Original article

Misleading abstract conclusions in randomized controlled trials in rheumatology: Comparison of the abstract conclusions and the results section

Sylvain Mathieu\textsuperscript{a,b,c,d}, Bruno Giraud\textsuperscript{a,e,f,g}, Martin Soubrier\textsuperscript{d}, Philippe Ravaud\textsuperscript{a,b,c,*}

\textsuperscript{a} Inserm U738, Paris, France
\textsuperscript{b} Centre d'épidémiologie clinique, hôpital hôtel-Dieu, Assistance publique–Hôpitaux de Paris, Paris, France
\textsuperscript{c} Faculté de médecine, université Paris Descartes, Paris, France
\textsuperscript{d} Service de rhumatologie, hôpital Gabriel-Montpied, université Clermont-Ferrand 1, Clermont-Ferrand, France
\textsuperscript{e} Inserm, CIC 202, Paris, France
\textsuperscript{f} CHRU de Tours, Tours, France
\textsuperscript{g} Université François-Rabelais Tours, Tours, France

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\textbf{Abstract}

Introduction: Readers of scientific articles often read only the abstract and its conclusions because of lack of time or of access to the full-length articles.
Objectives: To assess the prevalence of misleading conclusions in abstracts of randomized controlled trials (RCTs) in rheumatology, determine whether trials are registered and whether abstract conclusions are based on the primary outcome (PO), and identify the predictors of misleading abstract conclusions.
Methods: We searched Medline, Embase and the Cochrane Collaboration for reports of RCTs assessing rheumatoid arthritis, osteoarthritis or spondylarthropathies published between January 2006 and April 2008. Abstract conclusions were misleading if: the PO was not reported in the conclusion; the conclusions were based on only a secondary outcome or subgroup results; the results and conclusions were in disagreement; negative results were suggested as equivalent, or if there was no discussion of benefits and risks in cases of serious adverse events.
Results: Of the 144 reports selected, we focused on the 105 articles containing a clear PO. Twenty-four reports (23%) contained misleading conclusions. Lack of PO reporting (\(n=10\)) and conclusions disagreeing with article results (\(n=7\)) were the most frequent reasons. Nineteen out of 144 (13.2%) declared study registration with clear and similar registered and published POs and no misleading abstract conclusions. Reports of negative results showed a higher frequency of misleading conclusions as did those assessing osteoarthritis. On multivariable analysis, only negative results predicted misleading abstract conclusions (OR = 9.58 [3.20–28.70]).
Conclusions: Almost one-quarter of these RCT in rheumatology had misleading conclusions in the abstract, especially those with negative results.

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1. Introduction

Randomized controlled trials (RCTs) are generally considered as the best guarantee of the efficacy of health care interventions, and the number of published reports of RCTs is on the increase [1]. Biased results from poorly designed or inadequately reported trials can lead to flawed decision making in individual and public health care treatment [2]. Providing clear, unambiguous results and decreasing bias in RCTs have become prime objectives for medical authors and journals [3–5]. The use of reporting guidelines such as the CONsolidated Standards of Reporting Trials (Consort), Statements and extensions has improved the quality of reporting [6–11] in the full text of articles. Since the present study was begun, other recommendations have been drawn up for the writing of abstracts [12]. However, despite these guidelines, the quality of reporting is still uneven, and evidence of bias persists [13–17]. Le Henanff et al. assessed the quality of non-inferiority and equivalence randomized trials and found misleading conclusions in four of the 33 articles assessed (12.1%) that fulfilled guideline requirements specific to these trials, mainly because of discrepancy between the declared aims and the results obtained [18].

Medical practitioners have limited time to read articles and as a result, as Gotzsche remarked, “Most users of the scientific literature read vastly more conclusions than they read abstracts, and vastly more abstracts than full papers. Conclusions are the worst part of papers…” [19]. The problem is compounded by the fact that
conclusions presented in an abstract can be influenced by various interests that distort or modify the results of a clinical trial [19–22].

Our aim was to:
1) assess the prevalence of misleading conclusions in abstracts of reports of RCTs;
2) determine whether abstract conclusions are based on the primary outcome (PO) stated in the article;
3) identify the factors that might predict misleading conclusions.

2. Methods

We analyzed RCTs of rheumatology because the pharmacological and non-pharmacological treatments of this disorder vary widely.

2.1. Search strategy

One of us (SM) searched Medline, Embase and the Cochrane Central Register of Controlled Trials to identify reports of two parallel-group, superiority RCTs in rheumatoid arthritis (RA), spondylarthropathies and osteoarthritis (OA), published between January 1, 2006 and March 31, 2008 in general and specialty medical journals. We used the search terms "rheumatoid arthritis" or "spondylarthropathies" or "osteoarthritis" and "randomized controlled trials". Our search concerned only articles published in English.

2.2. Exclusion criteria

Potentially relevant articles were selected by one of us (SM) who, after reading the title, keywords and abstract obtained the full text of the article. The exclusion criteria were:

1) commentary or discussion papers;
2) observational studies (cohort studies, case-control studies) or meta-analyses;
3) a particular RCT design (e.g., cluster randomized trials or N-of-1 trials);
4) study design with more than two parallel groups;
5) a non-inferiority or equivalence objective;
6) only the abstract being available.

If several papers referred to the same trial, only the main publication was retained. We excluded any subsequent papers as duplicate publications of the initial trial.

2.3. Data extraction

One reviewer (SM), who was not blinded to journal and author, extracted all data using a standardized data abstraction form based on preliminary discussion.

2.3.1. Extraction of journal characteristics

We found the impact factor and whether the journal involved peer-review from the journal’s website [23] and whether the journal was a general medical or internal medicine journal from the Institute for Scientific Information (ISI) Web of Knowledge 2007 data.

2.3.2. Information about authors and sponsors

We recorded the nature of the funding source (no funding, government, industry, private non-profit, multiple sources, other or not reported) and the financial ties of each author (no financial ties, financial ties with the sponsor of the study disclosed, financial ties with any other company disclosed or not reported) [23]. Information about the role of the sponsor was recorded as:

1) the role of sponsor not mentioned;
2) the sponsor not involved in the study design and analyses;
3) the sponsor involved in the study design and statistical analysis;
4) no sponsor.

2.3.3. Trial registration

For each published trial report, one of us (SM) systematically searched whether the trial was registered. We checked whether the authors reported registering their trial and whether the registration number was included in the published article.

When no registration number was reported in the published article, we searched the following clinical trial registries: ClinicalTrials.gov (NCT) and International Standard Randomized Controlled Trial Number Register (ISRCTN).

To identify the record of these trials in the registries, we proceeded as follows.

1. We searched for references to the published article in the registry;
2. If the registry contained no reference to the published article, we checked whether the principal investigator and the funding source matched those reported in the article. When these tallied, the report was included and data were extracted;
3. If multiple registry records were found when the article title was used as the search string, we checked the experimental treatment, the comparator, the design, and the sample size to select the relevant report.

If no registration number was found after these searches, the trial for the published article was considered not registered.

2.3.4. Extraction of the primary outcome

If the PO was clearly identified in the article, it was recorded as such. If no PO was given, we recorded the outcome used for sample size calculation. If none of this information was available, we recorded the PO registered in a clinical trial registry (obtained as described above).

For each selected report, we compared, if possible, the registered PO and that reported in the published text. For articles with differences between the registered and published PO, we used the PO stated in the article. If no PO was found in the article or in the registry, the study was excluded from analysis. The PO was considered “unclear” if it could not be determined after these three steps and the study was left out.

2.3.5. Definition of a misleading abstract conclusion

Each report was assessed by (SM) to determine whether the abstract contained a misleading conclusion. This analysis included the three stages given in Table 1:

1) assessment of the results section of the article [24];
2) assessment of the abstract conclusions;
3) determining the existence of a misleading conclusion [23,25–27].

Examples of studies classified as having misleading abstract conclusions are given in Appendix S1 (see the supplementary material associated with this article online).

All abstract conclusions identified as being misleading were confirmed by two other authors (PR and BG), with disagreements resolved by consensus.
2.4. Statistical analysis

Data are reported as median and interquartile range (IQR) or mean and standard deviation (SD) for quantitative variables and number of articles (%) for categorical variables for the different characteristics of each article. Impact factor and sample size were divided into quartiles, with the upper three quartiles compared with the lowest quartile for impact factor and the inverse comparison for sample size. Differences between groups were tested by Chi² test for categorical data, or Student’s unpaired t test for numerical data. A P<0.05 (two-sided) was considered statistically significant.

Associations between the misleading abstract conclusions (defined as a binary outcome) and manuscript characteristics were studied by logistic regression models. Univariate analysis was performed, followed by multivariate analysis, which included any covariate with P<0.20 on univariate analysis. Although impact factor and sample size were continuous variables, they were modeled categorically, on the basis of four classes previously defined. SAS v9.1 (SAS Inst., Cary, NC) and R v2.6.0) were used for statistical analyses.

3. Results

3.1. Characteristics of included articles

Our final sample consisted of 144 published reports of RCTs (Fig. 1). The characteristics of the full sample are shown in Table 2. Most studies were published in peer-reviewed (n=109; 75.7%) and specialty journals (n=122; 84.7%). Sixty-seven articles (46.5%) concerned patients with OA, 63 (43.8%) RA (two assessing both RA and OA) and 16 (11.1%) spondyloarthopathies. Of the 144 trials selected, 69 (47.9%) disclosed funding from industry sponsors, with 32 of them (46.4%) reporting that the sponsor was involved in the study design (nine), in statistical analysis (one) or in both (22). Ten reports (14.5%) stated that the sponsor was not involved in the design or analysis, and 27 (39.1%) gave no information about the role of the sponsor. In 26% of reports (37), the authors declared financial ties with the sponsor of the study. However, for many reports, this information was not provided (41.7%). The PO was unclear in 39 articles (27.1%) (Fig. 2) and was more often unclear in articles published in journals that were not peer-reviewed (28.2% vs 7.6%; P=0.002). Non-peer-reviewed journals also had a lower impact factor than peer-reviewed journals (1.35 [IQR: 1.07–3.00] vs 4.02 (2.25–4.75); P<0.001) (Table 2).

In 40 of the 144 articles, the studies had been registered (27.8%). For 16, the trial registration number appeared in the text (40%), and for 37, the PO was clear. The PO was the same in the text and in the registry for 25 of the 40 articles (25; 62.5%).

3.2. Analysis of articles with a clear primary outcome

In all, 105 articles reported a clear PO in the text or in the registry (72.9%) (Fig. 2). The most frequent characteristics of the PO were patient-reported outcomes (n=56; 53.3%) and clinical measures (n=40; 38.1%). In 61 (58.1%) of these 105 articles, the results were positive, in 42 (40.0%) negative and in two (1.9%) inaccurate. In 24 (24/105; 22.9%) articles the abstract conclusions were misleading and in seven, there was disagreement between the abstract conclusions and the study results (Table 3). The other reasons for misleading abstract conclusions are in Table 3. In four of 24 articles with misleading conclusions, the efficacy of the study treatment was based on intra-group comparisons, and yet inter-group comparisons revealed no statistically significant difference between the study treatment and the control.

For articles with negative or inaccurate results, the proportion of misleading abstract conclusions was greater than that in articles with positive results (19/42 [45.2%] vs 3/61 [4.9%]; P<0.001).
### Table 2
Characteristics of the selected articles.

<table>
<thead>
<tr>
<th></th>
<th>All articles (n = 144)</th>
<th>Articles with a clear PO n = 105 (72.9%)</th>
<th>Articles with an unclear PO n = 39 (27.1%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Journal characteristics</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Year of publication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>62</td>
<td>48 (77.4)</td>
<td>14 (22.6)</td>
</tr>
<tr>
<td>2007</td>
<td>70</td>
<td>48 (68.6)</td>
<td>22 (31.4)</td>
</tr>
<tr>
<td>2008</td>
<td>12</td>
<td>9 (75.0)</td>
<td>3 (25.0)</td>
</tr>
<tr>
<td>Type of journal</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>General</td>
<td>22</td>
<td>16 (72.7)</td>
<td>6 (27.3)</td>
</tr>
<tr>
<td>Speciality</td>
<td>122</td>
<td>89 (73.0)</td>
<td>33 (27.0)</td>
</tr>
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<td>Peer-review status</td>
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<tr>
<td>Yes</td>
<td>109</td>
<td>87 (79.8)</td>
<td>22 (20.2)</td>
</tr>
<tr>
<td>No</td>
<td>19</td>
<td>8 (42.1)</td>
<td>11 (57.9)</td>
</tr>
<tr>
<td>Unknown</td>
<td>16</td>
<td>10 (62.5)</td>
<td>6 (37.5)</td>
</tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1</td>
<td>17</td>
<td>8 (47.1)</td>
<td>9 (52.9)</td>
</tr>
<tr>
<td>1–4</td>
<td>82</td>
<td>57 (69.5)</td>
<td>25 (30.5)</td>
</tr>
<tr>
<td>5–10</td>
<td>41</td>
<td>36 (87.8)</td>
<td>5 (12.2)</td>
</tr>
<tr>
<td>&gt; 10</td>
<td>4</td>
<td>4 (100.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td><strong>Authors’ characteristics</strong></td>
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<td></td>
</tr>
<tr>
<td>Funding source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>84</td>
<td>67 (79.8)</td>
<td>17 (20.2)</td>
</tr>
<tr>
<td>Multiple</td>
<td>23</td>
<td>19 (82.6)</td>
<td>4 (17.4)</td>
</tr>
<tr>
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<td>33</td>
<td>16 (48.5)</td>
<td>17 (51.5)</td>
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<td>No funding</td>
<td>4</td>
<td>3 (75.0)</td>
<td>1 (25.0)</td>
</tr>
<tr>
<td>Industry</td>
<td>69</td>
<td>59 (85.5)</td>
<td>10 (14.5)</td>
</tr>
<tr>
<td>University/hospital</td>
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<td>16 (72.7)</td>
<td>6 (27.3)</td>
</tr>
<tr>
<td>Government</td>
<td>22</td>
<td>19 (86.4)</td>
<td>3 (13.6)</td>
</tr>
<tr>
<td>Private non-profit</td>
<td>5</td>
<td>2 (40.0)</td>
<td>3 (60.0)</td>
</tr>
<tr>
<td>Other (association)</td>
<td>14</td>
<td>10 (71.4)</td>
<td>4 (28.6)</td>
</tr>
<tr>
<td>Financial ties</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>45</td>
<td>35 (77.8)</td>
<td>10 (22.2)</td>
</tr>
<tr>
<td>With the sponsor of the study</td>
<td>37</td>
<td>34 (91.9)</td>
<td>3 (8.1)</td>
</tr>
<tr>
<td>Not reported</td>
<td>2</td>
<td>2 (100.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Role of the sponsor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>41</td>
<td>33 (80.5)</td>
<td>8 (19.5)</td>
</tr>
<tr>
<td>In study design</td>
<td>9</td>
<td>7 (77.8)</td>
<td>2 (22.2)</td>
</tr>
<tr>
<td>In statistical analysis</td>
<td>1</td>
<td>1 (100.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Not reported</td>
<td>60</td>
<td>34 (56.7)</td>
<td>26 (43.3)</td>
</tr>
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<td><strong>Sample size</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quartile 1</td>
<td>43.8</td>
<td>58.0</td>
<td>31.0</td>
</tr>
<tr>
<td>Quartile 2</td>
<td>88.5</td>
<td>121.0</td>
<td>55.0</td>
</tr>
<tr>
<td>Quartile 3</td>
<td>221.3</td>
<td>247.0</td>
<td>83.5</td>
</tr>
<tr>
<td>Quartile 4</td>
<td>7111.0</td>
<td>7111.0</td>
<td>652.0</td>
</tr>
<tr>
<td><strong>Disease assessed</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>63</td>
<td>47 (74.6)</td>
<td>16 (25.4)</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>67&lt;sup&gt;a&lt;/sup&gt;</td>
<td>47 (70.1)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20 (29.9)</td>
</tr>
<tr>
<td>Spondyloarthropathies</td>
<td>16</td>
<td>13 (81.3)</td>
<td>3 (18.7)</td>
</tr>
<tr>
<td><strong>Registered article</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>40</td>
<td>37 (92.5)</td>
<td>3 (7.5)</td>
</tr>
<tr>
<td>Same registered and written primary outcomes</td>
<td>25</td>
<td>24 (96.0)</td>
<td>1 (4.0)</td>
</tr>
<tr>
<td><strong>Methodological characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description of the sample size calculation</td>
<td>75</td>
<td>69 (92.0)</td>
<td>6 (8.0)</td>
</tr>
<tr>
<td>Real and calculated sample size similar</td>
<td>54</td>
<td>51 (94.4)</td>
<td>3 (5.6)</td>
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<tr>
<td><strong>Nature of primary outcome</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Patient-reported outcome</td>
<td>73</td>
<td>56 (76.7)</td>
<td>17 (23.3)</td>
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<tr>
<td>Clinical outcome</td>
<td>52</td>
<td>41 (78.8)</td>
<td>11 (21.2)</td>
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<td>12</td>
<td>10 (83.3)</td>
<td>2 (16.7)</td>
</tr>
<tr>
<td>Biological outcome</td>
<td>6</td>
<td>5 (83.3)</td>
<td>1 (16.7)</td>
</tr>
<tr>
<td>Safety outcome</td>
<td>3</td>
<td>2 (66.4)</td>
<td>1 (33.3)</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>1 (50.0)</td>
<td>1 (50.0)</td>
</tr>
<tr>
<td><strong>Serious adverse events reported</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>82</td>
<td>58 (70.7)</td>
<td>24 (29.3)</td>
</tr>
<tr>
<td>Yes</td>
<td>35</td>
<td>34 (97.1)</td>
<td>1 (2.9)</td>
</tr>
<tr>
<td>Unknown</td>
<td>27</td>
<td>13 (48.1)</td>
<td>14 (51.0)</td>
</tr>
</tbody>
</table>

Data are number (%); PO: primary outcome.

<sup>a</sup> Two studies assessed both rheumatoid arthritis and osteoarthritis.
misleading conclusions;

28.70]).

Articles with misleading abstract conclusions more often assessed

significantly more likely to contain misleading abstract conclusions.

Summary of articles selected, statement of primary outcome in the text and

the trial registration and misleading abstract conclusions.

Misleading abstract conclusions in articles with negative results

were mainly due to lack of PO reporting (n = 7/19) (Table 3).

On univariable analysis, reports with negative results were sig-

ificantly more likely to contain misleading abstract conclusions. Articles with misleading abstract conclusions more often assessed OA than RA and spondyloarthropathies (35.6% vs 17.0 and 0%,

respectively; P < 0.012) (Appendix S2).

On multivariate analysis, only negative trial results were asso-

ciated with misleading abstract conclusions (OR = 9.58 [3.20–28.70]).

4. Discussion

A clear description of the PO was given in 105 of 144 abstracts

of reports of superiority RCTs in rheumatology. In 24 (23%) of the

105, the conclusions in the abstract were misleading. Only negative

trial results were associated with misleading abstract conclusions.

Of the 144 articles, only 19 (13.2%) declared study registration in the
text, had the same PO in both the published text and the registry,

and did not contain misleading abstract conclusions.

Articles reporting negative results are more likely to contain

misleading abstract conclusions. For instance, we found five arti-
cles in which negative results were suggested as being equivalent.

This is because the chance of an article being published can depend

on whether the results are positive or negative [28,29]. Chan et al.

reported that articles with statistically significant efficacy out-

comes had more than 2-fold greater odds of being fully reported

than those with non-significant efficacy outcomes [13]. Conse-

quently, authors may be less likely to submit manuscripts reporting

negative results [30].

Only 34 articles reported serious adverse events, and of these

three did not discuss the benefit–risk balance of the intervention

in their abstract conclusions. However, authors should weigh the

advantages and disadvantages of an intervention in abstract con-

clusions, as recommended in the Consort statement for abstracts

[19]. The existence of adverse effects can have a major impact on

whether a particular intervention is deemed acceptable and useful,

and readers need both efficacy and safety results to make rational

and balanced decisions.

It is now mandatory for a trial to be registered before publication

[31], but only 40 articles (27.8%) in our sample did so. Of these, 16

(40.0%) declared the information in the text and 15 (37.5%) reported

a PO different from the registered one, which agrees with other

recent findings [32]. Although trial registration aims to improve the
reporting of RCTs results [33,34], our study shows that registra-
tion is still inadequate and does not prevent authors from changing
the PO when reporting the trial results. Reviewers should, there-
fore, systematically check whether the features of the manuscript
they are reviewing agree with those of the registered study.

Our study has several limitations. First, the Consort statements
extension for abstracts refers to overgeneralization in misleading
conclusions, an element we did not deal with in our definition
because we considered it too subjective to be assessed. Thus,
our findings probably underestimate the proportion of mislead-
ing abstract conclusions. Second, safety issues were considered
only as discussed or not, with no attention given to the quality of
the reporting of safety data, which is often insufficient or inade-
quate [21,35,36]. Third, we focused on RCTs in one medical field
(rheumatology). We restricted our selection of articles because

Table 3

Frequency of misleading conclusions in articles with a clear primary outcome.

<table>
<thead>
<tr>
<th>Misleading conclusion</th>
<th>All (n = 105)</th>
<th>Articles with positive results (n = 61)</th>
<th>Articles with negative results (n = 42)</th>
<th>Articles with inaccurate results (n = 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>24 (22.9)</td>
<td>3 (4.9)</td>
<td>19 (45.2)</td>
<td>2 (100.0)</td>
</tr>
<tr>
<td>Reasons for misleading conclusions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary outcome not reported</td>
<td>*</td>
<td>£</td>
<td>†</td>
<td></td>
</tr>
<tr>
<td>Conclusions based on only secondary outcome results</td>
<td>10 (41.7)</td>
<td>3 (100.0)</td>
<td>7 (36.8)</td>
<td></td>
</tr>
<tr>
<td>Conclusions based on only sub-group analysis</td>
<td>1 (4.2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative results suggested as equivalent</td>
<td>5 (20.8)</td>
<td>5 (26.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conclusions not in agreement with results</td>
<td>7 (29.2)</td>
<td>6 (31.6)</td>
<td>1 (50.0)</td>
<td></td>
</tr>
<tr>
<td>Serious side effects without discussion of benefit–risk balance of the intervention</td>
<td>1 (4.2)</td>
<td>1 (33.3)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data are number (%).
* three conclusions had two reasons for misleading conclusions; † two conclusions had two reasons for misleading conclusions; £: one conclusion had two reasons for misleading conclusions.

Fig. 2. Summary of articles selected, statement of primary outcome in the text and in the trial registration and misleading abstract conclusions.
of our particular experience in this specialty and because being familiar with a topic makes it easier to assess the results of a trial. However, other studies are needed to see whether our results are confirmed in other medical areas. We found discussion of misleading or wrong conclusions in articles on anaesthesia, cardiology or infectious diseases in letters to the editor or editorials [37–39] but to our knowledge, the present study is the first assessment of the frequency of misleading abstract conclusions in a sample of RCTs. Fourth, we focused on RCTs with an objective of superiority. We decided to exclude non-inferiority or equivalence trials because their methodology is unrelated to superiority trials and their interpretation is completely different.

Finally, only the abstract conclusions identified as being misleading by one of us (SM) were confirmed by two of the other authors (PR and BC). At worst, this underestimates the prevalence of misleading conclusions.

In conclusion, this study shows that almost one-quarter of the abstracts in a sample of 144 reports of rheumatology RCTs, especially those with negative results, contained misleading conclusions. Authors should report their results with greater transparency, and reviewers and editors should ensure that the salient features agree with information provided in the trial registration.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

Appendix A. Supplementary data

Supplementary data (Fig. S1, S2) associated with this article can be found at http://www.sciencedirect.com, at doi:10.1016/j.jbspin.2011.05.008.

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