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Authorship and Responsibility in Health Sciences Research: A Review of Procedures for Fairly Allocating Authorship in Multi-Author Studies

Elise Smith · Bryn Williams-Jones

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Abstract While there has been significant discussion in the health sciences and ethics literatures about problems associated with publication practices (e.g., ghost- and gift-authorship, conflicts of interest), there has been relatively little practical guidance developed to help researchers determine how they should fairly allocate credit for multi-authored publications. Fair allocation of credit requires that participating authors be acknowledged for their contribution and responsibilities, but it is not obvious what contributions should warrant authorship, nor who should be responsible for the quality and content of the scientific research findings presented in a publication. In this paper, we review arguments presented in the ethics and health science literatures, and the policies or guidelines proposed by learned societies and journals, in order to explore the link between author contribution and responsibility in multi-author multidisciplinary health science publications. We then critically examine the various procedures used in the field to help researchers fairly allocate authorship.

Keywords Allocation of authorship · Credit · Responsibility · Publication ethics · Multi-author studies · Health sciences

Introduction

Widely accepted metrics for the success of a researcher in the academic health sciences[1] are the quality and quantity of journal publications. Publications have a

[1] We use the term "health sciences" broadly to encompass research that is both "biomedical" (e.g., medical genetics, biochemistry, pharmacology, nursing) and which is more generally health focused

E. Smith (✉) · B. Williams-Jones
Bioethics Programs, Department of Social and Preventive Medicine, School of Public Health, Université de Montréal, C.P. 6128, succ. Centre-ville, Montréal, QC H3C 3J7, Canada
e-mail: elise.smith@umontreal.ca

direct bearing on career advancement (hiring, promotion and tenure), the acquisition of research grants, awards and prizes, and provide prestige and respect for authors (Shamoo and Resnik 2003). For doctoral students and postdoctoral researchers, the publication of noteworthy research can jump-start careers. First authorship of a particularly original and innovative work may also help substantiate legal rights to a patent (Claxton 2005). In a context where research funding is very competitive, a strong publication record is all the more critical.

Along with prestige, authorship also brings with it certain responsibilities. Authors are responsible for the veracity and reliability of the scientific work (McKneally 2006); they must adhere to guidelines on research integrity and the responsible conduct of research involving humans and animals; and they must ensure that conflict of interest are declared. An author may also be responsible for communications with journal staff, reviewers and editor(s) during the peer-review process (Benos et al. 2005). Finally, authors should be able to publicly defend their contribution to the research, after publication (Strange 2008).

Responsibility and fair credit are easily attributed in the case of single authorship, but this becomes complex when there are multiple researchers and collaborators. There is a growing trend in the health sciences towards large collaborative research projects that are also increasingly multi- or interdisciplinary, with the result that scientific publications often have numerous authors named on the article by-line. But the norms regarding appropriate authorship practices within participating disciplines or specialities may vary substantially. For example, there are significant differences of opinion in the health sciences about the appropriate determination of authorship and the order of importance in a publication (Steneck 2007). While it is generally understood that individuals are listed or acknowledged by decreasing order and importance of contribution (Wager 2009), it may be difficult to recognize whose work is more valuable (meriting authorship) especially when different types of contributions are involved (e.g., intellectual, technical).

Allocation of authorship should be fair to ensure that individuals are acknowledged appropriately for their responsibility and contribution to a publication. But the nature of large group multidisciplinary health sciences research means that there are few if any well defined, agreed upon standards to support a determination of what constitutes "fair authorship" in multi-authored studies. This lack of consensus can, at a minimum, lead to conflict between researchers about appropriate authorship (e.g., what norms are best, who should be named). But this situation may also encourage unethical publication practices, such as ghost-authorship (where the author of the paper is not named) or gift-authorship (where individuals who did not contribute are named as authors), practices that have received much attention in the public and scientific press in recent years, and which contribute to scepticism about the integrity of scientific research and publications (Bennett and Taylor 2003). In this paper, we review different types of contributions and responsibilities associated with health sciences research, and then critically examine various

Footnote 1 continued
(e.g., public health). While this definition will clearly include a wide range of disciplines—and thus authorship practices—we feel that the generalisation is nonetheless appropriate for our analysis.

methods proposed (e.g., by journals, learned societies, and the academic literature) for fairly allocating authorship in multi-author multidisciplinary publications. Our aim, here, is to highlight the tensions that can arise in the context of multi-disciplinary collaborations and point to the need for further detailed reflection on how best to address these issues. For example, a systematic and comprehensive cross-disciplinary comparison of authorship practices would be extremely helpful. We are not, however, under the illusion that such a review would lead to a "one-size fits all" model or solution. Finally, while our focus here is on practices in the health sciences, the issues raised are arguably generalizable to other multidisciplinary research contexts.

Background

Group, team or network studies are becoming increasingly frequent in health sciences research. A bibliometric study by Abubakar and colleagues revealed that almost 70% of studies in health sciences are multi-authored, and often written by multidisciplinary groups that include researchers from both the pure and allied health sciences (Abubakar and Harande 2010). Extreme examples include the 1993 GUSTO paper in the *New England Journal of Medicine*, which involved 976 authors (GUSTO 1993), and a 1997 *Nature* article on genome sequencing which had 151 authors (Kunst et al. 1997). Obviously in such cases, the attribution of individual responsibility and credit will be a significant challenge. Even though health sciences researchers increasingly collaborate in large teams, groups or networks, the importance given to authorship—and notably, one's place in the list of authors—can set the stage for conflict and lead some to engage in unethical publication practices.

The literature examining (un)ethical publication practices has, for the most part, focused on issues such as gift or ghost authorship, alongside discussions of fraud, falsification and plagiarism (Bennett and Taylor 2003). However, in naming the *problems* associated with publication and authorship, there has been little attention to the *procedures* that researchers should implement to fairly assign credit for published works (Osborne and Holland 2009). In practice, very little guidance is given to authors beyond criteria on what does or does not warrant authorship, and what contributions are worthy of acknowledgement.

There are informal systems that govern the allocation of authorship in health sciences research. For example, there is general agreement that those individuals who "contributed substantially" to the research merit some level of authorship (Louis et al. 2008). As already mentioned, it is also generally understood—although rarely codified—that individuals are listed or acknowledged by decreasing order and importance of contribution (Wager 2009). But authorship may also be attributed in recognition of other responsibilities or roles. For example, the last author is often seen as the "driving force" or senior author of the team, having contributed financially and/or intellectually to the study (Tscharntke et al. 2007). Although this last author may not have done the most work, it is their research leadership that is acknowledged. There may also be acknowledgement of a "corresponding author"

who, with the approval of the research team, is responsible for responding to comments about the publication; this status often also denotes the author who obtained funding for the research (e.g., the principal investigator). While these informal authorship criteria may be generally accepted in the health sciences, differences and conflicts can still arise, e.g., because of a lack of communication, inability to decide who performed the most valuable work, or conflicts of interests.

Some formal policies or guidelines address the issues of contribution and responsibilities of authorship. A frequently cited guideline is the International Committee of Medical Journal Editors (ICMJE) "Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Ethical Considerations in the Conduct and Reporting of Research: Authorship and Contributorship" (ICMJE 2009). This guideline stipulates that for publications in the health sciences,

> Authorship credit should be based on (1) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; (2) drafting the article or revising it critically for important intellectual content; and (3) final approval of the version to be published. Authors should meet conditions 1, 2, and 3 (ICMJE 2009).

The World Association of Medical Editors (WAME; www.wame.org), the Committee on Publication Ethics (COPE; publicationethics.org), and the US Office of Research Integrity (ORI; ori.dhhs.gov) have developed or refer to various documents (guidelines, policies, recommendations) regarding ethical authorship practices. But while these documents are in turn referred to by many health science journals, studies have shown that such guidance is still not widely known, accepted or followed by researchers (Marušić et al. 2004). Similarly, there is also little use and awareness of these guidelines or recommendations by journal editors (Wager et al. 2009).

Awareness is definitely critical, but certain guidelines or recommendations may be difficult if not impossible to implement. For instance, the definition of certain terms such as "substantial contribution" are illusive and therefore particularly difficult to apply in the diversity of practices in health sciences research. Moreover, many researchers believe the ICMJE guidelines are too restrictive (Pignatelli et al. 2005), that they exclude key players involved in the research process, and that they are "out of touch with the realities of modern science" (Bhopal et al. 1997). In large multi-centre studies that can sometimes include hundreds of researchers, it may be simply unrealistic to expect every single individual involved in the research and meriting authorship to critically revise a publication. Thus while the ICMJE guidelines may establish standards, they may be too rigid, inadequate or insufficient to address emerging practices in large scale health science research. Researchers could, however, keep in mind that when lacking applicable authorship norms, ICMJE guidelines can be considered as "ideal" or even "inspirational".

Although these guidelines usually provide inclusion criteria for authorship, little tends to be said about the order of authorship (Claxton 2005). For example, the ICMJE notes that the research group or team should make decisions collectively regarding the order of authors (ICMJE 2009). COPE provides guidance for handling authorship disputes, but gives little concrete information on how to allocate

authorship (Albert and Wager 2003). Reviews of these guidelines and policies conclude that while they may be good starting points, there is still little or no practical information for researchers on how to fairly allocate authorship (Roberts 2009; Wager 2009; Osborne and Holland 2009). Similarly, an examination of health sciences journals revealed diverse and sometimes contradictory authorship guidelines (Wager 2007).

In 1994 and 1995, as members of the U.S. Commission on Research Integrity, Rennie and Emmanuel proposed that authors should declare their contributions to the journal and to the public in an effort to promote transparency and responsibility of authorship (Rennie 2001). Renowned health sciences journals such as *The Lancet*, *BMJ*, and *The Journal of Molecular Medicine* have since required compulsory authorship declarations in their policies; others, such as *Nature*, have made such declarations voluntary (Ganten et al. 2009; Rennie et al. 2000).

Contributions in Multi-Authored Collaborations

The traditional notion of authorship is often linked to intellectual contribution. As Claxton explains, the word "author" originates from the Old French *auctor* which means "creator, originator" (Claxton 2005). In the health sciences, "authorship" now includes notions of originality and scientific value; that is, publications are seen as presenting the findings of novel studies, new ideas, and critiques that contribute to the advancement of knowledge (McKneally 2006). The designer of the study is often designated as the main "originator" or author.

While there is little debate that significant intellectual contributions have to be considered for authorship, there is considerably more disagreement regarding the attribution of authorship for technical contributions (e.g., data or material compilation or support), contributions that are often indispensable in health sciences research. Many journals have begun including as authors those individuals who provided significant technical support. For example, in the *Journal of Molecular Medicine*, it is noted that "Each person listed as an author is expected to have made a significant (technical or intellectual) contribution to the submission and to be responsible for the quality, accuracy, and ethics of their work" (Ganten et al. 2009). Similarly, the ICMJE guidelines recognize as authors those individuals who engaged in tasks of a more "technical" nature. Yet these guidelines also require that authors be involved in all steps of the research.

In some cases, individuals who have completed technical tasks do take part in all steps of research, thus meriting formal recognition for their work; but other cases are less obvious. Take, for example, the Case Report by Welker and McCue (2007) in which researchers developed a result-viewer software that facilitated access to multiple clinical databases for routine care giving. Welker and McCue argue that it would be unethical to name the software developers as authors since these individuals were not involved in many steps of the research. Welker and McCue note, however, that as part of the process of defining roles and responsibilities in a project, the software developers should be asked at the beginning of the study if they are interested in authorship. If authorship is not an option, other methods of

recognition could be considered, such as naming individuals in Acknowledgments and/or referencing prior publications of the software development team (Welker and McCue 2007). Yet as Miller (2007) notes, in the case described by Welker and McCue there are important ethical issues at stake concerning intellectual property. Miller argues that if the software was an "original work" and had not been used in previous studies, the software developers could have released the software to demonstrate its effectiveness in a study, and thus authorship would be warranted (Miller 2007).

Some journals have responded by requiring that authors state their contributions (i.e., all contributors are assumed to be authors) while others have moved to separate "authors" from "contributors" as a means of distinguishing between substantial and technical contributions. But while such approaches may appear promising, they serve to reinforce existing confusion about what constitutes a legitimate contribution that warrants authorship. For example, is the act of textual editing or even more substantial technical writing a contribution that justifies authorship? According to the ICMJE guidelines, a technical writer not involved in the research cannot be an author. However, some journals now insist that anyone involved in drafting a manuscript be named as an author, while others note that a technical writer should be acknowledged, e.g., considered a "contributor" but not an author.[2]

Authorship could be considered for cases where material goods are developed as a result of significant technical effort, e.g., for reagents, pharmaceuticals or data sets (Cronin and Franks 2006). The ICMJE guideline notes that material support might simply be noted in the Acknowledgements. However, a study of authorship practices in the health sciences—including researchers from pharmacology, radiation/oncology, neurology and genetics—found different perspectives on this matter (Louis et al. 2008). Although most researchers would not give authorship to an individual who provided a reagent that had already been the subject of a publication, if the reagent was a novel material, then granting authorship was a *quid pro quo* comparable to recognizing intellectual contributions that underpin the new research.

But there are important differences between material and intellectual work. An idea is not tangible and is therefore easily transferable through the reading of a manuscript, so it is necessary to distinguish between an author who contributes an idea to a publication, and the citing of a paper from which particular ideas are drawn. By contrast, material is tangible and thus researchers often negotiate the transfer of certain materials (e.g., with contracts or material transfer agreements). Through negotiation, however, an individual may be encouraged or even coerced to give authorship to the material provider. It would be hard if not impossible to argue that the use of material that has been already the subject of a publication should be sufficient grounds for attributing authorship. Material may enable researchers to conduct their research, but this is true of all research equipment. Granting authorship to everyone who enables research would be an unrealistic and extreme extension of the notion of authorship; besides making for cumbersome by-lines, such authorship practices would arguably undermine the value of being named on a scientific publication.

[2] We thank one of the anonymous reviewers for bringing this very helpful example to our attention.

Contributions that involve technical work that is original or novel are significantly more controversial. The argument for not including such contributions in authorship is the limited or non-existent involvement of the individual(s) in all the steps of the project, as required for example, by the ICMJE guidelines. The question is not primarily whether one should give authorship to individuals who develop software, materials or data. Rather, the central issue is whether it is fair and appropriate to require that these individuals be implicated in *all* steps of the study to be credited with authorship (e.g., the Welker and McCue software case). Collaboration might not be feasible in many instances where personal or professional differences exist, such as in the case of conflicting methodologies or diverse research goals. But greater effort could be made on the part of researchers, funders, and academic institutions to build, sustain and ultimately acknowledge the collaboration between individuals that occurs throughout the research process, and not simply during one step of the research process.

Professional relationships are at the core of collaborative work in multi-author research. However, in academia, the often hierarchical nature of such relationships creates an asymmetry of responsibility and power. The professor-student relationship is a good example. Professor-student relationships are variable in specific fields and across the health sciences (MacDonald and Williams-Jones 2009). In authorship disputes, this asymmetric power can have a significant impact. Decisions may be determined according to a power ranking or hierarchical order, with the most powerful individuals listed first in the by-line (Lock and Wells 2001). Yet as Seeman and House note (2010), such power relations raise important concerns. For example, a professor could decide to give authorship to a student for reasons not directly linked to research contribution, such as the desire to help the student obtain a job or simply due to individual favouritism (Seeman and House 2010).

In their study of authorship practices in the health sciences, Louis et al. (2008) found that sponsorship—"the belief that senior scientists are responsible for furthering the careers and professional development of junior colleagues [and students]"—was a tacit rule for how researchers determined authorship (Louis et al. 2008). The career development of junior colleagues can be achieved by encouraging and supporting the publishing of their own work. But this support becomes unethical when senior researchers omit certain individuals, downplay those contributions in order to promote their own students, or play up the contribution (e.g., first author) when it is not warranted. In so doing, the senior researcher might help the career development of a student or junior colleague but undermine the contribution of others, with potentially serious ramifications for current or future collaborations.

Conversely, the need of senior researchers to be named on publications in leading journals (e.g., to build their CVs and their personal and laboratory/team reputations) in order to be competitive for grant funding may motivate some to take undue credit. It is common in the health sciences for senior researchers, more specifically Principal Investigators (PIs) of research projects, to be named as authors (e.g., last and/or corresponding author) on all the publications resulting from their projects or groups, even if these researchers have not contributed substantially to the studies leading to such publications. The argument is that the contribution of the PI is in securing the financing necessary to conduct the research, something sufficiently

important to merit authorship. But this practice raises serious concerns about determining who actually conducted the research, who provided the intellectual leadership, and importantly, who should have scientific and public responsibility for the research findings. Responsibility for the use of research funds is clearly that of the PI, but does it then follow that they also have responsibility—and merit authorship—on all publications associated with a grant or coming from their team?

The financing of research is not considered as a "substantial contribution" by many international bodies (e.g., ICMJE, COPE). As in the case of exchanging material goods for research, individuals who finance the research enable the research, but this role does not necessarily mean that they actually work on the research project and so warrant authorship. The individual PI who provides financing might, however, be recognized in the Acknowledgements in the same way that funding agencies or foundations are commonly recognized for providing research funds.

Responsibilities of Authorship

Clarifying the nature and extent of responsibility for a scientific publication can be the basis for greater accountability. The ICMJE guidelines state that "An author must take responsibility for at least one component of the work, should be able to identify who is responsible for each other component, and should ideally be confident in their co-authors' ability and integrity." This statement provides a logical starting point by requiring that each author be responsible for at least one component of the work. We could also add that individuals are responsible for the component(s) that they have worked on extensively.

If authors adhere to the listing of contributions proposed by Rennie and Emmanuel and identify contributors to each step of the study (Rennie 2001), it would be feasible to allocate responsibility for a moderate number of co-authors. For example, individuals who made intellectual contributions have the responsibility for the principal ideas and are often those who conceived of and secured funding for the study (i.e., the PI and the co-investigators); by contrast, technical responsibility could be limited to ensuring the validity and accuracy of the technical component of a study. In this way, individuals (e.g., colleagues, research collaborators) could also identify the responsible contributor for every component of the research. In a tight-knit group of individuals, the dynamic may be such that members can achieve greater insight or knowledge of the abilities and tasks of the various team members.

Health sciences research teams are not always tight-knit groups with years of experience collaborating together. In many cases, multiple technologies and several different research teams may be involved in national or international collaborations and/or multi-centre studies, where only a few members of each team or centre know those on the other team or centre. The nature of much health sciences research—most notably in the context of large scale randomized controlled trials—necessitates significant collaboration and substantiates the multi-authored publications (Cronin 2005). However, in such cases it will be rare for one researcher to have full

knowledge and assurance regarding the integrity and ability of all the other associated researchers. For all intents and purposes, researchers have to trust in the integrity of collaborators who they do not have experience working with; perhaps this is the reason that the ICMJE guideline qualifies the standards that authors should have regarding their colleagues, i.e., that they "should *ideally* be confident in their co-authors' ability and integrity."

But can responsibility be assigned clearly when groups are very large? In other disciplines where large research groups are common, methods of credit, acknowledgement and responsibility diverge from the model found in the health sciences. For example, in high energy physics (HEP), the reliance on large experimental apparatus may require the involvement of up to two thousand individual physicists, all of whom are considered as authors on resulting publications (Birnholtz 2006). In 2005, Cronin introduced the word "hyperauthorship" to define these instances of massive co-authorship (Cronin 2005). In these cases, authorship is listed in alphabetical order, and some have argued that this practice encourages a more communal approach to science that promotes internal scrutiny and increases trust (Cronin 2001).

However, recent data suggests that there is also significant tension surrounding the crediting of authorship in massive co-authored publications. Birnholtz's (2006) study of HEP researchers and students identified important differences in perspectives regarding appropriate authorship: some researchers believed it fair to recognize all contributions to a large project, while others preferred to give more credit to those who made a particularly valuable effort (Birnholtz 2006). Some researchers noted that while publications are still valued in HEP, it is more important that researchers "get noticed" through participation in informal seminars or through professional relationships with renowned senior researchers. There is also some evidence of the use of lax criteria in attributing authorship in HEP research; for example, researchers and postdoctoral students are named on publications that they may not have read but based on research in which they participated. In this case, it is obvious that not all researchers, and especially those who did not read the manuscript, have a sense of responsibility for the publication.

In order to try and prevent hyperauthorship and the resulting problems with authorship responsibility, some health sciences journals have begun limiting the number of individuals who can be named as authors. For example, the *Journal of the American Medical Association* proposes several options for large groups publications, the most common being to state the names of certain authors on behalf of their research teams (Flanagin et al. 2002). However, this means that some researchers (i.e., the named authors) will get more credit and visibility for their participation in the study. Further, in limiting the number of named authors, such a policy goes against the ICMJE requirement for including as authors on the paper all those individuals who qualify. Another approach is the "partial authorship model" which distributes responsibility equally among all researchers depending on their contribution (Tsao and Roberts 2009; Marušić et al. 2004). If there are ten researchers that participate in a study and all contribute equally, each is attributed 10% responsibility. More or less credit can be distributed to each author, and the more researchers involved the less value is attributed to each individual. However, it

is often very difficult to put a precise number on individual contributions or justify why one author contributed 10 or 30% to the publication. And what happens in the case of research misconduct (e.g., falsified data, plagiarism, fraud)? Are some or all authors ultimately responsible?

A good illustration of this problem is the "Korean stem cell scandal" involving Dr Woo Suk Hwang, and the publication of two articles in *Science* that claimed the successful generation of human embryonic stem cells through somatic cell nuclear transfer (Strange 2008). As with many scientific publications, Dr Hwang was not the only author named on his publications. Dr Gerald Schatten, Director of the Division of Developmental and Regenerative Medicine at the University of Pittsburgh School of Medicine was a senior (last) and corresponding author in one of these publications. In a ruling by the University of Pittsburgh, Dr. Schatten was judged to be innocent of "research misconduct"—defined as fabrication, falsification, and plagiarism (DHHS 2005)—but guilty of "research misbehavior" for his questionable scientific practices (Holden 2006). According to the summary investigation report by the University of Pittsburgh, Dr. Schatten did not "exercise a sufficiently critical perspective as a scientist". In accepting the benefit (i.e., prestige) associated with being senior author, Dr. Schatten also accepted the "responsibilities for the manuscript as a whole, approval of the manuscript by all co-authors, and the veracity of the data reported" (University of Pittsburg Investigative Board 2006).

The idea of making one individual (e.g., the first or last author) responsible—that is a "guarantor" (Graf et al. 2009; Rennie 2001; ICMJE 2009)—for a study as a whole is worth further consideration. This approach has the benefit of clearly defining the locus of responsibility for the study and resulting publication(s). But the argument could be made that if responsibility is narrowly attributed to one individual, then other participating researchers might not feel any sense of responsibility because "it's not our job". Further, the guarantor approach imposes a hierarchical structure, something that might be appropriate where the guarantor is also the PI who secured funding for the project and thus has responsibility for the appropriate use of research funds. But not all research projects have one PI or leader; sometimes multiple individuals with completely different expertise work on a multidisciplinary collaborative project that is supported by diverse research funds. In such situations, the narrow attribution of greater power and responsibility to one author may not adequately reflect the actual practices and contributions of the researchers involved in the project.

Conclusion

In this paper, we examined different types of contributions to research projects in the health sciences in order to determine how these contributions are reflected in the attribution of authorship on scientific publications. Some contributions to research may be intellectual, such as the creation or design of the project, while others will be more technical, such as the creation of a new reagent or software; both types of contribution may be legitimately important and so warrant authorship. While it makes sense to say that individuals are responsible for the contributions that they

make to a publication, these contributions—and associated responsibilities—will be difficult to define with precision, particularly for a large group of contributors. Different types of responsibility can be acknowledged, such as that of the guarantor who has overall responsibility (i.e., for the quality of the research findings and integrity of the research methods) or more diffuse role-specific responsibility shared among team members (e.g., for idea development, production of technical tools).

Determining who should have such responsibilities may be possible in certain types of health research, but this may not be generalizable. For example, the model of guarantor or lead author having overall responsibility can work well in cases where there is a PI who secured the research funds, supervised and directed the team, and reviewed and contributed in varying degrees to all resulting publications. But not all projects are guided or funded by one individual; large collaborative groups may involve dozens or even hundreds of researchers from numerous institutions who engage in a wide range of important research activities. Deciding upon the fair attribution of authorship on resulting publications (or distributing responsibility for various elements of the project) becomes especially challenging, something that necessitates well thought out and transparent procedures.

In many cases—maybe even as an initial "rule of thumb"—the method of allocating authorship should be determined prior to the study, through open dialogue with all individuals participating in the research. This procedural approach takes into consideration not only what decision is made but also how it is made. Individuals' reactions to decisions will be affected greatly by the method or process of arriving at a decision, as well as the underlying motivations and rationale (Dolan et al. 2007). As such, a transparent process that researchers can accept even if they are from different academic cultures could help promote open communication that would then limit conflicts and reduce or avoid tension between colleagues. While such a proposition may appear obvious, numerous studies of authorship practices—and examinations of the guidelines of health sciences journals and learned societies—demonstrate that practical recommendations for fairly attributing authorship are still lacking.

There is clearly a place for scientific journals and publishers to take a lead in setting the norms for authorship practices. For example, the Authorship Guidelines for Springer, the publisher of this journal, are unequivocal when they state that "Authorship credit should be based on: (1) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; AND (2) drafting the article or revising it critically for important intellectual content; AND (3) final approval of the version to be submitted for publication." Requiring authors to meet all three requirements, and explicitly excluding "Acquisition of funding, collection of data, or general supervision of the research group" as sufficient grounds for authorship makes it clear that many practices current in health sciences research will not be permitted. Further, placing the burden on all authors to "agree on the sequence of authors listed before submitting the article" and to "designate one author as the corresponding author" who will "dialogue with the co-authors during the peer-reviewing and proofing stages" makes it clear that transparent communication processes and procedures are essential (Springer 2010).

Nonetheless, in the context of diverse types of multi-disciplinary collaborations in the health sciences and in other fields of research, the varying natures and scales of these collaborations will mean that a "one-size fits all" solution to authorship is probably unrealistic, or at least not fully inclusive. An important first step, we suggest, is empirical research to map and compare authorship practices across the range of academic disciplines. Such information would then support ongoing critical reflection on how, in practice, the academic community (and its diverse disciplines and specialities) should address the tensions or conflicts that arise in different types of research, and ultimately contribute towards the development of generally accepted processes to effectively and fairly allocate authorship in multi-authored publications.

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