Review article: Does acupuncture have a role in providing analgesia in the emergency setting?
A systematic review and meta-analysis

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Abstract
Acupuncture might offer a novel approach to improve ED pain management. Our primary aim was to assess the efficacy of acupuncture in the emergency setting while secondary objectives were to explore its suitability through its side-effect profile, patient satisfaction, cost, administration time and points used. Seven databases and Google Scholar were searched up to 31 July 2016 using MeSH descriptors for three overarching themes concerning acupuncture, pain management and emergency medicine. Meta-analysis was performed on randomised trials for three comparator groups: acupuncture versus sham, acupuncture versus standard analgesia care and acupuncture-as-an-adjunct to standard care, to calculate the standardised mean differences of 1.08, 0.02 and 1.68, and weighted mean differences of 1.60, −0.04 and 2.84, respectively (all positive figures favour acupuncture). Where measured, acupuncture appears to be associated with improved patient satisfaction, lower cost and a low adverse effects profile. The data available were inadequate to ascertain the effect of acupuncture on analgesia use. Significant study bias was found, especially with respect to practitioner and patient blinding. We conclude that for some acute pain conditions in the ED, acupuncture was clinically effective compared to sham and non-inferior to conventional therapy. As an adjunct, limited data was found indicating superiority to standard analgesia care. Further studies will elucidate the most appropriate acupuncture training and techniques, use as an adjunct and the clinical situations in which they can be best applied.

Key findings
- Acupuncture appears to provide effective analgesia for some acute pain conditions in the ED.
- It is non-inferior to selected analgesia medications.
- There is insufficient evidence as yet to show that acupuncture reduces analgesic medication usage.
- The most appropriate techniques to use and the clinical situations in which to apply them, require further research.

Key words: acupuncture, emergency medicine, meta-analysis, pain management, systematic review.

Background
Pain is the primary reason for patients attending the ED in the Western world, with up to three quarters reporting pain. Despite this, pain is often poorly managed and undertreated. In the emergency setting, analgesia should ideally be evidence-based, safe, simple to administer, rapidly effective, titratable and cost-effective, with minimal adverse effects. In the ED, acute pain is often managed with opioids and NSAIDs. These have acknowledged adverse effects in both the short and long term.
There is evidence to support the use of acupuncture to treat chronic pain disorders such as headaches and musculoskeletal pain.\textsuperscript{11} Acupuncture (specifically ear acupuncture) has level one evidence from meta-analyses, reducing acute postoperative pain, opioid requirements and opioid adverse effects compared to controls.\textsuperscript{7} If effective, acupuncture could provide a useful alternative for pain management in the ED when pharmacological methods are contraindicated, or there are concerns about adverse drug effects. Currently in Australia, acupuncture is delivered occasionally in ED by doctors and nurses with varying levels of training, supervision and formal qualifications.

Kim et al. published a systematic review in 2013 on the role of acupuncture for acute pain in the emergency setting.\textsuperscript{12} Their review was diminished by a limited search strategy that did not include non-English language publications or prehospital settings, and excluded conditions frequently treated in the ED. Since 2013, further studies on the role of acupuncture for acute pain in the ED have been published. This, and a desire to perform a more thorough literature search, provided the impetus for our current review.

The primary aim of this systematic review and meta-analysis was to evaluate the effectiveness of acupuncture for acute pain management in the emergency setting. We assessed changes in acute pain scores with acupuncture as a stand-alone therapy or acupuncture-as-an-adjunct to other analgesia (AdjA), compared with standard analgesia care (SAC) or sham-acupuncture (sham). Secondly, we evaluated acupuncture-associated impacts on analgesic medication use, patient satisfaction, adverse effects and health care costs. Further, we aimed to describe the technical aspects and acute pain conditions where acupuncture was applied.

Methods

Search strategy

We undertook a systematic review and meta-analysis in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement.\textsuperscript{13} Seven databases: AMED, CINAHL, EMBASE, PubMed, Science Direct, Scopus and the Cochrane Library of Systematic Reviews and Central, as well as Google Scholar were searched from database inception to 31 July 2016. Three overarching themes were explored using a Boolean search strategy: acupuncture, pain management and emergency medicine. We used various combinations of Medical Subject Heading (MeSH) terms and key words relevant to the intervention (acupuncture therapy, acupuncture, acupressure and electro acupuncture) in conjunction with MeSH terms and key words regarding pain management (acupuncture analgesia, pain management, pain, acute pain and analgesia), and the setting of interest (emergency treatment, emergency medicine, emergency medical services, emergency, pre hospital, retrieval medicine, ED and acute care). In addition, references within included articles were hand-searched, as were proceedings of key scientific meetings. Finally, the Conference Papers Index was searched electronically. The study protocol was approved as part of the first author’s PhD proposal with the University of Notre Dame Australia, Fremantle.

Inclusion and exclusion criteria

Two reviewers (ALJ, ESA) independently screened studies for eligibility. Conflicts regarding inclusion or exclusion of studies were resolved by consensus. Both randomised control trials (RCTs) and uncontrolled observational studies (UOBS) were eligible for inclusion. RCTs were included in both the meta-analyses and systematic review, while UOBS were only included in the systematic review, specifically to inform some of the secondary outcome measures. Studies where the effectiveness of acupuncture for acute pain could not be evaluated during the first 4 h after treatment or where inadequate data was provided were excluded from the meta-analysis but included in the systematic review. Both traditional and modern variants of acupuncture were included. Acute pain conditions were included if they involved prehospital, retrieval, ED care or conditions that are frequently treated in the ED. Excluded studies were those concerning: animals; perioperative pain; chronic pain; non-emergency medical conditions; techniques of cupping, massage and moxibustion; or where pain was not assessed during the first 24 h after treatment. No language restrictions were employed and relevant papers were translated into English as appropriate.

Data extraction

After initial abstract screening, all eligible papers were read in full by two authors (ALJ, ESA). Data was abstracted to a standard template, recording subjects, methods, interventions and outcomes. Study definitions of key terms are provided in Table S1. Where possible, this process followed Standards for Reporting Interventions in Clinical Trials of Acupuncture (STRICTA) guidelines.\textsuperscript{14} Missing information was obtained by correspondence with the author, or derived from other sources within the paper.

Primary outcome

The primary outcome measure was the difference in standardised pain scores out of 10 (PS-10) between treatments in the three comparator groups: acupuncture versus sham, acupuncture versus SAC and AdjA versus SAC; presented as the standardised mean difference (SMD) and weighted mean difference (WMD). Only pain scores recorded within 240 min of treatment were eligible for meta-analysis and different pain score modes (e.g. visual analogue scale or numerical rating scale) were converted to the PS-10 as a continuous variable. Where multiple pain scores were recorded, the score with adequate data closest to 60 min after treatment was used. In order to be included in the meta-analysis, mean and standard deviations (SD) were retrieved or calculated. The methods of Wan et al. were used to calculate mean change in PS-10 and SD from median, interquartiles and minimum maximum range data.\textsuperscript{15} If SDs were not provided, they were calculated from the pre-and-post PS-10 SD and correlation coefficient approximated...
to 0.5 as outlined in the Cochrane Handbook. Subgroup analyses were performed if there were sufficient data to identify variations in effect size and heterogeneity for various acute painful conditions, ear versus body acupuncture, higher sample size, higher quality studies and varying sham techniques.

Secondary outcomes

Analgesia use was measured as: total dose, number of doses used or percentage of patients who took no analgesia, during the first 48 h after treatment. Patient satisfaction was measured as a numerical score (derived from continuous or Likert-scale data), or as the percentage of patients who said they ‘would use this treatment again’. Adverse effects were divided into minor (no treatment) or significant (treatment required) and measured as the percentage of patients affected. The training of the acupuncturist and the points used for both intervention and sham were the acupuncturist and the points used. The training of the acupuncturist and the points used.

Adverse effects were divided into minor (no treatment) or significant (treatment required) and measured as the percentage of patients affected. The training of the acupuncturist and the points used for both intervention and sham were noted. If data was sufficient, relative risk meta-analyses were performed on satisfaction and adverse events. Time-based outcomes were measured as length-of-stay (min) in the ED, time taken to perform procedures (e.g. ‘needling’ time) (min) and the duration of filiform needle insertion (min). The cost of acupuncture consumables was expressed in US dollars (US$) per person.

Risk of bias

Risk of bias was assessed using the Cochrane risk of bias tool regarding the following items: sequence generation, allocation concealment, blinding (subject, practitioner and assessor all as separate categories), completeness of outcomes data (reporting dropout and withdrawal), selective reporting and any ‘other’ potential forms of bias. The ‘other’ risk of bias item is a catch-all category for those factors that may influence effect size but not covered by the aforementioned categories and includes bias such as differences in participants, deviation from protocol and vested interest. A summary risk of bias placed studies into three groups: low (low risk of bias in all criteria), medium (high risk of bias in patient and practitioner blinding only) or high (risk of bias in multiple items).

Data synthesis and statistical analysis

Meta-analyses were performed using Stata software (14.1 StataCorp™, College Station, TX, USA). Individual study data were pooled and weighted to give an overall SMD and WMD. Given the likely heterogeneous nature of studies to be incorporated into the meta-analyses, a random effects model was used. The magnitude of the effect size, that is, SMD of 0.2, 0.5 or 0.8 was categorised as small, medium and large, respectively. A WMD for PS-10 greater than 1.3 was regarded as clinically meaningful.

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Primary outcome

Eight RCTs (nine arms) including 526 patients, compared the change in PS-10 for acupuncture versus sham with a SMD of 1.08 (95% CI = 0.62–1.54), I² = 84.0% (Fig. 2) and WMD of 1.60 (CI = 0.98–2.23) (Fig. S1) both favouring acupuncture. Four RCTs (five arms) including 505 patients showed acupuncture was comparable to SAC with a SMD of 0.02 (CI = −0.48–0.51), I² = 83.8% (Fig. 3) and WMD of −0.04 (CI = −0.89–0.82) (Fig. S2).

Subgroup analyses of primary outcome (Table S4)

Subgroup analysis of medium-to-high quality RCTs comparing acupuncture versus sham found the SMD was large at 1.09 (CI = 0.58–1.60) and the WMD = 1.14 (CI = 0.58–1.70). Ear acupuncture (two RCTs) appeared to have better efficacy with SMD = 1.69 (CI = 0.37–3.01) compared to body acupuncture (SMD = 0.91, CI = 0.42–1.40). Of the conditions treated, fractures (which also corresponded to studies with penetrating acupuncture), reduced the I² to 70.2% but the effect size became medium at 0.67 (CI = 0.31–1.03) and the WMD = 1.14 (CI = 0.58–1.70). Ear acupuncture (two RCTs) appeared to have better efficacy with SMD = 1.69 (CI = 0.37–3.01) compared to body acupuncture (SMD = 0.91, CI = 0.42–1.40). Of the conditions treated, fractures (which also corresponded to acupuncture only studies) had the largest effect size difference (SMD = 2.06, CI = 1.43–2.69) while being medium for back pain (SMD = 0.75, CI = 0.03–1.48) and migraines (SMD = 0.60, CI = 0.18–1.03). Isolating the distant sham points gave a large effect size (SMD = 1.26, CI = 0.63–1.89) while using the same acupoints (without penetration) reduced this to medium (SMD = 0.75, CI = 0.03–1.48). Examining renal colic in the acupuncture versus SAC comparator group (three arms) reduced the effect size (SMD = −0.21, CI = −0.86–0.43) and did not significantly change the I² (79.6%).

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Secondary outcomes

Analgesic medication usage

Of the four RCTs assessing analgesic medication usage, two reported a reduction in analgesic use at 24 and 48 h,\textsuperscript{26,38} while the other two found no difference.\textsuperscript{21,37}

Patient satisfaction

Patient satisfaction was reported in five RCTs. Three prehospital acupuncture trials showed improvement compared to sham on a 100-point scale,\textsuperscript{29–31} one reported an improvement in satisfaction with AdjA in both acupuncture and placebo groups over SAC alone,\textsuperscript{22} while another reported an improvement with acupuncture compared to SAC for ‘those that would use this treatment again’\textsuperscript{35}.

Adverse effects

Adverse effects were reported in 11 RCTs with an overall incidence of 34 out of 675 patients (5.04\%) with seven being potentially significant (four faints and three needle breakages)\textsuperscript{21,34} (Table S3). The relative risk of adverse events (four RCTs, five arms, 545 patients) in the acupuncture versus SAC comparator group was 0.09 (CI = 0.05–0.17) (Fig. S4).

Acupuncture points and acupuncturist training

Acupuncture intervention varied from individualised to set prescriptions,\textsuperscript{34,35} and ranged from 2 to 14 points in number. Points used in more than one study were: SI3, LI4, GV 20, PC 6, TE 5, GB 34, GB 20, GB 40 ST 36, BL 21–24, BL 45–47, BL 60 and ear points: Thalamus, Cingulate, Point zero and Shenmen. Many RCTs specified the use of deqi (creating a sensation of tingling, numbness or heaviness through movement of the acupuncture needle) (Table S2). Some RCTs used non-acupuncturists\textsuperscript{29–31,37,38} after training in a set prescription but most used trained acupuncturists.

Time and costs

The single study measuring length-of-stay with acupuncture versus SAC showed no difference.\textsuperscript{35} Time taken to administer acupuncture was less than 6 min in three RCTs.\textsuperscript{30,31,34} The duration of standard filiform needle insertion was between 15 and 30 min in seven RCTs.\textsuperscript{21,23,24,26,32–34} Three RCTs\textsuperscript{29,37,38} quoted costs of acupuncture consumables as less than US$5.00 per patient, while three RCTs\textsuperscript{21,30,31} simply stated that acupuncture is a ‘low cost treatment’.

Bias and heterogeneity

Significant potential bias was found, especially with respect to patient and practitioner blinding (Fig. S5, Table S5). The heterogeneity measures ($I^2$) for the three forest plots (Figs 2–4) ranged from 56.4\% to 86.2\%.

Observational studies (Table S6)

UOBS included 1402 patients and studied mixed pain conditions...
recent systematic review by Kim et al. Our analysis determined that acupuncture, as measured by three aspects, provided statistically significant, clinically meaningful and improved levels of patient satisfaction with respect to pain relief in the emergency setting.

Effectiveness of acupuncture across the three study groups

In the combined eight RCTs in the acupuncture versus sham group, we found significant statistical evidence superior to sham and a WMD (PS-10) above the clinical meaningful threshold of 1.3. Some caution is required in extrapolating this result to all acute painful conditions as this first meta-analysis confined itself to three major groups of conditions, namely back pain, fractures (including wounds and contusions) and migraines. When patient satisfaction was reported as a secondary outcome against sham, it favoured acupuncture but there was insufficient data for meta-analysis.

The use of sham in acupuncture RCTs is controversial with some arguing against using it as a control, reasoning that acupuncture is better studied against SAC. In our subgroup analyses, stimulating the same point with sham resulted in a smaller effect size that is consistent with other researchers claiming sham has a clinical effect. Acupuncture was found to be comparable (non-inferior) to SAC for both the SMD and WMD pain outcomes, and when measured (one study) in this comparator group, patient satisfaction favoured acupuncture. The SAC provided varied between RCTs but used typical analgesics common in ED practice for the specified condition such as paracetamol, NSAI ds and morphine in clinically appropriate dose ranges. However, one study used noramidopyrine and camylo after acupuncture versus sham or SAC suggest that acupuncture may be a suitable alternative when the concerns for analgesic drug side effects are high, are contraindicated or were previously ineffective.
AdjuA compared to SAC provided superior analgesia (SMD and WMD) but the strength of this conclusion is guarded, as it is derived from only two RCTs. Pending substantiation by further research, AdjuA might offer a way to reduce adverse pharmacological effects related to opioids and NSAIDs by reducing dosage or usage. There were no patient satisfaction outcomes in this adjunct group.

Study quality

In general, interpretation of acupuncture RCTs presents unique challenges in relation to patient and practitioner blinding, sham effects and other frequent flaws in methodology.54 The quality of the RCTs included in this meta-analysis was highly variable. Some researchers achieved practitioner and patient blinding, but most did not; while others had flaws in randomisation and assessor blinding. All three comparator groups in the meta-analysis showed substantial heterogeneity as expected.19 This could be explained by variations in patient demographics, sample size, time intervals, acupuncture point choice (body versus ear), drug comparator variation (type, dose and frequency) and pain conditions treated.55 The variable quality of RCTs and heterogeneity necessarily limits conclusions that can be drawn from this meta-analysis.

Adverse effects

A notable feature of this review is the low significant adverse effects (requiring intervention) profile of acupuncture compared to SAC with a rate of approximately 1% in the RCTs and none reported in the UOBS. A review of larger observational studies quotes significant side-effect rates as 0.02%–2.20%, which is consistent with our review.66 This is reinforced by the low relative risk of 0.09 for all adverse events in acupuncture versus SAC pharmacological therapy in our meta-analysis. This low risk should be interpreted in the light of inconsistencies in reporting of minor adverse events for both acupuncture and pharmacological arms.

Conditions treated

In both the RCTs and UOBS, acupuncture was used across a spectrum of acutely painful conditions in adults and children, including migraines, limb and rib fractures and acute abdominal pain (including renal colic). All of these are directly relevant to the emergency setting and are beyond the usual conditions where acupuncture is used in the non-emergency out-patient setting. Interestingly, subgroup analyses showed the largest effect size for fractures while being medium for back pain and migraines.

Acupuncturist training, technique and utilisation

Practitioners in both the RCTs and UOBS varied from non-acupuncturists trained in simple prescriptions with a small number points such as ear acupuncture to more individualised prescriptions delivered by emergency physicians with extra acupuncture qualifications or traditional Chinese medicine practitioners. Body acupuncture may delay usual ED care up to 30 min. Our subgroup analyses showed better efficacy for ear over body acupuncture and acupressure over penetrating acupuncture. It is yet to be shown whether longer acupuncture training significantly improves pain-related outcomes,57 or reduces the incidence of adverse effects, though intuitively it seems likely.58

Future research

In this review, we utilised three measures of acupuncture effectiveness as an analgesic technique. Future RCTs might look at other measures such as the number needed to treat for 30% to 50% pain reduction or ‘adequate analgesia’ that has a better correlation to patient satisfaction (defined as triage PS-10 reduction by ≥2 and to a level <4).59 More RCTs are required where AdjuA is compared to SAC and should include reduction of analgesia medication as a secondary outcome measure. Further investigation is warranted into other painful conditions with acupuncture versus SAC, ear versus body acupuncture and specifically that delivered by usual ED health providers compared with qualified acupuncturists. Both better and consistent adverse events reporting is also required.

Conclusion

Acupuncture appears to provide effective analgesia for some acute pain conditions in the ED, while being non-inferior to selected analgesic medications. Acupuncture has limited evidence suggesting it is an effective adjunctive analgesia technique when added to analgesic medications in the emergency setting. Acupuncture shows promise as a low cost, low risk and patient satisfying therapy with only limited minor adverse effects, but its effectiveness in reducing analgesic medication use is uncertain. Further studies will elucidate the most appropriate acupuncture training and techniques, its role as an analgesia adjunct and the clinical situations in which it can be best applied.

Limitations

While many non-English language publications were able to be included in the study, difficulties were encountered with accurate translation of key scientific terms. This trial and its outcomes were not pre-registered on a systematic review database. While grouping the meta-analyses into these three groups has advantages because of similarities in trial design, it may be that it assumes incorrectly that various forms of acupuncture are similarly effective across a range of painful conditions. A random effects model was used as it was assumed that the studies were not homogeneous. Substantial heterogeneity existed for the three comparator groups. While subgroup analyses have been performed in this review, researchers caution over-reliance on them in terms of evidence for or against an intervention.60

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Author contributions
ALJ, ESA, IRR, EJV, MKB and RCN conceived the study, designed the search and did the data collection. ALJ and ESA undertook data collection and analysis. All authors contributed to the review and revision of the manuscript, and all take responsibility for the final version.

Competing interests
The opinions and assertions contained herein are the private views of RCN and are not to be construed as evidence of or as representing the views of the USA Force Medical Corps, the Air Force at large or the Department of Defense.

References


Supporting information
Additional supporting information may be found in the online version of this article at the publisher’s web site:

Figure S1. Forest plot of acupuncture versus sham with calculated weighted mean difference for pain score difference (on a PS-10).

Figure S2. Forest plot of acupuncture versus standard analgesia care with calculated weighted mean difference for pain score difference (on a PS-10).

Figure S3. Forest plot of acupuncture as adjunct versus standard analgesia care with calculated weighted mean difference for pain score difference (on a PS-10).

Figure S4. Forest plot of relative risk of adverse events for acupuncture versus standard analgesia care.

Figure S5. Cochrane bias assessment of studies included in meta-analysis expressed as a percentage of included studies.

Table S1. Study definitions: key terms for this systematic review.

Table S2. Methods characteristics of RCT acupuncture studies on pain management in the emergency setting.

Table S3. Results of RCT acupuncture studies on pain management in the emergency setting.

Table S4. Subgroup analyses of the RCTs comparator groups acupuncture versus sham and standard analgesia care.

Table S5. RCT studies and bias according to the Cochrane assessment tool (H = high, U = unclear, L = low).

Table S6. Methods and results of observational acupuncture studies on pain management in the emergency setting.