IS THE PLACEBO POWERLESS?
An Analysis of Clinical Trials Comparing Placebo with No Treatment

ASBJØRN HRÖBJARTSSON, M.D., AND PETER C. GÖTZSCHE, M.D.

ABSTRACT

Background Placebo treatments have been reported to help patients with many diseases, but the quality of the evidence supporting this finding has not been rigorously evaluated.

Methods We conducted a systematic review of clinical trials in which patients were randomly assigned to either placebo or no treatment. A placebo could be pharmacologic (e.g., a tablet), physical (e.g., a manipulation), or psychological (e.g., a conversation).

Results We identified 130 trials that met our inclusion criteria. After the exclusion of 16 trials without relevant data on outcomes, there were 32 with binary outcomes (involving 3795 patients, with a median of 51 patients per trial) and 82 with continuous outcomes (involving 4730 patients, with a median of 27 patients per trial). As compared with no treatment, placebo had no significant effect on binary outcomes, regardless of whether these outcomes were subjective or objective. For the trials with continuous outcomes, placebo had a beneficial effect, but the effect decreased with increasing sample size, indicating a possible bias related to the effects of small trials. The pooled standardized mean difference was significant for the trials with subjective outcomes but not for those with objective outcomes. In 27 trials involving the treatment of pain, placebo had a beneficial effect, as indicated by a reduction in the intensity of pain of 6.5 mm on a 100-mm visual-analogue scale.

Conclusions We found little evidence in general that placebos had powerful clinical effects. Although placebos had no significant effects on objective or binary outcomes, they had possible small benefits in studies with continuous subjective outcomes and for the treatment of pain. Outside the setting of clinical trials, there is no justification for the use of placebos.


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to the study treatments but without their specific activity. We therefore defined placebo practically as an intervention labeled as such in the report of a clinical trial.

Literature Search

We searched Medline, EMBASE, PsycLIT, Biological Abstracts, and the Cochrane Controlled Trials Register for trials published before the end of 1998. The search was developed iteratively for synonyms of "placebo," "no treatment," and "randomized clinical trial" (the exact search strategy is available with the full text of this article at http://www.nejm.org and was based on a published protocol10). We systematically read the reference lists of included trials and selected books and review articles. We also asked researchers in the field to provide lists of relevant trials.

Selection of Studies

We included studies if patients were assigned randomly to a placebo group or an untreated group (often there was also a third group that received active treatment). We excluded studies if randomization was clearly not concealed — that is, if group assignment were predictable11 (e.g., patients were assigned to treatment groups according to the day of the month). We also excluded studies if participants were paid or were healthy volunteers, if the person who assessed objective outcomes was aware of group assignments, if the dropout rate exceeded 50 percent, or if it was very likely that the alleged placebo had a clinical effect not associated with the treatment ritual alone (e.g., movement techniques for postoperative pain). All potentially eligible trial reports were read in full by both authors. Disagreements concerning eligibility were resolved by discussion.

Extraction of Data

Data were extracted from the report of each trial with the use of forms tested in pilot studies. We contacted the authors of the included studies when reported outcome data were inadequate for meta-analysis. We noted how the randomization was conducted and whether the therapist responsible for the administration of placebo (as distinct from the observer) was unaware of group assignments. Furthermore, we noted the purpose of the trial, the drop-out rate, whether the placebo was given in addition to the standard treatment, and whether the main outcome was clearly indicated.

We noted whether the placebo was pharmacologic (e.g., a tablet), physical (e.g., a manipulation), or psychological (e.g., a conversation); whether clinical problems reported by the patients could have been observed by others (i.e., whether the symptoms were observable outcomes such as cough); and whether objective outcomes were laboratory data, were derived from examinations that required the cooperation of the patients (i.e., objective outcomes such as forced expiratory volume), or did not require such cooperation (e.g., edema). Both reviewers independently selected outcomes by referring only to the methods section of articles; any disagreements were resolved by discussion. As the primary outcome, we selected the main objective or subjective outcome of each trial (preferably a characteristic symptom). If a main outcome was not indicated, we used the outcome that we felt was most relevant to patients. Binary outcomes (e.g., the proportions of smokers and nonsmokers) were preferred to continuous ones (e.g., the mean number of cigarettes smoked). Data recorded immediately after the end of treatment were preferred to follow-up data, although end-of-treatment data were not always available. For crossover trials, we extracted data from the first treatment period only; if that was not possible, we used the summary data as if they had been derived from a parallel-group trial (i.e., using the between-group standard deviations and total number of participants for both groups).

Synthesis of Data

For each trial with binary outcomes, we calculated the relative risk of an unwanted outcome, defined as the ratio of the number of patients with an unwanted outcome to the total number of patients in the placebo group, divided by the same ratio in the untreated group. Thus, a relative risk below 1.0 indicates a beneficial effect of placebo.

For trials with continuous outcomes, we calculated the standardized mean difference, which was defined as the difference between the mean value for an unwanted outcome in the placebo group and the corresponding mean value in the untreated group divided by the pooled standard deviation.12 A value of −1 signifies that the mean in the placebo group was 1 SD below the mean in the untreated group, indicating a beneficial effect of placebo.

We calculated the pooled relative risk of an unwanted outcome for trials with binary outcomes and the pooled standardized mean difference for those with continuous outcomes.13 Because of the different clinical conditions and settings, we expected that the data sets would be heterogeneous — that is, that the effects of individual trials would vary more than expected by chance alone. The variance and statistical significance of the differences were therefore assessed with the use of random-effect calculations.13 We calculated the pooled effects for subjective and objective outcomes and for specific clinical problems that had been investigated in at least three trials by different research groups.14

We performed preplanned analyses of subgroups to see whether our findings were sensitive to the type of placebo or the type of outcome involved. Furthermore, for each trial, we plotted the effect against the inverse of its standard error (which increases with the number of trial participants). Since the variation in the estimated effect decreases with increasing sample size, the plot is expected to resemble a symmetrical funnel. If there is significant asymmetry in such funnel plots, it is usually caused by small trials’ reporting greater effects, on average, than large trials, which can reflect publication bias15 or other biases. We also performed several preplanned sensitivity analyses to determine whether our findings were sensitive to variations in the quality of the trials.

In trials with continuous outcomes, we used F tests to check whether the standard deviations of the placebo group and the untreated group were significantly different.16 We regarded the distributions of either group as non-Gaussian if 1.64 SD exceeded the mean for positive outcomes.17 Chi-square tests were used to test for heterogeneity on the basis of the DerSimonian and Laird Q statistic.13,18 Results are reported with 95 percent confidence intervals. All P values are two-tailed.

RESULTS

Selection and Characteristics of Studies

We identified 727 potentially eligible trials. We subsequently excluded 597 trials for the following reasons: 404 were nonclinical or nonrandomized, 129 were missing a placebo group or an untreated group, 29 were reported in more than one publication, 11 had clearly unblinded assessment of objective outcomes, and 24 met other criteria for exclusion, such as dropout rates over 50 percent. No relevant outcome data were available for 16 of the remaining 130 trials. The analysis therefore included 114 trials.19-132

There were 10 crossover trials, of which 7 (which included a total of 182 patients) were handled as parallel trials. In 112 trials, there was a third group assigned to active treatment in addition to the placebo and the untreated groups. In 88 of these, determining the effect of placebo was not mentioned as an objective of the study. The trial reports were published in five languages between 1946 and 1998. The outcomes were binary in 32 trials19-50 and continuous in 82.51-132

In 76 trials, the outcome in the data we extracted was
identified as a main outcome by the authors of the trials. If only patients in the placebo and untreated groups were counted, the trials with binary outcomes included 3795 patients with a median of 51 patients per trial (interquartile range, 26 to 72), and the trials with continuous outcomes included 4730 patients with a median of 27 patients per trial (interquartile range, 20 to 52).

The typical pharmacologic placebo was a lactose tablet. The typical physical placebo was a procedure performed with a machine that was turned off (e.g., sham transcutaneous electrical nerve stimulation). The typical psychological placebo was a nondirectional, neutral discussion between the patient and the treatment provider, referred to as an “attention placebo.” No treatment typically entailed observation only or standard therapy; in the latter case, all patients in the trial received standard therapy, and the placebo was additional.

The results for the individual trials are available with the full text of this article at http://www.nejm.org. The trials investigated 40 clinical conditions: hypertension, asthma, anemia, hyperglycemia, hypercholesterolemia, seasickness, Raynaud’s disease, alcohol abuse, smoking, obesity, poor oral hygiene, herpes simplex infection, bacterial infection, common cold, pain, nausea, ileus, infertility, cervical dilatation, labor, menopause, prostatism, depression, schizophrenia, insomnia, anxiety, phobia, compulsive nail biting, mental handicap, marital discord, stress related to dental treatment, organic difficulties, fecal soiling, enuresis, epilepsy, Parkinson’s disease, Alzheimer’s disease, attention-deficit–hyperactivity disorder, carpal tunnel syndrome, and undiagnosed ailments.

**Binary Outcomes**

As compared with no treatment, placebo did not have a significant effect on binary outcomes (overall pooled relative risk of an unwanted outcome with placebo, 0.95; 95 percent confidence interval, 0.88 to 1.02). The pooled relative risk was 0.95 for trials with subjective outcomes (95 percent confidence interval, 0.86 to 1.05) and 0.91 for trials with objective outcomes (95 percent confidence interval, 0.80 to 1.04) (Table 1).

There was significant heterogeneity among the trials with binary outcomes (P = 0.003), indicating that the variation in the effect of placebo among trials was larger than would be expected to result from chance alone. The heterogeneity was not due to small trials’ showing more pronounced effects of placebo than large trials (P = 0.56). Three clinical problems had been investigated in at least three independent trials with binary outcomes: nausea, relapse after the cessation of smoking, and depression. Placebo had no significant effect on these outcomes, but the confidence intervals were wide (Table 2).

### Table 1. Effect of Placebo in Trials with Binary or Continuous Outcomes.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>No. of Participants</th>
<th>No. of Trials</th>
<th>Pooled Relative Risk (95% CI)†</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Binary</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>3795</td>
<td>32</td>
<td>0.95 (0.88 to 1.02)</td>
</tr>
<tr>
<td>Subjective</td>
<td>1928</td>
<td>23</td>
<td>0.95 (0.86 to 1.05)</td>
</tr>
<tr>
<td>Objective</td>
<td>1867</td>
<td>9</td>
<td>0.91 (0.89 to 1.04)</td>
</tr>
<tr>
<td><strong>Continuous</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>4730</td>
<td>82</td>
<td>−0.28 (−0.38 to −0.19)</td>
</tr>
<tr>
<td>Subjective</td>
<td>3081</td>
<td>53</td>
<td>−0.36 (−0.47 to −0.25)</td>
</tr>
<tr>
<td>Objective</td>
<td>1649</td>
<td>29</td>
<td>−0.12 (−0.27 to 0.03)</td>
</tr>
</tbody>
</table>

*CI denotes confidence interval.
†The relative risk was defined as the ratio of the number of patients with an unwanted outcome to the total number of patients in the placebo group, divided by the same ratio in the untreated group. A value below 1.0 indicates a beneficial effect of placebo.
‡The standardized mean difference was defined as the difference between the mean values for unwanted outcomes in the placebo and untreated groups divided by the pooled standard deviation. A negative value indicates a beneficial effect of placebo.

**Continuous Outcomes**

The overall pooled standardized mean difference was −0.28 (95 percent confidence interval, −0.38 to −0.19). Thus, there was a beneficial effect of placebo, because the pooled mean of the placebo groups was 0.28 SD lower than the pooled mean of the untreated groups (P < 0.001). The pooled standardized mean difference was significant for trials with subjective outcomes (−0.36; 95 percent confidence interval, −0.47 to −0.25) but not for trials with objective outcomes (−0.12; 95 percent confidence interval, −0.27 to 0.03) (Table 1).

There was significant heterogeneity among the trials with continuous outcomes (P < 0.001). The magnitude of the effect of placebo decreased with increasing sample size (P = 0.05), indicating a possible bias related to the effects of small trials.

Pain, obesity, asthma, hypertension, insomnia, and anxiety were each investigated in at least three independent trials. Only the 27 trials involving the treatment of pain (including a total of 1602 patients) showed a significant effect of placebo as compared with no treatment (pooled standardized mean difference, −0.27; 95 percent confidence interval, −0.40 to −0.15). There was no significant effect of placebo on the other conditions, although the confidence intervals were wide (Table 2).

Expressing the standardized mean differences in terms of clinical outcomes indicates that the effect of
placebo on pain corresponds to a reduction in the mean intensity of pain of 6.5 mm (95 percent confidence interval, 3.6 to 9.6) on a 100-mm visual-analogue scale. The nonsignificant effect of placebo on obesity corresponds to a reduction in mean weight of 3.2 percent (95 percent confidence interval, 7.4 to −1.2 percent); on hypertension, a reduction in mean diastolic blood pressure of 3.2 mm Hg (95 percent confidence interval, 7.8 to −1.3); and on insomnia, a decrease in the mean time required to fall asleep of 10 minutes (95 percent confidence interval, 25 to −5). For asthma and anxiety, the measurement scales were too variable to allow clinical interpretation of the results.

Small trials involving the treatment of pain did not have significantly greater effects than large trials (P = 0.20), but the power of the test was low. There was no significant heterogeneity among the nine sets of data on specific clinical problems (P>0.10), but the power of these analyses was also low.

**Sensitivity Analyses**

The number of trials compared in the sensitivity analyses was in most cases nine or more, and they included more than 1000 patients. There was no difference in the effect of placebo between subcategories of objective and subjective binary outcomes (Table 3). The effect of placebo among subcategories of continuous outcomes did not differ significantly, except for a negative effect of placebo in four trials with laboratory data (Table 3). For both continuous and binary outcomes, there were no significant differences among the various types of placebos (Table 4).

The effect of placebo on continuous or binary outcomes was not influenced by the dropout rate (<15 percent vs. >15 percent) or by whether the observers were aware of group assignments, but only two trials with binary objective outcomes (involving 316 patients) included observers who were clearly unaware of the group assignments (data not shown). The effects of placebo were also unrelated to whether the care providers were unaware of the treatment type (placebo or experimental), whether placebos were given in addition to standard treatments, whether the effect of placebo was an explicit research objective, or whether we had identified the main outcome on the basis of clinical relevance (data not shown). The size of the effect in trials with clearly concealed randomization did not differ from that in other trials, but only four trials with continuous outcomes (involving 523 patients) and one with binary outcomes (involving 54 patients) reported clearly concealed randomization (data not shown). For continuous outcomes, the effect was not influenced by non-Gaussian distributions in the placebo or the untreated groups (data not shown).

**DISCUSSION**

We did not detect a significant effect of placebo as compared with no treatment in pooled data from trials with subjective or objective binary or continuous objective outcomes. We did, however, find a significant difference between placebo and no treatment in trials with continuous subjective outcomes and in trials involving the treatment of pain.

Several types of bias may have affected our findings. Blinded evaluation of subjective outcomes was not possible in the trials we reviewed. Patients in an untreated group would know they were not being treated, and patients in a placebo group would think they had received treatment. It is difficult to distinguish between reporting bias and a true effect of placebo on subjective outcomes, since a patient may tend to try to please the investigator and report improvement when none has occurred. The fact that placebos had no significant effect on objective continuous outcomes suggests that reporting bias may have been a factor in the trials with subjective outcomes.

If patients in the untreated groups sought treatment outside the trials more often than patients in the placebo groups, the effects of placebo might be less apparent. Very few trials provided information on concomitant treatment. The risk of bias is expected to be larger in trials in which placebo is the only treatment and is not given in addition to standard therapy. We
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did not, however, find a difference in effect between the two types of trials.

There was some evidence that placebos had greater effects in small trials with continuous outcomes than in large trials. This could indicate that some small trials with negative outcomes have not been published or that we did not identify them. It is difficult to identify relevant trials in this field; another systematic search for trials involving placebo groups versus untreated groups found only 12 studies. We identified 114 trials from which the outcomes could be extracted, but 88 of these trials investigated the effect of active treatment in a third group of patients and did not explicitly study the effect of placebo. Because the publication of such trials is not directly associated with the effect of placebo, it is unlikely that the existence of unpublished trials could explain the higher effects reported in small studies.

Poor methodology in small trials could also explain the large effects of placebo. It surprised us that we found no association between measures of the quality of a trial and placebo effects. However, the statistical power of our sensitivity analyses may have been

<table>
<thead>
<tr>
<th>Table 3. Effect of Placebo in Trials with Specific Types of Outcomes.*</th>
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</thead>
<tbody>
<tr>
<td><strong>OUTCOME</strong></td>
</tr>
<tr>
<td>Binary</td>
</tr>
<tr>
<td>Laboratory data</td>
</tr>
<tr>
<td>Objective, not involving patient’s cooperation</td>
</tr>
<tr>
<td>Objective, involving patient’s cooperation</td>
</tr>
<tr>
<td>Subjective and observable</td>
</tr>
<tr>
<td>Subjective and nonobservable</td>
</tr>
<tr>
<td>Continuous</td>
</tr>
<tr>
<td>Laboratory data</td>
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<tr>
<td>Objective, not involving patient’s cooperation</td>
</tr>
<tr>
<td>Objective, involving patient’s cooperation</td>
</tr>
<tr>
<td>Subjective and observable</td>
</tr>
<tr>
<td>Subjective and nonobservable</td>
</tr>
<tr>
<td>Subjective and nonobservable with pain excluded‡</td>
</tr>
</tbody>
</table>

*Observable outcomes were clinical problems reported by the patients that could have been observed by others (e.g., cough). CI denotes confidence interval.
†The relative risk was defined as the ratio of the number of patients with an unwanted outcome to the total number of patients in the placebo group, divided by the same ratio in the untreated group. A value below 1.0 indicates a beneficial effect of placebo.
‡The standardized mean difference was defined as the difference between the mean values for unwanted outcomes in the placebo and untreated groups divided by the pooled standard deviation. A negative value indicates a beneficial effect of placebo.
§The 27 trials involving the treatment of pain comprised 72 percent of the information in the analysis of subjective and nonobservable continuous outcomes; therefore, an unplanned calculation excluding these trials was performed.

<table>
<thead>
<tr>
<th>Table 4. Effect of Three Types of Placebo.*</th>
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<tbody>
<tr>
<td><strong>TYPE OF PLACEBO</strong></td>
</tr>
<tr>
<td>Binary</td>
</tr>
<tr>
<td>Pharmacologic</td>
</tr>
<tr>
<td>Physical</td>
</tr>
<tr>
<td>Psychological</td>
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<tr>
<td>Continuous</td>
</tr>
<tr>
<td>Pharmacologic</td>
</tr>
<tr>
<td>Physical</td>
</tr>
<tr>
<td>Psychological</td>
</tr>
</tbody>
</table>

*CI denotes confidence interval.
†The relative risk was defined as the ratio of the number of patients with an unwanted outcome to the total number of patients in the placebo group, divided by the same ratio in the untreated group. A value below 1.0 indicates a beneficial effect of placebo.
‡The standardized mean difference was defined as the difference between the mean values for unwanted outcomes in the placebo and untreated groups, divided by the pooled standard deviation. A negative value indicates a beneficial effect of placebo.

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too low. Furthermore, it is possible that small trials tended to investigate clinical conditions in which placebos truly had greater effects. Thus, although we found an effect of placebos on subjective continuous outcomes, the inverse relation between trial size and effect size implies that the estimates of pooled effect should be interpreted cautiously.

It can also be difficult to interpret whether a pooled standardized mean difference is large enough to be clinically meaningful. Some individual trials reported clinically relevant effects with standardized mean differences of less than −0.6, but such "outlier" values may be spurious. If the possible biases we have discussed are disregarded, the pooled effect of placebo on pain corresponds to one third of the effect of nonsteroidal antiinflammatory drugs, as compared with placebo, in double-blind trials. It is uncertain whether such an effect is important for patients.

Our study has other limitations. We did extensive analyses of predefined subgroups according to the type of placebo, disease, and outcome without identifying a subgroup of trials in which the effect of placebo was large. However, we cannot exclude the possibility that, in the pooling of heterogeneous trials, the existence of such a subgroup was obscured. Our conclusions are also limited to the clinical conditions and outcomes that were investigated. It should be noted that few trials reported on the quality of life or patients' well-being.

We reviewed the effect of placebos but not the effect of the patient–provider relationship. We could not rule out a psychological therapeutic effect of this relationship, which may be largely independent of any placebo intervention.

Moreover, the use of placebos in blinded, randomized trials is a precaution directed against many forms of bias and not only a way of controlling for the effect of the patient–provider relationship, which may be largely independent of any placebo intervention.

In conclusion, we found little evidence that placebos in general have powerful clinical effects. Placebos had no significant pooled effect on subjective or objective binary or continuous objective outcomes. We found significant effects of placebo on subjective outcomes and for the treatment of pain but also bias related to larger effects in small trials. The use of placebo outside the aegis of a controlled, properly designed clinical trial cannot be recommended.

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CORRECTION

Is the Placebo Powerless? An Analysis of Clinical Trials Comparing Placebo with No Treatment

Is the Placebo Powerless? An Analysis of Clinical Trials Comparing Placebo with No Treatment. In the Web-only Supplementary Appendix 3, the point estimates for Hall et al. (1974) and Davidson et al. (1980) should have read “–0.17” and “–0.94,” respectively, not “–1.17” and “0.94” as published. The confidence interval for Rybarczyk and Auerbach (1990) should have read “–0.73 to 0.40,” not “–0.40 to 0.13,” as published.