( \varepsilon 9180/QALY \))\textsuperscript{20} or \( \varepsilon 855/QALY \) (osteoarthritis)\textsuperscript{14} from the NHS perspective. On the other hand, each German CUA reported an ICER of \( \varepsilon 10 526/QALY \) (LBP),\textsuperscript{16} \( \varepsilon 11 657/QALY \) (headache),\textsuperscript{18} \( \varepsilon 17 845/QALY \) (osteoarthritis),\textsuperscript{13} \( \varepsilon 12 469/QALY \) (chronic neck pain),\textsuperscript{15} \( \varepsilon 3011/QALY \) (dysmenorrhoea)\textsuperscript{17} or \( \varepsilon 22 798/QALY \) (allergic rhinitis)\textsuperscript{19} when acupuncture was compared with a waiting list control from a societal perspective. In the subgroup analysis, two German CUAs for osteoarthritis\textsuperscript{13} and for allergic rhinitis\textsuperscript{19} showed that ICER values were too high to be cost-effective (north-east quadrant in figure 3) and even negative (north-west quadrant) for men, indicating that acupuncture does not dominate control.

**Cost-effectiveness analysis (CEA)**

Unlike the CUAs, CEAs showed inconsistent results partly due to various comparators and outcome measures. The detailed results of each CEA are presented in supplementary online appendices 4 and 5.

In two studies acupuncture yielded better clinical outcomes with lower costs; in one study acupuncture was dominant compared with medication in patients with migraine\textsuperscript{30} and in another study stroke patients treated with acupuncture in addition to usual care had greater symptom improvement and lower cost compared with those given usual care only.\textsuperscript{29} A CEA\textsuperscript{32} conducted in India reported that there was no difference in postoperative nausea and vomiting between acupuncture and

---

### Table 1: Continued

<table>
<thead>
<tr>
<th>Study population</th>
<th>Intervention (1 = group; 2 = co-intervention; 3 = follow-up)</th>
<th>Outcome measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jiang, 2010, China\textsuperscript{29}</td>
<td>Single-centre, RCT, CEA (ND)</td>
<td>60 patients (aged &lt;80) on stroke (2–12 weeks)</td>
</tr>
<tr>
<td>Allergic rhinitis</td>
<td>Witt, 2009, Germany\textsuperscript{19}</td>
<td>Multicentre, RCT, CUA (societal)</td>
</tr>
</tbody>
</table>
ondansetron but the cost of acupuncture was lower. For postoperative pain, two CEAs suggested that acupuncture might be a good alternative to conventional analgesia. Meanwhile, for LBP, acupuncture was not superior to massage in terms of either effectiveness or cost. For dyspepsia, there was no significant difference in efficacy between usual care and usual care with acupuncture, nor was there a difference in NHS costs in the UK. One reason for this might be the fact that this was a pilot study with a group size of 20 and was not powered to detect differences between groups. CEA for chronic tension-type headache measured the ICER in China,

### Table 2  Key results of cost-utility analyses

<table>
<thead>
<tr>
<th>Study</th>
<th>Perspective</th>
<th>Mean of differences</th>
<th>ICER (adjusted)</th>
<th>Probability acupuncture cost effective, % (for the threshold values of)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low back pain</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Witt, 2006, Germany</td>
<td>Societal</td>
<td>NA</td>
<td>€280.10</td>
<td>€10526/QALY†</td>
</tr>
<tr>
<td>Ratcliffe, 2006, UK</td>
<td>NHS</td>
<td>0.027</td>
<td>€114.50</td>
<td>€4241/QALY (€4209/QALY*)</td>
</tr>
<tr>
<td><strong>Headache</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Witt, 2008, Germany</td>
<td>Societal</td>
<td>0.030</td>
<td>€350.9</td>
<td>€11857/QALY† (€11403/QALY†)</td>
</tr>
<tr>
<td>Wonderling, 2004, UK</td>
<td>NHS</td>
<td>0.021*</td>
<td>€205.34*</td>
<td>€9951/QALY</td>
</tr>
<tr>
<td><strong>Osteoarthritis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whitehurst, 2011, UK</td>
<td>NHS</td>
<td>0.022</td>
<td>€84.81</td>
<td>€3855/QALY</td>
</tr>
<tr>
<td>Reinhold, 2008, Germany</td>
<td>Societal</td>
<td>0.024</td>
<td>€429.9</td>
<td>€17845/QALY† (€16969/QALY†)</td>
</tr>
<tr>
<td><strong>Chronic neck pain</strong></td>
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<tr>
<td>Willich, 2006, Germany</td>
<td>Societal</td>
<td>0.024</td>
<td>€293.91</td>
<td>€12469/QALY†</td>
</tr>
<tr>
<td><strong>Dysmenorrhoea</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Witt, 2008, Germany</td>
<td>Societal</td>
<td>NA</td>
<td>€195.40</td>
<td>€3011/QALY (€3296/QALY†)</td>
</tr>
<tr>
<td><strong>Allergic rhinitis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Witt, 2009, Germany</td>
<td>Societal</td>
<td>0.020</td>
<td>€457.43</td>
<td>€22798/QALY† (€17377/QALY†)</td>
</tr>
</tbody>
</table>

*Values indicate mean difference after adjustment for baseline.
†ICERs were calculated based on overall costs (overall costs involved those incurred during the treatment period following randomisation, including costs unrelated to the disease under direct study). The QALYs were calculated using the SF-6D except for one study. ICER, incremental cost-effectiveness ratio; M, men; NA, not available; NHS, National Health Service; QALYs, quality-adjusted life years; W, women.

Figure 2  Cost-effectiveness plane of cost-utility analyses. The true values of the effectiveness (x-axis) and cost differences (y-axis) between groups are expressed as points with a black circle (British CUAs) and triangle (German CUAs) on the plane. Euros were converted to GBP with the exchange rate at the time. NE, northeast quadrant; NW, northwest quadrant; SW, southwest quadrant; SE, southeast quadrant; CUA, cost-utility analysis; GBP, Great British Pound; QALY, quality-adjusted life year. For the exchange rate we referred to http://sdw.ecb.europa.eu/.
where the most cost-effective intervention against usual care was herbal medicine+usual care followed by acupuncture+herbal medicine+usual care and acupuncture+usual care.

**Safety**
Eleven included studies assessed the adverse events (AEs) of acupuncture (see supplementary online appendix 6). No severe AEs were reported. Several minor AEs including discomfort, pain, minor local bleeding or haematoma, fainting and nausea were identified. Five studies estimated that there were no negative acupuncture-related AEs during treatment. The economic impact of the identified AEs was not measured by any of these studies.

**Assessment of study design, conduct, analysis and reporting**
Generally, CUAs satisfied most of the items in the checklist (93%, range 80–100%) while CEAs satisfied 51% (range 20–70%). In the CUAs the ‘data collection’ domain (reporting of quantities of resources/unit cost, currency or details of any model used) was poorly reported (89%). In the CEAs the ‘analysis and interpretation of results’ domain was particularly poorly reported (42%), although other domains of the CEAs also presented insufficient information (study design 59%; data collection 56%). In particular, the following items were not reported in less than half of the CEAs: viewpoints, form of economic evaluation, primary outcome measure for the economic evaluation, quantities of resources/unit cost, details of any model used, discount rates for cost or benefit, sensitivity analysis and range of variables, and incremental analysis of costs and outcomes (see supplementary online appendix 7). As mentioned above, this assessment will inevitably rely on reporting quality.

**Methodological quality of the RCTs**
Most of the studies (especially CUAs) were assessed to have a low RoB except blinding as acupuncture was administered in addition to usual care or compared with the waiting list control (see supplementary online appendix 8). Most recorded subjective patient-reported outcomes which were clearly not blinded. Thirteen studies (76%) used adequate sequence generation and 12 studies (71%) concealed the group assignments appropriately. With one exception,29 all the included studies had a low RoB due to incomplete outcome data reporting. Most of the studies analysed were based on intent-to-treat or did not report serious dropout rates, which probably affected their outcomes. Eighty-two percent of the studies clearly reported their results in accordance with prescribed methods or protocols. With regard to baseline imbalance, two studies30 32 did not provide sufficient information to judge whether this may have caused bias in estimating the intervention effect.

**DISCUSSION**
This review indicates that acupuncture with or without usual care has acceptable cost-effectiveness. These results are based on the premise that acupuncture is more...
effective but also more expensive than the controls in various conditions. In the CUA s, acupuncture was most cost-effective in dysmenorrhoea and had the highest ICERs in allergic rhinitis. All the CUA s yielded satisfactory results for each hypothesised threshold of acceptability (figures 2 and 3). This evidence consists of high-quality studies with large sample sizes. The other eight CEA s suggested that acupuncture would be relatively cost-effective in several European countries and Asia except two studies.26 31 Unfortunately, it is unclear whether the CEA s were well-designed and conducted with low RoB. Our review shows that acupuncture is a safe intervention, and these results are consistent with a recent paper.35 Despite promising results, the long-term cost-effectiveness of acupuncture is still uncertain.

The ICERs ranged from €3011/QALY to €22 298/QALY in German studies and from €3855/QALY to €9951/QALY in UK studies. According to the reference providing an example of a league table for QALYs, the range of ICERs for acupuncture is similar to the cost per QALY of a CT head scan for a 35-year-old woman presenting with a single episode of an asymmetrical neurological symptom (£25 000).36 In other publications, ICERs ranged between €5520/QALY for osteopathy of subacute spinal pain and €73 310/QALY for surgical stabilisation of patients with chronic LBP.15 On the other hand, a threshold of ICER for a cost-effective intervention varies by country: £20 000–30 000/QALY in the UK37 38, €50 000/QALY in Germany39 40, and $50 000–100 000/QALY in the USA.40 41 These values are only hypothetical and arbitrary thresholds, not to be made public, but even such estimations have rarely been made in other countries. In some cases the gross domestic product per capita is used to judge cost-effectiveness.40 42 According to details of the ICERs in this review, all studies concluded that additional acupuncture was cost-effective, falling within these thresholds. This pattern did not change with sensitivity analysis, although gender differences emerged in two studies.13 19 The authors speculated that this phenomenon might result from psychological differences such as expectations of treatment. Another possibility is that women are more familiar with the use of complementary and alternative medicine (CAM) than men.43 Additionally, factors such as adherence to treatment, frequency of AEs, fear of acupuncture and intensity of work based on occupation need to be examined by gender.

The economic aspects of acupuncture have already been reported in several narrative44 46 and systematic reviews47–50 in relation to economic evaluations of CAM. Our review focused only on acupuncture and assessed the cost-effectiveness of acupuncture critically with rigorous methodology. One of the other strengths of the current review is that the included CUA s give information of consistent methodologies, outcome measures and cost categories. Using these studies, it is therefore easy to assess the overall cost-effectiveness of acupuncture over different disorders. Probabilistic sensitivity analysis and CEAC are part of the effort to deal with uncertainty.

Our review has several limitations. First, we cannot be absolutely certain that all relevant RCTs were located and included even though we searched a range of databases with no language restriction. Second, most included studies focused on chronic disorders for which long study periods are essential. Longer follow-up time might increase the costs beyond direct medical costs, including the cost for other healthcare agencies.1 Third, various outcome measures have to be taken into consideration in economic evaluation. Different multi-attribute utility instruments assessing general health, such as SF-6D and EQ-5D, might yield different results.51 52 Although there is no doubt that simplified consequences such as QALY facilitate flexible translation between other medical resources,1 symptom-specific outcomes are clinically sensitive and may be more responsive than generic measures.53 Treatment satisfaction is also an important outcome in countries with private insurance options. Fourth, more precise information for cost data is needed. Also, additional cost savings by intervention as well as intervention cost might be a good source of information for economic value. Fifth, it is difficult to distinguish non-specific effects from overall effectiveness in acupuncture research. Moreover, as acupuncture is a manual intervention, a head-to-head comparison with pharmaceutical products might inevitably cause many methodological biases. Finally, research across broad areas is required to assess how well these results can be generalised for other countries. Of the East Asian countries, only two Chinese studies were included in the present review. One modelling approach for patients with chronic LBP in Korea was recently carried out.34 However, these studies are not enough to reflect the diversity of the Asian countries including China, Korea and Japan. In some Asian countries such as Taiwan55 and Korea,56 acupuncture is covered by their healthcare system. Although limited, patients in the UK can obtain acupuncture treatment through the NHS. Even if it is not covered by national health insurance, tax deduction or supplemental insurance policies partially cover costs in France, Germany, Canada and the USA.57 58

There has been a lot of controversy over the failure to demonstrate substantial efficacy compared with placebo controls.59–61 Vickers et al62 suggested the following reasons to avoid placebos and to compare acupuncture with a no-treatment control for their economic analyses: (1) it better reflects real-world decisions and alternatives available to patients; (2) recruitment and patient compliance both increase; (3) a reduction in the need for a large sample in no-treatment controls; and (4) controversy about the placebo acupuncture effect is countered. They also suggested that biases due to the lack of placebo controls can be overcome through appropriate statistical analysis. However, placebo controls are still preferred in acupuncture research because they can help avoid biases and control for the placebo effect, thereby resulting in high internal validity in spite of low external validity and generalisability.63 Consequently, special attention should
be paid to placebo controls in economic evaluations. Previous studies have also debated whether or not the use of a placebo for the comparison in cost-effective analysis of acupuncture is appropriate. A recent study reported that the comparators (sham/placebo or usual care) can affect the cost-effectiveness results. One of the included CUAs suggested that economic aspects of a placebo control should be addressed because it is indeed an active placebo intervention.

As the cost of acupuncture is non-standardised, a clear definition is necessary for further research and decision-making. Many countries do not have fixed prices for acupuncture sessions and practitioner visits except in countries where acupuncture is routinely reimbursed. Thus charges for acupuncture treatment are negotiated by related organisations. More importantly, the cost of the practitioner is regarded as the main cost of acupuncture.

In conclusion, our systematic review of currently available economic analyses alongside RCTs showed the potential cost-effectiveness of acupuncture for the management of pain such as LBP, headache and osteoarthritis. Acupuncture appears to be most cost-effective for dysmenorrhea. Despite the promising clinical implications, any generalisation of these results needs to be made with caution given the diversity of the diseases and the different status of acupuncture in the various countries studied.

Summary points

- We investigated the overall cost-effectiveness of acupuncture.
- There is good evidence it is within the acceptable threshold for several conditions.

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Competing interests

None.

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