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Special Communication

The Rules and Realities of Authorship in Biomedical Journals: A Cautionary Tale for Aspiring Researchers

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Abstract

Medical research and publications are not only important for scientific development but also vital for the professional advancement and individual academic progress. Ranking is extremely important for appointments and leadership roles. Authorship is central to the credit and responsibility in medical research and appropriate assignment of authorship carries ethical, legal as well as intellectual implications. Despite being globally established for many years, deviation from the "International Committee of Medical Journal Editors (ICMJE)" criteria for authorship is still seen in varying orders of magnitude and in different shapes and forms. In this communication, we revisit the latest ICMJE criteria for authorship, highlight the increasingly recognized forms of potential of authorship misconduct (intentional or unintentional) and reflect on some emerging concepts and practices in authorship attribution. The target readers are primarily young and aspiring researchers who may err due to lack of experience but also veterans who may turn complacent for political reasons.

Keywords: Authorship, contributions, International Committee of Medical Journal Editors, misconduct, publications ethics

Introduction

An author in biomedical publications is generally regarded as an individual "who has made substantial intellectual academic contributions to a published study" to the extent that he/she ought to take both academic credit and intellectual responsibility publicly.[1] Thus, appropriate assignment of authorship carries ethical, legal as well as intellectual implications.[2] International Committee of Medical Journal Editors (ICMJE) has established 4 criteria for defining the role of both authors and nonauthor contributors.[2] Strict adherence to these criteria should resolve most of the disputes regarding authorship.

Research and publications are vital for the professional advancement and individual academic progress. Ranking is extremely important for many reasons including; financial, appointments to committees, as well as leadership rules.[3] The increasing emphasis on publications as the main criteria for promotion lead to fierce competitiveness and deliberate or unintended breaches of the ICMJE's guidelines.[4] Multiple authorship, honorary and ghost authors are only few examples of authorship misconduct. Unfairness in authorships may include under representation of laboratory and imaging services and favoritism among subordinates.[5] The complexity and multicenter nature of many studies, interference by sponsors in data presentation, role of medical writers promoted fertile environment for authorship misconduct. Such misconducts have led to emerging practices in authorship attributions, the need for clear and transparent processes and calls for innovative methods of authorship attribution.[6,7]

In this special communication, we revisit the latest ICMJE criteria for authorship, highlight the increasingly recognized forms of authorship misconduct, and reflect on some emerging concepts and practices in authorship attribution. Researchers should be clear on all of these matters from the planning stage of their experimentation and data collection rather than at the time of data analysis and manuscript drafting.

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Methodology

This is a narrative, non-systematic review with a view to exploring the points of agreements and differences between the rules of authorship and the realities of authorship misconduct in its various forms, the trends in authorship practices and authorship attribution. A search of the literature was done using one online database (PubMed) with the following search terms in various combinations: authorship, authorship misconduct, authorship ethics. Relevant records were retrieved and reviewed primarily by SAB and EAE with additional contribution from all authors. International authorship guidelines were reviewed too. The initial draft was developed and further developed by the rest of the authors via several rounds of multilateral electronic communications. This article is primarily intended for young and aspiring researchers who may err due to lack of experience. However, it may act as a gentle reminder for veterans who may turn complacent for political reasons of "keeping everybody happy".

Table 1: Responsible research publication: Highlights of the international standards for authors from the position statement of the Committee of Publication Ethics (COPE) published in 2010

Ethical imperative: The research being reported should have been conducted in an ethical and responsible manner and should comply with all relevant legislation
Honesty: Researchers should present their results clearly, honestly, and without fabrication, falsification or inappropriate data manipulation
Clarity: Researchers should strive to describe their methods clearly and unambiguously so that their findings can be confirmed by others
Decency: Researchers should adhere to publication requirements that submitted work is original, is not plagiarized, and has not been published elsewhere
Responsibility: Authors should take collective responsibility for submitted and published work
Accountability: The authorship of research publications should accurately reflect individuals' contributions to the work and its reporting
Transparency: Funding sources and relevant conflicts of interest should be disclosed

Authorship Rules: The International Committee of Medical Journal Editors Criteria Revisited

Authorship means accountability, responsibility, and credit.[1,2] To this end, the ICMJE established criteria for defining the role of both authors and nonauthor contributors. The first ICMJE criterion (study conception and design, or acquisition of data, or analysis and interpretation of data) and/or second ICMJE criteria (drafting the article or critical revision for important intellectual content) are the two core "credit" criteria that recognize intellectual ownership and physical processes of transferring an idea into a manuscript. Criteria 3 and 4 (approval of the final version to be published and agreement to be accountable for all aspects of the work) are the "responsibility and accountability" criteria. These two criteria are meant to answer questions related to the accuracy and integrity of the work. They also ensure that all parts of the work are appropriately investigated and resolved and the final version reflects the collective opinion of all the authors. In addition to being accountable for the parts of the work he or she has done, an author should be able to identify which co-authors are responsible for specific parts of the work. Furthermore, authors should have confidence in the integrity of the contributions of their co-authors.[2]

A number of general medical journals and ICMJE request authors to disclose their contributions within the text and in the copyright transfer form. To support authors' and editors' adherence to integrity in research and ethical practices in publishing, the "Committee of Publication Ethics (COPE)" issued a position statement on responsible research publication including international standards for authors.[8] These principles are highlighted in Table 1.

Several investigators have documented either remarkable lack of knowledge, clear deviation from, or disagreements with the ICMJE criteria in different disciplines and regions [Table 2]. For example, knowledge, views, and behavior of researchers on criteria for authorship and causes and control of gift authorship captured by interview of 66 academic staff from the United Kingdom, revealed a gap between editors' criteria for authorship and researchers' practice.[9] The choice of names of co-authors did not follow the ICMJE recommendations in France and half of the respondents stated they were aware of criteria for authorship and knew of ICMJE. Most of them did not cite any of the ICMJE criteria among those they applied in deciding authorship. Also, most of the respondents disagreed with the obligation to meet the three criteria justifying co-authorship because of their perception of rigidity and unpracticality.[10] Out of the total respondents, over half were recipients of gift authorship, nearly two thirds were aware of ghost authorship and the majority considered it questionable and blameworthy.[10] Poor awareness of criteria for authorship and acknowledgement among the faculty was reported also from India. Furthermore, conflict over authorship issues existed in the research environment, but was not influenced by the level of awareness.[11] Semi-structured interviews were conducted with staff, student advocates and doctoral candidates working in health research in two universities in Australia.[12] Interestingly, participants gave a variety of reasons for attribution to authorship including writing the paper, seniority, and student supervision. Gift authorship was seen by some participants as a way of maintaining relationships, a reward, a means to increase a paper's credibility, or a demonstration of collaboration between authors.[12] Norms and beliefs varied markedly between disciplines for authorship attribution and to a lesser extent, for authors' responsibility for content integrity.[12] A study from Pakistan revealed that a vast majority of young faculty members were not aware of the existence of authorship criteria and gift authorship is quite common.[13] A study from Norway was conducted to evaluate the variation in the attitudes to, and practices of, scientific authorship among researchers in a university hospital and medical school.[14] Almost all the responding researchers had

Table 2: Published data on the lack of knowledge, clear deviation from, or disagreements with the International Committee of Medical Journal Editors criteria in different disciplines and regions

Author, year	Country/Region	Observations and conclusions	References
Bhopal *et al*., 1997	UK	There is a gap between editors' criteria for authorship and researchers' practice	[9]
Pignatelli *et al*., 2005	France	59% received gift authorship; 64% were aware of ghost authorship and the majority considered it questionable and blameworthy	[10]
Dhaliwal *et al*., 2006	India	Poor awareness of criteria for authorship and acknowledgement in research publications among the faculty. Conflict over authorship existed	[11]
Street *et al*., 2010	Australia	University staff, student advocates and doctoral candidates gave a variety of reasons for attribution of authorship. Gift authorship was accepted for different reasons	[12]
Jawaid and Jawaid, 2013	Pakistan	A vast majority of young faculty members of medical institutions were not aware of authorship criteria. Gift authorship is common	[13]
Nylenna *et al*., 2014	Noway	Almost all the responding 654 faculty, researchers and PhD students had knowledge of formal authorship requirements. Most of them agreed with the criteria, but found it harder to put them into practice	[14]
Alshogran and Al-Delaimy, 2018	Jordan	Low awareness of ICMJE guidelines. Over ¾ agreed that all ICMJE criteria must be met for authorship. Unethical authorship practices were reported and majority agreed that violation of authorship criteria is scientific misconduct	[15]
Breet *et al*., 2018	South Africa	Most researchers (88%) had knowledge of academic authorship criteria and 52% found it easy to apply the criteria. Many respondents experienced disagreement regarding who qualifies for co-authorship (59%) and over authorship order 48%)	[16]

ICMJE: International Committee of Medical Journal Editors

knowledge of formal authorship requirements and most of them agreed with the criteria, but found it harder to be put into practice. More experienced researchers found decisions on authorship and about the order of authors easier than less experienced researchers. Evaluation of the perceptions, attitudes, and practices of Jordanian researchers toward the ICMJE authorship criteria revealed a low awareness of ICMJE guidelines. Nevertheless, 77% agreed that all ICMJE criteria must be met for authorship, and 56% believed that it was easy to implement the guidelines.[15] Unethical authorship practices were reported by 17%–31% of participants and majority agreed that violation of authorship criteria was a scientific misconduct. Despite 88% South African researchers had knowledge of academic authorship criteria, only 52% found it easy to apply these criteria. The disagreement regarding who qualifies for co-authorship compared with authorship order (59% vs. 48%) was practiced in more respondent. It was mostly linked to different ways of valuing or measuring contributions. Level of agreement was higher in academic authorship criteria than the perceived ability to apply the criteria.[16]

Authorship Trends in The Real World

In many biomedical sciences, changes in patterns of collaboration and authorship have complicated the assignment of credit and responsibility for research. Observations on authorship trends in journals by specialty are summarized in Table 3 and are highlighted below.

In a descriptive study comparing two full years of published articles spaced 10 years apart from five medical journals,[17] physicians reviewed all articles of one medical journal for the 1995 and 2005 publication years. Bibliometric characteristics collected for each article with a focus on authorship details. There was trend of increasing mean authors, editorial authorship, study groups, and multicenter trials over time with fewer solo authors publishing original research or case reports. A suggestion was made that academic medical community must pursue an authorship requirement consensus to assure that a standard of contribution for all authors on a given paper is met. Furthermore, trends in authorship and type of article in 8 urology journals over 6 decades were examined from 1946 to 2010.[18] The multiple-authorship trends observed were similar on both sides of the Atlantic and appeared to be mainly due to changes in original articles and case reports. A study evaluating the patterns of international collaboration based on authorship of epidemiological articles[19] revealed that articles published in nine high-impact public health journals in 2006 had a high rate of local co-authorship in both low/middle-income countries (LMICs) and high-income countries (HICs). However, most articles that focused on HICs included only authors from HIC. Most articles that focused on LMICs were "north-to-south" international collaborations that included co-authors from both LMICs and HICs. "South-south" partnerships are rare. Authorship characteristics in orthodontics were analyzed in 3 orthodontic journals with impact factors to assess the changes in the contents of 3004 article entries over two time intervals.[20] An increased contribution of articles from East Asia and Oceania was noted in the second time interval which reached almost 100% of the previous time frame. The changes in authorship and characteristics of articles in pharmacy journals over a 20-year period were evaluated.[21] All articles published in 2 journals during 1989, 1999, and 2009 were reviewed. The number of authors per article increased over time. The explanations for these changes are likely multifactorial, including increased pressure to publish, increased research complexity, and inappropriate authorship. Finally, the authorship and sampling of patterns of original research reports in three applied biomechanics and five similar

Table 3: Select observations on authorship trends in the real world

Specialty (journals)	Region	Author, year	Observations and conclusions	References
General Medical (5)	USA	Levsky *et al*., 2007	Authorship analysis revealed a trend of increasing authors, editorial authorship, study groups, and multicenter trials	[17]
Urology (8)	Trans-atlantic	Hammad *et al*., 2012	Study of 8 journals s increased number of authors per article mainly in original articles	[18]
Public Health (9)	Global	Jacobsen, 2009	High rates of local co-authorship in both LMICs and HICs. Articles that focus on HICs include only authors from HICs. Most articles that focus on LMICs are "north-to-south" collaborations including co-authors from both LMICs and HICs. "South-south" partnerships are rare	[19]
Orthodontics (3)	International	Kanavakis *et al*., 2006	Analysis of authorship of 3004 articles in 3 orthodontic journals revealed increased contribution of articles from East Asia and Oceania	[20]
Pharmacy (2)	USA	Dotson *et al*., 2011	They found: An increase in the number of authors due to increased pressure to publish, increased research complexity, and inappropriate authorship	[21]
Biomechanics and Sports Science (8)	International	Knudson, 2011	Single authorship of papers was rare (2.6%) with the mean number of authors ranging from 2.7 to 4.5. Sample sizes and the ratio of sample to authors varied widely	[22]

LMICs: Low/middle-income countries, HICs: High-income countries

sub-disciplinary journals within sport and exercise sciences were examined.[22] Original research reports from the 2009 volumes of these journals were reviewed. Single authorship of papers was rare, with the mean number of authors ranging from 2.7 to 4.5. Sample sizes and the ratio of sample to authors varied widely, and these variables tended not to be associated with number of authors. Original research reports published in 2009 tended to be published by small teams of collaborators, so currently there may be few problems with promiscuous co-authorship in these sub disciplines of sport and exercise science.

Authorship Misconduct

Proper authorship embodies honesty, integrity, fairness and transparency, which surely are the very essence of any scientific pursuit.[23] With increased pressure and demands on requirements for academic promotion and competition, authorship misconduct appears to be increasing. Misappropriation of authorship undermines the integrity of the authorship system.[1] Ethical problems can be seen in an article with multiple authors [Table 4]. By far, the commonest are related to number or the inclusion of nondeserving authors (ghost or gift/honorary authorship). The latter has been suggested to be seen in developing countries with rooted culture on seniority. Ghost authorship can be related pharma sponsored work with heavy reliance of professional medical writers. Sometimes, a more complex hidden ethical problem can be seen even in articles with equally credited authors (ECAs). For example, the duplication might be seen and the authors might submit the work for publication in different journals. Unethical behavior by authors is related to research fraud rather than a purely an authorship issue. Unfairness in authorships is exemplified lack of involvement of certain professional groups in all the stages of the work, thus they get to fail the ICMJE authorship criteria. These may occur due to ignorance or deception. The following is some elaboration on these concerns.

Table 4: Recognized forms of authorship misconduct

Honorary authorship	Plagiarism
Gift authorship	Pharmaceutical marketing authorship
Political authorship	Unfair authorship attribution
Ghost authorship	Text recycling
Group authorship	Academic disrespect of authorship rules
Unrealistically prolific authors	Redundant publication (salami slicing)
Duplicate publication	Falsification, fabrication

Honorary and ghost authorship

The numbers of named authors who do not meet ICMJE criteria for authorship, according to their published contributions were examined in 3 general medical journals with different contribution disclosure practices.[24] Honorary authorship was defined as the lack of contribution from the first ICMJE criterion and/or second ICMJE criterion. General medical journals differed in prevalence of honorary authors according to published research contributions of named authors. The prevalence of articles with honorary authors and ghost authors in peer-reviewed medical journals were examined to identify journal characteristics and article types associated with such authorship misappropriation.[25] Self-administered, confidential survey to corresponding authors of articles published in 1996 in 3 peer-reviewed, large-circulation general medical journals and 3 peer-reviewed, smaller-circulation journals. Of the 809 articles, a total of 156 articles had evidence of honorary authors; 93 had evidence of ghost authors and 13 had evidence of both. The prevalence of articles with honorary authors was greater among review articles than research articles but did not differ significantly between large-circulation and smaller-circulation journals.[25] Furthermore, the prevalence of honorary and ghost authors in articles in three peer-reviewed pharmacy journals published in 2009 was also examined.[26] One hundred and fourteen surveys were completed (24.9% response rate). Usable responses were provided by 112 authors. The prevalence of articles with honorary and ghost authors was 14.3% and 0.9%, respectively. Honorary authorship was also more common in

original research than review articles. Articles with honorary authors had longer bylines than articles without honorary authors. O'Brien *et al*. investigated the perception of honorary co-authorship among medical academics and the potential effect of honorary co-authorship on patient care.[27] Corresponding authors of every fourth primary research paper published in 4 international journals were surveyed electronically. Questions were focused on each author's personal experience and perception of honorary co-authorship. Sixty-five percent of corresponding authors responded and 55% of respondents had published more than 50 peer-reviewed journal articles, and 52% had been listed with an honorary co-author at some point in their career. Eighteen percent of respondents had been required at some point to list authors who had provided data via a commercial relationship. The majority of authors believed that there were potential negative effects of honorary co-authorship for both the authors themselves (73%) and for their coauthors (83%). These negative effects included personal liability for honorary authors (29%) and dilution of relative contribution for their co-authors (54%). Sixty-two percent of respondents stated that honorary co-authorship could have a negative effect on patient care. However, only 2% had been involved in an actual case. Internet-based survey among first authors publishing in Indian biomedical journals from 2012 to 2013 evaluated the frequency and factors associated with honorary authorship.[28] The prevalence of perceived, ICMJE-defined and unperceived honorary authorship of 20.9%, 60% and 46.9% respectively. Those residing in India were found to list more honorary authors. Perceptions and experience with unethical authorship practices were explored using 21 in-depth interviews of academics from Malaysia.[29] The study revealed variability in experiences with various types of unethical authorship practices among the interviewees. Unethical authorship practices are not so unusual among academia although the exact numbers of incidents are unknown as such practices are seldom reported. The interviewees suggested that the culture of "publish or perish" could be the main contributor to unethical practices of authorship because publication records are the main criteria for researcher's career evaluation besides, others, which are set by the university. "Political co-authorships" may be inferred when some authors may be listed as senior or honorary authors despite offering little or no contribution to the original research project. This may be done in an effort to enhance the gravitas of a research project, and attain publication in a highly regarded medical journal.[30] This is more likely to take place in developing countries. Such co-authorship practices corrupt the integrity of the research process as they attempt to bypass the safeguard that medical journals and institutions have put in place to prevent fraud and falsification. A number of strategies have been proposed to combat the practice of co-authorship, but it may ultimately be an unavoidable feature of contemporary medical research publishing that is difficult to police.[30]

Misuse of co-authorship in medical theses

The experiences of authorship issues among persons who have recently received their doctoral degrees in medicine in Sweden were examined using a survey that was mailed to all who received their PhD at a medical faculty of a Swedish university during the first half of 2016.[31] The questions concerned the experiences of violations of the first three authorship criteria in the Vancouver rules and of misuse of authorship order in the articles of their thesis, and the respondents' attitudes to these matters. The questionnaire was returned by 285 respondents. According to the majority (53%), the Vancouver rules were not fully respected in the articles of their thesis. A vast majority (97%) found it important that authorship issues were handled correctly, but only 19% reported that their department had a clear and consistently applied policy.

Authorship misconduct from low/middle-income countrie health researchers

LMIC health researchers' views about authorship, redundant publication, plagiarism and conflicts of interest by corresponding authors of Cochrane reviews working in LMICs were investigated by in-depth interviews with 15 respondents.[32] LMIC researchers reported that guest authorship is widely accepted and common. While respondents reported that plagiarism and undeclared conflicts of interest were unacceptable in practice, they appeared common. Determinants of poor practice were related to academic status and power, fuelled by institutional norms and culture. Corresponding authors of papers published in Iranian journals indexed in Scopus during 2009–2011 were surveyed by E-mail.[33] These individuals were indirectly questioned about committing one of the five misconducts. Guest authorship was reported by 18.1% of respondents.

Unfair authorship attribution

The temporal trends in the number of authors per article in Rev Med Chile and authors' compliance with the ICMJE authorship criteria were evaluated.[34] A retrospective analysis of the number of authors per article between 1969 and 2000; and a prospective survey applying a contribution checklist to authors of manuscripts published in the year 2000. "Justified authorship," "partial authorship" and "unjustified authorship" was assigned to subgroups of authors according the number of ICMJE's criteria fulfilled. The authors suggested that laboratory medicine professionals were underrepresented as co-authors in laboratory medicine studies appearing in high-impact general medicine journals. Unjustified "kid authorship" was the subject of a recent investigation in Korea.

Text recycling

Text recycling, the reuse of material from one's own previously published writing in a new text without attribution, is a common academic writing practice that is not yet well understood. A survey of over 300 journal editors from 86 top English-language journals in 16 different academic fields investigated text recycling in scholarly articles.[35] A large majority of academic gatekeepers believed text recycling was permitted in some circumstances; however, there was a lack of clear consensus about when text recycling was or was not appropriate. Opinions varied according to the source of the

recycled material, its structural location and rhetorical purpose, and conditions of authorship conditions-as well as by the level of experience as a journal editor.

Unrealistically prolific authors

Authoring an unfeasibly large number of publications might indicate disregard of authorship criteria or even fraud. Publication patterns of highly prolific authors in 4 medical specialties in Medline 2008–2012.[36] Twenty-four authors in the chosen areas were listed on at least 25 publications in a single year (i.e., >1 publication per 10 working days). Types of publication by the prolific authors included substantial numbers of original research papers. The authors suggested that when measuring and creating incentives for researcher productivity, institutions and funders should be alert to unfeasibly prolific authors.

Pharmaceutical marketing and authorship

The strengths and weaknesses of the ICMJE's recommendations in prevention of commercial bias in industry-financed journal literature were examined on three levels-scholarly discourse, article content, and article attribution.[37,38] With respect to overall discourse, the most important measures in the ICMJE recommendations are enforcing clinical trial registration and controlling duplicate publication. The ICMJE promotes stringent author accountability and adherence to established reporting standards in respect to author content. However, it accepts the use of commercial editorial teams to produce manuscripts, which is a potential source of bias, and agrees private company ownership and analysis of clinical trial data. New ICMJE guidance on data sharing may address but not eliminate problems of commercial data access.

Emerging Practices in Authorship Attribution

The authorship misconducts and increasing disputes stimulated attempts to rectify them with policies and interventions. The effectiveness of educational or policy interventions in research integrity or responsible conduct of research on the behavior and attitudes of researchers in health and other research areas was recently evaluated.[39] Thirty one studies described in 33 articles in English were analyzed including different designs. Effects of interventions were related to plagiarism and research integrity/ethics. The evidence base relating to interventions to improve research integrity was incomplete and the conducted studies were heterogeneous, inappropriate for meta-analyses and their applicability to other settings and population was uncertain. Changing practices in authorship/contributorship attribution have emerged recently [Table 5]. Some of the notable practices are reviewed below.

Table 5: Some emerging practices in authorship attribution

Equal contribution and credit
The evolving role and recognition of medical writers and publication consultants
Publication planning
Authorship grids and author matrix
Data sharing
Transparent collaboration between industry and academia
Authorship training
Authorship literature

Equal contributions and credit

Scientific manuscripts sometimes have two or more authors explicitly designated as having "contributed equally" to the study. The longitudinal trends and characteristics of the practice of explicitly giving authors equal credit in publications was found in major medical journals.[40] Electronic keyword searches looking for original research articles with ECAs published over 10 years in the five general medical journals with the highest impact factors were conducted. Original research articles with authors explicitly given equal credit were found in all five journals. Articles with ECAs formed a greater proportion of the total number of articles published in each journal in 2009 versus published in 2000. There was a statistically significant increasing trend in yearly prevalence of ECAs articles for all the journals. The first two authors listed in the byline received equal credit the majority of the time, but the practice was also applied to authors in nearly every position in the byline. Finally, none of the journals provided specific guidance regarding this practice in their instructions to authors. However, the prevalence and characteristics of the practice of giving authors equal credit were assessed in three major spine journals over 10 years.[41] The practice of ECAs was found in all three journals. Articles with ECAs comprised a greater proportion of the total number of publications in each journal in 2013 versus 2004 with a statistically significant increasing trend in the annual proportion of papers with ECAs for all three spine journals. The practice of ECAs was applied in nearly every position in the byline, and the first two authors received equal credit in most cases. Although some authors concurred with the view that ECA is not the bad thing, they warned that it will be so only if the authors actually equally contributed.[42] They alerted that determination of amount of contribution seems difficult. Furthermore, others provided a simple tool to assist researchers in assessing contributions to a scientific publication, for ease in evaluating which contributors qualify for authorship, and in what order the authors should be listed.[43] The tool identifies four phases of activity leading to a publication from conception to manuscript preparation. In summary, articles with ECAs are increasingly published by authors from various countries and regions around the world. Nevertheless, many journals do not provide specific guidance on this practice in their author instructions. A guideline for authors regarding when and how to designate equal credit is warranted. Also, the potential impact of this practice on evaluations for academic promotion needs to be assessed.

Medical writers and publication consultants

Many papers in biomedical journals are drafted not by the named authors, but by professional medical writers working under the direction of those authors, usually funded by pharmaceutical companies. Although this practice can improve

both the quality and speed of publications, it has attracted controversy as a result of concerns about the inappropriate influence of pharmaceutical companies. Jacobs and Wager defined ethical standards for professional medical writers who prepare papers for publication in medical journals.[44] Guidelines were drafted after a 4-round Delphi consultation among a group of experienced medical writers. The guidelines were then further refined by seeking comments on the draft from a range of interested parties. The guidelines stress the importance of respecting widely recognized authorship criteria, and in particular of ensuring that those listed as named authors have full control of the content of papers. Also, there is a growing industry where publication consultants will work with authors, research groups or even institutions to help get their work published, or help submit their dissertation/thesis. This help can range from proof reading, data collection, analysis (including statistics), helping with the literature review and identifying suitable journals/conferences. Kendall *et al*. debated whether these external services are required, given that institutions should provide this support and that experienced researchers should be qualified to carry out these activities.[45] However, if these services are used, they argued that their use should at least be made transparent either by the consultant being an author on the paper, or by being acknowledged on the paper. They also argued that publication consultants should provide an annual return that details the papers, dissertations and thesis that they have consulted on.

Publication planning

Pharmaceutical companies integrate scientific publications into the communication strategies they employ to influence the practices of health professionals. In their "publication plan," pharmaceutical companies, or the communication agencies they hire, develop key messages to promote their drugs and then plan in advance how, when and where to disseminate them in medical journals or at conferences.[46,47] Although their true intent is promotional, these messages must appear to be purely scientific, and are therefore disseminated as research articles, review articles, editorials, commentaries. Publication planning involves the use of "ghost" authors who work directly for pharmaceutical companies, but whose contribution is rarely acknowledged in the final published article. Key opinion leaders are recruited as the honorary authors of these articles, to which they have made little, if any, contribution. The criteria for authorship set by journals that publish primary research articles do not provide adequate protection against the practice of ghost and honorary authorship. Certain journals publishing primary research derive a large proportion of their revenue from selling reprints used by pharmaceutical companies to promote their drugs, especially by their sales representatives.[46,47]

Authorship matrix and grids

Newer methods for rational methods for addressing authorship attribution were proposed recently.[48,49] It was recommended that the scientific community should view authorship in terms of contributions and responsibilities, rather than credits. For instance, a new paradigm that conceptually divides a scientific article into four basic elements: Ideas, work, writing, and stewardship was proposed.[48] These four fundamental elements to modify the well-known ICMJE authorship guidelines. The modified ICMJE guidelines are then used as the basis to develop an approach to quantify individual contributions and responsibilities in multi-author articles. The outcome of the approach is an authorship matrix, which can be used to answer several nagging questions related to authorship. Another approach presented three forms of authorship grids that are based on national and international author recommendations.[49] These "author grids" are tailored to quantitative research, qualitative research, and literature synthesis. These customizable grids can be used while planning and executing projects to define each author's role, responsibilities, and contributions as well as to guide conversations among authors and help avoid misconduct and disputes. The grids also can be submitted to journal editors and published to provide public attribution of author contributions.

Data sharing

The ICMJE provides recommendations to improve the editorial standards and scientific quality of biomedical journals. These recommendations range from uniform technical requirements to more complex and elusive editorial issues including ethical aspects of the scientific process. Recently, registration of clinical trials, conflicts of interest disclosure, and new criteria for authorship-emphasizing the importance of responsibility and accountability, have been proposed.[50] An editorial initiative to foster sharing of clinical trial data was launched in 2016. This novel initiative aimed to increasing awareness among readers, investigators, authors and editors belonging to the Editors' Network of the European Society of Cardiology.

Transparent collaboration between industry and academia

There is increasing partnership between industry and academia needed to shorten the timeline between innovation and application, and to achieve faster access to better diagnostics, drugs and devices for the benefit of patients and society, based on complementary knowledge, skills and expertise. Such partnerships can include joined preclinical/clinical and postmarketing research and development, joint intellectual property, and joint revenue.[51] Although it is easier to blame industry for bias, academia is not totally from bias. The challenge is to be transparent about this reality at all times, and to behave in an informed, balanced and ethical way as medical and scientific experts, taking into account compliance and legal regulations of both industry and academic employers, in the best interest of patients and society.

Final Remarks

Late discussions about authorship allocation might lead to serious conflicts and disputes among coworkers which could even endanger cooperation and successful completion of a research project. It seems that discussion and education about ethical standards and practical guidelines for fairly allocating

authorship are insufficient and the question of ethical practices related to authorship in multi-authored publications remains generally unresolved.[52] The special issues of authorship disputes with discussion of its roots, illustrative examples and how to prevents it and resolve it are elaborated elsewhere.[53]

The ICMJE recommendations set important research and reporting standards, without which commercial bias would likely be a significantly greater problem than it is today. However, they also support practices of commercial data control, content development and attribution that run counter to science's values of openness, objectivity and truthfulness. These weaknesses could be addressed with appropriate modifications to the recommendations.

It is necessary to work for raising awareness about the importance and need for education about principles of scientific communication and fair allocation of authorship, ethics of research and publication of results. The use of various forms of education in the scientific community, especially young researchers and students, in order to create an ethical environment, is one of the most effective ways to prevent the emergence of scientific and publication dishonesty and fraud, including pathology of authorship.[52]

Authorship contribution

All authors jointly conceived the idea of the article. SAB and EAE drafted the manuscript. All authors critically and extensively revised the manuscript and approved its final version.

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Conflicts of interest

There are no conflicts of interest.

Ethical principles

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