
Proliferation of Authors on Research Reports in Medicine*

Joost P. H. Drenth

University Hospital St. Radboud, Nijmegen, The Netherlands

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ABSTRACT: *Publication in the biomedical literature is important because it is the major pathway by which new concepts and discoveries are disseminated amongst scientists. In the last 30 years there has been a dramatic increase, not only in the volume of publications but in the number of authors per article as well. This paper summarizes the current literature on authorship and its proliferation in medicine. From the literature it becomes clear that for biomedical articles, the mean number of authors increased from 1.7 in 1960 to 3.1 in 1990, and there are indications that this trend is even greater in clinical medicine such that single authorship almost has disappeared. Formal guidelines of who should be considered an author have been set by the International Committee of Medical Journal Editors. There are studies suggesting that not all authors on multiauthor papers fulfill these criteria. Inappropriate multiple authorship leads to dilution of authorship responsibility and unjustified citation in curriculum vitae. Recommendations regarding the prevention of inappropriate authorship are given in this paper.*

INTRODUCTION

Publication in the medical literature serves many purposes. It is an important pathway by which new concepts and discoveries are disseminated among members of the scientific community and hence essential for the advancement of medicine. There are many components which are considered crucial for biomedical communication. This article focuses on several aspects of authorship and highlights the proliferation of authors on medical papers particularly during recent years. Formal guidelines of who should be considered an author have been set by the International Committee of

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Address for correspondence: Joost P. H. Drenth, Department of Medicine, Division of General Internal Medicine, University Hospital St. Radboud, P.O. Box 9101, 6500 HB Nijmegen, The Netherlands.

Dr. Drenth is a clinical investigator and resident in internal medicine.

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Medical Journal Editors. There are indications suggesting that not all authors on multiauthor papers fulfill these criteria. Inappropriate multiple authorship leads to dilution of authorship responsibility and unjustified citation in curriculum vitae. This paper provides a general surveys of the literature pertaining to the definition and proliferation of authorship in medicine, the order and contribution of coauthors and possible solutions for the prevention of multiauthorship.

PROLIFERATION OF MEDICAL JOURNALS

The first two journals that published medical articles appeared in 1665: *The Journal de Scavans* and the *Philosophical Transactions of the Royal Society*.¹ The number of biomedical journals has increased ever since to over 100,000, and physicians can currently choose from approximately 20,000 medical journals. From 1665 onwards, the number of journals grew by a mere 7% per year, a doubling every 10-15 years.² In contrast to the time-hallowed journals which started as publications for a broad audience, most of the journals which started in the last decade focus on a highly specialized field. Parallel to increasing specialization, there is a continuing growth of medical journals.

The *Cumulated Index Medicus*, containing data from the most widely referenced biomedical publications, is a suitable indicator of the magnitude of increase of journals and/or articles. The weight of the hardcopy of the *Cumulated Index Medicus* remained consistent at approximately 2 kg until 1946. After this long lag-phase, a phase of exponential growth began. Between 1946 and 1955, its weight doubled to about 4 kg. Since 1955 the weight of the *Cumulated Index Medicus* has increased more than sevenfold to more than 30 kg in 1977.³ Although it has been shown that the increased bulk of the medical literature has kept pace with the increase of professionals in the field, citation analysis has demonstrated that only approximately 10% of the published papers really contribute to medical advancement and that those 10% articles receive 90% of the total citations.^{4,5} Only 19% of the papers published between 1981 and 1985 received more than one citation during the 5 years after they were published. More worrisome is that about 55% of papers published receive no citation at all, which may suggest that many of the papers are redundant.⁵

MULTIPLE AUTHORSHIP

Apart from the growing number of publications, there are changes in the way clinical researchers publish. In recent years not only are the number of articles and journals on the rise but also the number of authors per article.⁶⁻⁸ Multiple authorship is an increasing phenomenon, highlighted by a survey of the number of authors per article in *The Lancet*, a general medical journal, where it was shown that the average number of authors increased from 3.2 in 1975 to 4.2 in 1990.⁹ It appears that an increase in authorship with time is occurring not only in general medicine, but also in the other speciality journals. (Table 1, see p. 477)¹⁰⁻¹⁷ A survey of biomedical specialities showed that the average number of authors increased from 1.7 in 1960 to 3.1 in 1988.

To evaluate clinical medicine as compared with other branches of biomedical research, the number of authors for the 100 most-cited papers from general medical journals (*The Lancet*, *British Medical Journal* {BMJ} and the *Journal of the American Association* {JAMA}), were compared to 400 counterparts in other biomedical fields. Before 1935, medical papers had an average number of authors of 1.8 as compared to 1.2 for other biomedical papers; in the period 1966-1990 the average number of authors increased to 4.7 and 3 respectively. Medical papers gained 0.7 authors more than other scientific papers each 15 years.¹⁸ The increase in the mean number of authors is a consequence of both a rise in multiauthored papers and a decrease in single-author papers. In recent years there has been a trend toward publishing papers authored by large groups of investigators. For example, whereas no articles with more than 10 authors were published in *The Lancet* in 1975, 36 out of the 771 original articles in 1994 carried over 10 authors.⁹ From 1984 through 1995 author statements were truncated by MEDLINE beyond 10 names. In this period the percentage of manuscripts carrying over 10 authors increased from 0.64% (1984) to 1.51% (1995) (Figure 1, see p. 476). From data reported by the *Institute for Scientific Information* in Philadelphia it appears that 37 biomedical papers were published in 1994 with more than 100 authors as compared to almost none throughout the 1980's.¹⁹ Almost all of those multiauthored papers report the results of large multicenter clinical trials designed to search for causes of diseases or to test the efficacy of therapy. An article authored by a single investigator is a phenomenon of the past in most medical periodicals.^{3,10-12,21} Whilst 42% of all MEDLINE citations in 1966 were by single authors, this figure decreased to 22% in 1986, and the number of papers with 3 or more authors increased over time (Figure 2, see p. 476).

Lone authorship in 4 peer-reviewed otolaryngology journals decreased from 39% in 1969 to 9.3% in 1989. (Table 1) This trend is evident for all other medical disciplines studied.^{10,12,16,20} Of the types of publications appearing in medical journals, some are more likely to carry multiauthorship than others. For example, multicenter clinical trials usually have a large number of authors.²¹ Based on a study of two journals on radiation oncology, considerable differences existed between types of articles with regard to the mean number of authors.¹⁷ Few scientists authored more contemplative papers such as editorials (mean 1.3) and literature reviews (mean 2.5). In contrast, papers reporting original research carried significantly more authors (brief communications - 4.3 authors, original papers - 4.5 authors) These data suggest that papers requiring only literature reviews such as editorials can be performed with a limited number of authors in contrast to original articles.¹⁷

There are several explanations for the development of multiauthorship. Complex clinical questions often need input from a wide range of disciplines, resulting in a large number of potential authors. Research has become multidisciplinary and often international. The need for recognition of collaboration within these networks may serve as an indicator. Large clinical trials need the input from a great number of individual researchers. Coauthorship is given to participating physicians because it aids in the cementing of the collaboration and devotion to the study, and without their input the study would be difficult to perform.²² Although these reasons may explain in part the increases of authors, some authors still do not fulfill the formal criteria for

authorship and the inclusion of such has been termed gift authorship. Gift authorship may be used to repay the gift of certain materials needed for the study such as biological materials or assays. Separate groups that are funded jointly may work independently on a project and be tempted to add each other names to what should be autonomous articles. Such granting of gratuitous coauthorship has been attributed to the complex web of reciprocal obligations.²³ Noncontributors, generally those with positional power such as the head of the department and/or supervisor, may insist on coauthorship and may be granted it by the legitimate author. Some have argued that the head of the department should be granted authorship, even if that role does not comply with the strict definition of authorship, because that person makes the study possible by dedicating the department's resources to the first author and as the department head is responsible for the shortcomings of the department he or she is entitled to share any fame from it. Moreover, inclusion of the head of the department provides the study with more prestige, which may aid publication of the study.²⁴ Although these arguments are conceivable, authorship should not be credited to those who did not contribute substantially to the study and who consequently do not qualify for authorship according to the criteria.

DEFINITION OF AND REASONS FOR AUTHORSHIP

Who does qualify for authorship? The most widely accepted guideline of who should be considered an author has been promulgated by the International Committee of Medical Journal Editors.²⁵ Only substantial contributions to the more intellectual tasks of research, conception, design, analysis, and interpretation of the data and revision of the paper may be used to justify authorship (Table 1, p. 477).

Authorship credit based on:	
a	conception and design or analysis and interpretation of data
b	drafting the article or revising it critically for important intellectual content
c	final approval of the version to be published
Conditions a), b), and c) should all be met	

Whilst these guidelines provide justifications for authorship, they do not explain why physicians write. An essential aim in medical publishing is to expand and disseminate knowledge useful to the medical profession. It also assists in demonstrating expertise in a particular field, allowing expression of pride in a medical advance. It may also be important as publication leads to name recognition and possibly to appointments on executive committees.²⁶ In addition, economic benefits are important because high quality publications assist in raising research funds through successful grant applications.²⁷ Development of writing skills may also motivate physicians to write. Last but not least career advancement is a very important motive for physicians, both at junior and senior level, to write. Papers are regarded as a medium for academic success and academic achievement and are used as such by committees for grant applications and academic promotions.²⁸ In the US and

elsewhere, publications are no longer just a means of communication but are used as a criterion for employment and academic promotion. A survey amongst 17 chairpersons of prestigious departments of internal medicine, revealed that three of the departments surveyed require a minimum number of 3-5 papers for appointment to assistant professor. The average was 2-10 articles for candidates seeking such positions. A typical number of publications considered as a requirement for appointment to associate professorship was 27 (range 15-50). A small number of high-quality articles was considered to be sufficient for appointment at only 5 departments.²⁹ Another survey amongst chairmen of family practice departments demonstrated that the successful candidates for each professional rank had twice as many publications as candidates not promoted.³⁰ These data suggest that emphasis is on the volume of publications produced by nominees for academic positions. The pressure to advance academically, may be so strong that physicians misrepresent their academic accomplishments. In a recent study of 236 applicants in the U.S.A. for gastroenterology fellowships, 53 applicants reported that they had published at least one paper or abstract. After careful evaluation some 30% had listed nonexistent articles as being published in actual journals or articles in nonexistent journals. This misconduct illustrates that publications have become the currency of modern academic times and that these applicants regard articles not as a forum for communication but as means to secure their job appointment.^{31,32}

ORDER AND CONTRIBUTION OF COAUTHORS

Decisions about authors and the order in which the names will appear should be made as early as possible by the investigators of the research project. The sequence of the other coauthors is determined by their relative contributions to the work and the relative importance of their participation and may be assigned by the first or last author.³³ Rearrangements may be necessary later but only by group consensus and disagreements should be resolved by the authors and not the editor.³³ The first author is, in most instances, the one who contributed most to developing the thesis, analyzing the data, and writing the manuscript.²⁶ The last author may be the senior member of the research team, but only if there is a strong level of participation in design, implementation and analysis of the work. The place of last author perhaps symbolizes the anchoring role played by that person and might lead to enhanced recognition of manuscripts produced by the research group.³⁴ Other influences such as local tradition may play a role in assigning the actual order of authorship. The oft-heard call for alphabetical listing of authors and the development of mathematical formulas to make the order do not take into account these subtleties.^{35,36} Whilst it may seem logical to suppose that the first author invests the most time in a paper, the sequence of the other coauthors may not necessarily represent the relative contribution of coauthors. Of a sample of 176 first authors, 93 devoted more than 500 hours to the research.²¹ Second authors spent the next most time with 18% investing more than 500 hours on the work. However, 31% of middle authors and 20% of the last authors spent 10 hours or less.²¹ Do these coauthors who made few contributions meet the requirements for authorship? Two surveys have determined the individual contributions of individual authors to

multiauthored medical research papers.^{21,37} In both surveys questionnaires were sent to the first authors of multiauthored papers published in leading peer-reviewed medical journals who were asked to estimate the contributions of their coauthors. From 84 authors of 13 papers, only 38% fulfilled the previously described criteria for authorship.^{37,38} Another survey investigating 184 papers with 1014 authors found that only 26% of all authors did not contribute substantially to the work.²¹ Most of the authors surveyed provided contributions of a technical nature such as the disposal of chemical or biological materials. Most honorary coauthors were found among papers with greater numbers of authors.²¹

We should be concerned about the proliferation of the number of authors on medical papers. Assigning authorship to people who have not earned it leads to dilution of the responsibility for authorship and, in particular if questions arise, coauthors of multiauthored papers may deny responsibility.³⁹ Moreover, certain authors may gain public scientific credibility in an area where they do not have real competence. Further to this line of argument, misleading conclusions on that person's achievements and originality may be assumed which, in some instances, could be inappropriate.

ANTIDOTES FOR MULTIAUTHORSHIP?

What can be done to prevent inappropriate coauthorship? The International Committee of Medical Journal Editors, consisting of editors of major medical journals, have issued uniform requirements for manuscripts (URM) submitted to biomedical journals requiring verification from the separate authors that their names are included only if they made a substantial contribution to the paper.³⁸ The URM clearly define requirements for authorship. However, the number of coauthors is continuously rising despite these guidelines, suggesting that a stronger policy is required to change the behavior of authors. Another possible solution could be that editors of medical journals require and publish an annex to a paper indicating the individual contributions of each coauthor. This practice might force authors to be more careful about the contributors included in the list of authors.⁴⁰ Another suggestion could be that journals refuse to publish articles that have grossly inflated numbers of authors.⁴¹ Some journals ask the corresponding author to reconfirm that all authors deserve authorship when the number of authors seems excessive, and some even contact secondary authors to examine their knowledge of the contents of the paper.⁴² If many physicians contribute to a study, it may be worthwhile reporting on behalf of a study group and list the members in the annex; this is permitted in the major clinical periodicals as long as all members of the group meet full criteria for authorship and sign a such a declaration.⁴³ An alternative could be that journals present the qualifications and functions of all authors which might help in the assessment of the paper's contents.⁴⁴ In an effort to reduce the emphasis on the volume of publications, authors might be requested to list only the 3 best publications in a given year, with a maximum of 10 in any 5-year period.⁴⁵ To a limited extent, these simple and practical measures have already been put into practice. For example, applicants for the European BioMed grants may not list more than their 5 best publications, and Harvard University now asks applicants for tenured

professorships to select only their top ten papers. All in all, a more critical approach to the publication records would be welcome and appointments committees and research funding bodies should be encouraged to scrutinize not only the publications list but also the articles thoroughly.⁴⁶ Lastly, it has been proposed that the heading of scientific papers should be altered in order to recognize the work of coworkers, who do not meet the actual criteria for authorship. This additional citation would appear in alphabetical order below the usual title.⁴⁷

CONCLUSION

Multiple authorship continues to the rise and ever increasing numbers of authors appear on papers, especially in clinical medicine. This increase might imply that coauthorship is granted to colleagues who do not fulfill the criteria for authorship. The lone author is threatened with extinction, but the literature on the ethics of authorship show that despite the apparent trend this species may be saved. The articles cited within this article carry an average authorship of 1.25 per paper! But in general, even formal conventions with a strict definition of authorship seem to be of little avail. It would seem that many individuals succumb to the rewards that authorship provides. An apt quotation might be the following line "before you put your name on the next paper; ask yourself, do I really deserve authorship? Or is it more like claiming credit for writing Hamlet because you furnished Shakespeare with a pencil?"⁴⁸

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LEGENDS

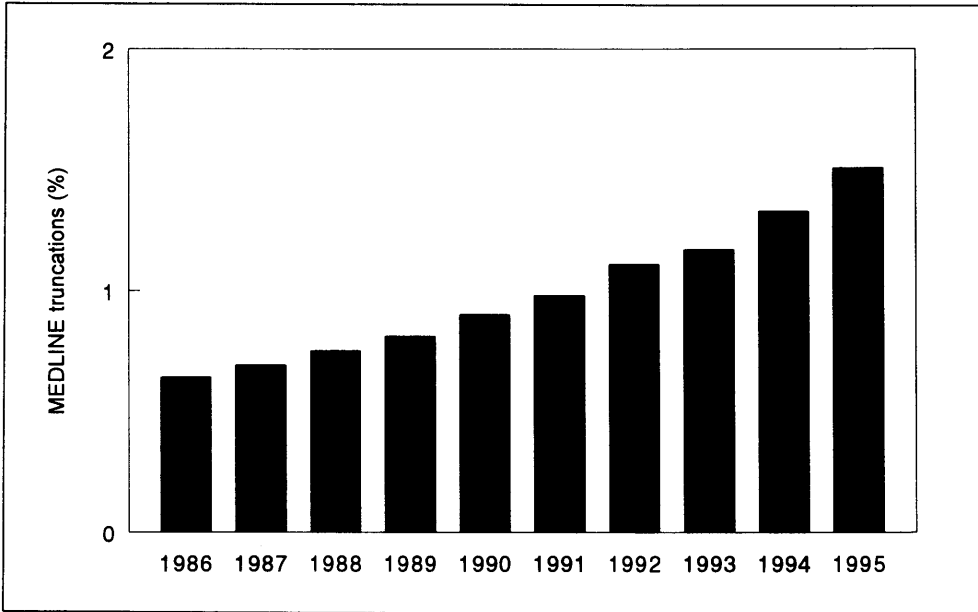


Figure 1. Plot of the 1986 to 1995 MEDLINE truncations of author statements. For this period MEDLINE truncated the authors' statements beyond 10 names. There is a steady increase of multi-authorship.

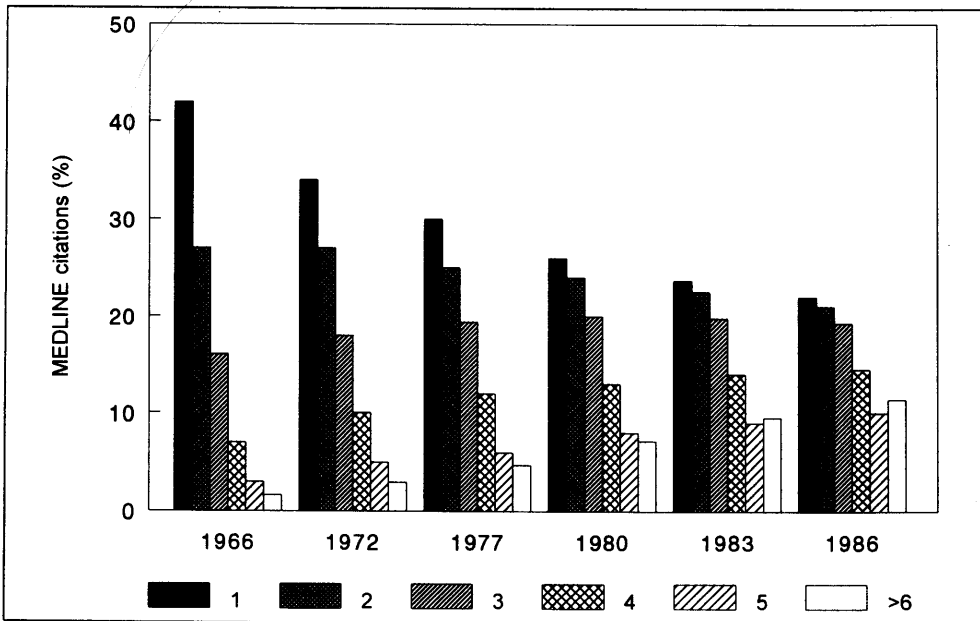


Figure 2. Plot of the 1966 to 1986 percentages of authors as compiled by MEDLINE. Single authorship gradually decreased over the years, while papers with 3 and more authors increased in number.

TABLE 1

SURVEY OF NUMBER OF AUTHORS OF ARTICLES IN SELECTED JOURNALS

(List of full titles of selected journals on page 478)

Author	Year	Field	Sample	Journal	Time period studied	Mean number of authors (\pm SD)	Percentage of articles with one author
Rosenfield	1991	Otolaryngology	1831 original articles	Ann Otolaryngol (1), Arch Otolaryngol (2), Head and Neck Surg (3), Otolaryngology (4)	1969; 1979; 1989	1969= 2.0 1979= 2.5 1989= 3.4	1969=39 1979=23 1989=9.3
Mustrakis	1993	Radiology	47910 original articles 14353 case reports	Acta Radiol (5), AJNR (6), AJR (7), Br J Radiol (8), Clin Radiol (9), Invest Radiol (10), J Clin Ultrasound (11), J Comput Assist Tomogr (12), J Nucl Med (13), Neuroradiology (14), Radiology (15), ROFO (16)	1966-1991	1966= 2.2 \pm 1.17 1991= 4.4 \pm 2.31	1966= 35 1970= 28 1975= 19.3 1980= 14.9 1985= 8.8 1990= 7
Brunner	1991	Pathology	1030 articles	Virchows Archiv (17), Zentralbl Allg Pathol (18), Pathol Res Pract (19), Verh Dtsch Ges Pathol (20), Pathologie (21)	1898; 1899; 1923; 1934; 1955; 1988	1898= 1 1923= 1 1934= 1.16 1955= 1.26 1988= 3.5	
Friesinger	1986	Cardiology	original articles for 6 consecutive months in a given year	JACC (22), Br Heart J (23), Circulation (24), Circulation Res (25)	1964; 1974; 1984	1964= 2.95 1974= 3.73 1984= 4.8	
Halperin et al.	1992	Radiation Oncology	1510 articles	Int J Oncol Biol Physics (26)	1983-1987	1983= 3.8 1987= 4.4	
Amacher	1995	Neurosurgery	clinical or research article	J Neurosurg (27)	1965 (volume 25) 1992 (volume 77) 1994 (volume 80)	1965= 2.6 1992= 4.5 1994= 4.6	
Sobal & Ferenz	1990	Medicine	all MEDLINE listed articles (3419) abstracts	N Engl J Med (28)	1975-1989	1975= 3.9 \pm 2.0 1977= 4.6 \pm 2.9 1979= 4.8 \pm 2.4 1981= 5.4 \pm 3.0 1983= 5.6 \pm 3.1 1985= 5.6 \pm 2.8 1987= 6.0 \pm 2.9 1989= 6.4 \pm 3.0	1975= 8.9 1977= 8.4 1979= 5.9 1981= 3.3 1983= 4.2 1985= 5.3 1987= 3.1 1989= 3.0
Norris	1992	Nursing	all major articles	Can J Nurs Res (29)	1970-1991		1982-1986= 57 1987-1991= 34

LEGEND TO ACCOMPANY TABLE 1

List of full titles of selected journals

- (1) Annals of Otolaryngology
- (2) Archives of Otolaryngology
- (3) Head and Neck Surgery, Laryngoscope
- (4) Otolaryngology Head and Neck Surgery
- (5) Acta Radiologica
- (6) American Journal of Neuroradiology
- (7) American Journal of Roentgenology
- (8) British Journal of Radiology
- (9) Clinical Radiology
- (10) Investigative Radiology
- (11) Journal of Clinical Ultrasound
- (12) Journal of Computer Assisted Tomography
- (13) Journal of Nuclear Medicine
- (14) Neuroradiology
- (15) Radiology
- (16) RÖFO
- (17) Virchows Archiv
- (18) Zentralblatt für Allgemeine Pathologie
- (19) Pathology Research and Practice
- (20) Verhandlungen der Deutschen Gesellschaft für Pathologie
- (21) Pathologe
- (22) Journal of the American College for Cardiology
- (23) British Heart Journal
- (24) Circulation
- (25) Circulation Research
- (26) International Journal of Radiation Oncology, Biology, and Physics
- (27) Journal of Neurosurgery
- (28) New England Journal of Medicine
- (29) Canadian Journal of Nursing Research

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