

*Trust, but Verify**The Accuracy of References in Four Anesthesia Journals*

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To determine the accuracy of bibliographic citation in the anesthesia literature, we reviewed all 1988 volumes of *ANESTHESIOLOGY*, *Anesthesia and Analgesia*, *British Journal of Anaesthesia*, and *Canadian Journal of Anaesthesia* and sequentially numbered all references appearing in that year ( $n = 22,748$ ). One hundred references from each of the four journals were randomly selected. After citations to nonjournal articles (i.e., books or book chapters) were excluded, the remaining 348 citations were analyzed in detail. Six standard bibliographic elements—authors' names, article title, journal title, volume number, page numbers, and year—were examined in each selected reference. Primary sources were reviewed, unless our institution did not own the source or could not obtain it through interlibrary loan, in which case standard indexes, abstracting services, and computerized databases were consulted. Each element was checked for accuracy, and references were classified as either correct or incorrect. A reference was correct if each element of the citation was identical to its source. Of the examined references, more than half (50.3%) contained an error in at least one element. The elements most likely to be inaccurate were, in descending order, article title, author, page numbers, journal title, volume number, and year. No significant differences ( $P = 0.283$ ) existed in the error rates of the four journals; the percentage of citations containing at least one error ranged from 44% (*Anesthesia and Analgesia*) to 56% (*British Journal of Anaesthesia*). The citation error rate of anesthesia journals is similar to that reported in other specialties, where error rates ranging from 38% to 54% have been documented. (Key words: Publications, documentation: *ANESTHESIOLOGY*; *Anesthesia and Analgesia*, *British Journal of Anaesthesia*; *Canadian Journal of Anaesthesia*.)

REFERENCE LISTS appended to published papers serve a number of useful functions for both writers and readers. A thorough and thoughtful review of the literature, as evidenced by accurate textual incorporation and bibliographic citation, places the article within a context of similar and contrasting studies and establishes the judgment

and credibility of authors.<sup>1,§</sup> Some readers will retrieve the cited documents to increase their own knowledge or to substantiate the authors' claims. Errors in citation detract from the functions of a bibliography and often impede retrieval of cited literature.

Previous reports have examined the accuracy of references in the journals of several specialties.<sup>1-6</sup> No study, however, has specifically reviewed the anesthesia literature. Although a rate of citation error in the anesthesia literature has not been established, if it were as high as that of the literature of other specialties, identification would be the first step toward corrective action on the part of authors and journal staffs. Our study was therefore designed to calculate an error rate for citations in the anesthesia literature, to identify bibliographic elements most likely to be erroneous, and to suggest ways to correct ubiquitous citation errors.

**Materials and Methods**

All 1988 issues of four journals, *ANESTHESIOLOGY*, *Anesthesia and Analgesia*, *British Journal of Anaesthesia*, and *Canadian Journal of Anaesthesia*, were examined. Beginning with the first reference in the January issues and ending with the last reference in the December issues, every citation was numbered sequentially ( $n = 22,748$ ). Using a random-number generator, we identified 100 references from each journal, for a total of 400. References to nonjournal items, such as books and book chapters, were excluded from the analysis, leaving a total of 348 references.

A reference form was created; this identified the citation by its sequential number and the journal in which it appeared. Data fields for the cited reference corresponded to six standard elements of bibliographic citation: authors (including correct number, order, initials, and spelling), article title, journal title (including proper Index Medicus abbreviation), volume number, page numbers, and year.

Citations were then verified by comparison with the original publication (primary source). If our institution did not own the source, we attempted to procure a copy of it through interlibrary loan. Only when a copy of the article could not be located did we refer to standard indexes or computerized databases.

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§ Goodrich JE, Roland CG: Accuracy of published medical reference citations. *Journal of Technical Writing and Communication* 7:15-19, 1977.

Citations containing no errors were classified as correct; if an error existed in any element, the citation was classified as incorrect.

Data are presented as frequencies and percents overall and by element for each journal. Differences in errors among journals were assessed using chi-square tests. Fisher exact tests for  $r \times c$  contingency tables were used when assumptions underlying the chi-square tests were not met.

### Results

More than half of all references examined contained an error in at least one element of the citation (table 1); 16% contained two or more errors. Figure 1 shows the distribution of errors among each of the six chosen bibliographic parameters. Errors in the title and author fields of the citation were common, each occurring in about one fourth of the references. Errors in page numbers occurred in 10% of the citations; journal, volume, and year errors were less frequent, each occurring in fewer than 5% of the references.

Error rates by journal ranged from 44–56% (table 2). No journal's error rate was significantly different from that of the others ( $P = 0.283$ ). Errors in titles were more common in three of the four journals, with author errors the second most common. Page number errors were the third most common error for all journals. The journals did not differ significantly for any of the elements.

The performance of anesthesia journals compared to those of other disciplines is shown in figure 2. Our error rate could not be directly compared to the rates of other journals because of widely varying methodologies; however, the rate of error we calculated for the anesthesia literature does fall within the range established in the literature of other specialties.

### Discussion

Our study is the first to examine the accuracy of references in the anesthesia literature. The 50.3% rate of error in the anesthesia journals examined, though discouraging, is consistent with the findings of studies of the literature of other medical specialties. Furthermore, we suggest ways to solve the problem of citation error, thereby rendering the anesthesia literature more useful to its readers.

Several studies have examined the accuracy of references in the medical literature. Key and Roland<sup>3</sup> surveyed

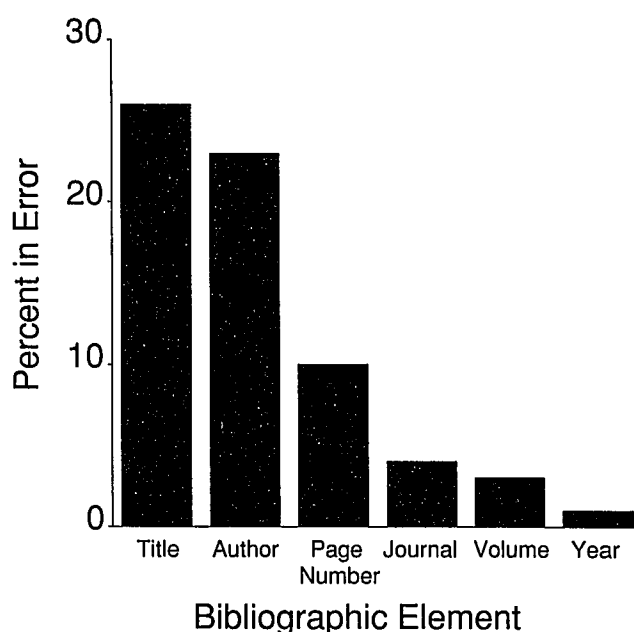


FIG. 1. Percent error shown by bibliographic element in which the errors appeared. Most likely to be erroneous was the title, followed by author, pagination, journal, volume, and year.

citations appearing in 129 articles accepted for publication by the *Archives of Physical Medicine and Rehabilitation* from 1975 to 1976. Citations were compared with the original publication when possible, and standard indexes were consulted when the source was not available. The authors grouped errors into categories of standard bibliographic elements. Of the 1,867 references examined, 54% contained at least one error. Most references were formatted according to journal style, but failure to adhere to these instructions was not counted as an error. Since it is the policy of the *Archives of Physical Medicine and Rehabilitation* to verify references before publication, errors were corrected after identification.

Other studies have examined the accuracy of citation in the nursing and dental literature. Foreman and Kirchhoff<sup>1</sup> divided 17 nursing journals into clinical and nonclinical groups and then randomly sampled references from the first article in the final 1983 issue of each journal. Citations in clinical journals contained more errors (38.4%) than citations in nonclinical journals (21.3%), although this difference did not attain statistical significance. Errors were further classified as alphabetic or numeric and major or minor. Major errors had the potential to prevent retrieval of the source document; these included, for example, incorrect journal title or incorrect numbers for volume or year. No major errors were discovered in the nonclinical literature, whereas 4.6% of examined citations in clinical journals contained a major error. Though classified as major, these errors did not actually prevent retrieval of the cited documents. Of the total er-

TABLE 1. Number of Errors per Citation

Number of Errors Per Citation	Frequency	Percent
0	173	49.7
1	120	34.5
2 or more	55	15.8
Total	348	100.0

TABLE 2. Citation Errors by Journal

Element	Anesthesiology (n = 87)	Anesthesia and Analgesia (n = 86)	British Journal of Anaesthesia (n = 91)	Canadian Journal of Anaesthesia (n = 84)	Combined (n = 348)
Title	25 (29%)	18 (21%)	22 (24%)	24 (29%)	89 (26%)
Author	17 (20%)	21 (24%)	21 (23%)	21 (25%)	80 (23%)
Page numbers	5 (6%)	7 (8%)	14 (15%)	8 (10%)	34 (10%)
Journal	1 (1%)	7 (8%)	3 (3%)	3 (4%)	14 (4%)
Volume	5 (6%)	0 (0%)	5 (5%)	2 (2%)	12 (3%)
Year	1 (1%)	1 (1%)	1 (1%)	2 (2%)	5 (1%)
Any error	40 (46%)	38 (44%)	51 (56%)	46 (55%)	175 (50%)

rors found, numeric errors predominated in the clinical journals and alphabetic errors in the nonclinical group.

A survey by Doms<sup>6</sup> of five dental journals yielded a total error rate of 42% among 500 randomly selected references. References were first classified as either correct or incorrect; errors were then grouped by citation element or listed as unverifiable. The errors were ranked as major or minor; major errors prevented immediate location of the cited article. Of the 248 citations labeled as incorrect, 75 (30%) contained major errors, including incorrect journal title, incorrect author, and incorrect article title. Twenty-five such citations could not be located by source, index, or computerized search; *i.e.*, ten percent of the examined references were nonretrievable.

Some studies also have examined the accuracy with which quotations are attributed to the proper reference source, an area that may be of far greater significance than that of bibliographic citation alone. Eichorn and Yankauer surveyed both citation and quotation accuracy in three public health journals.<sup>2</sup> They calculated an error rate of 31% in citation and 30% in quotation. Standard bibliographic elements were included in their examination, although punctuation mistakes were not counted as errors. These deviations were grouped into major and minor categories; major errors were those preventing immediate identification of the source, and minor errors included the remaining citations, a definition put forth by de Lacey *et al.* in an earlier study of reference and quotation accuracy.<sup>5</sup> Errors in quotation also were defined as major or minor. Major errors (23 errors in 50 references) were assertions in contradiction to, unrelated to, or unsubstantiated by the cited source. Minor errors (22 errors in 50 references) were oversimplification or extension of conclusions not stated by the cited article.

Citation errors tend to perpetuate themselves so that once entered into the literature they can be difficult to eradicate. A classic error of this type occurred in the case of Dr. O. Uplavici, who was "born" in 1887 and finally laid to rest by Dobell some 50 yr later.<sup>7</sup> In this case, the title of a Czech-language article—"O úplavici," or "On dysentery"—was mistaken for the author's name. The error was repeated and indeed, expanded upon; until 1938, when Dobell wrote his "obituary," the work of "Dr. Uplavici" was cited throughout the literature of amoebic

dysentery. Errors of this type still occur, as evidenced by a recent misprint in ANESTHESIOLOGY, in which the name of an anesthesiology department was taken to be the coauthor of a letter to the editor.<sup>8</sup> That the author was for a time in the distinguished company of Sir Humphry Davy was doubtless of little cheer either to the writer or to the journal, which later clarified the matter.<sup>8</sup>

The most disturbing implication of the case of Dr. Uplavici is that the authors who cited his work were relying on secondary sources (*i.e.*, authors who had previously cited the paper), rather than consulting the original publication. That the original article appeared in the Czech language naturally makes it accessible to few readers; however, language barriers cannot absolve authors from their responsibility to ensure the accuracy of interpretation and citation. As Foreman and Kirchhoff<sup>1</sup> have pointed out, reliance upon secondary sources perpetuates errors in both areas.

Readers may naturally assume that authors who are careless with their references may also have been less than

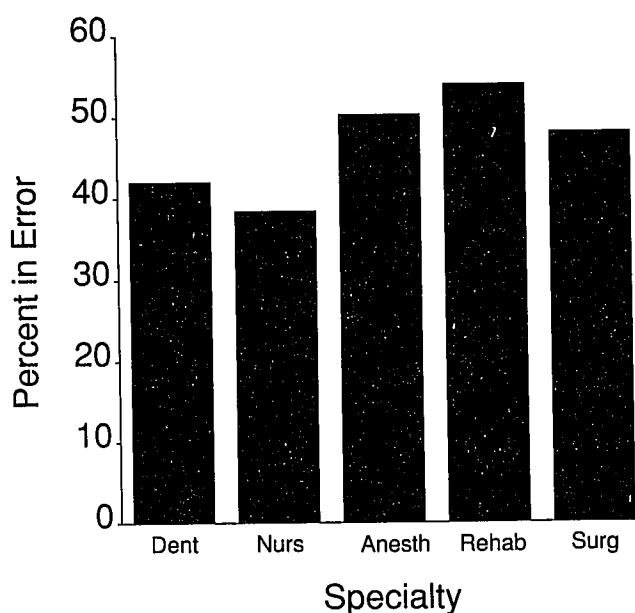


FIG. 2. The performance of anesthesia journals compared with journals of other specialties in which citation error rates have been established. Dent = dentistry<sup>6</sup>; nurs = nursing<sup>1</sup>; anesth = anesthesia (current study); rehab = rehabilitation medicine<sup>3</sup>; surg = surgery.<sup>4</sup>

scrupulous with other parts of the work,<sup>6</sup> an assumption that points to what Roland calls "a philosophical-ethical issue: the published article is the culmination of an author's work. It should be error-free, for who can have confidence in a work in which he finds mistakes, whether in the data, the interpretations, or the references?"<sup>9</sup> Disdain for careless authors may extend to a lack of confidence in the journals in which their work appears.<sup>§</sup>

Small errors in citation ("typical of hurrying humanity"<sup>9</sup>) are altogether too easy to make because of the necessary transcription of the bibliographic information. Unusual author names, combined with technical terms appearing in titles, abbreviated journal names, and numeric fields in the rest of the citation create many opportunities for error. Substituting letters that look alike, inverting letters or integers, and copying a reference that has already been incorrectly cited are possible causes of error.<sup>1,10</sup>

How can the problem of citation error be corrected? It is generally agreed that accurate bibliographies are primarily the responsibility of the author,<sup>5,6</sup> who should verify all references against the original documents,<sup>1,11</sup> preferably late in the writing process<sup>8</sup> and again when the article appears in galley proof.<sup>1,5</sup> Once the author has ensured the accuracy of citations against the original publications, further reference verification can be performed by authors' editors or other trained personnel.<sup>9</sup>

Authors alone may be unable to ensure the integrity of the scientific literature; consequently, the responsibilities of peer reviewers should be clarified in this regard.<sup>4</sup> Reviewers might as a matter of course verify a random sample of references from papers and indicate their findings in their critique. Evans *et al.* note that inaccuracy in statistical design encouraged journals to institute review by statisticians of submitted manuscripts; by extension, perhaps "citational and quotational consultants are needed" as well to eradicate the problem of bibliographic error.<sup>4</sup> Finally, journal editors, who have a vested interest in upholding readers' confidence in what they publish, may play a role in reference verification. Error rates could be greatly reduced by verification of all<sup>3</sup> or a sample of citations<sup>6</sup> from each article.

Such a process could be accomplished easily without overwhelming expense by the use of any or all of several approaches. First, journals could establish a limit on the number of references any one paper might contain. Such a limitation would narrow the task of verification and encourage authors to be more discriminating in their citations. Second, journals could adopt a uniform system of citation, thereby creating a standard by which citations could be compared electronically against a scrupulously accurate database (*e.g.*, that maintained by the National Library of Medicine). By eliminating the task of reformatting bibliographies for submission to different jour-

nals, this approach would also lessen the burden of revising a rejected manuscript. We envision a simple computer program that would compare all citations in an electronic file with the National Library of Medicine database, automatically identifying and correcting any errors encountered. In the best of all possible worlds, this process would begin at quitting time in the journals' offices, verification thus taking place at non-prime-time rates, freeing staff to perform more engaging tasks, and allowing editors to sleep more soundly, confident in the knowledge that clean, accurate copy awaits them in the morning. Then, information about identified errors could be faxed to authors, whose responsibility it would be to confirm that the corrected citation is, in fact, the one intended.

Whatever method of verification is used, reference accuracy is essential. Accurate references assist the reader who wants to learn about a *new* field. Such a reader uses the reference list to approach the background literature for a study already determined to be interesting. Nothing could be more frustrating for those readers than to uncover an unidentifiable reference. Bibliographies with which care has obviously been taken prevent this sort of frustration, uphold authors' credibility and reputations, and serve a larger purpose in the preservation of integrity within the scientific literature.

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