Pharmacotherapy for post-traumatic stress disorder: systematic review and meta-analysis

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Background
Pharmacological treatment is widely used for post-traumatic stress disorder (PTSD) despite questions over its efficacy.

Aims
To determine the efficacy of all types of pharmacotherapy, as monotherapy, in reducing symptoms of PTSD, and to assess acceptability.

Method
A systematic review and meta-analysis of randomised controlled trials was undertaken; 51 studies were included.

Results
Selective serotonin reuptake inhibitors were found to be statistically superior to placebo in reduction of PTSD symptoms but the effect size was small (standardised mean difference $-0.23$, 95% CI $-0.33$ to $-0.12$). For individual pharmacological agents compared with placebo in two or more trials, we found small statistically significant evidence of efficacy for fluoxetine, paroxetine and venlafaxine.

Conclusions
Some drugs have a small positive impact on PTSD symptoms and are acceptable. Fluoxetine, paroxetine and venlafaxine may be considered as potential treatments for the disorder. For most drugs there is inadequate evidence regarding efficacy for PTSD, pointing to the need for more research in this area.

Declaration of interest
None.

Post-traumatic stress disorder (PTSD) is a common mental disorder with an estimated prevalence of 15.4% in the most robust epidemiological studies (those using diagnostic interviews and random samples) of conflict-affected populations, and a 12-month prevalence across the world of 3–4%. The disorder may occur in people of any age who have been exposed to one or more exceptionally threatening or horrifying events. Characteristic symptoms include re-experiencing, avoidance and hyperarousal. The disorder is associated with substantial comorbidity, such as depression, anxiety and substance misuse, and significant economic burden. Previous meta-analyses of pharmacological treatment of PTSD have been inconsistent. The UK’s National Institute for Health and Care Excellence (NICE) guidelines found that only paroxetine, mirtazapine, amitriptyline and phenelzine were significantly superior to placebo. Owing to the relatively small effect sizes and sample sizes, none of these drugs was included as a first-line treatment for PTSD; all were recommended as second-line treatment after the initiation of trauma-focused psychological treatment. The guidelines of the Australian Centre for Posttraumatic Mental Health (ACPMH), consistent with NICE, recommended that pharmacological interventions should not be used in preference to trauma-focused psychological treatment. Other reviews have been more positive about pharmacological treatment, grouping selective serotonin reuptake inhibitors (SSRIs) together and rating them as equivalent to trauma-focused psychological treatments. A Cochrane review reported strong benefits, but the Institute of Medicine found inadequate evidence to determine the efficacy of pharmacological treatment for PTSD. There are, however, major differences between the methodological quality of these reviews, making direct comparison problematic. Given the inconsistent findings of previous meta-analyses and the increasing number of randomised controlled trials (RCTs) of pharmacological treatments, the World Health Organization (WHO) commissioned an update of the information obtained by the most methodologically robust systematic reviews published to date: those by NICE, ACPMH and the Cochrane Collaboration. We reviewed RCTs that assessed the efficacy of pharmacological treatment compared with placebo control groups at reducing traumatic stress symptoms in individuals experiencing PTSD.

Method
All double-blind, randomised, placebo-controlled and comparative trials of the pharmacological treatment of PTSD completed from October 2005 (to ensure all eligible trials not published at the time of the NICE, Cochrane and ACPMH searches would be included) were considered in our primary and additional searches, covering 13 separate databases. Trials completed before October 2005 that were included in the NICE, Cochrane and ACPMH reviews were also considered. Published and unpublished abstracts and reports were sought out in any language. Studies were not excluded on the basis of differences between them such as sample size and duration. Pharmacotherapy trials in which there was ongoing or newly initiated trauma-focused psychotherapy or where the experimental medication served as an augmentation agent to ongoing pharmacotherapy were excluded. Pharmacotherapy trials in which there was ongoing supportive counselling were allowed provided it was not initiated during the course of the treatment, on the basis that this is common in trials and the limited evidence for supportive counselling. Open label trials were not considered. Our review followed the Preferred Reporting Items for Systemic Reviews and Meta-analyses (PRISMA) checklist and reporting guidance.

Participants
All studies of participants with PTSD according to ICD or DSM criteria were eligible. There was no restriction on the basis of onset, duration or severity of PTSD symptoms, or on the presence of comorbid disorders, trauma type, age or gender of participants.
Interventions
Pharmacological treatments for adults with PTSD, in which the comparator was a placebo or other medication, were eligible for inclusion.

Outcome measures
The primary outcome of interest were clinician-administered continuous measures of symptom severity such as the Clinician Administered PTSD Scale. Self-rated PTSD symptom scales were considered separately. The total number of participants who left the trial early for any reason was used as a proxy measure of treatment acceptability.

Search strategy
We conducted a primary bibliographic database search of Medline, Medline In Process, EMBASE, the Health Management Information Consortium (HMIC) database, PsycINFO, ASSIA and CINAHL using the Ovid interface on 22 February 2013. In order to avoid language bias, we separately searched (using the same search strategy, and in consultation with regional experts) the Japanese, Chinese and WHO regional databases (Spanish, Russian and Portuguese languages). This initial broad search was intended to identify not only the RCTs of interest but also reviews of pharmacotherapy for PTSD. The comprehensive search term used (see online Appendix DS1) was created by amalgamating the previous search strategies from the NICE, Cochrane and ACPMH guideline reviews with an updated list of medications. Additional searches for published and unpublished studies were made in the National Center for PTSD PILOTS database, the Cochrane Library, the Controlled Trials Register, Web of Knowledge, OpenSIGLE and Google Scholar. Reference lists of all selected studies and reviews were further scrutinised for any additional RCTs. An expert group was consulted to identify any additional studies they were aware of. Authors of identified studies were contacted to request data if outcome information was missing.

Study selection
One reviewer transferred the initial search hits and studies included in the earlier systematic reviews into EndNoteX4 software for Windows. Duplicates were removed. Two reviewers then independently screened the titles and abstracts. Studies that were clearly irrelevant were excluded; potentially relevant ones were assessed for inclusion as full texts. Any discrepancies between reviewers’ decisions were resolved by discussion with a third reviewer.

Data extraction and risk of bias assessment
All data from newly identified studies were double-extracted by two independent reviewers into a standardised table and any discrepancies were discussed with a third reviewer. Data for change from baseline to end-point were extracted when available, otherwise end-point data were used. Continuous data were extracted for clinician-administered PTSD symptom severity using the Clinician Administered PTSD Scale as the gold standard; for self-rated PTSD, the Davidson Trauma Scale was used as the gold standard. If these scales were not used, data from alternative scales were extracted. Dichotomous data were extracted for number of people withdrawing from the trial using total number of participants in the group as the denominator. One reviewer entered the outcome data into Review Manager 5 software for Windows, which was then checked by another reviewer. Data from studies included in previous systematic reviews were double-extracted by two independent reviewers, cross-checked for accuracy and any discrepancies were discussed with a third reviewer.

Risk of bias
Two reviewers, using the domain-based evaluation method recommended by the Cochrane Collaboration, independently assessed risk of bias in individual studies for each trial. This method considers the following domains: random sequence generation; allocation concealment; masking of participants and personnel; masking of outcome assessment; incomplete outcome data; selective reporting; and other sources of bias. Any discrepancies between reviewers’ decisions were resolved by discussion with a third reviewer. Risk of bias across studies was assessed by considering publication bias through the visual examination of funnel plots.

Results
The database search yielded 13 634 records and an additional 74 were identified from other sources. From these, 4613 duplicates were removed leaving 9095 records. These were screened and 8064 irrelevant studies were removed. This left 1031 abstracts from which 896 were removed as ineligible. This left 135 full-text articles which were reviewed to find 84 not meeting the inclusion criteria. A total of 51 studies were included in this systematic review, of which five did not meet our inclusion criteria. Thirty-five studies were identified in the Cochrane review, of which 19 were already included in the NICE guidelines (references 38–54 plus six unpublished studies A–F in Appendix 1). Thirty-five studies were identified in the Cochrane review, of which 19 were already included in the NICE review and removed as duplicates. A further four used completer-only data and were not included; another allowed concomitant psychotropic medications and was excluded. This left an additional 11 studies from the Cochrane review, which were included. There were 12 additional pharmacotherapy studies identified from the ACPMH guidelines, of which seven were already present in the above reviews and were removed as duplicates. A further four did not meet our inclusion criteria, leaving one additional study which was included.
Efficacy of pharmacotherapy

Data from 21 studies (n = 3932) were available for inclusion in a meta-analysis of reduction in severity of PTSD symptoms for any SSRI vs. placebo (Fig. 2). This found a small positive effect for SSRIs when grouped together. The results of meta-analyses for individual drugs, which had been tested against placebo in at least two RCTs, are shown in Table 1. Three drugs were significantly superior to placebo on either clinician- and self-rated PTSD symptom severity combined (paroxetine) or clinician-rated PTSD symptom severity alone (fluoxetine and venlafaxine). We found insufficient evidence to support the preferential use of individual agents in either combat-related or non-combat-related trauma (Table 2).

Discussion

This systematic review found statistically significant evidence on meta-analysis for three pharmacological agents vs. placebo in the treatment of PTSD (fluoxetine, paroxetine and venlafaxine) but no evidence for brofaromine, olanzapine, sertraline or topiramate. Four drugs – amitriptyline, GR205171 (a neurokinin-1 antagonist), mirtazapine and phenelzine – showed superiority over placebo in single RCTs, whereas eleven did not: alprazolam, citalopram, desipramine, escitalopram, imipramine, lamotrigine, nefazodone, risperidone, tiagabine and valproate semisodium. When meta-analyses were undertaken by class of drug rather than individual drug, SSRIs were found to perform better than placebo. The absence of sufficient data precluded meta-analyses of other drug classes. The absence of difference in numbers of individuals leaving the study early for any reason suggests that the drugs included were well tolerated overall.

The effect sizes for pharmacological treatments for PTSD compared with placebo are low and inferior to those reported for psychological treatments with a trauma focus over waiting-list or treatment as usual controls. They are, however, similar to those found for antidepressants for depression compared with placebo. Unfortunately, the absence of a common control condition and head-to-head pharmacological vs. psychological treatment trials makes comparison of the relative efficacies of these treatment approaches difficult. This is compounded by the fact that a significant number of participants in psychological treatment trials were continuing pre-existing pharmacological treatment at the same time.

It is well accepted that a well-masked, placebo-controlled trial is a tougher test for an experimental intervention than a trial with a waiting-list control. The UK’s NICE guidelines development group attempted to address this by determining a higher effect size threshold for psychological treatments than pharmacological ones (0.8 v. 0.5), but it is unclear whether such arbitrary cut-offs may have introduced bias against either form of treatment. What is clear is the marked effect of the placebo in several of the trials reported in this review. For example, in the two venlafaxine studies the mean reduction in PTSD symptoms of those on placebo was greater than 40%. There is a need for RCTs of specific psychological interventions compared with an adequate non-specific psychological intervention. It is only through such trials and direct head-to-head comparisons that the relative effectiveness of differing treatment approaches could be established. The current meta-analyses are a later iteration of the

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### Risk of bias assessments

Risk of bias assessments are included in online Table DS1. Fourteen of the studies included enough information on adequate random sequence generation to be judged as having a low risk of bias; the remainder were unclear. Only eight studies included an adequate description of allocation concealment. All 51 studies described themselves as 'double blind' but only eight provided sufficient information to judge the masking of participants, personnel and outcome assessors as being of low risk. Incomplete outcome data were addressed adequately in 15 studies. Thirty-eight of the studies were deemed to be free from selective reporting.

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**Fig. 1** Study search profile.
evidence used to determine what to recommend for recent WHO guidelines. 77 A WHO guidelines development group examined this evidence and recommended antidepressants as a second line of treatment of PTSD when psychological interventions with known efficacy did not work or were not available. The recently updated Australian guidelines also concluded that pharmacological interventions should not be preferentially used as a routine first treatment of PTSD over trauma-focused psychological treatments. 78 There are various other reasons for considering the prescription of antidepressants, including

**Table 1** Efficacy and tolerability of individual agents v. placebo

<table>
<thead>
<tr>
<th>Active drug</th>
<th>PTSD symptoms (clinician-rated)</th>
<th>PTSD symptoms (self-reported)</th>
<th>Leaving study early</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SSRIs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paroxetine</td>
<td>Four studies, 20, 33, 6, 64, ( n = 1134 )</td>
<td>SMD = 0.43 (95% CI 0.53 to -0.29)*</td>
<td>Two studies, 20, 33, 64, 6, ( n = 1307 )</td>
</tr>
<tr>
<td></td>
<td>( I^2 = 176% )</td>
<td>SMD = 0.38 (95% CI 0.49 to 0.26)*</td>
<td>RR = 0.98 (95% CI 0.71 to 1.34)</td>
</tr>
<tr>
<td><strong>Sertraline</strong></td>
<td>Nine studies, 21, 38, 42, 54, 6, 64, 6, 60, 6, ( n = 1441 )</td>
<td>SMD = -0.13 (95% CI -0.27 to 0.01)</td>
<td>6 studies, 21, 38, 42, 54, 6, 64, 6, ( n = 1257 )</td>
</tr>
<tr>
<td></td>
<td>( I^2 = 37% )</td>
<td>SMD = 0.14 (95% CI -0.35 to 0.05)</td>
<td>RR = 1.14 (95% CI 0.95 to 1.37)</td>
</tr>
<tr>
<td><strong>Fluoxetine</strong></td>
<td>Three studies, 23, 32, 6, 6, ( n = 771 )</td>
<td>SMD = 0.24 (95% CI 0.41 to -0.08)*</td>
<td>Three studies, 23, 32, 6, 6, ( n = 313 )</td>
</tr>
<tr>
<td></td>
<td>( I^2 = 0% )</td>
<td>SMD = 0.01 (95% CI -0.19 to 0.15)</td>
<td>RR = 1.5 (95% CI 0.72 to 1.45)</td>
</tr>
</tbody>
</table>

| **MAOIs**  |                                 |                              |                    |
| Brofaromine | Two studies, 89, 67, \( n = 159 \) | SMD = -0.24 (95% CI 0.81 to 0.33) | Two studies, 89, 67, \( n = 180 \) |
|             | \( I^2 = 63% \)            | SMD = -0.19 (95% CI 0.40 to 0.01) | RR = 1.56 (95% CI 0.87 to 2.79) |

| **Other antidepressants** |                                 |                              |                    |
| Venlafaxine | Two studies, 18, \( n = 687 \) | SMD = 0.20 (95% CI -0.35 to 0.05)* | Two studies, 18, \( n = 687 \) |
|             | \( I^2 = 0\% \)           | SMD = 0.00 (95% CI 0.11 to 0.15) | RR = 0.91 (95% CI 0.67 to 1.25) |

| **Antipsychotics** | Olanzapine |                                 |                              |                    |
|                   | Two studies, 31, 39, \( n = 39 \) | SMD = 0.01 (95% CI 1.13 to 0.01) | Two studies, 31, 39, \( n = 39 \) |
|                   | \( I^2 = 53\% \)           | SMD = 1.15 (95% CI 1.52 to 3.71) | RR = 0.91 (95% CI 0.67 to 1.25) |

| **Other drugs** | Topiramate |                                 |                              |                    |
|                 | Two studies, 29, 30, \( n = 69 \) | SMD = 0.46 (95% CI 0.94 to 0.02) | One study, 29, \( n = 38 \) |
|                 | \( I^2 = 0\% \)           | SMD = 0.6 (95% CI 1.26 to 0.05) | RR = 0.92 (95% CI 0.3 to 2.84) |

**Fig. 2** Meta-analysis of selective serotonin reuptake inhibitors v. placebo (SMD, standardised mean difference).
concurrent depression, lack of availability of psychological treatments, failure to respond to or tolerate psychological treatments and the personal preference of the individual with PTSD.

The variation in efficacy between different agents is striking and could be explained by a number of factors. First, there may be real differences between drugs, even those in the same family. For example, paroxetine’s superior efficacy over sertraline may possibly be explained by its increased dopamine receptor activity. Differences in the pharmacology of phenelzine and brofaromine are also marked, and grouping all drugs in one class together seems less desirable as considering each individually. This confirms previous views that class membership does not confer the same level of efficacy in the treatment of PTSD.11 This meta-analysis supports this assertion, with the SSRIs paroxetine and sertraline, which suggests that power was not the issue. The same cannot be said for the majority of drugs reviewed, the evaluation of which was based on single RCTs with fewer than 100 participants. This review added 15 new RCTs to the evidence previously reported in systematic reviews but added no new trials for three of the four drugs recommended in the NICE guidelines (mirtazapine, amitriptyline and phenelzine). Of particular note is that new evidence resulted in drugs not recommended by NICE (fluoxetine and venlafaxine) now meeting the requirements laid down by NICE for recommendation as a second-line treatment. This review used particular rigour in assessing studies. Most of the other reviews that have concluded more favourably about pharmacotherapy grouped drugs from the same class together,10,11 the other reviews that have concluded more favourably about pharmacotherapy grouped drugs from the same class together,10,11 and could be explained by a number of factors. First, there may be real differences between drugs, even those in the same family. For example, paroxetine’s superior efficacy over sertraline may possibly be explained by its increased dopamine receptor activity. Differences in the pharmacology of phenelzine and brofaromine are also marked, and grouping all drugs in one class together seems less desirable as considering each individually. This confirms previous views that class membership does not confer the same level of efficacy in the treatment of PTSD.11 This meta-analysis supports this assertion, with the SSRIs paroxetine and sertraline, which suggests that power was not the issue. The same cannot be said for the majority of drugs reviewed, the evaluation of which was based on single RCTs with fewer than 100 participants. This review added 15 new RCTs to the evidence previously reported in systematic reviews but added no new trials for three of the four drugs recommended in the NICE guidelines (mirtazapine, amitriptyline and phenelzine). Of particular note is that new evidence resulted in drugs not recommended by NICE (fluoxetine and venlafaxine) now meeting the requirements laid down by NICE for recommendation as a second-line treatment. This review used particular rigour in assessing studies. Most of the other reviews that have concluded more favourably about pharmacotherapy grouped drugs from the same class together,10,11 did not include unpublished studies,79,80 and adopted different inclusion criteria.8,10,79,80 This probably accounts for differences in conclusions between different meta-analyses despite apparently having the same raw data available. For example, sertraline performed significantly better than placebo in two recent meta-analyses,79,80 which did not include the two unpublished studies included in our review.1,2

### Study limitations
There were, however, some important methodological flaws in the studies identified in this review as illustrated by the risk of bias assessment undertaken. Clinical and statistical heterogeneity was apparent in the meta-analyses; this makes interpretation and generalisation across different trauma populations difficult. A major issue was that, despite having systematically tried to access unpublished data on the studies without ITT efficacy data, sufficient data for analysis were only available from only 41 of the 51 studies included. This raises the risk of outcome reporting bias.81 Incorrect definition of the ITT sample population was a
problem. This is an important principle where data from every person who is randomised should be included in the analysis of efficacy. Participants might leave a study because of adverse effects, failed efficacy or greater symptom severity at baseline; not including their data in the analysis leads to bias, as a treatment might appear to be more effective than it is. Another important issue to consider is that this review considers drug monotherapy as opposed to drug or placebo in combination with psychological treatment. This evidence cannot, therefore, be used to consider whether or not pharmacotherapy augments psychological treatment for PTSD; many people with the disorder do receive both.

Several of the new studies identified by our search defined their ITT population as participants who received at least one dose of the study medication and received at least one post-baseline assessment. This could exclude some participants from analysis who had received treatment but not been assessed after the baseline. The most extreme case was a study of fluoxetine that defined ITT in this way, but measured PTSD symptom severity only at baseline and end-point, so was actually a completers assessment. This could exclude some participants from analysis but acknowledge that this affects the reliability of the results.

Implications
Pharmacological interventions for PTSD can be effective but the magnitude of effect unfortunately is small, and the clinical relevance of this small effect is unclear. This review supports the use of paroxetine, venlafaxine and fluoxetine as pharmacological interventions for PTSD. For most drugs, there remains inadequate evidence regarding efficacy for PTSD, pointing to the need for more research in this area to confirm the utility of pharmacological treatments for this disorder.

References

Unpublished studies
Further details of the studies listed below are available from the authors.


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Appendix 1
Further details of the studies listed below are available from the authors.


30 Yeh MS, Mari JJ, Costa MC, Andreoli SB, Bressan RA, Mello MF. A double blind, randomized controlled trial to study the efficacy of topiramate in a civilian sample of PTSD. CNS Neurosci Ther 2010; 175: 305–10.


