BMJ Open
Management of chronic neuropathic pain: a protocol for a multiple treatment comparison meta-analysis of randomised controlled trials

Sohail M Mulla,1,2 D Norman Buckley,3,4 Dwight E Moulin,5 Rachel Couban,4 Zain Izhar,1 Arnav Agarwal,1 Akbar Panju,4,6 Li Wang,3 Sun Makosso Kallyth,4 Alparslan Turan,7 Victor M Montori,8 Daniel I Sessler,7 Lehana Thabane,1,3,9 Gordon H Guyatt,1,6 Jason W Busse1,3,4


ABSTRACT

Introduction: Chronic neuropathic pain is associated with reduced health-related quality of life and substantial socioeconomic costs. Current research addressing management of chronic neuropathic pain is limited. No review has evaluated all interventional studies for chronic neuropathic pain, which limits attempts to make inferences regarding the relative effectiveness of treatments.

Methods and analysis: We will conduct a systematic review of all randomised controlled trials evaluating therapies for chronic neuropathic pain. We will identify eligible trials, in any language, by a systematic search of CINAHL, EMBASE, MEDLINE, AMED, HealthSTAR, DARE, PsycINFO and the Cochrane Central Registry of Controlled Trials. Eligible trials will be: (1) enrol patients presenting with chronic neuropathic pain, and (2) randomise patients to alternative interventions (pharmacological or non-pharmacological) or an intervention and a control arm. Pairs of reviewers will, independently and in duplicate, screen titles and abstracts of identified citations, review the full texts of potentially eligible trials and extract information from eligible trials. We will use a modified Cochrane instrument to evaluate risk of bias of eligible studies, recommendations from the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) to inform the outcomes we will collect, and the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) system to evaluate our confidence in treatment effects. When possible, we will conduct: (1) in direct comparisons, a random-effects meta-analysis to establish the effect of reported therapies on patient-important outcomes; and (2) a multiple treatment comparison meta-analysis within a Bayesian framework to assess the relative effects of treatments. We will define a priori hypotheses to explain heterogeneity between studies, and conduct meta-regression and subgroup analyses consistent with the current best practices.

Ethics and Dissemination: We do not require ethics approval for our proposed review. We will disseminate our findings through peer-reviewed publications and conference presentations.

Strengths and limitations of this study

▪ Our broad study eligibility criteria will allow us to generate more precise estimates of treatment effects, thus increasing generalisability of our results.
▪ We will use the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach to evaluate our confidence in treatment effects, and the IMMPACT guidelines to inform the outcomes we will collect. No existing review on the topic has done so.
▪ We will ensure interpretability by presenting risk differences and measures of relative effect for all outcomes reported, and by presenting our findings with GRADE evidence profiles. No existing review on the topic has done so.
▪ Our results will be limited by possible shortcomings of the primary studies.

Trial registration number: PROSPERO (CRD42014009212).

BACKGROUND

Chronic neuropathic pain is defined as “pain arising as a direct consequence of a lesion or disease affecting the somatosensory system.”1 It may be classified as central or peripheral, depending on the site of the lesion.2 Among the causes of chronic neuropathic pain are metabolic disease (eg, diabetes), infection (eg, shingles), trauma (eg, spinal cord injury) and autoimmune disease (eg, multiple sclerosis).3–5 The pain may be spontaneous or evoked in response to physical stimuli. The latter may manifest as increased sensitivity to pain (hyperalgesia) or as a painful response to a stimulus that would not normally be painful (allodynia).1 6

For numbered affiliations see end of article.

Correspondence to
Sohail M Mulla; mullasm@mcmaster.ca

Prepublication history and additional material is available. To view please visit the journal (http://dx.doi.org/10.1136/bmjopen-2014-006112).

Received 15 July 2014
Revised 14 October 2014
Accepted 31 October 2014

Chronic neuropathic pain is common worldwide, affecting 7% to 10% of the general population. It is associated with depression, anxiety and sleep disturbances, and patients with chronic neuropathic pain experience lower health-related quality of life than the general population.

Chronic neuropathic pain is associated with substantial economic burden. Tarride et al. estimated that managing a Canadian patient with chronic neuropathic pain over a 3-month period costs an average of $2567, of which 52% are direct costs, for example, cost of physicians, diagnostic tests and surgical procedures. Others report that people suffering from chronic neuropathic pain generate medical costs that are three times greater than those not living with pain. In the USA alone, almost $40 billion annually in healthcare, disability and related costs is attributed to chronic neuropathic pain.

The underlying mechanisms of chronic neuropathic pain are poorly understood, which complicates management. Non-pharmacological and pharmacological treatments are currently used. A limited number of systematic reviews focus on non-pharmacological options, including electrical nerve stimulation, acupuncture and cognitive behavioural therapy. Most report pharmacological treatments for chronic neuropathic pain, including antidepressants, anticonvulsants and opioid analgesics.

However, significant gaps remain. For example, randomised controlled trials (RCTs) exploring treatment for chronic neuropathic pain often compare pharmacological treatments against placebo and seldom against each other. Consequently, there are few direct comparisons among treatments. A recent systematic review found that among 131 RCTs published between 1969 and 2007, addressing painful diabetic neuropathy and postherpetic neuralgia, both common types of peripheral neuropathic pain, only 25 studies (19%) compared drugs directly against each other.

No review to date has systematically evaluated all evidence for management of chronic neuropathic pain; existing reviews focus on select therapies or specific syndromes. Additionally, risk of bias assessment of studies included in existing reviews has been highly variable, and authors often depended on instruments that have been criticised for being overly simplistic (eg, Jadad system) and/or assessed risk of bias on a per-study basis rather than overall for reported outcome. Furthermore, strategies to identify studies have been limited, as authors used few search terms, did not search major literature databases, and/or did not consider foreign language studies—an approach that would have excluded 12% of eligible trials in a systematic review of another chronic pain syndrome. As well, none of the existing reviews facilitated interpretability, for instance, by presenting results in terms of minimally important differences (MID).

The limitation of previous works suggests the need for a new systematic review to be conducted using state-of-the-art methodology to inform evidence-based management of chronic neuropathic pain. We thus plan a systematic review and multiple treatment comparison meta-analysis of therapies for chronic neuropathic pain.

METHODS
Standardised reporting
Our paper will conform to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for reporting systematic reviews of RCTs.

Protocol registration
Our protocol is registered on PROSPERO (registration number: CRD42014009212).

Search strategy
We will identify relevant RCTs, in any language, by a systematic search of CINAHL, EMBASE, MEDLINE, AMED, HealthSTAR, DARE, PsychINFO, PapersFirst, ProceedingsFirst and the Cochrane Central Registry of Controlled Trials, from the inception of each database. Our search will be refined for individual databases by a highly experienced medical librarian (RC; see online supplementary appendix 1, which is a proposed search strategy for MEDLINE). Reviewers will scan the bibliographies of all retrieved trials and other relevant publications, including reviews and meta-analyses, for additional relevant articles.

Eligibility criteria and their application to potentially eligible articles
Using standardised forms, reviewers trained in health research methodology will work in pairs to screen, independently and in duplicate, titles and abstracts of identified citations, and acquire the full-text publication of articles that both reviewers judge as potentially eligible. Using a standardised form, the same reviewer teams will independently apply eligibility criteria to the full text of potentially eligible trials. We will measure agreement between reviewers to assess the reliability of full-text review using the guidelines proposed by Landis and Koch. Specifically, we will calculate κ values, and interpret them using the following thresholds: <0.20 as slight agreement, 0.21–0.40 as fair agreement, 0.41–0.60 as moderate agreement, 0.61–0.80 as substantial agreement and >0.80 as almost perfect agreement. Eligible trials will be: (1) enrol patients presenting with chronic neuropathic pain (see online supplementary appendix 2 for lists of all syndromes we are studying) and (2) randomise patients to alternative interventions (pharmacological or non-pharmacological) or to an intervention and control arm.

Data abstraction and analysis

Before starting data abstraction, we will conduct calibration exercises to ensure consistency between reviewers. Teams of reviewers will extract data independently and in duplicate from each eligible study using standardised forms and a detailed instruction manual to inform tailoring of an online data abstraction programme, DistillerSR (http://systematic-review.net/). We will extract data regarding patient demographics, trial methodology, intervention details and outcome data guided by the Initiative on Methods, Measurement and Pain Assessment in Clinical Trials (IMMPACT).62 63 Specifically, we will collect outcome data across the following nine IMMPACT-recommended core outcome domains: (1) pain; (2) physical functioning; (3) emotional functioning; (4) participant ratings of improvement and satisfaction with treatment; (5) symptoms and adverse events; (6) participation disposition; (7) role functioning; (8) interpersonal functioning; and (9) sleep and fatigue. We will collect data for all adverse outcomes as guided by Ioannidis and Lau.64 We will resolve disagreements by discussion to achieve consensus.

Evaluating risk of bias in individual studies

Reviewers will assess risk of bias using a modified Cochrane risk of bias instrument that includes response options of ‘definitely or probably yes’—assigned a low risk of bias—or ‘definitely or probably no’—assigned a high risk of bias, an approach we have previously shown to be valid.65 We will evaluate sequence generation, allocation sequence concealment; blinding of participants and study personnel; and incomplete outcome data.66 We will resolve any disagreements between reviewers by discussion. We will contact study authors if limitations in reporting lead to uncertainties in eligibility, risk of bias, or outcome.

Direct comparisons meta-analyses

In comparison to fixed effect models, random effect models are conservative in that they consider the within-study as well as the among-study variability. Recent methodological research has shown that while popular, the DerSimonian-Laird method67 can produce narrow CIs when the number of studies is small or when they are substantively heterogeneous.68 69 Therefore, to pool outcome data for trials that make direct comparisons between interventions and alternatives, we will use the likelihood profile approach.70 We will pool cross-over trials with parallel design RCTs using methods outlined in the Cochrane handbook to derive effect estimates.66 Specifically, we will perform a paired t test for each cross-over trial if any of the following are available: (1) the individual participant data; (2) the mean and SD or SE of the participant-specific differences, and between the intervention and control measurement; (3) the mean difference (MD) and one of the following: (a) a t-statistic from a paired t test; (b) a p value from a paired t-test; (c) a CI from a paired analysis; or (4) a graph of measurements of the intervention arm and control arm from which we can extract individual data values, so long as the matched measurement for each individual can be identified.66 If these data are not available, we will approximate paired analyses by calculating the MDs and the corresponding SEs for the paired analyses.66 If the SE or SD of within-participant differences are not available, we will impute the SD using the methods outlined in the Cochrane Handbook.66

Ensuring interpretable results

We will use a number of approaches to provide interpretable results from our meta-analyses. For studies that provide binary outcome measures, we will calculate relative risks (RRs) to inform relative effectiveness. To generate measures of absolute effect (risk differences), we will use estimates of baseline risk from the control arm of eligible RCTs.

When pooling across studies reporting continuous endpoints that use the same instrument, we will calculate the weighted mean difference (WMD), which maintains the original unit of measurement and represents the average difference between groups. Once the WMD has been calculated, we will contextualise this value by noting the corresponding MID—the smallest change in instrument score that patients perceive is important. We will prioritise use of anchor-based MIDs when they are available, and calculate distribution-based MIDs when they are not. We will also divide WMDs by their corresponding MID to obtain estimates in MID units. However, contextualising the WMD through the MID can be misleading; clinicians may mistakenly interpret any effect in MID units smaller than 1 as suggesting no patient obtains an important benefit, and any effect estimate greater than 1 as suggesting that all patients benefit, which is not accurate. Therefore, we will also calculate the proportion of patients who have benefited, that is, demonstrated improvement greater than or equal to the MID in each trial, then aggregate the results across all studies.71 Further, we will convert the proportion data to probabilities of experiencing benefit to calculate pooled RRs and numbers needed to treat (NNTs).

For trials using different continuous outcome measures that address the same underlying construct, we will calculate the between-group difference in change scores (change from baseline) and divide this difference by the SD of the change. This calculation creates a measure of the effect (quantifying its magnitude in SD units), called the standardised mean difference (SMD), which allows for comparison and pooling across trials.66 However, the SMD is difficult to interpret and is vulnerable to the heterogeneity of patients who are enrolled: trials that enrol homogeneous study populations and thus have smaller SDs will generate a larger SMD than studies with more heterogeneous patient populations. To address this issue, we will calculate the effect estimates in MID units by dividing between-group difference in change scores by the MID. However, as with WMDs, contextualising the SMD in MID units can be misleading; therefore, we will,
for each trial, calculate the probability of experiencing a
treatment effect greater than or equal to the MID in the
control and intervention groups, then pool the results to
calculate RRs and NNTs.74

Patients may be interested in the ability of a given
intervention to provide more than an MID—to produce
improvement that allows patients to feel much better
(i.e., substantially greater than the MID). Thus, for our
analyses, where studies report percentage reduction in
pain we will also use thresholds of ≥20%, ≥30% and
≥50% reduction of pain from baseline to calculate the
proportion of patients who have benefited in each trial, and
derive RRs and risk differences.

Assessment of heterogeneity and subgroup analyses
We will conduct conventional meta-analyses (see above)
for each paired comparison. For each of these compari-
sions, we will examine heterogeneity using a χ² test and
the I² statistic—the percentage of variability that is due
to true differences between studies (heterogeneity)
rather than sampling error (chance).72 73

We have generated five a priori hypotheses to explain
variability between studies: (1) subjective syndromes will
show smaller treatment effects versus objectively diag-
nosed syndromes; (2) trials comparing treatment to
placebo will show larger treatment effects than trials
using active comparators; (3) trials that exclude patients
who are receiving disability benefits and/or involved in
litigation will show larger treatment effects than trials
that include such patients; (4) chronic neuropathic pain
syndromes defined by peripheral nervous system lesions
(e.g., diabetic neuropathy) will show larger effects than
central nervous system lesions (e.g., chronic post-stroke
pain); (5) trials with higher risk of bias will show larger
treatment effects than trials with lower risk of bias; and
(6) trials with longer follow-up times will show smaller
treatment effects than trials with shorter follow-up times.

To inform our subgroup analyses based on risk of bias
we will, if we detect variability within the individual risk
of bias components, perform subgroup analyses on a
component-by-component basis. We will perform
meta-regression and subgroup analyses to explore these
hypotheses, and interpret the results in the context of
the GRADE system (see below).74

Confidence in the estimates of effect
We will use the GRADE approach to evaluate confidence
in effect estimates for all reported outcomes.75 GRADE
has been adopted by over 70 organisations worldwide,
and this approach facilitates transparent, rigorous and
comprehensive assessment of evidence quality on a per
outcome basis.76–89 Our review of the management of
chronic neuropathic pain will be the first to use the
GRADE criteria to evaluate confidence in effect esti-
mates. We will categorise the confidence in estimates
(quality of evidence) as high, moderate, low or very low.
Using this approach, randomised trials begin as high
quality evidence but may be rated down by one or more

of four categories of limitations. We will use GRADE
guidance to determine whether to rate down confidence
in the body of evidence for (1) risk of bias87 and for (2)
imprecision,89 inconsistency83 and publication bias.84

For the risk of bias assessment, for any comparisons that
suggest a statistically significant treatment effect, we will
use recently developed approaches to address missing
participant data for dichotomous outcomes and contin-
uous outcomes.90 91 When plausible worst case scenarios
reverse the treatment effect we will rate down for risk
of bias. We will present the results of our meta-analyses in
GRADE evidence profiles that will provide a succinct,
easily digestible presentation of the risk of bias and mag-
nitude of effects.75

Multiple treatment comparison meta-analyses
To assess relative effects of competing treatments, we will
construct a random effects model within the Bayesian
framework using Markov chain Monte Carlo methods.92
We will use trace plots and calculate the Gelman-Rubin
statistic to assess model convergence. We will model
patient-important outcomes in every treatment group of
every study, and specify the relations among the effect
sizes across studies.93 This method combines direct and
indirect evidence for any given pair of treatments.
We will use the resulting 95% credible intervals to assess
the precision of treatment effects.94 A key assumption
behind multiple treatment comparison meta-analysis is
that the analysed network is consistent or coherent, that
is, that direct and indirect evidence on the same com-
parisons do not disagree beyond chance. We will identify
and estimate incoherence by employing a mixed treat-
ment comparisons incoherence model in the Bayesian
framework.95 For each comparison, we will note the
direct estimates and associated CIs from the previous
analysis and calculate the indirect estimate using a node
splitting procedure as well as the network estimate. We
will conduct a statistical test for incoherence between
the direct and the indirect estimate.

We will have assessed confidence in estimates of effect
from the direct comparisons in our pair-wise meta-analyses
described previously. For rating confidence in the indirect
comparisons, we will focus our assessments on first-order
loops (i.e., loops that are connected to the interventions
of interest through only one other intervention; e.g., A vs C
and B vs C to estimate effects of A vs B) with the lowest var-
iances, and thus contribute the most to the estimates of
effect. Within each loop, our confidence in the indirect
comparison will be the lowest of the confidence ratings we
have assigned to the contributing direct comparisons. For
instance, if treatment A versus C warrants high confidence
and B versus C warrants moderate confidence, we will
judge the associated indirect comparison (A vs B) as war-
ranting moderate confidence. We may rate down confi-
dence in the indirect comparisons further if we have a
strong suspicion that the transitivity assumption (i.e., the
assumption that there are no effect modifiers—such as dif-
fences in patients, extent to which interventions have
been optimally administered, differences in the comparator, and differences in how the outcome has been measured—in the two direct comparisons that may bias the indirect estimate) has been violated.

Our overall judgement of confidence in the network estimate for any paired comparison will be the higher of the confidence rating among the contributing direct and indirect comparisons. However, we may rate down confidence in the network estimate if we find that the direct and indirect estimates are incoherent.

As a secondary analysis, we will rank the interventions using the SUCRA (surface under the cumulative ranking) method. The SUCRA rankings may be misleading: if there is only evidence warranting low confidence for most comparisons; if the evidence supporting the higher ranked interventions warrants lower confidence than the evidence supporting the lower ranked interventions; or if the magnitude of effect is very similar in higher versus lower ranked comparisons. We will consider these issues in interpreting the SUCRA rankings.

**DISCUSSION**

With the established high prevalence of chronic neuropathic pain worldwide, the associated high socioeconomic burden and the paucity of evidence on the comparative effectiveness of treatment options, there is an urgent and critical need for a high-quality systematic review to inform evidence-based management of chronic neuropathic pain.

Our proposed review has several strengths in relation to existing reviews. First, we will include all nonpharmacological and pharmacological treatment options for all chronic neuropathic pain syndromes. It is plausible that individual pain syndromes, in general, respond similarly to similar interventions, and thus by pooling across individual syndromes, it may be possible to provide a more precise estimate of treatment effect. In addition, examining all therapies for all chronic neuropathic pain syndromes would provide comprehensive guidance for management of chronic neuropathic pain, which increases utility to healthcare providers, patients and payers. Second, we will update the search to present date, explore a wider range of literature databases than existing reviews and include eligible articles in all languages. Third, we will make all subjective decisions, including determining trial eligibility and collecting data, in teams of reviewers, independently and in duplicate, with assessments of the reproducibility of judgements. Fourth, we will focus on collecting patient-important outcomes across IMPACT-recommended core domains. Fifth, we will use the GRADE approach to evaluate our confidence in treatment effects. Sixth, we will ensure interpretability by presenting risk differences and measures of relative effect for all outcomes reported, and by presenting our findings with GRADE evidence profiles. Seventh, we will generate a limited number of a priori subgroup hypotheses to explain heterogeneity of pooled estimates of treatment effect, and conduct meta-regression and subgroup analyses consistent with best current practices.

As with existing reviews, the results of our proposed systematic review will be limited by possible shortcomings of the primary studies, including presence of publication bias, high heterogeneity, and poor quality of reporting and methodological rigour. Another likely limitation, unique to multiple treatment comparison meta-analyses, will be the nature of available treatment comparisons to build robust networks for our analyses.

The findings of our review will help inform patients with chronic neuropathic pain about their therapeutic options, so that they can make more autonomous health management decisions. In addition, to help educate clinicians responsible for managing such patients, our review will facilitate updating clinical practice guidelines for the management of chronic neuropathic pain.

**Author affiliations**

1. Department of Clinical Epidemiology & Biostatistics, McMaster University, Hamilton, Ontario, Canada
2. Outcomes Research Consortium, Cleveland Clinic, Cleveland, Ohio, USA
3. Department of Anesthesia, McMaster University, Hamilton, Ontario, Canada
4. Michael G. DeGroote Institute for Pain Research and Care, McMaster University, Hamilton, Ontario, Canada
5. Departments of Clinical Neurological Sciences and Oncology, Western University, London, Ontario, Canada
6. Department of Medicine, McMaster University, Hamilton, Ontario, Canada
7. Department of Outcomes Research, Cleveland Clinic, Cleveland, Ohio, USA
8. Knowledge and Evaluation Research Unit, Divisions of Endocrinology and Diabetes, and Health Care & Policy Research, Mayo Clinic, Rochester, Minnesota, USA
9. Department of Pediatrics, McMaster University, Hamilton, Ontario, Canada

**Contributors** All authors made substantial contributions to conception and design. SMM drafted the article, and DNB, DEM, RC, ZI, AA, AP, LW, SMK, AT, VMM, DIS, LT, GHG and JWB revised it critically for important intellectual content. All authors provided final approval of the version to be published.

**Funding** This systematic review is supported by the Canadian Anesthesia Research Foundation and the Canadian Institutes of Health Research.

**Competing interests** DEM and AP are chair and member, respectively, of the Canadian Pain Society Guideline Committee for management of chronic neuropathic pain. DEM has received research grant funding from Pfizer Canada, and has received honoraria for educational presentations from Janssen-Ortho, Lilly, Purdue Pharma and Merck-Frosst.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Open Access** This is an Open Access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/

**REFERENCES**
