

Guidelines on Authorship of Medical Papers

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IN THE belief that authors and potential authors may be helped by explicit statements of justification for authorship, the following guidelines are offered for research papers, case-series analyses, case reports, review articles, and editorials. These guidelines are based on statements issued by the International Committee of Medical Journal Editors (ICMJE) that were published recently (1-3) and will eventually be incorporated into the Committee's document, "Uniform Requirements for Manuscripts Submitted to Biomedical Journals" (4, 5).

The ICMJE statements on authorship represent five principles that are applied below in the specific guidelines. (These principles have been developed directly from the ICMJE statements with some clarifications.)

Principles for Authorship

Principle 1. Each author should have participated sufficiently in the work represented by the article to take public responsibility for the content.

Investigators in the sciences and others who use scientific information must have confidence in its accuracy and validity. Such confidence rests in part on knowing that at least one person has taken public responsibility for the information, and for published information the responsible persons are authors (6, 7). "Public responsibility" means that an author can defend the content of the article, including the data and other evidence and the conclusions based on them. Such ability can come only from having participated closely in the work represented by the article and in preparing the article for publication (7). This responsibility also requires that the author be willing to concede publicly errors of fact or interpretation discovered after publication of the article and to state the reasons for error. In the case of fraud or other kinds of deception attributable to one or more authors, the other authors must be willing to state publicly the nature and extent of deception and to account as far as possible for its occurrence.

Principle 2. Participation must include three steps: (1) conception or design of the work represented by the article, or analysis and interpretation of the data, or both; (2) drafting the article or revising it for critically important content; and (3) final approval of the version to be published.

The work represented by a scientific article includes forming the hypothesis tested by the research it reports or forming the question it answers, developing the means of gathering the reported data or other evidence, collect-

ing the data or the other evidence, critically analyzing the evidence and any counter-evidence, and writing the article so that it reports accurately all of these steps and their products in the structure of critical argument (8). Authors could not publicly defend the intellectual content of an article unless they understand thoroughly the basis for its origin (conception) and can testify to the validity of its argument (critical analysis of evidence). Authors must also have sufficient involvement in writing the paper, either in drafting the initial version or revising subsequent versions to insure validity of the argument and conclusions, to be able to defend the article as an accurate report (7) of the work that led to it.

Principle 3. Participation solely in the collection of data (or other evidence) does not justify authorship.

Data and other evidence bearing on the conclusions and validity of a scientific article may be gathered by persons who know little or nothing of the steps critical to its main intellectual substance: the genesis, design of the work, and the critical analysis of evidence. Such persons could not take public responsibility for the main elements of an article and could testify only to the validity of elements of evidence and not to how they support the argument and its conclusion. Contributions of data by persons for whom authorship is not justified can be acknowledged by other means (see Principle 5).

Principle 4. Each part of the content of an article critical to its main conclusions and each step in the work that led to its publication (steps 1, 2, and 3 in Principle 2) must be attributable to at least one author.

"Scientists can proceed with confidence only if they can assume that the previously reported facts on which their work is based are indeed correct" (7). Each element of a scientific article vital to its conclusions therefore must be publicly defensible or its validity is open to question. Therefore, the authorship of a paper must include one or more persons able to defend any of its critically vital elements (9).

Principle 5. Persons who have contributed intellectually to the article but whose contributions do not justify authorship may be named and their contribution described—for example, "advice," "critical review of study proposal," "data collection," "participation in clinical trial." Such persons must have given their permission to be named. Technical help must be acknowledged in a separate paragraph.

Contemporary research can involve persons whose contributions are not vital to the argument and conclu-

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sions of the article but that have been supportive for the authors. Lest authors misrepresent themselves as being solely responsible for all that the article represents, they should indicate who provided intellectual assistance and its nature. Purely technical assistance should be acknowledged separately. Technical assistance includes building equipment, collecting data (specimen gathering and laboratory measurements), locating and abstracting literature, and work in preparing a manuscript that is not intellectual work on its scientific content.

Guidelines for Specific Kinds of Articles

Principle 2 defines participation in three steps as a requirement for authorship:

- Step 1. Conception of the work represented by the article, design of the work, analysis and interpretation of data or other evidence presented in the article, or all of these.
- Step 2. Drafting the article or revising it for critically important content.
- Step 3. Approving the final version of the article for publication.

Steps 2 and 3 necessarily apply to *all* types of articles. Specific contributions in Step 1 may differ for the various types of articles written for a clinical journal.

STEP 1 FOR ARTICLES REPORTING CLINICAL, EPIDEMIOLOGIC, OR LABORATORY RESEARCH

Conception: Framing a specific hypothesis to be tested or specific question to be answered.

Design of the work: Drafting and deciding on the structure and methods for the research.

Analysis and interpretation of the data. This function includes assessing the precision, accuracy, and relevance of data, and statistical analysis. It also includes reviewing the literature for supportive evidence and counter-evidence.

Participation solely in study design or in data analysis or in both may represent adequate participation in Step 1 to justify authorship. Providing technical help, simple referral of patients, or collecting data do not by themselves represent adequate participation in Step 1. In epidemiologic studies the referral of a problem for study does not by itself represent adequate participation in Step 1, but recognizing in the problem an hypothesis to be tested or a specific question to be answered may be adequate.

STEP 1 FOR ARTICLES REPORTING A CASE-SERIES ANALYSIS

Conception: Framing the specific question or questions the analysis is expected to answer.

Design of the work: Defining the characteristics of the cases to be analyzed and the scope of the literature to be considered for supportive evidence and counter-evidence.

Analysis and interpretation of the case data and literature evidence: Critical assessment; structuring and presentation; statistical analysis.

Locating and abstracting case data or literature do not by themselves represent adequate participation in Step 1 for this kind of article. Providing case data ("routine

examination and tests") that would have been obtained even if the case-series analysis was not to be carried out is not participation justifying authorship (see Principle 3).

STEP 1 FOR INDIVIDUAL CASE REPORTS

Conception: Recognizing and defining the case characteristics that appear to justify further study of the case and eventually the report.

Design of the work: Deciding on and securing additional case data and relevant literature evidence that support the importance identified in "Conception."

Analysis and interpretation of the case data and literature evidence: Critical assessment and selection of case data and literature evidence. Providing case data (such as "routine tests," laboratory estimations, roentgenographic or other imaging studies, cardiac studies) does not by itself represent adequate participation in Step 1 to justify authorship. Just the referral of the patient (case) to the person or persons responsible for "Conception" does not justify authorship.

STEP 1 FOR REVIEW ARTICLES, EDITORIALS, AND SIMILAR ARTICLES BASED ON CRITICAL ASSESSMENT OF THE LITERATURE AND PERSONAL EXPERIENCE

Conception: Framing the specific question or questions to be answered.

Design of the work: Defining the characteristics of the literature to be reviewed.

Analysis and interpretation of the evidence considered: Selection of evidence through critical assessment.

Locating and abstracting the literature are not by themselves participation in Step 1.

Additional Considerations

TIME OF DECISIONS ON AUTHORSHIP

At least tentative decisions on authorship should be made, if possible, at the beginning of the study, after the potential authors have agreed on its design. Early decisions may reduce the risks of late arguments about authorship. These decisions may have to be revised because of events during the execution of the study, but the final decision should be made no later than the beginning of the first draft of the article (10).

RESPONSIBILITIES FOR DEFINING AUTHORSHIP

Agreement should be reached at the time of the initial decision on authorship as to who will be responsible for subsequent decisions. Generally this person should be the one who will have had the most responsibility for the work in Step 1, defined above. If the first candidate is not available when a final decision on authorship must be reached, the responsibility may be assigned to another person, preferably another author, who is familiar with the conduct of the reported work.

At the time of the initial decision on authorship, agreement should be reached on how subsequent persisting disagreements will be arbitrated. The most impartial arbitration is likely to come from a person familiar with the field of study but not associated with any of the potential authors.

Credit for work done is not a basis for assigning authorship. "Credit" is the appreciation, esteem, or reputation gained by an author after the article has been published, authorship having been assigned before publication on the basis of taking responsibility as discussed above. The credit is assigned to an author by a reader or an institution after estimating the article's importance and whether it represents meritorious work.

SEQUENCE OF AUTHORS

The relative contributions of authors to the intellectually most critical aspects of the work should determine their sequence. Contributions in Step 1 should be given the greatest weight. The first author should have made major contributions in Steps 1 and 2; the following sequence of authors should represent progressively lesser contributions.

THE SINGLE AUTHOR

A single author should take all the responsibilities defined by the five principles set forth above. Single authors must not violate Principle 4; no one who should be taking responsibility for some part of the content of the paper should be omitted from authorship.

CORPORATE (COLLECTIVE) AUTHORSHIP

When a study has been carried out by a group, and no one person can be identified as having a substantially greater responsibility for its content than the others, the group should consider representing themselves by a corporate (collective) title that should reflect the field of the study. The article should carry in a footnote or as acknowledgments the names of the persons represented by the corporate title and of their institutions.

Conclusion

These guidelines are subject to revision in response to needs for additional specific guidelines and to criticism.

Appendix

The guidelines given in the body of this article are largely based on the statements on authorship issued by the International Committee of Medical Journal Editors (1-3); those statements were in turn based in part on previously published opinions and organizational guidelines. I consulted additional documents in preparing the guidelines set forth here. I have selected short quotations from both of these sets of documents to represent their essence and have added brief comments to put them into an historical frame.

1945: WALTER B. CANNON ON AUTHORSHIP

Toward the end of his long and highly fruitful career in physiology, the eminent American physiologist Walter B. Cannon published his scientific autobiography, *The Way of an Investigator* (11).

The treatment of his collaborators by the head of a laboratory may be put to a real test when the time arrives for publishing papers. Methods which have proved satisfactory in my experience through several decades are as follows. If I have merely suggested the problem to be investigated, indicated the pertinent literature, demonstrated the method to be employed, and from time to time have supervised the work, I have not allowed my own name to appear on the published paper as a joint author. Although the beginner

who has carried on research in these circumstances has usually thanked me graciously at the end of his report, that acknowledgement has never been requested. When I have participated in the experimental procedures, my name has appeared as one of the authors. If I have done a major part of the work my name has been placed first, but if my role has been secondary it has not had that prominent position.

1953: MULTIPLE AUTHORSHIP BEGINS TO GROW

The support by foundations of research in the years immediately before World War II and the even greater support by the National Institutes of Health after the war steadily increased the pace of research. As studies became more complex, the number of medical investigators grew rapidly; increasing numbers of claims on authorship apparently were responsible for more frequent multiple authorship (12).

A major trend in the organization of science during the past two decades has been an evolution away from the individual investigator in favor of research teams. Accompanying this trend, scientific publications have become afflicted with an increasing tendency towards multiple authorship of papers. . . .

At the risk of being presumptuous, we would define the requisites for authorship of a scientific paper as being "the contribution of creative thinking to the advancement of science." Creative thinking assumes . . . its greatest importance in the design of an experiment. How many creative minds contribute to the design of the usual experiment? . . .

Instead of being a means of credit for creative endeavors, it is evident that there is a tendency to degrade authorship into a form of menial patronage. . . . A reversal of present trends will require the stringent elimination of the practice of carelessly offering co-authorship to one's colleagues as a token for small services rendered in the conduct of research.

1957: A NEED FOR ETHICS FOR MEDICAL AUTHORSHIP

Dr. Richard M. Hewitt, senior consultant, Section of Publications, the Mayo Clinic, was thoroughly familiar with medical journals and the problems of writing medical papers, including decisions on authorship. In his classic on medical writing, *The Physician-Writer's Book* (6), he defines a high standard for authorship. Responsibility, not credit, is the essence of Hewitt's standard.

If we would define publication of unoriginal, repetitious material as not in accord with medical ethics, and would officially reprove it as such, the tawdry author would be silenced and the genuine one helped. A man of the latter type, having something noteworthy to say, may justifiably say it half a dozen times in as many months, but he would prefer to publish it only once. . . . "Johnson was by no means of opinion," wrote Boswell . . . "that every man of a learned profession should consider it incumbent upon him . . . to appear as an author." What would the forthright old man have had to say of the professional man who appeared as an author even though he had not the full right of authorship?

Authorship cannot be conferred; it may be undertaken by one who will shoulder the responsibility that goes with it. To a responsible writer, an article, with his name on it, is the highest product of his mind and art, his property, as nearly flawless as he can make it, founded in his character and evidence of it. If that describes the acceptable standard, medical writers, a responsible group, are in present need of reconsidering the implications of joint authorship. The reader of a report issued by two or more authors has a right to assume that each author has some authoritative knowledge of the subject, that each contributed to the investigation, and that each labored on the report to the extent of weighing every word and quantity in it.

... The by-line, then, is not merely a credit line. He who took some part in the investigation, be it ever so minor, is entitled to credit for what he did. If, however, any one of the reader's assumptions mentioned above cannot be applied to such a one, the credit due him, be it ever so major, does not justify his inclusion as an author. His contribution should be acknowledged preferably in the body of the paper, or in a footnote. Further, the generous chap who would bestow authorship on another, perhaps without even submitting the manuscript to him, may do his colleague no favor.

1970: AUTHORSHIP IN PSYCHOLOGY

Other fields have faced problems in authorship. Psychology has had research of growing complexity and thus increasing difficulties with decisions on multiple authorship. Spiegel and Keith-Spiegel (13) saw a consensus in the data from a survey of a large group of psychologists.

... most of the psychologists surveyed felt that publication credit should be given only to persons who are very actively involved in contributing to a project and that authorships should never be given out of gratitude or deference to persons of higher status. They should be given when considerable important work has been done, and authorship should reflect the relative significance of the contributions made. Footnotes should be relatively concise indications of minor contributions and should be as explicit as possible concerning the nature of the contribution.

... When collaborators cannot agree about authorship order or credit assignment, perhaps some disinterested arbitrators should be engaged to judge the relative merits of the contributions made to the final research product.

1979: COOPERATIVE CLINICAL TRIALS AND AUTHORSHIP

Growth in the number and size of cooperative clinical trials led to questions of authorship for large groups of collaborators. In a 1979 article, Relman gave his definition (14).

Authorship of a paper ought to denote a significant share of responsibility for the conception and design of an experiment and for the analysis and interpretation of the results. At least some personal involvement in the actual gathering of the data is desirable but not always possible. At the very least, however, a coauthor ought to be thoroughly familiar with the experimental details and should feel comfortable about assuming responsibility for them. The essential criterion is the quality of the intellectual input. A scientific paper is a creative achievement, a record of original productivity, and coauthorship ought to be unequivocal evidence of meaningful participation in the creative effort that produced the paper. ... the use of coauthorship as a kind of payment for faithful technical assistance or data collection violates this principle. So does the all too common practice of adding the chief's name to every paper published from his department or laboratory, regardless of whether he has made any intellectual contribution to the design, execution, or interpretation of results.

1982: RESPONSIBILITY FOR WHAT A PAPER SAYS, NOT ONLY FOR WHAT IT REPRESENTS

A scientific paper is more than a report of research findings and their interpretation. It also represents thought about how to relate its conclusions to the scientific literature and about what to say in print and how. An author is responsible not only for the research reported but for the report itself (15).

An author should have taken part in the writing of the paper.

... An author should have read the entire contents of a paper and assented to its publication before it is sent to a journal.

... Consider that the person entitled to put his name on a mosaic is not he who gathered the chips but the artist who put together the picture; the two persons may be the same but the claim to creation lies in the picture.

An editorial in *The Lancet* (16) makes a similar point.

Perhaps the least to be expected of authors is that they have participated in and contributed to the published study, that they have read the paper to which they have put their names, and that within the limits of their skills they are prepared to vouch for the work.

1983: STATEMENTS ON AUTHORSHIP FROM PROFESSIONAL SOCIETIES

Scientific organizations with responsibilities for standards in publication are becoming aware that authorship must be defined more precisely if decisions on authorship are to be rational and ethical. In 1983 (17) the American Psychological Association amplified its relevant 1981 ethical principle.

Authorship is reserved for persons who receive primary credit and hold primary responsibility for a published work. Authorship encompasses, therefore, not only those who do the actual writing but also those who have made substantial contributions to a study. This concept is discussed in Principle 7f of the "Ethical Principles of Psychologists" (APA, 1981). ... *Principle 7f. Publication credit is assigned to those who have contributed to a publication in proportion to their professional contributions. Major contributions of a professional character made by several persons to a common project are recognized by joint authorship, with the individual who made the principal contribution listed first. Minor contributions of a professional character and extensive clerical or similar nonprofessional assistance may be acknowledged in footnotes.*

... Substantial professional contributions may include formulating the problem or hypothesis, structuring the experimental design, organizing and conducting the statistical analysis, interpreting the results, or writing a major portion of the paper. Those who do so are listed in the by-line. Lesser contributions, which do not constitute authorship, may be acknowledged in a note. ... These contributions may include such supportive functions as designing or building the apparatus, suggesting or advising about the statistical analysis, collecting the data, modifying or structuring a computer program, and arranging for research subjects. Combinations of these (and other) tasks, however, may justify authorship. In any case, the writer should always obtain a person's consent before including that person's name in a by-line or in a note.

Authors are responsible for determining authorship and for specifying the order in which two or more authors' names appear in the byline. The general rule is that the name of the principal contributor should appear first, with subsequent names in order of decreasing contribution.

Authors are also responsible for the factual accuracy of their contributions.

A short statement was issued by the Council of Biology Editors (7) in 1983.

The authorship of a paper should be decided when the paper is written, even if the decision is only tentative. This decision should come from the scientist who has been most engaged in designing and executing the research. Any conflicts on authorship or content of the paper should be resolved among the co-workers. The basic requirement for authorship is that an author should be able to take public responsibility for the content of the paper. ... An author should be able to indicate why and how the observations were

made, and how the conclusions follow from the observations. An author should be able to defend criticisms of the paper, as, for example, in a letter-to-the-editor responding to published criticisms. These abilities should come from having participated in design of the study, in observing and interpreting the reported findings, and in writing the paper.

Claims to authorship may come from persons who have had little to do with the intellectual content of the paper, but who have provided financial support, routine technical assistance, or research space and equipment. Such contributions need not be rewarded with authorship but can be acknowledged in the appropriate section of the paper. . . . A paper must report only observations actually made by one or more of its authors. . . . At least one of the authors, preferably the principal author, should have been closely enough involved with conduct of the study to be reasonably sure that data have not been fabricated or improperly manipulated by any of the other authors or by technicians. . . .

1984: A SUCCINCT STATEMENT OF CRITERIA FOR AUTHORSHIP

Dr. Claude T. Bishop, Editor-in-Chief, National Research Council of Canada Research Journals, has stated (18) succinct criteria.

The authors of scientific papers clearly bear the full responsibility for the veracity of the work reported therein. . . . who warrants coauthorship? . . . Since authorship implies responsibility, one simple guideline could be that all authors should be capable of participating in a discussion or defense of their paper.

1984: AUTHORSHIP CONSIDERED IN THE CONTEXT OF ETHICAL SCIENCE

Sigma Xi, the scientific research society, has issued a broad but detailed discussion (19) of ethical and unethical conduct in science. Several passages cover the questions of legitimate authorship.

The literature of science does have a long tradition of cooperation among two or three authors, who come together because each can contribute specialized knowledge, or because research is often more exciting and rewarding if it is not done entirely alone. What is comparatively new is the practice, in some disciplines, of publishing reports in which five or even fifty individual scientists claim "authorship" of the same paper. It is particularly evident in some forms of biomedical research. . . . If the research requires such cooperation, it is argued that those who contributed should be credited with authorship of the report.

What, it might be asked, has this to do with scientific honesty? How is multiple authorship related to our taxonomy of trimming, cooking, forging and plagiarism? Nothing in principle, perhaps but it seems evident that multiple authorship increases the opportunity for each of these to occur, if only because the responsibilities of authorship are diffused or diminished when they are widely shared.

Irresponsible authorship, rather than multiple authorship, is in fact the real problem in such situations. In principle, it is possible for fifteen or fifty scientists to coauthor a single research report, using the term "author" in the full sense of that word. More usually, however, multiple authorship indicates a claim for credit rather than an acceptance of responsibility. . . . Too often, someone is named as an author less because of the need to accord appropriate recognition than because a publication list is regarded as the index of a scientist's worth, and the more the better.

. . . If [a] paper contains fraudulent statements, or mistakes caused by the carelessness or self-deception of others, it should not have been published and you

should not have attached your name and scientific reputation to it as a coauthor. In short, the time to take responsibility for a paper is not after its errors have been exposed but before. Whatever view of the matter is taken by other coauthors, it is up to you to ensure that the manuscript is free of error or bias.

. . . Authorship . . . should mean the same thing in any branch of science.

1985: STANFORD'S PRESIDENT CONSIDERS PROBLEMS OF ACADEMIC AUTHORSHIP

Questions on criteria for authorship and their application in increasingly complex academic settings have been recommended by Dr. Donald Kennedy, President of Stanford University, to his Academic Council as needing systematic discussion. Two paragraphs in his request to the Council (20) focus sharply on the main problems in authorship.

. . . faculty members often rely on their own familiarity with the conventions of the discipline regarding coauthorship and other forms of credit, forgetting that students and other participants in a project may not be acquainted with them. Again, I wonder whether departments or laboratories could ameliorate the bitterness of disappointed expectations by a general discussion, in advance, of the ground rules. The understanding in my laboratory was this: If I had contributed to the idea of the project and had also contributed significantly to the hands-on work, coauthorship was justified; but any coauthor had to have a complete enough grasp of the whole record to defend it effectively in a scientific meeting. This test, of course, is tailored to an experimental science and surely is not the only one applicable even there.

. . . There is a tight coupling between authorship and responsibility. Let us suppose that the name of a faculty member has been included on a paper resulting from the relatively independent experiments by a student or fellow. If the data are then shown to be faulty, or worse, invented, it seems clear to me that the faculty member is responsible. Indeed, as Provost Albert Hastorf's 1984 memorandum on academic fraud pointed out, faculty members are generally responsible for the scholarly conduct of staff and students involved in their research enterprises. When one assumes coauthorship, a still higher duty of certainty prevails. The defense of minimal participation in work done in one's laboratory is generally questionable; surely it is entirely inapplicable when one is coauthor of the disputed work.

1986: GUIDELINES ON AUTHORSHIP FROM THE AMERICAN CHEMICAL SOCIETY

Authorship is one aspect of scientific publication considered in "ACS Ethical Guidelines to Publication of Chemical Research" (21), issued in 1986 by the American Chemical Society.

. . . The co-authors of a paper should be all those persons who have made significant scientific contributions to the work reported and who share responsibility and accountability for the results. Other contributions should be indicated in a footnote or an "Acknowledgements" section. An administrative relationship does not of itself qualify a person for co-authorship (but occasionally it may be appropriate to acknowledge major administrative assistance). Deceased persons who meet the criterion for inclusion as co-authors should be so included, with a footnote reporting date of death. No fictitious name should be listed as an author or co-author. The author who submits a manuscript for publication accepts the responsibility of having included as co-authors all persons appropriate and none inappropriate. The submitting author should have sent each living co-author a draft

copy of the manuscript and have obtained the co-author's assent to co-authorship of it.

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