Authorship Ethics in the Era of Team Science

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The dissemination of research findings in articles is essential. Held to the same ethical standards of the studies themselves, the level of contribution determining authorship and authorship order needs to be established a priori. In the current era of team science, with its focus on the acceleration of personalized care, many people are needed to answer comprehensive research questions. This article explores how a large number of authors can contribute meaningfully to team science articles.

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Today, in the era of precision health, the ability to ask more comprehensive research questions related to cancer prevention, treatment, symptom management, and survivorship has increased exponentially. This type of research involves numerous data sources (e.g., genomic data, electronic health record data, geophysical mapping data, social networking data) that require a research team with a wide range of expertise. Although team science occurs in large and small research teams, in the current context of research, a large group of individuals who bring their own unique expertise to the table is often needed. By its very nature, team science facilitates the development of robust research questions. It is equally important that, when data are collected and analyzed, team members' different perspectives and expertise enrich the interpretation of the study findings. In addition, many large work groups publish salient white papers, guidelines, and findings from large-scale, multicenter trials and, sometimes, multination trials that contribute essential information on cancer prevention and management. Many of these publications include tens or even hundreds of authors. In the November 2015 issue of *Oncology Nursing Forum*, Katz's (2015) editorial discussion focused on the ethical question of how large numbers of authors listed on a manuscript could each contribute meaningfully. For some manuscripts, this questioning is well merited. In this column, the authors will provide a different perspective on how a large number of authors can make unique and substantive intellectual contributions to team science articles.

Intellectual Significance

As a key dissemination piece of research studies, published articles are held to the same ethical standards as the studies themselves, including integrity of author contributions. These large team science articles contain multiple components that often require the expertise of many team members. For example, the principal investigator and other content experts may write the introduction and rationale for the article, the project director and research staff may write the methods section, the biostatistician may conduct the analysis and write up the results, and the entire team may participate in the interpretation of the study findings and the writing and revision of the discussion. In many cases, specific team members make intellectual contributions based on their particular area of expertise (e.g., genomic markers, machine learning techniques, analyses of big data). Sometimes, the methods and data are so extensive that large portions are posted online as supplements. Authorship order usually depends on each author's level of contribution

to the development and revision(s) of the article. Effective teams determine who will take the lead on each article and the order of authorship a priori.

The determination of contributions that merit authorship is open to interpretation, prompting ethical considerations. For example, some authors could more appropriately be placed in the acknowledgements section of the article (e.g., an institutional leader who supports the conduct of the study in the clinical setting). To assist team members in determining whose contribution warrants authorship or acknowledgement, as noted in Katz (2015), the International Committee of Medical Journal Editors developed guidelines for author contributions. According to these guidelines, authorship requires that an individual make a "substantial contribution to the conception or design . . . or the acquisition, analysis, or interpretation of data" (International Committee of Medical Journal Editors, 2017, para. 4) and contribution to the writing or critical revision of its intellectual content, as well as approve the final version and agree to be held accountable for its accuracy (Katz, 2015). Applying these guidelines can ensure that the ethical conduct of research is maintained with the authorship in dissemination of study findings.

In 1975, the Johns Hopkins University Press published an article on ethics and etiquette in biomedical communication (DeBakey & DeBakey, 1975). Highlighted in it was the academic pressure to "publish or perish" (DeBakey & DeBakey, 1975, p. 524). Publications in peer-reviewed journals remain the benchmark for progress in academia (Hammer, 2016). DeBakey & DeBakey (1975) noted that, in some cases, the quantity, not the quality, of publications drives the advancement process. They felt that this pressure drove the work of multiple authors contributing to each article (DeBakey & DeBakey, 1975). To a certain extent, the publish or perish idea still exists today and may be the rationale for multiple authors contributing to current manuscripts. However, as the tide of scientific advancements shifts to big data science, large lists of authors who each make unique intellectual contributions to articles are appropriate and ethical, and they advance science. In fact, in most research universities, faculty members are encouraged to indicate their level of unique contribution to an article. In addition, a recent trend is to ensure an equal level of contribution is annotated for the first and last authors.

State of the Science

Scientific advances are occurring at an exponential rate. These advances need to be disseminated much more rapidly. Undoubtedly, in the next few decades, the current fast-paced, high-tech approach to science and the dissemination of research findings will be antiquated. In 1975, personal computers did not exist, and writing manuscripts entailed actually placing pen on paper, with final versions pounded out on a typewriter. The genome was not yet sequenced, with the identification of the four nucleotides that comprise DNA having been discovered only about 10 years earlier (Nirenberg, 1963; Nirenberg et al., 1966). In this mid-20th century scientific era, the justification for authorship was based on the "origin of a literary production" (DeBakey & DeBakey, 1975, 529), discouraging the inclusion of individuals who had not made a substantial contribution. This was long before the enormous scientific endeavor to unveil the order of 3.2 billion base pairs of nucleotides.

Completed four years ahead of schedule, the massive worldwide effort to sequence the human genome was exemplary. Publications in *Nature* (McPherson et al., 2001) and *Science* (Venter et al., 2001) contained a few hundred authors each. Authorship for these publications clearly fit the 2015 criteria set by the International Committee of Medical Journal Editors. In addition, the committee itself is not opposed to large author lists in the current state of team science and big data. In fact, it published an article on data sharing that had 48 authors (Alfonso et al., 2017).

In current team science, data sharing is an integral part of these large-scale, accelerated translational research studies. The American Society of Clinical Oncology DataLinQ aggregates multiple data elements from various settings to connect patient data with clinical outcomes at an exponential rate (Sledge, Miller, & Hauser, 2013). In addition, nurse scientists are at the forefront of investigations using common data elements. A landmark article by Redeker et al. (2015) described symptom science with common data elements. These types of shared data with complex statistical analyses require very large research teams with varying and complementary areas of expertise. The contribution of each member of the research team warrants author recognition, regardless of how long the final list is.

Conclusion

In the current era of team science, with its focus on the acceleration of personalized care, many individuals are needed to answer comprehensive research questions. By their very nature, big data from a variety of sources (e.g., genomic data, electronic health records) need to be analyzed and interpreted by individuals with diverse areas of expertise.

Not attributing authorship to individuals who contribute intellectual acumen is unethical. It is appropriate and necessary to include all intellectual contributors as authors.

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