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La distribution 'juste' de la signature savante dans les collaborations de recherche multidisciplinaire en sciences de la santé

Fair Distribution of Authorship in Multidisciplinary Health Sciences Collaborations

par

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Cette thèse intitulée:

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RESUME

L'auteur qui appose son nom à une publication universitaire sera reconnu pour sa contribution à la recherche et devra également en assumer la responsabilité. Il existe divers types d'agencements pouvant être utilisés afin de nommer les auteurs et souligner l'ampleur de leur contribution à ladite recherche. Par exemple, les auteurs peuvent être nommés en ordre décroissant selon l'importance de leurs contributions, ce qui permet d'allouer davantage de mérite et de responsabilité aux premiers auteurs (à l'instar des sciences de la santé) ou bien les individus peuvent être nommés en ordre alphabétique, donnant une reconnaissance égale à tous (tel qu'on le note dans certains domaines des sciences sociales). On observe aussi des pratiques émergeant de certaines disciplines ou des champs de recherche (tel que la notion d'auteur correspondant, ou directeur de recherche nommé à la fin de la liste d'auteurs). En science de la santé, lorsque la recherche est de nature multidisciplinaire, il existe différentes normes et pratiques concernant la distribution et l'ordre de la signature savante, ce qui peut donner lieu à des désaccords, voire à des conflits au sein des équipes de recherche. Même si les chercheurs s'entendent pour dire que la signature savante devrait être distribué de façon 'juste', il n'y a pas de consensus sur ce que l'on qualifie de 'juste' dans le contexte des équipes de recherche multidisciplinaire.

Dans cette thèse, nous proposons un cadre éthique pour la distribution juste de la signature savante dans les équipes multidisciplinaires en sciences de la santé. Nous présentons une critique de la documentation sur la distribution de la signature savante en recherche. Nous analysons les enjeux qui peuvent entraver ou compliquer une distribution juste de la signature savante tels que les déséquilibres de pouvoir, les conflits d'intérêts et la diversité de cultures disciplinaires. Nous constatons que les normes internationales sont trop vagues; par conséquent, elles n'aident pas les chercheurs à gérer la complexité des enjeux concernant la distribution de la signature savante. Cette limitation devient particulièrement importante en santé mondiale lorsque les chercheurs provenant de pays développés collaborent avec des chercheurs provenant de pays en voie de développement.

Afin de créer un cadre conceptuel flexible en mesure de s'adapter à la diversité des types de recherche multidisciplinaire, nous proposons une approche influencée par le

Contractualisme de T.M. Scanlon. Cette approche utilise le respect mutuel et la force normative de la raison comme fondation, afin de justifier l'application de principes éthiques. Nous avons ainsi développé quatre principes pour la distribution juste de la signature savante en recherche: le mérite, la juste reconnaissance, la transparence et la collégialité. Enfin, nous proposons un processus qui intègre une taxonomie basée sur la contribution, afin de délimiter les rôles de chacun dans le projet de recherche. Les contributions peuvent alors être mieux comparées et évaluées pour déterminer l'ordre de la signature savante dans les équipes de recherche multidisciplinaire en science de la santé.

Mots-clés : Auteur, intégrité en recherche, conduite responsable en recherche, distribution juste, responsabilité, mérite

ABSTRACT

Authorship of scientific publications is a means of recognizing both a researcher's contribution to a paper as well as their responsibility for the integrity of their work. Various approaches to author order may be used to rank individuals and convey the extent of their contribution. For example, authors may be listed by decreasing level of contribution, whereby most credit and responsibility are allocated to the first authors (common in the health sciences), or they may be named in alphabetical order, giving equal recognition to all (common in the social sciences). There are also "rules of thumb" or preferred practices that exist in the respective disciplines or research fields (e.g., corresponding author first, Principal Investigator last). In the case of multidisciplinary health research, differing norms and practices regarding authorship distribution may be held by the respective team members; and, this can give rise to disagreement and even conflict within research teams. Although researchers and scholarly organizations agree that authorship should be distributed "fairly", a shared understanding or consensus as to what constitutes fairness, as well as its practical implementation in multidisciplinary research collaborations, remains a significant challenge.

This thesis proposes a conceptual ethical framework for the fair distribution of authorship in multidisciplinary health sciences research. At the outset, the various methods recommended by journals, learned societies, as well as in the academic literature to distribute authorship are critically reviewed; issues that may impede or complicate fair authorship distribution in multidisciplinary research are highlighted; these include, for example, power differentials, conflicts of interests, and conflicting disciplinary norms and cultures. The analysis will show that current universal normative authorship guidelines are overly broad, and therefore, are insufficient to effectively resolve many of the diverse issues that are often specific to differing contexts of research. As will be discussed, the limitations of such guidelines are particularly significant in the case of global health collaborations that involve researchers from low and middle income countries and those from high income countries. A theoretical approach influenced by T.M. Scanlon's Contractualism is proposed as a means of achieving the flexibility needed for the diversity of multidisciplinary research contexts; mutual agreement and reasonability are used to determine whether ethical principles are "fair". Four

central and interconnected principles – desert, just recognition, transparency and collegiality – are presented as the conceptual foundation to support the development of a process for the fair distribution of authorship. This authorship distribution process integrates the detailed research tasks commonly used in "contributorship" taxonomies to delineate individual duties and roles in the research project and subsequent publication. Contributions are then compared and valued more efficiently to determine authorship order while promoting fairness in multidisciplinary health sciences research.

Keywords: Authorship, Research Integrity, Responsible Conduct of Research, Fair Distribution, Responsibility, Merit

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

COPE   Committee on Publication Ethics

CSE   Council of Science Editors

FFP   fabrication, falsification or plagiarism

HIC   High income countries

ICMJE   International Committee of Medical Journal Editors

IP   Intellectual property

IOM   Institute of Medicine

LMIC   Low to medium income countries

NIH   National Institutes of Health

NSF   National Science Foundation

ORCID   Open Researchers and Contributor Identification

ORI   Office of Research Integrity

RCR   Responsible Conduct of Research

RRI   Research on research integrity

SSHRC   Social Sciences and Humanities Research Council

US   United States

WAME   World Association for Medical Editors

Many have said that researchers should "Stand on the Shoulder of Giants"

I dedicate this thesis to all the giants who have gone unrecognized.

ACKNOWLEDGEMENTS

facilitate the inclusion of individuals in research regardless of their limitations. Such organizations are essential in promoting equal opportunity in research.

PREFACE

I knew from the outset of my doctoral research on scientific authorship that it would not be possible to study this topic in a completely objective fashion. As a student/researcher/author myself, complete impartiality or detachment was and remains impossible. Many post-modern thinkers, especially those in the feminist movement, have promoted 'standpoint' theories showing the advantages of inter-subjectivity (Harding 2004). They argue that being part of the object that one studies should provide insight into and a more authentic understanding of that object. While this may be true, I have also found that being part of the object that I am studying has at times been difficult and uncomfortable. My own experiences in research have changed the way I see the distribution of authorship. Because of this, it is important that I briefly share my observations and conclusions prior to launching into the full analysis presented in this thesis.

During my Masters research, I interviewed researchers to understand their views on sharing information and materials stored in databases and biobanks. Authorship was raised as an important concern that could limit the sharing of knowledge; simply put, a number of researchers balked at sharing their information because they believed that they deserved authorship in exchange for data and materials, while others did not have the same concerns. At the time, I was taken aback by the emphasis that researchers put on this notion of 'authorship'. My more experienced research partner in this project explained that authorship represented the success of an individual and in effect showed "who won the race" in science. I remained somewhat unconvinced: after all, was not the advancement of knowledge the most important thing at the end of the day?

Over the last four years, I have conducted research on authorship and published papers on the topic as a member of a collaborative and multidisciplinary team; as such, I have my own personal experiences with authorship. Most of my research, which is contained in several articles in this thesis, is the result of enriching and invaluable discussions and work with my peers, with more experienced researchers from various fields, and notably, with generous mentors and professors. I have benefited from a collaborative process wherein we debated diverse perspectives, argued, questioned and developed ideas. I was fortunate to benefit from this rich diversity of perspectives.

It is somewhat ironic, but no less important, that this project would also be enriched by real-life or real-time issues relating to authorship distribution. My collaborators and I had ongoing discussions throughout the research process to decide authorship and its order for articles in various publications. And, although we have done extensive research on the subject, we also held different perspectives on how authorship should be distributed in practice. Although we all promote principles of ethical and fair authorship, we had to work out differences as to our individual perceptions regarding our contributions to the work, as well as to research more generally. Since authorship distribution often gauges value and quantity of research contribution, differing objectives or visions of a research project could lead to an impasse.

Scholars may promote 'open' and rational discussion, but when questioning authorship – and the value and extent of someone's work – the human dynamic manifests itself in the decision-making process. This includes a person's personal and professional background and training (as well as professional culture and traditions), personal needs, ambitions, biases, beliefs, perceptions, and emotions. My own experience with authorship has been invaluable in that it has helped me realize that my ethical propositions, as well-founded and rational as they might be, would nonetheless be challenging to implement. In addition to an ethical framework and improved guidance, an effective decision-making process regarding authorship requires sensitivity, tact and excellent interpersonal skills.

When I mentioned to other researchers and students that I was working on authorship, people – some of whom I hardly knew but happily listened to – would share with me the injustices, quarrels, questions and problems that they had experienced regarding authorship. At times, I felt like the authorship ombudsman or psychologist. There were students who did not understand why so many people were named on the paper that they had written. Researchers asked whether they should be named on their students' work, as they were unsure if they had really contributed substantially. And almost everyone was confused as to what authorship order should be used. Researchers and students were often angry, emotional, and frustrated about issues regarding authorship. Power-games, injustices and miscommunication seemed commonplace. While I have had interesting and enriching conversations as to what the ethical decision might ultimately be, at the end of the day, the resolution of issues depended mainly

on effective communication and negotiation with peers or superiors. Once again, it was abundantly clear that theoretical models alone were not going to solve the problem. In my research, the gap between normative ethical theory and practice was greater than I had first imagined; and as I will discuss in the thesis, more research is necessary to help close this gap.

At the beginning of my studies, I held the view that the advancement of science was to be the valued and promoted as the "be all and end all" of the scientific endeavour. I considered individual conflicts regarding authorship as simply a hindrance to the creation of knowledge; and, I was of the opinion that individuals should somehow become selfless and secondary to the system of knowledge production. In the course of my research, I grew to recognize, through my experiences and those of my peers, that underestimating the human dynamic or the individuals (including their conflicts and disputes) within the system is itself problematic and even counterproductive. The advancement of science is not a seamlessly rational and orderly journey in which objective individuals build knowledge and share it in an impartial manner. Decisions about authorship are critically important to the careers of students and researchers. Measuring and acknowledging a person's performance and the value of their work is not a dispassionate, professional exercise; it is a human experience. Since authorship is an important recognition of individual accomplishment, the process of authorship distribution is and will be challenging at times, and it would be unrealistic to think otherwise. As noted above, in addition to a sound ethical framework and practical guidelines to assist researchers in the decision-making process about authorship, there must also be open dialogue supported by good negotiation and people management skills in order to bridge differences and reach agreement to the extent possible. In sum, my research, as well as my experiences as a researcher, have enabled me to argue forcefully and with conviction for principles that are conceptually valid, while acknowledging the important practical challenges of the human dynamic at the center of scientific research and knowledge production.

INTRODUCTION

From Misconduct to Authorship

Since the 1980s, there have been numerous scientific scandals presented in the public media that documented alleged and confirmed cases of misconduct (Macrina 2005, 8–9). The number of individuals named in confirmed cases involving fabrication, falsification or plagiarism is considerable; notable examples include John Darsee (Harvard Doctoral Fellow in Cardiology), Stephen Breuning (Psychologist at the University of Pittsburgh), Jan Hendrik Schön (Physicist at Bell Labs), Hwang Woo-Suk (Professor of Veterinarian Sciences at Seoul National University) and Dierdrick Stapel (Social Psychologist at Tilburg University). Misconduct in science has many negative consequences and ramifications; in addition to the obvious distortion of the science itself (Fanelli 2009), misconduct can potentially harm patients, waste research funds, damage or ruin individual or institutional reputations, and diminish trust in science and its institutions (Stroebe, Postmes, and Spears 2012).

The term 'research misconduct' is defined by the United States (US) in code of federal regulations and adopted by various funding agencies such as the National Institutes of Health (NIH) and the National Science Foundation (NSF) as the presence of deliberate fabrication, falsification or plagiarism (FFP) (NSF 2009). But there is a recognition that misconduct can be much broader than FFP. For example, in recent years Canadian funding agencies have chosen to talk about 'breaches' of responsible conduct of research guidelines, and listed a wider array of inappropriate and deliberate behaviours: e.g., fabrication, falsification, destruction of research records, plagiarism, redundant publication, invalid authorship, and inadequate acknowledgement and mismanagement of conflict of interest (Interagency Advisory Panel on Research Ethics 2014).

While some have proclaimed that dubious practices in research are rare or simply the result of "a few bad apples", others have suggested that they are in fact the "tip of the iceberg" (Fanelli 2009). As is the case with many other behaviours that are considered unethical or socially undesirable, studying the prevalence of misconduct or questionable conduct in science more generally is difficult (Harley, Faems, and Corbett 2014). In 2005, Martinson and colleagues published a large empirical research study of more than 3000 NIH funded

researchers who disclosed instances of their own questionable behaviour. The focus was not on the rate of "scandalous" activities such as research misconduct (defined in the US as FFP); rather, it was on the presence and pervasiveness of common, questionable but 'mundane' practices, such as "inappropriately assigning authorship", which was reported by 10% of researchers (Martinson, Anderson, and De Vries 2005). More recently, a meta-analysis of fourteen survey studies on authorship showed that 29% (pooled weighted average) of researchers reported that they or their colleagues had experienced misuse of authorship (Marušić, Bošnjak, and Jerončić 2011). It is possible to infer that authorship issues are quite obviously more than the actions of a "few bad apples". While important limitations and heterogeneity exist at the moment in empirical research regarding authorship, it is still possible to conclude that we are facing a *considerable* rate of problematic authorship issues in scientific research.

Authorship issues have often been overlooked or seen as falling within the diversity of acceptable or marginally problematic research practices (Nylenna and Simonsen 2006). Those that may fall into the category of "questionable conduct" include ghost-authorship (where an author of the paper is not named), gift-authorship (where an individual who did not contribute is named as an author), and questionable authorship order (where order is not distributed in keeping with scientific norms and/or values)[1]. While many dubious authorship practices are based in deceit and trickery that may even be concomitant to fraud, these types of practices have rarely been interpreted as such and thus they are not typically labelled as fraudulent activities. Since authorship issues do not have a direct causal link to the integrity of a particular research project – and as such do not directly distort research – they are often interpreted as less serious than falsification and fabrication (Steneck 2006). However, as empirical research shows, authorship issues can lead to significant disputes and tension among research collaborators (Marušić, Bošnjak, and Jerončić 2011).

The social context of academia itself may also contribute to inherent conflict between individual ambition and team success and exacerbate strains in the distribution of authorship. The research in scientific integrity seems to have given little attention to the role of research

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[1] More specific definitions and considerations will be developed regarding authorship order, later in this thesis.

institutions, putting much of the blame on the shoulders of individual scientists (Redman 2013; Master 2015). While team research typically calls for values that build collegiality, collaboration and sharing among team members, analysis of the academic context reveals that universities, more than most other organizations, are founded on, and promote, autonomy and individualism (Coaldrake and Stedman 1999; House and Seeman 2010; Deem and Brehony 2000). This paradox may explain to some extent the conflict or dispute among members regarding matters of authorship. An overly individualistic work dynamic may create an excessively competitive and somewhat hostile workplace which in turn could contribute to systemic misconduct such as sabotage, fabrication or falsification, and harassment. What is particularly disconcerting is the significant probability that authorship misuse creates long-term issues that we do not fully understand at the present time. The impact of authorship issues on the behaviour of researchers and the integrity of science itself are at times subtle, indirect and difficult to fully comprehend.

What is made clear to researchers upon entering academia is that they will "publish or perish" (Katchburian 2008; Beasley 2005; van Dalen and Henkens 2012; McGrail, Rickard, and Jones 2006). This imperative drives researchers to constantly create, develop and diffuse knowledge in addition to discharging their many other scholarly responsibilities (e.g., supervision, knowledge transfer, teaching, administration). Failure to publish at a constant and productive rate has even been deemed by some to be a "scientific crime" (Clapham 2005). Because of the increasingly competitive nature of research, individuals might feel that in order to succeed, stepping into the grey zone of dubious authorship practices may be understandable and even justifiable. While not commendable, adding a friend's name as an author on one's paper may seem acceptable. Naming the whole research team on a paper could also seem acceptable in order to make everyone appear more productive. Excluding a name or two in an effort to hide conflicts of interest may be seen as acceptable, under the pretext that there is no direct impact on an individual's research. Claiming a student's work as one's own and then naming him or her as third or fourth author may be justified as harmless; the rationale being that the student is not actually staying in academia, and so there is no negative impact on their career. Individuals may invoke the excuse that such practices are common and therefore somewhat acceptable in academia; and in so doing, they rationalize or justify decisions or

actions that serve their own interests but that are not necessarily in keeping with the interests of their peers and of the scientific enterprise more generally. If we all buy into this dynamic and choose to step into this grey zone and attribute authorship based primarily on self-interest, then tensions and disputes will inevitably create an environment where collaborative research becomes difficult, if not impossible.

Authorship in Scientific Research

The history of authorship, and more specifically, of scientific authorship, is in no way a simple, uncomplicated narrative that can be fully and adequately explained in the scope of this thesis (nor is this the goal). As historians of science have shown, explanations of discovery are often simplified and stripped of the true conflict and intellectual debate that are often at the centre of the evolution of the scientific enterprise (Latour 2004). For the purposes of this thesis, it is sufficient to note that over time, the definition, meaning and symbolism linked to scientific authorship have evolved and have differed in importance. In so doing, we realize that authorship is not only of great value and significance to those named on the by-line but more importantly, it is of fundamental relevance to the integrity of the contemporary scientific system more generally.

The notion of author and authorship finds its origin in the Old French word *'auctor'* meaning "creator, originator" (Claxton 2005b). In the Middle Ages, science was only considered as 'truthful' when an individual of noble standing (a Nobleman) attached his name to a paper, even if this nobleman did not contribute to any of the research (Chartier 2014); a type of aristocratic validation was necessary. In keeping with this aristocratic view, throughout the Modern period scientific findings or articles were usually written with few or no specifics as to the contributions of the researcher(s) involved in a project. Science was said to be 'truthful' through methods of verification and replication; as such, 'Good science' should stand on its own and the contributing researcher(s) remained anonymous for the most part (Chartier 2014). While many scholars today note that "authorship is essential" (Lacasse and Leo 2010; Hoffmann 2008), clearly this has not always been the case; and, it has not always had the same meaning or significance as it does in contemporary science.

4

Contemporary scientific authorship is a multi-faceted, complex notion that can be interpreted in various ways. It is often defined as necessitating a "substantial contribution" to a research project (Louis et al. 2008; Council of Science Editors (CSE) 2012). In recent scholarly literature, authorship consists of two integrated elements: responsibility for research, and merit – speaking comparatively, it is a coin with two sides (Wilcox 1998; Drummond Rennie and Flanagin 1994). Authorship merit has become an extremely important determinant in a researcher's reputation and career (Shamoo and Resnik 2009). In a team setting, authorship is distributed between many individuals. Since it is of great value and potential in the professional advancement of researchers, sharing it has become quite difficult and often contentious and controversial (Ankeny and Leonelli 2011; Katchburian 2008).

However, sharing authorship has become common practice with the significant increase in collaborative research that grew out of the professionalization and institutionalization of science. For centuries, collaboration in research was very limited; issues regarding the sharing of authorship were fewer and they were not given much attention or significance. For example, analysis of research publications produced between 1665-1800 show that collaboration (measured through co-authorship) was present in little more than 2% of scientific publications (Beaver and Rosen 1978). After World War II, governments became cognizant of the power that scientific inquiry could have on a country's development and started funding large-scale international projects (Cronin 2005; J. Katz and Martin 1997). Laboratories with high-tech equipment became standard at universities and research centres. Researchers became increasingly specialized. Collaboration, and by extension multi-authorship, became necessary in order to successfully undertake many wide scale projects. The increased scope and complexity of problems being addressed by scientists required the combined efforts, knowledge, skills, and perspectives of individuals from various disciplines. Over the last fifty years, large scale collaboration has become the trend as evidenced by the rise in the mean number of researchers per scientific article (Cronin 2001; Cronin 2005; Gingras and Archambault 2006). Moreover, team research generally has had a greater impact than single authored papers (Wuchty, Jones, and Uzzi 2007); team research seems to also combine ideas in less conventional (or atypical) ways which is associated with novelty and innovation in research (Uzzi et al. 2013).

Context: Multidisciplinary Collaboration in the Health Sciences

The focus of this thesis will be limited to authorship distribution in multidisciplinary health sciences collaborations. The participation in health sciences research of individuals from different academic disciplines has proven to be instrumental in understanding, assessing and tackling important health issues. For example, public health research has shown time and again that a diversity of social, environmental, genetic, and behavioural factors interact and that they are fundamental to the understanding of health issues, health care, health promotion and prevention (Baum 1995; Mariner 2007). The concept of "One Health" – defined as "combining human, animal, and environmental components to address global health challenges that have an ecological interconnectedness" (Bidaisee and Macpherson 2014, 1) – has become increasingly popular, and underscores the importance of the collaboration of individuals from a diversity of disciplines. Multidisciplinary collaborative teams have also facilitated translational research, allowing basic scientific research to be applied to practical health problems (Hall et al. 2012).

In the 1990s, medical journals began publishing commentaries and editorials focused on the problems related to multi-authorship, which in turn led to an important debate about authorship in health sciences research (Drummond Rennie and Flanagin 1994; Smith 1997; Constantian 1999). This debate was mainly concerned with practices that *do not* respect the concept of "substantial contribution" that is central in many definitions of authorship in the health sciences. For example, "guest", "gift", "unjustified" and "honorary" authorship involve naming an individual as an author when they did not substantially contribute to the research, thus receiving undeserved credit and recognition (Ross et al. 2008; Street et al. 2010; B. Moffatt 2011). Conversely, "ghost" authorship – i.e., the omission of an individual who has contributed substantially to a study or in the writing of a paper – has also been discussed as an important ethical issue in the authorship literature (Anstey 2014; Matías-Guiu and García-Ramos 2011b; Mowatt et al. 2002). It is most likely because of such unethical practices that authorship emerged as a topic of particular interest in the biomedical sciences, and in the health sciences more generally. In light of the particular complexities of multidisciplinary research within this debate, preconceived norms based on any one discipline are hard if not

impossible to apply. This invites individuals to reconsider the *status quo* and engage in more open dialogue about what should be appropriate authorship.

There are a variety of ways or approaches where diverse disciplines can co-exist and inspire team members in the conduct of health research. Scholars have defined, discussed and debated the definition, pertinence and application of terms such as 'multidisciplinarity', 'interdisciplinarity', 'transdisciplinarity', and 'cross-disciplinarity' (Sulmasy and Sugarman 2010). This debate is beyond the scope of this thesis, so I will simply use the term 'multidisciplinary' to mean any research in which individuals from different disciplines collaborate. Further, I define 'discipline' quite broadly as an institutionalized and recognized set of knowledge, approaches and/or methods used towards the evolution of science. While the definition of 'discipline' as well as 'research field' has been the subject of debate for quite some time in the philosophy of science (Darden and Maull 1977; Ziman 2002; Toulmin 1977), it too is outside the scope of this thesis.

In multidisciplinary health sciences research, many types of assignment of authorship are adopted. Particular disciplines may adhere to, or prefer, specific although often tacit norms. For example, in disciplines such as sociology, economics, and mathematics, authors are named in alphabetical order; notably, this may not necessarily recognize individual contributions to the research project (Van Praag and Van Praag 2008). In disciplines such as psychology, philosophy, computer science, and the biomedical sciences, individuals are usually granted authorship by decreasing order of contribution (Bennett and Taylor 2003), but this makes it difficult to determine each author's contributions (e.g., intellectual, technical). These different approaches have their respective strengths and weaknesses and these may well lead to debate within the particular field of study. There may be important disagreements in multidisciplinary collaborative research where various team members may prefer or hold to the authorship practices of their respective disciplines.

This co-existence of multiple authorship practices and disciplinary norms, and the likelihood of significant disputes around authorship distribution, make multidisciplinary teams an ideal context in which to investigate the adequacy or the need for principles of ethical authorship. This is not to say that authorship issues or injustices are not present in disciplinary contexts. However, in well-established disciplinary circles, a given or 'traditional' authorship

norm will likely have existed for a sufficiently long time so that there is little or no comment or discussion on the subject. The result is that problematic or even unethical authorship behaviours may go unchallenged in the academic community and may not even be noted in the literature. This is not to say that the authorship orders used in different disciplines are inherently right or wrong, but rather that there is likely to be greater disagreement and discord when different norms conflict in authorship decisions. These disagreements in multi-authored teams (especially in the health sciences) have led to increasing concern and debate in recent years, which should give impetus to continued reflection and calls for enhanced guidance and practices to effectively mitigate or resolve issues.

Yet, guidance has not been easy to develop because of the diverse make-up of teams in multidisciplinary health sciences. Since science has become increasingly applied and problem-driven (Milojević 2014), research has extended beyond disciplinary lines to create teams based on the knowledge, skills, and expertise required to solve particular problems. In effect, the team is designed or shaped to meet the challenge at hand. For example, conceptual research teams in health sciences, including bioethics teams, that do conceptual work are typically small and consist of less than five individuals stemming from two or three different disciplines. However, other teams may be quite large. For example, in order to successfully recruit a significant number of patients for a drug-trial, large teams dispersed across multiple geographical sites may be necessary. The notion of the 'team' and 'collaboration' can vary substantially depending on the research project (even if within the broader realm of health sciences). Thus, it is important to remember that while the scope of this thesis is limited to multidisciplinary collaborations in health sciences, the object of this research is of itself quite extensive, diverse and complex.

Research Questions and Goals

To mitigate ethical issues regarding authorship, organizations such as the International Committee of Medical Journal Editors (ICMJE 2013c), The World Association for Medical Editors (WAME 2007a) and the Committee on Publication Ethics (COPE 2011b) have developed or referred to various documents (guidelines, policies, recommendations) regarding ethical authorship practices (these will be discussed in detail in **Chapter 1** of the thesis). Generally, these documents outline criteria for authorship with a view to limiting unethical

issues such as gift authorship and ghost authorship. Notably, these organizations do not provide any detailed guidance regarding how in practice to determine *authorship distribution* or *order* in collaborative research. Guidance generally remains limited to undeserved authorship (e.g., gift authorship), contributorship (e.g., who contributed to specific tasks) and plagiarism. The denial of authorship credit to deserving individuals is under considered in terms of having suitable mechanisms to counter such practices. This might be the case because the rise of the multi-authored papers in the health sciences causes us to focus on the idea that undeserving authorship is perhaps the prominent unethical practice and not denial of deserved authorship.

Scholars may generally agree that authorship should be distributed fairly and equitably (Master 2011; Shamoo and Resnik 2009). However, the understanding and implementation of fairness in multidisciplinary research collaborations remains a challenge and a source of discord. In the literature on research integrity (also known as responsible conduct of research, RCR), certain scholars and guidelines have promoted notions of transparency and agreement in authorship decision-making; however, once again these values remain unexplained and lack any justification for their application in authorship decision making. In order to arrive at a fair agreement regarding authorship distribution, a level of justifiability is necessary; we must know why certain values are to be promoted and why they should guide our actions. While education on RCR and implementation of policies and procedures to prevent misconduct might have stimulated important discussions regarding ethical norms of research, there has been relatively little attention to the conceptual foundations of ethical research practices (Comstock 2013). Given this theoretical weakness or gaps in RCR research, specifically with regards to authorship, editors and policy-makers have little basis upon which to develop fair authorship guidance. Researchers in multidisciplinary teams are left to defer to their superiors or fall back on their respective differing disciplinary practices; and as already mentioned, this may well lead to confusion and discord when different practices conflict.

The central research question of this thesis is: What would constitute a theoretical grounding for the fair distribution of authorship in multidisciplinary health sciences collaborations? A subset of more specific questions will be examined, beginning with: *what issues do researchers come across when distributing authorship in different multidisciplinary*

team contexts? This contextual background will help in the development of a sound theoretical basis for authorship distribution, i.e., *what theories and concepts may be used to define fairness in authorship distribution?* And based on such a view of fairness, *what values and guiding principles may be applied to help in the distribution of authorship?* Following these conceptual considerations, it then becomes possible to ask the practical question: *what could a fair authorship distribution process look like in multidisciplinary health sciences collaborations?*

The goal of the thesis is thus to develop a theoretical grounding for a preliminary process that can be used in the fair distribution of authorship in multidisciplinary health sciences collaborations. The process developed in this thesis is intended as an example that can help mitigate injustices; it is certainly not a "one size fits all" mechanism that should be applied to any situation in order to achieve a fair outcome. In other words, the process should *not be* considered as a form of procedural justice in authorship distribution. Many types of procedural justice have been developed but generally the more classical notion implies that a procedure can been developed in a way that all outcomes that follow the steps of the process are considered fair; no external criteria could be appealed to that would characterize decisions as unfair (Daniels 2007; Rid 2009). Instead, in this thesis I argue for fairness in the promotion of certain principles that are theoretically grounded in contractualism. As will be discussed later in this thesis, any process must be tailored to the context and nature of the research collaboration. It would not be realistic to suggest the universal application of a single process that would effectively yield fair outcomes concerning authorship in all situations. Therefore, the example provided in this thesis should be seen as a fairly generic and pragmatic approach to engage team members in a constructive and open forum to arrive at fair authorship decisions.

Scope

Given the interdisciplinary nature of the subject matter, literature from a variety of fields of scientific research will be reviewed. Much of the current literature about authorship is already interdisciplinary in nature: for example, the science and technology studies (STS) literature includes accounts from history, anthropology and sociology. I will also draw from

applied ethics, social science methodology, and education and higher education management, fields that are directly relevant to scientific authorship. Note that the authorship of literary work or works of art is substantially different from authorship in scientific research. As such, the notion of author in general (not scientific author) as analysed by Foucault in his seminal work, *What is an Author?,* will be excluded (Foucault 1984).

Certain legal considerations regarding copyright and patents are also linked to authorship. For example, when publishing a paper, the author usually signs over copyright to a publisher which limits a researcher's right to replicate the published work. Also, research that has translational and practical value may be subject to patent rights. There is, however, a considerable disconnect between the attribution of 'inventorship' (basis for patents) and authorship. According to recent scholarly studies (Seymore 2007), inventorship is distributed much more sparingly than authorship, showing a certain divergence between these two modes of credit distribution. While these are interesting legal matters related to authorship, they are quite distinct and separate from the issue of fair distribution of authorship. Scientific authorship definitions are not codified in any intellectual property (IP) law, and the reward system in which scientific authorship is contextualised is very different than the logic of protecting IP (Biagioli 2000). Further, IP is set in a legal context that also differs depending on national jurisdiction. An examination of these various IP systems is not relevant to the goals of this thesis, and so will be set aside.

There is considerable overlap between authorship misappropriation and plagiarism. While there are various definitions and interpretations of the notion of plagiarism (Gullifer and Tyson 2014), the Canadian Tri-Agencies define plagiarism as

> Presenting and using another's published or unpublished work, including theories, concepts, data, source material, methodologies or findings, including graphs and images, as one's own, without appropriate referencing and, if required, without permission (Tri-Agency 2011).

According to this definition, withholding authorship from an individual who has contributed substantially could be considered plagiarism. However, other instances, such as the use of inappropriate authorship order, or authorship attribution to individuals who did not contribute substantially, would most likely not be considered cases of plagiarism. Interestingly, while

plagiarism is viewed as a highly reprehensible form of misconduct (Walker 1998), authorship misappropriation is often deemed to be less deplorable; the underlying rationale for this important discrepancy is unclear, and intriguing. Nonetheless, plagiarism will not be addressed in this thesis as the focus is mainly on the act of distributing authorship rather than the potential negative consequences of authorship decisions, including plagiarism.

Lastly, the scope of this thesis will remain within the broad area of applied ethics and the contemporary debate regarding distribution of authorship in responsible conduct of research. While I will be using contractualist theory, I do not aim to develop a thesis based on the historical foundations or contemporary details/debates of various contractualist theories; this subject has been the topic of much reflection in philosophy (Darwell, 2003; Freeman, 1991; Hooker, 2002; Kumar, 2001; Matravers, 2002) and is outside the scope of this thesis. I will, however, in Chapter 4 present the various reasons for choosing one specific contractualist approach (i.e., that of T.M Scanlon), and justifying the pertinence of its application to the problem of authorship distribution.

Thesis Structure

This thesis is divided into five chapters. **Chapter 1** reviews the main body of literature that examines issues of scientific authorship in contemporary science. Three main areas of research are considered: 1) science and technology studies (STS), 2) responsible conduct of research (RCR) and 3) authorship guidance written by international publication ethics organizations. This interdisciplinary review also highlighted the information necessary to write the subsequent chapters (and articles). The literature review also outlined the need for the current research undertaken in the thesis. While the literature on authorship promotes certain values such as fairness, transparency, agreement and consensual decision-making, these remain poorly defined and lack theoretical sophistication. As such, there is little concrete guidance for fair authorship distribution. A sound and justifiable theoretical basis is a necessary pre-requisite to achieving a reasonable degree of consensus and agreement in the process of authorship distribution.

Prior to examining the pertinent theoretical considerations, it is important to provide a more extensive contextual description of ethical issues regarding authorship distribution.

Chapter 2 presents an article entitled ***Authorship and Responsibility in Health Sciences Research: A Review of Procedures for Fairly Allocating Authorship in Multi-Author Studies*** written in collaboration with one of my two supervisors, Professor Bryn Williams-Jones, published in the journal *Science and Engineering Ethics* (2011). This article critically examines various authorship distribution methods proposed by journals, learned societies, and in the academic literature in order to better understand the different issues that may arise when distributing authorship in multidisciplinary health science teams. This article also considers informal systems that govern the distribution of authorship, such as the notion that the last author position acknowledges the team leader, even if this practice is not explicitly stated or defined as such in guidelines or codes of conduct. Since most authorship distribution in the health sciences is based on contribution (e.g., authorship in decreasing order based on contribution), different types of responsibilities and contributions are compared and evaluated. While intellectual contributions remain prominent, the importance and value of technical contributions seem to be more controversial in authorship guidelines and in the scholarly literature. As well, there are a number of contentious determinants that can influence authorship decisions, including: power, friendship, self- interest, *quid pro quo*, financing; these are factored into the discussion on authorship. Finally, this article addresses the nature and extent of the responsibility of authors so that they can be considered accountable for their work, or more specifically, for their contribution to the research project. The notion of responsibility – and of sharing responsibility – can be complex and difficult to implement, especially when there are numerous individuals on the by-line who work at different institutions (e.g., multi-centre research).

Chapter three presents an article entitled ***Authorship Ethics in Global Health Research: Analysing Collaborations Between Researchers from LMIC and HIC***, written in collaboration with Professors Matthew Hunt and Zubin Master (co-supervisor of this thesis) and published in the journal *BMC Medical Ethics* (2014). This article studies authorship practices and considerations in the specific context of Global Health Research (GHR) partnerships between researchers from low and medium income countries (LMIC) and high-income countries (HIC). Four key authorship issues are discussed:

1. Most international authorship guidelines (e.g., ICMJE) emphasize that every member of the group should have read the manuscript. However, in GHR collaborations this unfairly disqualifies researchers who do not read English.

2. Current authorship guidelines do not consider the extensive power discrepancies that often determine or sway authorship distribution in these partnerships; individuals from LMIC often have significantly less power in such structures.

3. There is real or perceived editorial bias in favour of citing prominent Westerners and this can have an important influence on authorship distribution.

4. Cultural differences may account for differences in authorship decision-making.

At the conclusion of the chapter, several authorship distribution recommendations are proposed to address concerns specific to the GHR context. Both **Chapters 2** and **3** outline a diversity of issues that currently make the fair distribution of authorship difficult. These chapters show how ethical issues are often exacerbated by the lack of a sound theoretical foundation and the ensuing limited norms and vague or insufficient guidance for the distribution of authorship in multidisciplinary collaborations.

To help fill this theoretical gap, **Chapter 4** presents an article entitled *A Theoretical Foundation for the Ethical Distribution of Authorship in Multidisciplinary Publications*, in press in the *Kennedy Institute of Ethics Journal*. Using T.M. Scanlon's theory of Contractualism, I developed a theoretical foundation based on mutual agreement and reasonability. Many contractualism theorists justify their view of 'fairness' through mutual agreement by considering everyone's view as equal in any decision-making process. In Scanlon's theory, reasonability (values based on reason) is the central criteria in justifying or validating the value, approach or solution that will be appropriate to specific contextual considerations. It is argued that this theoretical base can serve to develop, justify and achieve agreement on specific ethical interpretations of desert, equality, transparency and collegiality that apply particularly well to authorship distribution in multidisciplinary health sciences collaborations. I show in this article that such principles can provide a sound theoretical foundation in support of ethical, justifiable and non-arbitrary authorship decision-making.

In **Chapter 5**, I use the theoretical basis developed in **Chapter 4** to propose a decision-making process that features ongoing dialogue and negotiation about authorship decisions

during the life of a research project. In an article entitled *A New Proposal to Order Authors in Multidisciplinary Biomedical Research Publications* written in collaboration with Professor Zubin Master and in review for publication in the journal *Accountability in Research*, we propose a general procedure that includes the more detailed 'contributorship' taxonomies as a tool in decision-making regarding authorship decisions. Initially, the article assesses the strengths and weaknesses of the current literature on contributorship. Contributorship can be generally defined as the self-declaration of research contributions on published works. Usually, researchers working in teams in the health sciences declare individuals as authors when they have substantially contributed to study conception and design, data collection, analysis and/or writing. However, recently Allen and colleagues developed a more detailed contributorship taxonomy based on 14 different research tasks (e.g., draft writing, data collection, data analysis, administrative duties, computation, etc.) that researchers could use to declare their contribution within the manuscript (Allen et al. 2014). The literature on contributorship seems to suggest that it could eventually replace authorship (Allen et al. 2014). In the article, we argue that while contributorship does have its advantages, it also has important limitations that are underestimated or not considered in the current literature. We argue that both models of authorship and contributorship are mutually beneficial and consequently, Allen et al.'s contributorship taxonomy could be integrated into an authorship distribution process. We propose a practical procedure for authorship distribution that considers the principles of merit, fair recognition, transparency and collegiality.

As previously mentioned, many of the articles in this thesis are the result of research collaborations. As first author, I have contributed most substantially to the work, and this justifies the presence of these articles in the thesis. The names of those individuals who have contributed in addition to myself are noted as authors at the beginning of each article. Before each article, a linking statement explains the nature of the collaborations and identifies who contributed to different tasks of the research process and subsequent manuscript development.

CHAPTER 1: SUMMARY OF LITERATURE ON SCIENTIFIC AUTHORSHIP AND ITS DISTRIBUTION

Three main sources of literature may be considered as central in contemporary scientific authorship. First, the science and technology studies (STS) literature discusses the reward system of science, which includes publication; this literature is important in understanding the context of scientific authorship. Even if the notion of authorship might not be a focal point, the way STS researchers see the reward system of science affects their appreciation of authorship as a socio-cultural process. Second, there is literature dedicated to authorship in the field of responsible conduct of research (RCR), also called research integrity; this literature discusses the ethics of authorship, and includes articles, commentaries, empirical studies and editorials mainly from the fields of medicine, physics, and the biosciences. Interestingly, although both are considered interdisciplinary literatures, STS and RCR have not overlapped or influenced each other in any significant way. Third, it is important to consider the authorship guidance that has been developed by editorial groups or learned associations to promote publication ethics. These guidance documents have been quite effective in fostering dialogue in the scientific community (particularly the applied and health sciences) about authorship issues. Although these three bodies of literature have helped to contextualize issues, the last two (RCR and authorship guidelines) will be featured most prevalently throughout the thesis because of their important normative dimensions.

Science and Technology Studies

Publication is central in the academic *reward system,* an important object of study in STS. As such, the reward system can be helpful in understanding the contextual specificities influencing publication and authorship. Sociological and anthropological accounts explain the contextual aspects of the reward system in terms of power struggles. For example, Bourdieu maintains that the amount of individual power depends on the agent's (e.g., researchers, teams) scientific capital derived from knowledge and recognition (Bourdieu 2001). This is consistent with recognition and prestige being dependent on the number of publications authored by an individual researcher. According to Bourdieu, there are constant power struggles between agents to obtain more knowledge and recognition. The hierarchical structure

of science (Bourdieu 1976) frames an order of relationships between agents (individuals and groups); it is a power structure wherein agents interact and engage in confrontation with the goal of changing or sustaining power relations within that structure. Bourdieu sees the scientific structure as a meritocracy where 'scientific authority' or 'symbolic capital' is distributed depending on the scientific production of the agents. In effect, 'scientific authority' is the acknowledgement and recognition of status that is merited through authorship; it is also a valuable asset and represents a form of capital that can leverage or attract new research opportunities and additional funding. The result is a continuous cyclical dynamic where symbolic capital generates funding for new scientific production, which in turn produces new symbolic capital that then leads to new funding, and so on.

Another well-known author in STS, Bruno Latour, considers science from an ethnographic standpoint. Latour acknowledges that researchers obtain rewards through publication, but he argues that the system or cycle of science can be explained more fully through his notion of credibility rather than in terms of Bourdieu's economic notion of capital (Latour and Woolgar 1979, 206). Latour examines the reward system on a smaller scale than does Bourdieu; he sees the reward system as a "cycle of credit" wherein credit is a measure of *credibility* (Latour and Woolgar 1979, 194). The more credibility an individual has, the more recognition he receives. This recognition can in turn attract research grants or be converted to other sources of revenue, equipment, or data, which in turn allow the researcher to publish new articles. These new articles result in still more credibility and recognition, thus feeding or maintaining a continuous cycle. Latour notes that researchers may consider rewards important but their main motivation – which is central in the cycle of science – is scientific credibility. Rewards remain a means by which researchers acquire credibility.

In addition to the anthropological and sociological analyses of STS, genealogy (a historical method) has been used to analyse the history of a scientific technology, practice, or method. Biagioli explains that authorship is heavily influenced by the 17th century legal account of scientific practices as an individual endeavour (Biagioli 1999). Although 17th century laboratory technicians worked alongside the main or 'sole' author of the research project, they were never credited nor publicly responsible or accountable for their work. Biagioli notes that "Historically, then, the author has always been more of an efficient

accounting device for intellectual property or scientific credit than an accurate descriptive tool of knowledge-making practices" (Biagioli 1999, 24). Contributors omitted from authorship were usually from a lower social class and they were essentially exploited for their scientific expertise (Shapin 1989). Biagioli mentions that this exploitation might be less apparent today but it is still perpetuated in scientific practice through questionable authorship practices (e.g., the exploitation of or insufficient recognition given to students or technicians) (Biagioli 1999).

Although there are diverse accounts of the reward system in STS, power struggles, competition, and notable differentials between individuals or groups are commonly acknowledged. And, regardless of their respective theories – Latour favours credibility, Bourdieu symbolic capital, and Biagioli power or class differential – they all view publication as a valuable asset. The practical implications for the distribution of authorship are significant. Consider, for example, a student, who will likely have little symbolic capital, credibility, and be of a lower class in the academic hierarchies; this individual would probably be hesitant to raise any objections with a professor or researcher about authorship decisions because of the inherent power discrepancies. This is true *a fortiori* in relations between student and their supervisors. Because of the dyadic nature of the student-supervisor relation, a student will likely be very uncomfortable about confronting their supervisor about authorship because of the risk of alienation by the supervisor and possibly by the scientific community (Driscoll et al. 2009). Generally, it is in the best interest of a student to be on good terms with his/her supervisor as a prerequisite to inclusion or recognition in the scientific community. As such, the student may be more susceptible to tolerating injustices and thus at greater risk of being exploited (Oberlander and Spencer 2006; MacDonald and Williams-Jones 2009). Empirical studies have found that students put their supervisor's name on their papers even if their supervisor did not contribute substantially to their work (Mitchell and Carroll 2008; Bennett and Taylor 2003). While many of the actors in this power dynamic know that the appropriation of another individual's work is tantamount to plagiarism, they appear to quietly condone this unethical practice.

In an attempt to fit within the power structure and conform to the theories, assumptions, and methods of a superior, a student might refrain from making valid criticisms, or suggesting potentially creative innovative and solutions to problems. Further, in a

18

hierarchical system where credit and recognition is given to the supervisor, there might be little incentive for the student to extend their research beyond accepted boundaries of enquiry. Science is not well served within this dynamic (The professor-student dynamic will be examined further in **Chapter 2**).

In the more empirical studies in STS, elements such as power and credibility are seen to influence authorship but so too are other factors such as seniority and gender. This may be observed in Seeman and House's (2010) study on authorship practices in chemistry, which suggests that the seniority of researchers who have more power can unduly influence authorship distribution. Gender inequity in research publication is also recognized in the literature (Leahey 2006; Benschop and Brouns 2003; Larivière et al. 2011) as an element that influences publication productivity rates and could thus affect authorship. Larivière's team (Larivière et al. 2011) note that in the province of Quebec, women researchers over the age of 38 have less funding and less publications than their male counterparts. This productivity differentiation is explained notably by the fact that women are less likely to direct research teams, indicating that women occupy a lower status in academia. With less power, women may be the subject of more exploitation than their male colleagues and could thus be given a less than fair position in authorship.

The descriptive literature in STS helps demonstrate that authorship must be considered as part of the larger reward system of science. Like many institutionalized human endeavours, the creation of science, including authorship distribution, is influenced by multiple variables such as competition, power dynamics, gender and seniority. Accordingly, these influences should be considered in the creation of any normative framework for deciding fair authorship distribution. However, it must be noted that specifics regarding authorship decisions within the dynamics of multidisciplinary collaborations are often not considered; the descriptive STS research is based on information about certain fields or related to science as one general entity.

Other than this descriptive work, which is typical in STS, there has been some discussion regarding the normative system of science. The meaning and importance of collaboration and authorship distribution is influenced and determined to some extent by the norms espoused by the contemporary scientific community. While adherence to these norms varies to some degree depending on various factors (e.g., research institution, nationality and

discipline), Mertonian norms – i.e., communism, universalism, disinterestedness and organized scepticism (Merton 1973) – are still valued by contemporary researchers (Anderson 2000). In simple terms, 'communism' is the open sharing of research findings; 'universalism' is the evaluation of science, based on "pre-established impersonal criteria" (e.g., disciplinary norms) (Merton 1973, 270); 'disinterestedness' is the promotion of the scientific endeavour while precluding any personal interests or gain; and 'organized scepticism' involves the suspension of all beliefs and judgement so as to base the scientific process on logical and empirical enquiry. In Merton's *The Normative Structure of Science* (1973), these norms are "held to be binding on the man of science" (p.269) conveying a sense of obligation and perhaps even making the case for or emphasizing a restrictive *status quo.* In reality, such norms are more commonly interpreted as scientific *ideals* (Ziman 2002; Anderson, Martinson, and De Vries 2007). Authorship issues are often based on self-interest and competitiveness that can contradict the beliefs set out in the *ideal* normative system. Cases where beliefs and practice are not aligned give way to "normative dissonance", creating a sense of alienation and work strain (Anderson, Martinson, and De Vries 2007).

While there has been much critique of Merton's work (Anderson et al. 2010; Ziman 2002), it has remained quite influential (Barnes and Dolby 1970). For example, STS researchers have also studied a number of interesting post-publication injustices that were first introduced by Merton, such as the Matthew effect and Obliteration by incorporation. These two main injustices in publication practices have been reviewed and critiqued by contemporary authors such as Small (2004) and Van Looy's team (2004). The Matthew effect refers to the fact that those authors who are well cited have a greater chance of receiving further citations, while those authors who are less cited or not cited at all will remain poorly cited (Merton 1968; Small 2004; Van Looy et al. 2004; Merton 1988). Obliteration by incorporation (Small 2004) occurs when a concept becomes so popular that it is perceived as common knowledge and the author is no longer cited and given recognition for their contribution to the scientific endeavour.

Such research on post-publication injustices does not, however, address the influence or significance of unfair authorship distribution practices. For example, consider the naming as first author to a paper a prestigious author who did not make a contribution. If there is

obliteration by incorporation and this same first author does not get cited as often as he or she should, according to dominant citation practices, is there really an injustice? After all, he or she did not do the work in the first place. In other words, if distribution of authorship starts out in unjust fashion, the justification or assessment of those practices that follow will be further complicated and tenuous. Repeated and reoccurring unethical and unfair authorship distribution practices can thus distort and undermine the scientific systems of citation, recognition and reward.

The Responsible Conduct of Research

Many of the current ethical concerns of scientific authorship have been raised in the literature on research integrity, also called responsible conduct of research (RCR) which was developed in the US in the 1980s (Steneck and Bulger 2007). Since cases of misconduct were rarely the subject of media attention and public concern, self-regulation was generally seen as sufficient to encourage good conduct amongst researchers. After some notable and publicly denounced scientific scandals (Macrina 2005, 8–9), and in response to recommendations from the US Institute of Medicine (IOM) in 1989 (Rubenstein 1989), US funding agencies and research institutions instituted formal RCR education programs. In 1990, the National Institutes of Health (NIH) and the Alcohol, Drug Abuse, and Mental Health Administration made RCR education mandatory for institutions receiving federal funding; other funding agencies did so at a later date (e.g., the NSF in 1999 and PHS in 2000) (National Institutes of Health. Alcohol, Drug and Abuse, and Mental Health Administration. 1989). Since its inception, RCR training in the US has recommended the inclusion of "responsible authorship" in its curriculum (Committee on the Responsible Conduct of Research 1989, 36).

In the early days of RCR education and research, "responsible authorship" was mainly focused on the elimination of unethical practices such as the aforementioned gift/honorary and ghost authorship (Manton and English 2006; Manton and English 2008; Murray 2009; Ross et al. 2008; Wager 2007a). Current RCR research has expanded to include consideration of unethical practices related to granting credit, such as plagiarism, self-plagiarism, and "citation amnesia" whereby researchers omit important works in their field (Shamoo and Resnik 2009). Authors are also said to be held responsible for declaring any conflict of interest, minimising

bias, duly adhering to ethics protocols involving human participants or animal subjects, and, ensuring originality and truthfulness ("absence of false claims") of the proposed work (Anderson and Boden 2008, 156). Accepting responsibility for authorship is also considered a type of certification of the integrity of one's work (Bennett and Taylor 2003).

A definition of authorship is a prerequisite to identifying those individuals deserving authorship. As previously mentioned, in RCR research and guidelines, the notion of "significant contribution" is often used as the definition of authorship (Louis et al. 2008; Council of Science Editors (CSE) 2012). The notion of "significant contribution" is not, however, a concept accepted by all. For example, Shamoo and Resnik (2009) argue that this criteria is too vague, and so instead propose a more detailed and extensive description of authorship: "People should be listed as author on a paper only if they a) have made a significant intellectual contribution to the paper; b) are prepared to defend and explain the paper and its results; and c) have read and reviewed the paper." (Shamoo and Resnik 2009, 101) (A more detailed discussion of inclusion and exclusion criteria will be considered in the next section on authorship distribution guidelines.)

In RCR, it is also mentioned that authorship should have a direct link to the research accountability (Shamoo and Resnik 2009; Davidoff et al. 2001; Drummond Rennie, Yank, and Emanuel 1997). Without authorship practices that provide clarity or transparency as to the nature and extent of individual contributions, and also regarding the responsibilities for specific roles or tasks on a team, it is difficult to hold individuals to account for ethical or/and scientific wrongdoing, especially in a large team. Consider the following scenario. An individual decides to intentionally falsify data, and in so doing introduces bias that seriously compromises the results of a study. Since this individual's contribution may not be considered substantial, she is excluded from authorship and *de facto*, from any accountability. She may be to blame for her actions, but she is not accountable as an author. So in this case, we may blame an individual for wrongdoing without necessarily holding them accountable.[2] The individual who has made a substantial contribution to, and who has been assigned the task for data

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[2] This definition is not, however, universally accepted since one might also consider different types of responsibility and accountability, especially in interdisciplinary studies where there are, for example, differing degrees of legal and/or ethical responsibility. Other definitions will be considered, and a position on the subject will be taken, in the section on desert in Chapter 5.

quality should be accountable. However, if this role or task is unclear, then all or any number of authors on the team may be associated with the wrongdoing, even if they were not responsible. Indeed, obtaining an explanation from an accountable author as to how compromised data was introduced may be difficult if, for example, ten different individuals collected data and 100 individuals are considered authors.

In addition to accountability, authorship is equated with credit, merit or prestige for individual contribution (Resnik 1998, 105). This is consistent with the STS literature where authorship has a type of positive value (be it credibility, symbolic capital, or power). It is also in keeping with the practice of science where a researcher's success is measured by the amount and quality of publications on which he/she is an author. The only cases in which publication is negative to one's career are if the publication is ethically or scientifically questionable, e.g., found to involve fabrication, fraud, exploitation of human subjects, or undeclared conflicts of interest.

In RCR, there seems to be a growing consensus to define authorship in terms of both credit and responsibility. The amount of credit for research may differ within a team. Sometimes, order of authorship through ranking in decreasing order of contribution (Bennett and Taylor 2003) provides some clues as to who did the most work in a team (as is often the case in biomedicine). The one who contributed the most (the first author) often receives the most prestige and accountability. But this particular approach to authorship ranking may prove challenging in practice, especially when the nature of each author's contribution (e.g., intellectual, technical) is different and also difficult to measure and to compare. Further, individuals may interpret contribution differently; the exercise of comparing various contributions often necessitates open communication between individuals to understand what one contributed and to what extent. Such dialogue may be very difficult to undertake especially for team members located in different institutions or geographical areas.

Other than ranking individuals by decreasing order of contribution, some research teams attribute authorship using alphabetical order on the by-line. While this approach may seem much simpler and would create less competition within the team, it too has its problems. As shown in an empirical study in economics, since alphabetical order always gives first mention to those authors whose last name is at the beginning of the alphabet, there is a

negative bias towards individuals with names at the end of the alphabet (Chambers, Boath, and Chambers 2001). This is especially true when citing authors in text with conventions such as "(Albert et al.)" or "Albert and colleagues". A reader will rarely if ever remember the twentieth author on a large team. Further, alphabetical order does not provide information about a person's contribution to the research project (Van Praag and Van Praag 2008), and thus cannot address issues of individual accountability and merit. This approach to author order is frequently used in the humanities and in certain social science teams. To reduce bias caused by alphabetical ordering, Easterbrook has suggested reversing the order and starting with names that are at the end of the alphabet (Easterbrook 2003). While this attempt to reduce bias is well intentioned, it is rarely applied and may simply create further confusion.

In certain disciplines or fields, other authorship ordering practices have emerged. In the fundamental and some applied sciences, for example, the team leader may be listed last to give credit for leadership. The last author or the first author also usually has the role of corresponding author charged with responding to peer-reviewers or any inquiry about the study following publication. Another interesting approach in the health sciences and fundamental sciences is the "contributorship model" wherein the specific contribution of each individual is acknowledged (Drummond Rennie, Yank, and Emanuel 1997; Allen et al. 2014). However, listing the tasks completed by individuals in the process of research (e.g., data collection, analysis, or writing of the manuscript) does not answer the question of how authors should be named on the by-line. "Corporate authorship" has also been proposed where the group name and not the names of individual contributors appears in the by-line, e.g., the GUSTO team research (GUSTO 1993). This last option is rarely adopted (Weeks, Wallace, and Kimberly 2004) and journals invariably still require that individuals be named somewhere in the publication (e.g., in a footnote or endnote) to ensure a degree of individual accountability for the publication. It is unclear whether corporate authorship is meant to abolish individual responsibility by hiding behind a group name or whether it is meant to promote more collaborative arrangements.

Journals may accept various orders of authorship and this may promote controversy within teams. Because of the diversity of orders that can be used, certain authors consider fairness as an important guiding principle in authorship distribution. Shamoo and Resnik

mention the importance of distributing "a fair share of rewards of research, such as authorship or intellectual property rights" (Shamoo and Resnik 2009, 69), but they do not indicate what a fair share is nor how it is measured or determined in RCR.

Authorship Guidance

There are three main Journal editor organizations that have gained prominence for their ethical publishing guidance: the International Committee of Medical Journal Editors (ICMJE 2013c), The World Association for Medical Editors (WAME 2007a) and the Committee on Publication Ethics (COPE 2011b). Their publication policies address a variety of subjects including conflicts of interest, peer-review, responsibilities of different actors (e.g., authors, peer-reviewers, and editors), scientific misconduct (e.g., FFP), legal issues (e.g., copyright), duplicate publications and authorship. These international organisations remain the primary sources of guidance cited in the academic literature with regards to authorship (Hwang et al. 2003; Zachariah et al. 2013; Louis et al. 2008). Institutional (e.g., university or hospital) guidance concerning authorship is extremely limited (Louis et al. 2008). Specific journals may have some guidance but they are often disciplinary-specific and/or refer to one of the three international organizations. Institutional and journal guidelines remain part of the grey literature, and are outside the scope of this thesis.

The authorship guidance developed by international organizations is relatively recent, written in the last 20 years and then subsequently amended a number of times. As such, the definitions of authorship and statements about order proposed by these organizations have changed from one article (or Chapter) to the next in this thesis; e.g., the authorship definition is different in the first article (in **Chapter 2**) as compared to the last (in **Chapter 5**). The ICMJE guidance is currently the most popular and widely cited in health sciences research, and it has received the most amendments in the last five years.

The ICMJE authorship criteria in the 2008 version of the *Uniform Requirements for Manuscripts Submitted to Biomedical* (ICMJE 2008) state that

> 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. …Each author should have participated sufficiently in the work to take public responsibility for appropriate portions of the content. (ICMJE 2008, 2–3)

This definition of authorship was used until 2013 when the ICMJE's central policy on publications ethics was renamed the *Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals* (ICMJE 2013b). In the updated 2013 version of the policy – as well as subsequent versions until 2014 (ICMJE 2014) – authorship is based on four criteria:

1. Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
2. Drafting the work or revising it critically for important intellectual content; AND
3. Final approval of the version to be published; AND
4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. (ICMJE 2014)

Although many elements such as the notion of "substantial contribution" have remained unchanged, the wording of the different contributions in criterion 1 has been clarified. Moreover, a fourth criterion was added in the 2014 version to ensure that individuals remain accountable for the investigation of questions regarding the integrity of the work. This differs from the previous ICMJE guidance which stated that individuals were responsible for a part of the research without being accountable for the outcome of the rest of the article. Accountability and responsibility are key elements of authorship and they are addressed in more detail later in the thesis.

The WAME guidance states that "Everyone who has made substantial intellectual contributions to the study on which the article is based (for example, to the research question, design, analysis, interpretation, and written description) should be an author" (WAME 2007b). This definition seems more encompassing than that of the ICMJE. However, the notion that "intellectual contribution" must be necessary, without a similar mention of "technical contribution", would seem to undervalue the latter as a lesser contribution to research. The challenges inherent in the comparative assessment and valuing of different types of contributions will be discussed in **Chapter 2**.

COPE does not define criteria for authorship but rather mentions that guidance should flow from and be consistent with standards of the relevant, respective field of research. Journals should "provide guidance about criteria for authorship and/or who should be listed as a contributor following the standards within the relevant field." (COPE 2011b) Both COPE and WAME have not changed their policies in recent years.

Other than the aforementioned criteria for authorship, there is little in the way of substantive guidance for determining authorship order and distribution. In fact, the notion of order, which was present in older versions of the ICMJE, has since been withdrawn. In the 2007 ICMJE policy it is noted that:

> The group should jointly make decisions about contributors/authors before submitting the manuscript for publication. The corresponding author/guarantor should be prepared to explain the presence and order of these individuals. It is not the role of editors to make authorship/contributorship decisions or to arbitrate conflicts related to authorship. (ICMJE 2007)

The following year (in 2008), the policy was modified and stayed in effect until 2013. With regards to authorship order, the policy notes that:

> The corresponding author/guarantor should be prepared to explain the presence and order of these individuals. It is not the role of editors to make authorship/contributorship decisions or to arbitrate conflicts related to authorship. (ICMJE 2008, 3).

Interestingly, the 2007 version seems to put more emphasis on some type of joint decision-making, while the 2008 version seems to validate the justification of authorship order by one individual (e.g., the guarantor) without mention of any debate or negotiation amongst the authors involved.

The notion of "order" is entirely absent in the 2013 and 2014 versions, even though it is mentioned as a central issue in authorship discussions in the scientific literature (Marušić, Bošnjak, and Jerončić 2011). In a personal communication (in 2015) with representatives of the ICMJE, it was affirmed that they "do not include recommendations for or criteria upon which the ordering of authorship should be determined as the contributions / roles served by the individuals involved may vary substantially among papers. Editors are not in a position to

determine who did what and similarly the appropriate ordering of authors." (personal communication, 2015). This statement by the ICMJE thus clearly removes from journal editors any responsibility for the management of authorship order disputes; order must be debated and resolved by the authors prior to manuscript submission and ensuing publication.

While the open discussion and resolution of authorship issues prior to publication is the ideal scenario, it is not always the case. There may be situations in which there is no forum for discussion, no resolution mechanism, and consequently conflicting views and disagreements may remain unaddressed. Journal editors nonetheless may still receive emails from disgruntled authors who are dissatisfied with a particular order. The COPE website, for example, publishes case studies to inform and guide editors who may face ethical challenges; and there are 96 different cases under the rubric "authorship" (COPE 2015). Yet, there remains a policy void. Without clear guidance regarding authorship order, editors can find themselves embroiled in a dispute where the following questions are raised. *Should all authors agree with the order? Does order need to be accepted by all authors or only by the guarantor? Can peer-review be initiated before order is set? Should an editor give more weight to one type of order or another? Can reviewers that make substantial comments be considered as authors? How do we adjudicate cases of authorship misappropriation?* While it is understandable for organizations such as COPE, ICMJE or WAME to want to stay out of disputes between authors, journal editors may still find themselves implicated, which can ultimately complicate the publication process.

Nonetheless, the authors of a manuscript are the individuals who know first-hand who contributed to the research and to what extent. They remain responsible for their own manuscript, including the order of authors. WAME thus suggests that authors decide order but it also calls for transparency in explaining that order:

> Readers cannot know, and should not assume, the meaning of order of authorship unless the approach to assigning order has been described by the authors. Authors may want to include with their manuscript a description of how order was decided (WAME 2007b).

Similarly, COPE mentions that it would not be right to presume that by-line order is typically the given or preferred option, because other practices may be equally or more appropriate

(COPE 2011b). This acknowledgment of, and openness to, a range of authorship orders is not surprising since COPE provides guidance to journals from all fields of research with different authorship practices, and it most likely does not want to favour, or cater to, any one field over another.

Before concluding, it is important to point out that the effective implementation of, or adherence to, the aforementioned guidance is limited by the absence of any enforcement mechanisms. While serious unethical behaviour may constitute an infraction under criminal law (e.g., fraud), unethical authorship practices are for the most part not considered criminal offenses and thus they are not dealt with by the justice system. In certain countries, oversight organizations have been created, such as the Office of Research Integrity (ORI) in the US, but they usually deal only with scientific misconduct defined as "fabrication, falsification and plagiarism" (NSF 2009).

Generally, science is self-governing. But with the growth of multidisciplinary research collaborations, if science is to remain an effective and credible self-governing system, it must develop a practical, coherent and ethical way to address challenges about appropriate authorship. Disciplines can be seen as separate self-governing systems (with different norms), but these systems must somehow work together with regards to authorship in multidisciplinary teams. There are no policies that seem to address the realities of multidisciplinary teams (e.g., contradictions in norms, needs, values). International guidance in health sciences (mainly ICMJE) seems to consider science norms as universal, giving little or no consideration for disciplinary specificities or diversity.

Conclusion

This chapter reviewed the literature from STS, RCR as well as authorship guidelines provided by three renowned publication ethics organizations (ICMJE, WAME, COPE). As we have seen, the STS literature describes reward systems that place emphasis on publication. Authorship can be seen as capital or as credibility that gives status or prestige to individuals within the university hierarchy. STS considers certain variables that influence authorship (e.g., gender, seniority); however, it does not provide any practical guidance to researchers regarding how to manage or distribute authorship. While the STS literature describes the

context of research in interesting detail, it is limited in its consideration of the normative aspects of authorship. The RCR literature and guidelines, by contrast, consider certain values that could apply to authorship distribution, such as transparency and consensual decision-making, but any normative guidance remains poorly defined. Even with transparency and consensual decision-making, agreement on authorship can be particularly difficult to achieve given the different and sometimes conflicting authorship traditions that may be held by team members from diverse disciplines. Journal editor organizations such as WAME, ICMJE and COPE have taken the initiative of developing authorship guidelines, and these are receiving increasing attention in the literature on authorship. But while these guidelines may prescribe exclusion and inclusion criteria for authorship in biomedical or health sciences, authorship order and distribution remains particularly vague, especially for multidisciplinary research teams. Moreover, there are as yet no clear and well-argued theoretical justifications to support the principles put forward in these guidelines, nor are there any specific practical processes to help researchers determine appropriate authorship and order.

LINKING STATEMENT

The review of the literature provided in **Chapter 1** was interdisciplinary and wide-reaching, and provided pertinent information on the state of authorship distribution from three different sources: 1) STS, 2) RCR and 3) authorship guidance. This information established the basis for determining areas of further study and informed the drafting of the articles that are presented in this thesis. Notably, the review revealed that both credit and responsibility are acknowledged as integral parts of authorship in science, and, more specifically in the health sciences. Also, certain definitions regarding authorship such as the notion of "substantial contribution" exist, but it was noted that there are still significant gaps in identifying issues and providing concrete guidance. The literature is also relatively silent with regards to what order authors should use when distributing authorship; this is a major shortcoming since the issue is particularly relevant in multidisciplinary health science collaborations where diverse and sometimes conflicting norms and practices may exist.

The next chapter is presented in article format and maps out the general issues that may arise in distributing authorship in multidisciplinary health science collaborations. Co-authored by myself and Professor Bryn Williams-Jones, it was published in 2011 in the journal *Science and Engineering Ethics*. In this paper, we analyze how the notions of credit and responsibility are interpreted and addressed in authorship distribution. Credit and responsibility are usually tied to specific intellectual or technical contributions to research. We show here that determining the value as well as the relative ranking of contributions is often difficult, especially when the contributions are different in nature. In instances where researchers use ranking based on contribution as a type of order (which is often the case in the health sciences), this problem is particularly striking. The importance and value of a contribution may also vary according to the type of project. Finally, with the growing number of individuals being named on papers, determining responsibility for diverse contributions and also, for a research project overall, remains a significant challenge. While each individual can be responsible for his or her own contribution, it is hard to know who is responsible for the work as a whole.

The review of the literature for this article was part of an independent study that I completed under the supervision of Bryn Williams-Jones. We then discussed the main

problems and structure of the article in order to transform the work into a publishable form. I wrote the first draft of the article; Bryn Williams-Jones then commented on the article adding information and ideas to strengthen the argumentation and logical flow of the text. We both critically revised all the subsequent drafts until we agreed on the version of the manuscript submitted for peer-review. We also agreed on authorship order and distribution.

It should also be noted that the main ethics publication guidance documents (the ICMJE policy) have been amended multiple times since the publication of this article. Although changes remain minor, they are important for this thesis because they concern the notion of "authorship order". As mentioned in **Chapter 1**, ICMJE did previously mention that order should be the result of consensus among team members. In the newest ICMJE publication policy, the notion of order is completely absent (ICMJE 2014).

CHAPTER 2: AUTHORSHIP AND RESPONSIBILITY IN HEALTH SCIENCES RESEARCH: A REVIEW OF PROCEDURES FOR FAIRLY ALLOCATING AUTHORSHIP IN MULTI-AUTHOR STUDIES

Authors: Elise Smith and Bryn Williams-Jones

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.

Introduction

Widely accepted metrics for the success of a researcher in the academic health sciences[3] are the quality and quantity of journal publications. Publications have a 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 2005a). 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 specialties 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

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[3] 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.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.

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 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 multidisciplinary 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. 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 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, Maisonneuve, and Chapuis 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 2005b). 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 2007b).

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, Semenza, and Nolte 2009; D Rennie, Flanagin, and Yank 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 2005a). 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, Semenza, and Nolte 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 (Cronin 2005).

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.[4]

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.

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

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

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, Wells, and Farthing 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 (2009) 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 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 (Department of Health and Human Services 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 "agreed 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 specialties) 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.

Acknowledgments

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LINKING STATEMENT

The article presented in **Chapter 2** discussed a variety of issues concerning the distribution of authorship in multidisciplinary health sciences research. A review of the authorship guidance and advice from learned societies and from the academic literature revealed that certain guidelines address definitions of authorship, but little is said about the order of authors on the by-line. The more popular practice is to rank individuals in descending order of contribution (e.g., those who contribute most, first and those who contribute less, later). This approach is complicated when contributions are of a different nature, which in turn makes comparative assessment or rating difficult. While we may assume and agree that individuals are responsible for their own contribution to research, connecting identifying an individual to specific research tasks is not always straightforward. **Chapter 2** showed how responsibility and accountability might be distributed differently, either according to guarantorship or contributorship; both models have been promoted by international publication ethics organizations such as the ICMJE.

Chapter 3 extends the discussion of the limitations of authorship guidelines (e.g., ICMJE) to the specific context of Global Health Research (GHR). The article presented in this next chapter was co-authored by myself and Professors Matthew Hunt and Zubin Master and published in 2014 in *BMC Medical Ethics*; it analyzes partnerships between researchers from High Income Countries (HIC) and researchers from low to medium income countries (LMIC). We show in this article how authorship ethics promoted by ICMJE can be problematic in such partnerships, analyze the issues and recommend ways to develop ethical authorship guidance and practices that are applicable and relevant to GHR realities.

The idea for this article emerged from a discussion at the Symposium on Professional Ethics in 2012 in which Professor Hunt and I participated. We realized that the authorship practices in GHR differed significantly from current norms and practices in health research more generally or even with international guidelines. For example, the distribution of authorship based on geographic location is a new method used to ensure that researchers from both HICs as well as LMICs are given equal acknowledgement regardless of the work or contribution involved. The rationale for such different authorship distribution practices seemed worth further study. As an expert on authorship ethics, Professor Master was then

included in the research collaboration. All co-authors met to discuss the main issues and together determined the general elements of the article. I conducted the literature review and drafted the first version of the paper, which was then shared with the co-authors for comments and further revision. The final draft was submitted for publication with the approval of all authors, and we agreed on authorship order and distribution.

CHAPTER 3: AUTHORSHIP ETHICS IN GLOBAL HEALTH RESEARCH: ANALYSING COLLABORATIONS BETWEEN RESEARCHERS FROM LMIC AND HIC

Authors: Elise Smith, Matthew Hunt and Zubin Master

Abstract

Background: Over the past two decades, the promotion of collaborative partnerships involving researchers from low and middle income countries with those from high income countries has been a major development in global health research. Ideally, these partnerships would lead to more equitable collaboration including the sharing of research responsibilities and rewards. While collaborative partnership initiatives have shown promise and attracted growing interest, there has been little scholarly debate regarding the fair distribution of authorship credit within these partnerships.

Discussion: In this paper, we identify four key authorship issues relevant to global health research and discuss their ethical and practical implications. First, we argue that authorship guidance may not adequately apply to global health research because it requires authors to write or substantially revise the manuscript. Since most journals of international reputation in global health are written in English, this would systematically and unjustly exclude non-English speaking researchers even if they have substantially contributed to the research project. Second, current guidance on authorship order does not address or mitigate unfair practices which can occur in global health research due to power differences between researchers from high and low-middle income countries. It also provides insufficient recognition of "technical tasks" such as local participant recruitment. Third, we consider the potential for real or perceived editorial bias in medical science journals in favour of prominent western researchers, and the risk of promoting misplaced credit and/or prestige authorship. Finally, we explore how diverse cultural practices and expectations regarding authorship may create conflict between researchers from low-middle and high income countries and contribute to unethical authorship practices. To effectively deal with these issues, we suggest: 1)

undertaking further empirical and conceptual research regarding authorship in global health research; 2) raising awareness on authorship issues in global health research; and 3) developing specific standards of practice that reflect relevant considerations of authorship in global health research.

Summary: Through review of the bioethics and global health literatures, and examination of guidance documents on ethical authorship, we identified a set of issues regarding authorship in collaborative partnerships between researchers from low-middle income countries and high income countries. We propose several recommendations to address these concerns.

Background

There has been considerable coverage in the popular press and in academic scholarship about authorship ethics including such topics as plagiarism, ghost authorship, and even the selling of authorship (Bast and Samuels 2008; Wager 2007a; Wager 2009; Coats 2009; Ross et al. 2008; Hvistendahl 2013). Authorship is very important to researchers in all disciplines because it directly impacts decisions regarding hiring, tenure and promotion, and awards and grants. Notwithstanding the guidance on ethical authorship and publication practices, several reports show that unethical authorship occurs in upwards of 10% of cases (Martinson, Anderson, and De Vries 2005; Martinson et al. 2006). Disagreement about authorship allocation also occurs frequently within research teams. In a recent study of Nigerian researchers, 36.4% of respondents reported authorship disagreement (Okonta and Rossouw 2013). Similarly, an editorial published by Zachariah et al. describes difficulties associated with distributing authorship in research teams conducting operational research in low and middle-income countries (LMICs) (Zachariah et al. 2013). These authors note that the application of guidelines on authorship often excludes recognition of important actors who have made essential contributions to research in LMICs (e.g., nongovernmental organisations, policy makers). Fair distribution of authorship has also been a concern in global health research (GHR) partnerships (Costello and Zumla 2000; Emanuel et al. 2004), where scholars from LMICs collaborate with researchers from high-income countries (HICs).

It is generally accepted that authorship credit should be given to individuals who make "substantial contributions" to the design and/or conduct of research, and the reporting of research (ICMJE 2013c). However, many other factors come into play during decision-making around authorship credit, including: disciplinary norms (Seipel 2003), competition (Drummond Rennie and Flanagin 1994), departmental politics (Ezsias 1997), and favouritism (Seeman and House 2010). Authorship practices in the context of GHR can be even more challenging given the variety of roles and responsibilities of researchers from LMICs and HICs. Ultimately, various factors may contribute to, or influence authorship decisions.

The aim of this paper is to explore issues relating to authorship practices in GHR partnerships and to propose recommendations. We limit our focus on partnerships in which authors from LMICs collaborate with researchers from HICs. We begin by providing

important background information including the general context of global health research and authorship as well as current norms or guidelines concerning authorship. We then consider four specific issues related to authorship, namely: language barriers limiting opportunities for authorship attribution; the lack of guidance for ranking authors; the risk of gift authorship linked to perceptions of editorial bias for well-known researchers from English-speaking HICs; and, the impact of diverse cultural understandings and expectations regarding research contribution and ownership. The two former issues are linked to authorship shortcomings regarding authorship recommendations outlined in the International Committee of Medical Journal Editors (ICMJE) authorship guidance while the latter two concern authorship practices more generally. While some issues may appear to be practical in nature, we will demonstrate that they often have significant ethical consequences. To address the ethical and practical concerns about authorship in GHR partnerships, we recommend further research on norms and practices in GHR settings, additional training for researchers, and finally, improved guidance.

Discussion

The Context of Authorship in Global Health Research

Global health "places a priority on improving health and achieving equity in health for all people worldwide" and "emphasizes transnational health issues, determinants and solutions." (Koplan et al. 2009, 1995). Research in the field of global health is often multi or interdisciplinary and is highly collaborative (Koplan et al. 2009). For the purposes of this paper, the focus will be on a specific subset of partnerships in global health: situations where LMIC and HIC researchers collaborate as members of multi- or interdisciplinary research teams, and where authorship is attributed to many individuals, each responsible for specific tasks. These collaborative partnerships bring together researchers from LMICs and HICs to share and maximize their diverse expertise, experiences, and perspectives within a knowledge network. For example, researchers from HICs and LMICs may obtain a grant to study the genetics of a tropical disease. HIC researchers may have scientific expertise and access to state-of-the-art technology required for the study. LMIC researchers from countries affected by this disease can provide scientific expertise, as well as valuable insight and knowledge respecting local realities and needs; they are also likely to have easier access to, and be more

easily accepted by, research participants and local institutions than are "outsiders" (Zarowsky 2011). Together they may be able to develop epidemiological genetic information that can lead to more effective public health interventions to treat the targeted disease.

Such partnership collaborations have been promoted, in part, to counter inequality and imbalance in GHR where researchers from HICs have not always studied topics of relevance to local communities in LMICs (Simon, Mosavel, and van Stade 2007). For GHR projects undertaken in LMICs, funders and research ethics boards often require that the research address local interests and needs. Accordingly, researchers involved in GHR partnerships are increasingly being held ethically responsible to support "community collaboration and engagement" (Simon, Mosavel, and van Stade 2007, 1961).

While many researchers and commentators have acknowledged the laudable goals and benefits of such GHR partnerships, they have also pointed out practical challenges and limitations of such collaborations. These challenges include power inequities, communication barriers, diverging research priorities, as well as important differences in research cultures (Riddes and Cappelle 2011). Even if there is little wide scale empirical evidence, the allocation of research credit through authorship is a key issue that is often raised (Okonta and Rossouw 2013; Zachariah et al. 2013; Costello and Zumla 2000; Emanuel et al. 2004). It remains, however, unclear how authorship is or should be appropriately reflected through the order of attribution.

Authorship policies in GHR

Various organisations such as the ICMJE (2013c), World Association of Medical Editors (WAME) (WAME 2013) and the Committee on Publication Ethics (COPE) (COPE 2011c) have discussed ethical authorship and publication considerations in scientific manuscripts. However, health-based researchers and journals have not as yet consistently applied current guidance (Wager 2007b). COPE mentions that editors should adopt guidance related to authorship, but does not propose specific criteria on authorship (COPE 2011c) and WAME provides very general guidance recommending that all authors make "substantial intellectual contribution" (WAME 2007b). The ICMJE has set out more specific detailed authorship recommendations. ICMJE lists the following criteria for authorship:

1. Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND 2. Drafting the work or revising it critically for important intellectual content; AND 3. Final approval of the version to be published; AND 4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. (ICMJE 2013c)

While ICMJE authorship recommendations may at first glance seem onerous, they aim to ensure that all researchers who are authors are engaged throughout the life cycle of the research project including conducting the research, drafting, revision and approval of the article, and accepting responsibility for the work. While the ICMJE recommendations have been and are still at times the subject of criticism, they have become the leading standard in health science research, including GHR (ICMJE 2013c).

Issues regarding authorship in GHR

Satisfying Authorship Criteria for Researchers with Limited English Language Abilities

Although the ICMJE recommendations are reflected in many scientific codes of ethics and have been adopted by many journals (Wager 2007b) they do not adequately address the more complex nature of research collaborations where contextual factors influence whether every researcher contributes to, or participates in, the entire research process. This is particularly true in GHR where language abilities may pose significant barriers.

In GHR partnerships, HIC researchers are more likely to have stronger English language abilities than their colleagues in LMICs. The latter may be at a distinct disadvantage in drafting part of or an entire article for English health sciences publications, or critically revising it for important intellectual content (ICMJE criterion 2). While it is possible to publish in scientific journals in languages other than English, these journals are less likely to be in international databases and would not receive similar international readership or exposure (Salager-Meyer 2014).

If LMIC researchers are unable to draft or critically revise the article, they would technically fail to satisfy the ICMJE recommendations for authorship. Thus a researcher who may have substantially contributed to the research by participating in the study's conception

or design, or the acquisition, analysis or interpretation of data (thereby satisfying condition 1), may not be named as author due to a lack of English reading and writing skills. Having a non-English speaking individual draft the article in their native language with the aid of a professional translator might prove burdensome because of the substantial translation costs, and would also necessitate the verification of the translated text by a native English speaker to ensure its accuracy. Consider as well, that most free online translation tools are fraught with errors, requiring massive edits by the English-speaking author or payments for additional editorial services. Due to financial costs and the added time required, many researchers may be reluctant to pursue such steps to satisfy ICMJE criteria.

The ICMJE recommendations clearly state that

…the criteria are not intended for use as a means to disqualify colleagues from authorship who otherwise meet authorship criteria by denying them the opportunity to meet criterion #s 2 or 3. Therefore, all individuals who meet the first criterion should have the opportunity to participate in the review, drafting, and final approval of the manuscript (ICMJE 2013c).

Providing adequate opportunity is a fundamental principle in the ethics of science and helps to prevent discrimination based on gender, race, and sexual orientation (Resnik 1998). However, LMIC researchers may still fall short of satisfying all four ICMJE criteria even if ample opportunity is given to write, revise and approve the manuscript because of limited knowledge of the English language.

In a similar vein, all researchers who are authors need to be accountable for the work as indicated in ICMJE criterion 4, and to do this they need to satisfy criterion 3 and approve the final version of the text to be published. Researchers who cannot read or write in English might be able to partially satisfy criterion 3 using online translation tools. But similar to the point made above, translation generated by these tools is far from flawless and language discrepancies are likely to result in a loss in translation. While not a perfect approach, online translation tools will often be sufficient to allow researchers who cannot read in English to approve the final version of the article and be accountable for the published work.

However, even if ways are found to satisfy criteria 3 and 4, criterion 2 – drafting the work or revising it critically for important intellectual content – will be much more difficult

for non-English writing researchers to satisfy for English publications. To limit the shortcoming of translation tools, the manuscript's revision could be achieved through verbal discussions in order to ensure that all researchers agree that the manuscript properly conveys the research. The notion of "revising the article critically" (as stated in ICMJE criterion 3) could be interpreted differently in the GHR context to mean "reviewing" the article for important intellectual content so that there is less dependence on LMIC authors' English writing abilities. In this sense, the LMIC author, like any other author, is still engaged in the drafting and review process of the manuscript and is still contributing in substantial ways to the research. Further examination is warranted as to how current ICMJE guidelines could contribute to systematic exclusion of some GHR researchers from authorship based on language ability. Ultimately, the aforementioned and other amendments to ICMJE should be given further consideration in order to avoid unfair exclusion of authors based on language.

Ranking Authors in GHR Collaborations

The ICMJE recommendations state that authorship decisions should be made by all authors as a group, and that the corresponding author "should be prepared to explain the presence and order of these individuals" (ICMJE 2009). This does not suffice to address the complexities of GHR collaborations. In the health sciences more generally, authorship is often attributed in descending order of contribution (Wager 2009) although other methods may also be applied (e.g., alphabetical order, principal investigator/team leader being senior last author) making distribution quite variable (Street et al. 2010). Moreover, ranking would most likely not apply when a number of authors have contributed more or less equally. The comparative assessment of contributions may also be tricky for different types of work (e.g., technical tasks or conceptual contributions to the design of research). Since GHR collaborations are often interdisciplinary, other distribution methods from various disciplines may also be considered, including alphabetical order (Waltman 2012). In large teams where ranking is complex because many have contributed relatively evenly, a mixed method of ordering may be applied: the first few authors are listed according to the importance of contribution in descending order, while others are named in alphabetical order. In the interest of accuracy and transparency, an asterisk may be added with a disclaimer mentioning that certain individuals have contributed equally. Akhabue and Lautenback's empirical study on equal credit in top medical journals

shows that disclaimers were a growing trend in medical journals from 2000 to 2007 (Akhabue and Lautenbach 2010). Diversity in naming authors might be due to the fact that norms regarding ranking have never been formally codified.

The lack of guidance respecting authorship order in general can also be applied in GHR collaborations and could potentially create confusion and lead to insufficient recognition of LMIC researchers. For example, LMIC researchers may be given reduced ranking on the author byline because their contributions to subject recruitment, data collection, administration and analysis are categorized as "technical tasks" and may be considered of lesser value than drafting the manuscript. This reduced authorship ranking is ethically problematic because it may place LMIC researchers at a disadvantage, which could negatively affect their career prospects, access to research funds, and the scholarly recognition they deserve.

Unfairness stemming from a lack of clear ranking methods may also be the effect of power differentials within and between teams. HIC researchers are often better positioned to obtain the funding essential to GHR projects. Funding eligibility for the team may be deemed more valuable in securing resources. Consequently, individuals from LMICs with less funding leverage might accept, or feel obliged to accept, a lower ranking of authorship, even when their contribution is more substantive and deserving of higher authorship ranking. Power differentials often linked to research financing is certainly an issue in many contexts of research (Lucas 2006). However, in partnerships between HIC and LMIC researchers, power differentials are likely more pronounced because of greater discrepancies in access to research funds.

In order to address differences in types of contributions and mitigate disadvantages to LMIC researchers, some research teams have elected to alternate the order of authors based on geographic origin instead of maintaining the extent of contribution as the sole determining factor in ranking. For example, in an HIV study in Guatemala, the authors elected to alternate their names based on their geographic location (e.g., one author from Canada, one from Guatemala, etc.) (Johri et al. 2010). The intent is to recognize the amount of contribution of each author, as well as to address the reality that the contributions of LMIC contributors might, by their very nature, receive lower authorship recognition than those made by HIC

contributors. While seeking to address issues of equity in GHR partnerships, concerns about fairness would arise especially where levels and the types of contribution differed extensively.

In an attempt to level the playing field, HIC researchers may provide greater visibility and opportunity to researchers in LMICs by offering authorship or a higher ranking than was deserved based on contribution alone. The rationale behind this may be similar to that found in affirmative action or redistributive justice programs which seek to compensate for past and/or present discrimination or bias. It may indeed put LMIC researchers on a more equal footing with HIC researchers. However, it is far from clear that authorship – which should establish responsibility and accountability for research (Rennie, Yank, and Emanuel 1997) – is the appropriate method to level this playing field. Building research capacity in LMICs, providing more opportunities for LMIC researchers to contribute to research, and expanding the possibility of LMIC researchers to secure grant funding, are more promising means to bring balance than undeserved authorship.

The use of a disclosure statement to explain authorship order can be effective in clarifying and justifying authorship order, or to avoid misinterpretations. Disclosure statements (or "contributorship") usually outline the contribution of individuals in research design, data collection and analysis, and drafting; however, they are limited in that such declarations do not clearly indicate how authors were ranked based on the amount of work or its level of difficulty (Rennie, Yank, and Emanuel 1997). Regardless of such shortcomings, declaring author contributions has increased transparency regarding the type of work of each individual. Certainly, further discussion about effective strategies for authorship ordering in GHR is needed in order to establish fairness and opportunity for all team collaborators.

Perceived Editorial Bias may Promote Unethical Authorship Practices

The underrepresentation of research from LMICs in peer-reviewed journals is well documented (Horton 2000; Langer et al. 2004; Mendis et al. 2003). There are a number of reasons to explain this situation, such as the lack of infrastructure; inadequate human and financial resources in LMICs (Salager-Meyer 2008); weaknesses in manuscript preparation (presentation, logic, language); and limited access to scientific literature (Langer et al. 2004). Several studies suggest that there may also be an inherent bias by journal editors who favour

research from English speaking researchers (Coats 2009; Landa 2006; Yousefi-Nooraie, Shakiba, and Mortaz-Hejri 2006; Tutarel 2004; Matías-Guiu and García-Ramos 2011a). However, when discussing the potential bias in favour of well-known or "star" authors, Godlee and Dickersin report that "the available evidence is patchy […] and inconclusive" (Godlee and Dickersin 2003, 96).

Regardless of whether editorial bias regarding well-known authors is widespread or not, certain researchers might believe in the existence of such bias. This perception could incentivise researchers from LMICs to bestow "prestige authorship" upon their collaborators from HICs by offering them senior author or primary (first) author positions. Researchers may think that this helps their chances of getting the paper accepted for publication. Researchers from HICs could use the same rationale and advocate that they should be given primary or senior author positions, arguing that it will increase the likelihood of having the paper accepted in a high impact journal.

Several strategies have been implemented to address the underrepresentation of research from LMICs. Journals provide editing services for non-English authors (Lillis, Magyar, and Robinson-Pant 2010; "AuthorAID" 2014); space is devoted to local research on issues relevant to specific regions; certain costs are subsidized for LMIC researchers and institutions ("Research4Life" 2012); and open access journals provide waivers for authors from LMICs (PLoS 2013). While these initiatives are laudable, they do not eliminate perceptions of editorial bias for prominent well-known, English speaking researchers. Researchers from LMICs may still decide to provide prestige authorship to their HIC counterparts irrespective of measures to increase access and reduce costs associated with publication. It is necessary to look for other means to address this potential bias. Perhaps open discussion of this topic to reduce misconceptions may help avoid such issues. It might also be warranted to ask why such perceptions may be present and to assess empirically the extent to which such perceptions actually influence authorship practices.

Differing Values and Practices Related to Research Integrity

Most research on the responsible conduct of research (RCR) comes from HICs – more specifically the US – and only recently are we learning about RCR practices in LMICs (Ana et

al. 2013). Consequently, the values, practices and principles defining research integrity mainly reflect the social norms and values in HICs, and do not always adequately take into consideration the norms and values of LMIC researchers. There is also little research documenting cultural differences and the related perceptions and norms of research integrity across different countries and regions for both HICs and LMICs. Cultural differences between GHR collaborators are likely to play an important role in authorship decisions and may explain some authorship practices that fall outside ICMJE recommendations. Cultural differences can lead to conflicting views or positions regarding RCR. In some cultural contexts, it may be deemed appropriate or even required to give authorship credit out of respect (e.g., to senior colleagues, or directors of institutes). Of course, this runs counter to norms and practices endorsed by guidance documents like the ICMJE.

Gender bias might also lead to unethical authorship practices in GHR collaborative partnerships. In some settings, women may be less likely to be named authors in research publications as often as men even if they have made the same contributions to the project. For example, one study found that black women in South Africa are particularly marginalised and rarely given first author positions in collaborative publications (Shefer, Shabalala, and Townsend 2004). While the rate of women conducting research and publishing in South Africa has increased during the last 20 years (Duncan, van Niekerk, and Townsend 2004), there remains significant underrepresentation of women in scientific authorship. More knowledge is needed to truly understand the effect of gender bias on authorship distribution in GHR.

As GHR is often undertaken by multi/interdisciplinary, international teams comprised of researchers from a variety of backgrounds and cultures, there is likely to be divergence respecting authorship practices and expectations. These differences may lead to conflicts within GHR teams or questionable authorship practices, which in turn may jeopardize future collaborations, or tarnish reputations and careers. Global health researchers especially need to be mindful of these differences. Disputes over authorship in GHR collaborative teams can be minimized and may be handled more collegially if they are discussed openly at the outset of a project (Afsana et al. 2009). Increased awareness of cultural differences among GHR team members is important in order to establish a reciprocal understanding of the views of

researchers from different cultures, and facilitate negotiations and buy-in with respect to authorship decisions.

Recommendations for Ethical Quthorship in GHR

We recommend three initiatives to begin addressing authorship issues related to GHR collaborative partnerships: (1) to undertake research on research integrity (RRI) with a focus on authorship in GHR, (2) to increase awareness and understanding in the research community about authorship issues in the GHR context, and (3) to strengthen ethical guidance on authorship in GHR.

Research on Authorship Norms and Practices in GHR Settings

Performing conceptual as well as empirical RRI is a necessary preliminary undertaking to understand the norms, values, and practices of authorship specific to GHR. RRI will address descriptive questions such as how authorship is allocated, how authors are ranked, and what factors influence authorship decisions. Policy related questions would include the following: Are current authorship standards sufficient? Do we need to reform authorship criteria? What should be the basis for authorship ordering in GHR? Description of GHR practices might help us understand how authorship is distributed and how researchers perceive important topics related to authorship such as responsibility and merit.

Educating Researchers about Authorship in the GHR Context

Raising awareness about ethical authorship can be done through RCR education. Given the relatively high prevalence of authorship issues and disputes (Martinson, Anderson, and De Vries 2005; Martinson et al. 2006; Okonta and Rossouw 2012), and the likelihood that researchers will face authorship issues early in their careers, training on authorship ethics should be included in graduate studies. This would introduce students to a culture of research integrity at the outset of their research careers and help them to better recognize problematic issues and understand the implications of unethical conduct. Training can lead to better understanding, negotiation and acceptance regarding authorship at the outset of a project to prevent or mitigate reduced morale and conflict about authorship. More specifically, in practice, researchers may learn a variety of ethical ways to distribute authorship in GHR by

providing opportunity for contributors to become authors without creating systematic disadvantages or unfairness.

Education programs used to promote RCR vary considerably between countries (Ana et al. 2013; Resnik and Master 2013; National Science Foundation (NSF) 2009). While RCR training is obligatory in the U.S. for all NIH funded researchers, it is not implemented systematically in all HICs (Resnik and Master 2013). We have also not identified any systematic education programs in LMICs. However, more empirical research is necessary to document ongoing initiatives that have not yet been reported in the literature. While there is a general trend toward greater international cooperation and harmonization respecting RCR (Resnik 2009), there is little information concerning authorship in the context of GHR partnerships in educational material. This gap may be related to the limited knowledge about specific authorship practices in GHR partnerships, as well as sparse policy guidance. Therefore, in addition to educating researchers about authorship generally, there is a pressing need for training that addresses authorship issues in GHR partnerships. Course curricula should be inclusive and relevant to both HIC researchers and LMIC researchers who participate in GHR partnerships. This approach is consistent with the notion of collaborative partnership.

Strengthening Guidance on Authorship in GHR Settings

A growing number of health science journals have adopted the ICMJE recommendations in their policies (Wager 2007b; Jaykaran, Chavda, and Kantharia 2011). The ICMJE recommendations help bring clarity, and provide useful reference points for the development and enhancement of authorship practices. However, it should be noted that GHR researchers are not primarily focused on trying to remedy broad or systemic inequities associated with authorship allocation. Rather, they are focused on conducting good science, answering relevant research questions, and advancing their careers within established norms and practices.

Despite the worthy efforts of the ICMJE, there may be circumstances in which global health researchers reasonably deserve credit for their contributions, but do not satisfy all of the authorship criteria; as well, they may be exposed to unethical authorship practices i.e., prestige

or gift authorship that is influenced by the GHR context. In an attempt to acknowledge various researchers in GHR, some may opt to follow ICMJE and simply list other major contributors in the acknowledgement section. Yet this may be considered ethically problematic to the extent that these practices reflect a systematic disadvantage of LMIC researchers. Perhaps the necessity of "critically revising" or drafting a paper is simply not always realistic in the case of GHR. Alternatively, it may be appropriate to give authorship credit for critically reviewing the paper and ensure accountability through signed attestations of one's contribution (e.g., data collection, analysis, writing and review).

As stated previously, authorship policies that address GHR collaborations should be founded on empirical data and conceptual research of authorship norms, values and practices. Expanding authorship policies to be more responsive to the GHR context is important for GHR researchers from both HICs and LMICs. This policy base is essential in guiding the development of best practices to address or counter disproportionate advantage due to geographic location, language ability, academic affiliation, institutional reputation, and access to resources in GHR collaborations. Best practices are not meant to be restrictive; quite the contrary, they serve to pre-empt potential issues and help ensure consistency in the ethical practice of authorship assignment and ranking. Many key actors should be involved in this important discussion regarding authorship guidance including researchers, funding agencies, scientific societies, and journal editors.

Summary

In this paper, we report and discuss potential ethical issues related to authorship attribution in GHR. Despite the growth of GHR collaborative partnerships, very little has yet been done to understand the ethical underpinnings of fair authorship practices in this setting. Deficiency in authorship policies, perceptions of bias, and cultural differences are likely to contribute to questionable or unethical authorship practices in GHR settings. To address these issues and promote ethical authorship practices, several strategies should be pursued. Further conceptual and empirical research is needed to better understand authorship practices in GHR. Responsive and applicable authorship policies for GHR should be developed. Finally, training should be implemented to share knowledge and expose researchers to authorship norms and

practices in GHR. If authorship issues are not dealt with, they may not only undermine the integrity of research, demoralize researchers, and damage important future GHR collaborations.

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LINKING STATEMENT

The article presented in **Chapter 3** examined authorship distribution issues that could be of importance within partnerships involving researchers from LMIC and HIC. The notion of partnerships in GHR has been used to promote a more equitable sharing of responsibilities and rewards in research collaborations. For years, LMIC researchers have been and continue to be adversely affected by systemic injustices inherent in authorship practices. Since guidelines and norms have often emphasized as an authorship criteria the drafting or at least critical revision of the document, individuals who do not speak English (often from LMIC) may be consistently disadvantaged and excluded from authorship. Moreover, the technical work of LMIC researchers (e.g., field work such as participant recruitment or data collection) has often been undervalued in the research process and therefore may be underrated and unrecognized in authorship decisions. Ironically, the LMIC researchers' unique cultural and linguistic knowledge as well as their access to research participants may be invaluable in data gathering and analysis and critical to the success of the research project. Finally, certain power discrepancies, notably the access to funding and publications by HIC researchers as compared with LMIC individuals, may be significant factors in explaining systemic injustices or biases in authorship distribution and ordering.

In an attempt to redress injustices and mitigate disadvantages affecting LMIC researchers, a number of partnership arrangements feature counterbalancing authorship distribution norms. Since primary roles and responsibilities were often distributed to the most powerful (usually the HIC researcher), the value and merit attributed to contributions typically reflected that initial distribution, which may result in systemic bias. To redress this inequity, the emphasis on contribution as a primary metric to distribute authorship has, in certain cases, been limited and a deliberate and increased weighting of other factors, such as geographic location, was introduced. However, it is necessary to question whether inequality in research should be mitigated or remedied through authorship distribution and order. Indeed, in an attempt to make authorship practices more equitable, new and unintended ethical problems might be created.

The article in **Chapter 3** does not take any strong position regarding authorship in GHR collaborations because a detailed understanding of specific contextual realities and their

significance does not as yet exist and further research is required. While the previous chapter provides an analysis of issues in the literature on GHR, of researcher's experience, and offers a theoretical reflexion on those issues, it is not the result of empirical research conducted by the authors. Empirical research is nonetheless very important to address these challenges, as I will discuss further in the **Conclusion** of this thesis. But, good conceptual research is also fundamental in supporting and guiding the selection of values and norms to be applied in authorship distribution more generally. While some scholars may hold to the notion that 'fairness' is central in the distribution of authorship, as demonstrated in the previous two articles/chapters, there is little clarity or detail as to what 'fairness' is or implies in multidisciplinary research collaboration. While it can be argued that certain situations such as systematic authorship exclusion on the basis of language or gender are unfair, currently, there is no conceptual framework that sets out values and principles to facilitate a determination and understanding of fairness in authorship distribution.

In order to arrive at some agreement regarding authorship distribution, a level of justifiability is necessary; as mentioned previously, individuals must know or understand 'why' certain authorship methods are fair and others are not. This is true, *a fortiori,* when a degree of consensus is required to offset the diversity of norms and cultures held by individuals in multidisciplinary collaborations. However, as previously stated, the academic literature pertaining to RCR does not provide any conceptual rationale for such justifiability. The article presented in **Chapter 4** aims to develop such a conceptual basis, and is in press in the *Kennedy Institute of Ethics Journal.*

CHAPTER 4: A THEORETICAL FOUNDATION FOR THE ETHICAL DISTRIBUTION OF AUTHORSHIP IN MULTIDISCIPLINARY PUBLICATIONS

Author: Elise Smith

Abstract

In academia, authorship on publications confers merit as well as responsibility. The respective disciplines adhere to their "typical" authorship practices: individuals may be named in alphabetical order (e.g. in economics, mathematics), ranked in decreasing level of contribution (e.g. biomedical sciences) or the leadership role may be listed last (e.g. laboratory sciences). However, there is no specific, generally accepted guidance regarding authorship distribution in *multidisciplinary* teams, something that can lead to significant tensions and even conflict. Using Scanlon's Contractualism as a basis, I propose a conceptual foundation for the ethical distribution of authorship in multidisciplinary teams; it features four relevant principles: desert, just recognition, transparency and collegiality. These principles can serve in the development of a practical framework to support ethical and non-arbitrary authorship distribution, which hopefully would help reduce confusion and conflict, promote agreement and contribute to synergy in multidisciplinary collaborative research.

Introduction

In 1953, James Watson and Francis Crick were named as the authors of the publication "Molecular Structure of Nucleic Acids; a Structure for Deoxyribose Nucleic Acid" in the journal *Nature* (Watson and Crick 1953). While historians have debated the relevance and importance of various discoveries in molecular science (de Chadarevian 2002; Abir-Am and Elliott 2000), there is little dispute as to the major significance of the discovery of the double-helix structure of deoxyribose nucleic acid (DNA). But what of Rosalind Franklin? There is little mention in science manuals of the contribution of the biophysicist Rosalind Franklin to the discovery of the structure of DNA. Watson has admitted that he used Franklin's unpublished experimental work without her knowledge, including her measurement of the repeating DNA unit and X-ray diffraction data showing the helical structure (Maddox 2003). While Watson and Crick were named on the paper, and later received the Nobel prize with a contributing colleague Maurice Wilkins, Franklin's name was absent. If authorship practices at the time had recognized everyone who had substantially contributed to the research, perhaps science history would tell a different story. One can only wonder how Rosalind Franklin's career would have progressed had her contribution been acknowledged. Would she have had more support leading to more scientific discoveries that could have shaped science in a different manner?

The expression "publish or perish" is an imperative in most disciplines, from the humanities and social sciences to the fundamental sciences, the health sciences and other applied sciences (Clapham 2005; Beasley 2005; De Rond and Miller 2005; van Dalen and Henkens 2012). Authorship of published works is considered an increasingly important reward in the contemporary system of science (Latour 1989; Latour and Woolgar 1979). A researcher's record of publication is a key criterion in the hiring, promotion, and tenure of researchers and professors, and a central consideration in deliberations to award grants, contracts, fellowships and prizes (Shamoo and Resnik 2009).

Issues surrounding authorship – i.e., who should be named an author, in what order, based on what contribution, and with what responsibility – have increased in number and complexity with the significant growth of collaborative research, especially when it involves contributors from different disciplines, countries, and cultures. Unlike the relatively small

team that discovered the structure of DNA in 1953, contemporary team research may include hundreds of members who may be named as authors on a publication. For example, in genetics/genomics research, large teams are the norm; the study of "The Complete Genome Sequence of the Gram-Positive Bacterium Bacillus Subtilis" (Kunst et al. 1997) had 151 authors, albeit an unusually large number for this field. While team research has become commonplace in the natural sciences, it has also achieved greater prominence in the social sciences where relatively smaller collaborative models now account for over half of research projects (Endersby 1996; Gingras and Archambault 2006). Collaborative practices in the humanities occur to a much lesser extent, with only 10% of papers being collaborative; the remaining 90% are sole authored publications (Gingras and Archambault 2006).

This transition from sole authorship to multi-authorship reflects the evolution toward strategies of collaborative research that are broader in scope and centered on addressing complex problems that require the competencies of researchers from many disciplines. An individual researcher who shuns multidisciplinary collaboration and attempts to "go it alone" without the necessary expertise and knowledge from other highly specialized (sub)fields may face the daunting prospect of falling short, i.e., being seen as a "jack-of-all-trades and master of none". As a result, new or "hybrid research fields" have been created by integrating knowledge from multiple disciplines (Barkovic 2010, p.954). For example, women's studies draws upon the contributions of scholars from political science, sociology, philosophy and history; and High Energy physics may involve scholars specializing in condensed-matter physics, the life sciences, material science, chemistry, and nano-science.[5]

For team members, the order of authorship may be critical, especially when it ranks the contribution of individuals and as such, bestows more or less prestige and responsibility. Disciplines such as psychology or computer sciences often list individuals in decreasing order of importance of contribution (Bennett and Taylor 2003). But, to distribute authorship in this manner, the team must distinguish whose work is more valuable and merits higher ranking. This is not an easy task, especially when the nature or types of contributions vary

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[5] In this article, I define "discipline" quite broadly as an institutionalized and recognized set of knowledge, approaches and/or methods used towards the evolution of science. I am aware that the definition of "discipline" has been a debate for quite some time in the philosophy of science, but this debate is outside the scope of the paper.

(e.g., intellectual, technical). In laboratory based sciences and in large biomedical teams, individuals may be named in decreasing order of importance of contribution and importance may be attributed to the last author as Principal investigator; this underscores one's leadership role in obtaining funding or grants, managing a research laboratory or mentoring students. In disciplines such as sociology, economics and mathematics, authors are often named in alphabetical order (Van Praag and Van Praag 2008); this approach might seem more egalitarian but it fails to indicate and thus recognize the nature, extent and relative importance of the various authors' contributions within a team. Further, while particular authorship distribution practices may be considered "the norm" in certain respective disciplines (i.e., obvious to all members of the discipline), they may be totally opaque or completely foreign to researchers from other disciplines. The differing meanings and values inherent in the authorship norms of various disciplines can be confusing and even contradictory. This can give rise to disputes and ethical challenges when determining authorship. What may be valued and considered an appropriate and acceptable authorship practice in one disciplinary culture may be considered unimportant, unworthy of authorship, or even unethical in another discipline.

The term "multidisciplinary research" is defined here as all research that includes more than one discipline; several different types of multidisciplinary research (e.g., interdisciplinary, cross-disciplinary, trans-disciplinary) have been the topic of much scholarly discussion (Sulmasy and Sugarman 2010), but these distinctions are beyond the scope of this paper. The co-existence of multiple authorship practices and disciplinary norms, and the likelihood of significant disputes around authorship distribution, makes multidisciplinary teams an apt context in which to investigate what could constitute basic principles of ethical authorship. This is not to say that authorship issues are not present in disciplinary contexts; nor is it to say that the authorship orders used in different disciplines are inherently right or wrong, but rather that there is greater disagreement and discord when different norms conflict in authorship decisions. These disagreements in multidisciplinary teams (especially in health based sciences) have created much debate in recent years, which gives impetus to continued reflection, and perhaps even to means of changing guidance and behavior.

In this paper, I present a theoretical approach – inspired by Scanlon's theory of contractualism as presented in his book *What We Owe Each Other* (Scanlon 1998) – as a foundation for elaborating methods for fair or ethical authorship distribution, and in particular, for decisions regarding the order of authors of multi-authored multidisciplinary academic publications. I begin by providing a brief background section that includes an overview of the relevant literature on authorship collaboration to shed light on important contextual elements and also to underscore the lack of theoretically grounded guidance for authorship distribution (mainly with regards to authorship order). I then show how Scanlon's contractualism, and the application of certain ethical concepts – such as specific interpretations of *desert*, *just recognition*, *transparency* and *collegiality* – can contribute to a sound theoretical foundation for the development of an eventual practical framework (which is beyond the scope of this paper) to support ethical and non-arbitrary authorship distribution in multidisciplinary team publications.

Background

Authorship and Collaboration in Science

The emphasis on collaboration in science started during the Big Science era after World War II (Cronin 2005; Katz and Martin 1997). Governments recognized the benefits of investing massively in science; projects became significantly bigger and more complex, necessitating more diverse expertise and greater collaboration (McClellan and Dorn 1999). This extended beyond the familiar, traditional model of scientific inquiry as a solitary endeavour. While it may be argued that throughout history, some degree of collaboration has existed among researchers through the exchange of ideas, the sharing of methods and cooperation with technical laboratory assistants (Biagioli 1999), one or very few individuals were considered authors. In contemporary science, researchers collaborate as members of a team where tasks and responsibilities are assigned, and ultimately acknowledged or reflected in multi-authored published works.

While definitions of scientific authorship may differ to some extent, there is general agreement in the literature as well as in academic practice, that individuals who "contribute substantially" to a research project merit some level of authorship (Louis et al. 2008).

However, the term, "substantial contribution" remains vague and largely undefined (Smith and Williams-Jones 2011). In some fields, especially in biomedical sciences, individuals might also need to participate in the critical revision or drafting of the manuscript and give final approval of the manuscript. While an increased number of collaborators may indeed indicate more contribution (because of more labor intensive projects), this may not necessarily be the case. Individuals might simply be contributing to different projects in smaller amounts and they could seek to bolster the quantity of their published works without in fact contributing or collaborating more to the general scientific enterprise.

In the scholarly literature about authorship, there has been considerable interest in practices that *do not* respect the concept of "substantial contribution". For example, "guest", "gift", "unjustified" and "honorary" authorship broadly include naming an individual as an author when they did not substantially contribute to the research, thus receiving undeserved credit and recognition (Ross et al. 2008; Street et al. 2010; Moffatt 2011). Conversely, "ghost" authorship – the omission of an individual who has contributed substantially to a study – has also been discussed as an important ethical issue in the authorship literature (Anstey 2014; Matías-Guiu and García-Ramos 2011b; Mowatt et al. 2002), especially in university-industry relations with the pharmaceutical sector (Sismondo 2009; Moffatt and Elliott 2007; Lexchin et al. 2003). In order to hide financial conflict of interests, individuals working for or being paid by pharmaceutical companies may refuse authorship (becoming a 'ghost author') and assign authorship to another individual or team (likely from the no-profit sector i.e. a university) to eliminate any concerns or doubts about bias in research.

Empirical studies of researcher self-reporting of behavior (e.g., surveys, interviews) show alarming rates of authorship issues. For example, Flanagin and colleagues surveyed corresponding authors who reported honorary authorship, ghost authorship, or both, and found that these were present in 21% of medical articles (Wislar et al. 2011). Mowatt and colleagues surveyed authors of Cochrane reviews who declared that 39% of articles have evidence of honorary authorship and 9% have evidence of ghost authorship (Mowatt et al. 2002). By simply looking at a list of authors on a byline, a reader will be hard-pressed to know if there is guest or ghost authorship. In many cases where there is collaboration, a reader will have little idea who truly contributed to what tasks or ideas, thus creating a general "obfuscation of

authorship" (Bennett and Taylor 2003). Without knowing who did what in a research group – especially in large research teams – journals, institutions and funding councils do not know who should receive credit or who should be held accountable if questionable practices like research misconduct (such as fabrication, falsification and plagiarism) have occurred. In a highly multidisciplinary team, there may actually be no one individual who can vouch for the project as a whole because of the necessity of so many different specializations. Further, if authorship is seen in its traditional mode as being an individual who is accountable for the project as a whole, the highly multidisciplinary project could even be construed as "authorless" (Kukla 2012).

This obfuscation of authorship has led to confusion and much debate, especially in the biomedical sciences. Consequently, a series of propositions were suggested as ways to replace authorship. For example, "corporate authorship" has been proposed where the team or group name may take precedence over the names of individual contributors in the byline, as in the case of the GUSTO team research (GUSTO 1993).[6] However, this last option is rarely implemented (Weeks, Wallace, and Kimberly 2004); many journals still require that individuals be named somewhere in the publication (e.g., in a footnote or endnote) to ensure a degree of individual accountability for the publication. Medical editors and scholars have argued that authorship could be replaced with contributorship (Smith 2012; Smith 1997; Rennie, Yank, and Emanuel 1997). Under this approach, individuals would be listed for their specific task(s) (e.g., study design, data collection, analysis, drafting of the manuscript), and as such, they would have a more direct link to, and accountability for, their contribution. A contributorship section has been added to a substantial number of well reputed journals (Rennie 2001). Recently in 2014, Allen and colleagues created a taxonomy to better categorize contributorship (Allen et al. 2014). However, the authorship concept has remained predominant (sometimes co-existing with contributorship), and it is still sought after as the most significant of metrics by which researchers are evaluated. The challenges in authorship distribution have not been entirely resolved by contributorship. Contributorship may augment transparency – noting who did what tasks – but it does not clarify who should

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[6] More discussion of this model will be presented in the section on transparency.

receive more or less credit. As such, contributorship will not suffice to 'fix' all authorship issues.

The considerable number of authorship distribution issues has led to a growing recognition of the importance of fairly distributing authorship (Shamoo and Resnik 2009, p.69), even if fairness remains – as I will discuss later – somewhat ill defined. There is growing awareness that unfair and misleading practices such as those mentioned above not only create doubt about "who did what" and "who is responsible for what", but can also undermine trust and confidence in the quality of the research itself and the reputation of the research community more generally. The scientific endeavor is arguably founded on trust in and the truthfulness of its various elements, including sound methodology, critical acumen, systematic rigor in testing and measurement, the mitigation of distortion and bias, and evidence-based findings. It stands to reason that if researchers are ready to lie about authorship, then there might be other elements within their research that are not truthful (Wager 2009).

Journal editor organizations have shown initiative and developed authorship guidelines or recommendations that are receiving attention in the literature on authorship (Tsao and Roberts 2009; Wager 2007b). These guidelines or recommendations are intended to promote publication ethics and have been quite effective in stimulating dialogue about authorship issues. Three major organizations occupy center stage, each having developed their own authorship guidelines or recommendations: the International Committee of Medical Journal Editors (ICMJE) (2013b), the World Association of Medical Editors (WAME) (2013), and the Committee on Publication Ethics (COPE) (2013). The most explicit and detailed authorship criteria are found in the ICMJE recommendations, which state that authorship should be based on:

1. Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
2. Drafting the work or revising it critically for important intellectual content; AND
3. Final approval of the version to be published; AND
4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. (ICMJE 2013c)

Alongside such guidance, specific journals have often remained very vague regarding authorship either referring to the guidance of a journal editor organization or simply mentioning that authors should agree on the final manuscript (Wager, 2007).

Once the criteria or qualifications for authorship have been determined and authors named, decisions must be made concerning the *order* of authors. The ICMJE guidelines mentions a "collective responsibility" (ICMJE 2014 p.2) to distribute authorship, which may suggest some form of democratic decision making, an approach also found in WAME documents. WAME mentions that "The authors themselves should decide the order in which authors are listed in an article" (WAME 2007b). Interestingly, the order of authorship would be the outcome of a simple agreement based on "many different criteria" (WAME 2007b). But, there is little clarity regarding relevant or acceptable criteria. COPE recommends that an authorship agreement be developed and adhered to by team members in order to foster constant communication from the outset and throughout the research process, in order to limit disputes. However, COPE does not outline the content of such an agreement.

In a self-governed system such as academia, an open and democratic forum may indeed help to mitigate disputes and conflicts among team members, but it cannot pre-empt or eliminate collusion that intentionally exploits some members or that perpetuates discriminatory practices. Further, the differing disciplinary cultures and practices of individuals in multidisciplinary teams can make decision-making and consensus on authorship particularly challenging. I argue that guidance should, have a sufficiently inclusive and broadly accepted theoretical grounding in order to mitigate conflict or discord. This would produce decisions based on a sound and ethical rationale, rather than power relations, traditions or belief structures which may no longer be adequate.

While editor organizations (ICMJE, WAME, COPE) have definitely stimulated debate regarding authorship criteria, there is no unanimity on the subject, and discussion remains quite limited when it comes to *authorship order.* Also, the critique has been made that rules, like those of ICMJE, are insufficiently flexible to adapt to the different research contexts. This may be the case, *a fortiori,* in multidisciplinary research where the scope of the scientific inquiry is complex, and the nature and value of contributions are diverse. While scholars have mentioned the need for more discussion about authorship distribution and order (Lambert-

Chan 2013), none have offered practical, detailed or ethically justified guidance. This paper will propose the *theoretical foundation* for the eventual development of a practical ethical framework for distributing authorship fairly.

Contractualism in Authorship Distribution

As noted in the previous section, not all agreements are ethical. Consider the arrangement where a student agrees to put her supervisor as first author on a paper in order to be in the latter's good graces, regardless of the fact that the supervisor did not contribute to the research; this is considered a form of gift authorship. So, while agreement might be one element of ethical theory, it is not in and of itself validation or proof of ethical behavior. Individuals have agreed (some more freely than others), and still do, to accept slavery, racism and sexism. I do, however, think that the dynamic or process of agreement can facilitate the development of ethical behavior, especially in a team setting. Comstock (2013) has developed a *Responsible Conduct of Research* (RCR) framework that relies extensively on agreement and mentions the notion of contractualism, although he does not expand on this theory and gives little detail as to how it can guide the distribution of authorship.[7] However, I agree that Comstock was heading in the right direction and so I intend to show that contractualism can indeed be effective in helping to address certain RCR issues, namely, authorship.

Different interpretations of contractualism have been at the heart of classic ethical theories such as those of Rousseau (1762) and Kant (1785), as well as a central notion in the works of contemporary philosophers such as Rawls (1971), Daniels (1990; 2000) and Scanlon (1998). The basic idea is that the ethical principles, rules or values governing our actions can be justified or deemed appropriate when they are the result of a *hypothetical* agreement between individuals. In the words of Darwell, "whether an action is right or wrong must depend on whether the act accords with or violates principles that are, or would be, the object of suitable agreement" (Darwell 2003, p.1). By referring to agreements as hypothetical, I follow these scholars in referring broadly to agreements to which individuals could reasonably agree. But I will focus, in this paper, on one particular version of contractualism, that of

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[7] These shortcomings can be explained by the fact that Comstock's book concerns the responsible conduct of research in general. To tackle such a wide range of issues, Comstock draws upon egoism, contractualism, moral rights and utilitarian theory. Contractualism and authorship distribution are but a small portion of his work.

Thomas Scanlon as developed in his book *What We Owe Each Other* (Scanlon 1998),[8] and I will argue that it applies particularly well to the context of authorship distribution.

Scanlon grounds his theory on a central statement about what constitutes a *wrong* action, rather than defining what is *right*: "An act is wrong if its performance under the circumstances would be disallowed by any set of principles for the general regulation of behavior that no one could reasonably reject as a basis for informed unforced general agreement" (Scanlon 1998, p.153). By refraining from defining precisely what the right action is, Scanlon provides room to accommodate a broad range of *possible right* actions while still acknowledging that unethical actions or *wrongness* exist. At the outset of his book, Scanlon describes the primal and foundational nature of reason in normative thought. He states that reasons are propositions (e.g., judgments about empirical facts or psychological states) that count "in favor of some judgment-sensitive attitude"[9] (Scanlon 1998, p.56). As such, a reason is not an ontological element but rather a proposition with a particular status or significance that gives it normative force. Consider the expression X gives me reason to do Y. This statement points to X as justification to act; in effect, X, is a proposition that has normative force as it provides "good reason" as the impetus for action.

According to Scanlon's theory, values are not metaphysical or teleological. There is no absolute, universal list of values that applies systematically to every context and all circumstances. Simply put, we value those things that we have reason to consider as valuable. Depending on one's reasons, the nature and order of importance of values vary; what we value takes diverse forms, e.g., pleasure, friendship, well-being and achievement of artistic and/or intellectual excellence. Also, what is valuable in one context or at one time may not always be valued as much or at all; a value may not be seen as reasonable in certain contexts or under certain conditions. Since the circumstances of our actions often change, Scanlon points to the need to consider the context as well as the intention behind an action, or what Scanlon calls the "moral motivation" (Matravers 2003, p.4). For example, while friendship is valued in many situations in our personal life, it may seem unreasonable and inappropriate to value

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[8] I will not consider Scanlon's earlier article entitled 'Contractualism and Utilitarianism' (Scanlon 1982) since his views changed substantially in his later work, notably by omitting reference to utilitarianism.
[9] For an attitude to be judgment-sensitive it must be "under the control of reason" (see Scanlon 1998 p.272).

friendship more than actual contribution in distributing authorship in a research publication. We should thus revise the reasonableness of values on an ongoing basis according to changes in context.

According to Scanlon, it is *reasonable* for individuals to take into account the reasons that they, as well as others, have to justify an action. This notion of "mutual recognition" is central in that it is an acknowledgment of others as rational equals. Mutual recognition is not only important in the process of practical reasoning, it also promotes morality; we seek a moral life because we exist in relation to others and we seek to justify our reasons in a way that others cannot unreasonably reject (Scanlon 1998, p.162). There is a degree of fairness and equality inherent in the notion of mutual recognition; no one rational individual is *prima facie* more important than another. Agreement between equals includes the notion of reciprocity where one respects the agreement knowing that others will do the same.

When deciding whether and to what extent an act is right or wrong, we must hypothetically consider principles that are mutually recognized and relevant in the given context. As such, a principle reflects a moral rationale or reasoning in support of a specific action in a given context. For example, if we acknowledge that it is important to be completely transparent about data and analysis in the verification of an experiment, we might conclude that there is sufficient reason to abide by a principle of transparency in publication, if in a given context there is no other perspective that makes this principle unreasonable. However, in the context where maintaining confidentiality and respecting the privacy of participants is paramount, the principle of transparency may not apply to the same extent or in the same manner as in the previous situation. In considering various principles, one must understand that the importance, relevance and applicability of a principle depend on the context of the action.

Why use Contractualism as a Theoretical Base in Authorship Distribution?

There are four main reasons why Scanlon's theory of contractualism applies nicely to authorship distribution:

1. It provides the necessary flexibility to adapt to the many different contexts of authorship distribution in multidisciplinary collaborations. Reasons to adopt or

exclude certain principles may differ depending on team size, the nature of the research area, the disciplines involved and the geographical location of team members, to name but a few contextual factors. This form of contractualism allows us to take into consideration the values and goals that are already considered reasonable and valued in the academic community, such as: rigor, competence, trustworthiness, and knowledge development. This is an important consideration in that it allows for the subsequent development of a fair and practical framework within the existing (albeit imperfect) value system.[10]

2. It is useful in developing principles that allow us to challenge authorship practices that have not been questioned in a reasoned manner and that should be updated to reflect advances in authorship ethics, emerging research issues, contexts and present-day values. For example, 17th century copyright (when the concept of authorship was born) was created to mirror existing class structures and as such, it discredited many contributors from being granted authorship (Biagioli 1999). Traditional practices that continue to enable exploitation or perpetuate unethical behavior need to be rationally and reasonably challenged and remedied.

3. The notion of mutual recognition opens the way to a fair and reasoned process wherein individuals are considered equals when making agreements and establishing principles and frameworks. This approach counterbalances to some extent the hierarchical nature and power dynamics of academia. The goal is not to eliminate hierarchy based on knowledge, which is necessary in teaching and mentoring relationships. The professor/supervisor with 'greater knowledge' necessarily occupies a position of authority and power, as she/he is responsible for evaluating and mentoring the student; this is an entirely reasonable arrangement. However, if we apply reason and mutual recognition in distributing authorship, the less powerful party (e.g., the student, research assistant, technician) should still receive equal consideration. A reasonable and acceptable agreement would take

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[10] As already mentioned, the development of such a framework would be the focus of future work, and thus is not presented in this paper.

into account the viewpoints of all team members, including students, researchers, coordinators, research assistants, and principal investigators.

4. Value is not limited to one object or element, such as well-being or utility; Scanlon considers the potential of value as a plural concept. This is particularly important and relevant in academia because of the multiple forms of value (intellectual or technical) as well as the value of reputation or the well-being of the individuals. I agree with Scanlon that many justice theories, especially those focused on the just distribution of necessary goods and services, mistakenly focus on one type of value, i.e., well-being, in measuring ethical conduct (Scanlon 1998, 110-143). While important, well-being is but one (insufficient) consideration in the scientific context, where multiple values are relevant and deserve consideration.

Limitations of Contractualism in Authorship Distribution

As with any moral theory, contractualism has its limitations and its critics, but I will limit my review of these to focus instead on the articulation of the theoretical basis for an eventual ethical authorship framework.

Briefly, Hughes and De Wijze (2001) argue that the words "reasonably reject", which determine wrongness in Scanlon's theory, are too vague. However, as in any theory, a certain level of vagueness is necessary to be applicable to the many contexts and arguments in moral theory. Another important critique is the so-called aggregation problem (Hooker 2002), i.e., that the views of the greater number of individuals should have more importance than those of a few individuals or even a single person, as would argue many utilitarians (Mill 1870). To be fair, however, Scanlon's argument is built on the notion that an act is right or wrong depending on the reasonableness of the argument, and not solely on the number of individuals who make an argument. Reasonableness thus does not always result in the aggregation problem, but it remains sometimes present.

Since the focus of my work, here, is on laying the groundwork for the eventual development of an ethical authorship framework, one practical shortcoming is particularly relevant. While Scanlon's statement on contractualism is helpful in discerning wrong or unreasonable principles for the distribution of authorship, it does not tell us exactly what to do

when more than one authorship distribution method and order might be reasonable to team members. In a later section on collegiality, I will discuss an approach to apply more fair procedures[11] to enable team members to agree on an ethical order of authorship in a collegial and respectful manner.

Developing Ethical Authorship Principles Using Contractualism

In this section, I will argue that in the distribution of authorship, the specific interpretation of certain principles such as *desert*, *equality*, *transparency*, and *collegiality* can be considered reasonable according to Scanlon's theory. As previously stated, contractualism does not provide one best decision or outcome; but it does help us to justify or refute principles that can be used in deliberations concerning authorship distribution. Careful reflection, reflexivity (following Anthony Gidden's (1986) view of self-awareness) and practical judgment are necessary for team members to agree upon principles that meet the test of reasonableness within diverse contextual realities. Once this exercise is completed, principles can be applied in determining the selection of an authorship order. I will focus on those principles that are primary in authorship distribution and order; they do not, however, constitute an exhaustive list.

Merit and Desert

Although the words "desert" and "merit" may be used interchangeably in common parlance to talk about certain aspects of justice and responsibility – "he got what he deserved" or "she will get merit through authorship" – these are not concepts used to explain or describe fairness in philosophy or social theory. Michael Young first introduced the term "meritocracy" in his book, *The Rise of Meritocracy* (Young 1958), a political satire about a highly meritocratic society structured according to levels of intelligence. His dystopia, which portrayed a ridiculous and unreasonable society, was intended to persuade the British Labour government of the 1950s that the application of the principle of merit was unjust (Dench 2006). Similarly, and consistent with its roots in justice theory, contemporary political

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[11] I have decided to limit the discussion about procedural justice in this paper because I consider it a more practical consideration that will be better addressed once further empirical data is collected on this issue and the context of authorship distribution is better understood.

philosophy does not attribute the same importance to merit and desert that it gives to equality, equity and welfare. In liberal egalitarian philosophy, authors such as John Rawls value highly the principles of liberty and equality, while libertarians such as Robert Nozick or Milton Friedman have favored entitlement theory based on the respect of individual rights (Olsaretti 2003). According to Lewis, merit is refuted on the basis that it creates social differentiation that is commonly rejected as unjust (Lewis 1998).

Rawls' theory of justice does not define individuals as responsible for or deserving of the native endowments which they receive in life. As Rawls notes:

> It seems to be one of the fixed points of our considered judgments that no one deserves his place in the distribution of native endowments, any more than one deserves one's initial starting place in society. The assertion that a man deserves the superior character that enables him to make the effort to cultivate his abilities is equally problematic; for his character depends in large part upon fortunate family and social circumstance for which he can claim no credit (Rawls 1971, p.104).

Even the willingness to make an effort, to try and so to be deserving in the ordinary sense is itself dependent in practice upon family and social circumstances. This underscores the skepticism about responsibility and free will in contemporary justice theory (in political philosophy) and has undermined any recourse to desert and merit (Pojman and McLeod 1999). But the disregard or dismissal of desert, merit and even responsibility-based arguments is at odds with many areas of ethics (e.g., professional ethics or organizational ethics) where responsibility is a key principle. It is important to note that political philosophers have largely focused on distributive justice to create fair institutions. And while I initially thought that fair distribution of authorship would be comparable to fair distribution in political philosophy, I have subsequently come to a different conclusion.

If we focus on the context of authorship distribution for multidisciplinary research, it is reasonable to acknowledge that a theoretical foundation with different principles is warranted and that the goal of "fairness" still applies. Concepts of desert and merit can, I argue, reasonably apply in a team setting that is already institutionalized. Academic institutions have specific tasks and obligations that involve a complex mix of professional ethics, organizational ethics and justice. While notions of need and welfare linked to primary rights (such as the

right to life, nourishment, etc.) found in justice theories are not the central principles or goals of academic institutions or in team research, fairness in team dynamics is nonetheless important. While I agree with many political philosophers that equity, equality and welfare are key principles in distributing essential primary goods or rights, desert may be more relevant and reasonable as a principle underlying fairness in the academic context.

In discussing authorship, I will thus use Louis Pojman's (1999) definitions of merit and desert. Pojman describes merit as "any feature or quality that is the basis for distributing positive attributions as praise, rewards and prizes" (Pojman 1999, p.86). This quality may be a natural endowment such as beauty, strength or intelligence. For example, a professor may merit tenure because of her brilliance; even though she may have achieved an excellent publication record with relative ease or less effort than other colleagues, she still merits her reward or career advancement. "Desert on the other hand is typically or paradigmatically connected with action, since it rests on what we voluntarily do or produce. It is typically connected with intention or effort" (Pojman 1999, p.86). A professor deserves tenure, in part because of her contribution to knowledge, but also because of her engagement in teaching and mentoring, involvement with administration, etc., all of which require effort and work, even if the professor may be more adept at these acts than other colleagues. The notion of effort and work is the action base for desert in this case. To summarize, people may receive merit for things for which they have not worked, such as natural beauty, innate strength or intelligence; but it is only in cases where individuals make a choice to use their talents through action that they deserve a prize or reward.

Research involves going through the often tedious processes (e.g., experiments, data collection), alongside more creative or rewarding activities (e.g., idea generation, analysis, writing) and these are choices that individuals make. These choices result in an effort to contribute to research that confers desert whereby one deserves praise for scientific contribution. This is consistent with Scanlon's contractualist approach; he mentions that it is often the case that an individual cannot reasonably reject outcomes that are sensitive to one's choice (Scanlon 1998, p.251). Choice is a precursor to responsibility which is also important

in the framework of desert.[12] Although individuals may receive credit or merit through authorship, we usually only consider this merit ethical if it is deserved; that is, the individual performed an action (e.g., work) that resulted in a contribution (e.g., a scientific article). If the author has not contributed but still obtains merit through gift authorship, we consider this undeserved and in Scanlon's words, unreasonable. Accordingly, the central concept in authorship distribution is desert since merit is really a consequence or result of desert.

In the literature on desert, we find Feinberg's classic expression: "S deserves X by virtue of P" (Feinberg 1974, p.61). In the case of authorship distribution, S would be an individual (professor, researcher, student, technician, etc.) who participates in the research process. Since authorship is our object of study, X would be authorship with the ensuing implications regarding credit (or merit) and accountability. Finally, there must be an action (P) that makes the individual deserving of authorship. David Miller mentions that the challenge with Feinberg's account of desert is to define P more precisely because "primary desert judgments are based on performances for which the agents in question are responsible, and which we appraise either positively or negatively" (Miller 2003, p.27). What Miller calls the primary desert judgment (the P in Feinberg's expression) is also typically called the desert base (Feldman 1995).

As mentioned previously, authors and academic journals are increasingly adopting the notion of "substantial contribution" as a central criterion for attributing authorship (regardless of the order used). The value that we put on contribution makes this a reasonable desert base. But in determining substantial contribution, should we give more credit to the amount of work or effort, or to the quality and importance of the act for the results achieved? In other words, should individuals who work harder or exert greater effort (e.g., do more writing) deserve more credit (in the form of authorship) than others whose quantitative contribution may be less but could also be more qualitatively valuable (e.g., a key idea or technical analysis)? While there may be some rationale for acknowledging hard work, in practice, there is no plausible or

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[12] While in the case of authorship distribution desert may be morally justified, I am not saying that outcomes are deserved if a choice is taken in *all* situations. Scanlon notes that the value of choice is "conditional and relative" (Scanlon, 1998, p.262).

reasonable way to objectively quantify or measure intellectual effort.[13] As with grading student essays, or reviewing grants or article submissions, the evaluation is on the final product and not on the effort involved. While it may be harsh to say, funding or praising a hard working researcher who lacks the competence or ability to contribute to the production of valuable research results   (including the development ideas, methodological innovation, analysis or results) and advance the collective body of knowledge can be considered a waste of scarce resources.

Why Use Desert as a Reasonable Principle in the Distribution of Authorship?

Desert can be considered a reasonable principle in the distribution of authorship for several reasons. First, desert is a reasonable and practical way to link and clarify the concepts of responsibility and credit; responsibility and merit are seen as two sides of the same coin (Rennie and Flanagin 1994). Some have argued that credit should be disregarded and that only responsibility should be considered in authorship. For example, Clement states that "journal authorship discussions should never involve the allocation of credit, a relatively easy part; instead they should focus on allocation of accountability or responsibility, a more difficult part" (Clement 2013, p.3). He is right in pointing out that responsibility deserves greater prominence in authorship attribution than it has, and that it should not be overshadowed by credit. However, the distribution of credit separately from accountability and responsibility is unreasonable since one implies the other and both are integral to authorship. If you are credited with achieving a result, you are also held accountable and responsible for that result to some degree. It is reasonable to hypothesize that the sense of responsibility and accountability for one's work can influence behavior and mitigate the occurrence of unethical or dubious practices. Since responsibility for results in a collaborative team effort is to some extent shared, then there may be a tendency for individuals to divert any blame or direct responsibility for errors or poor outcomes to other members, to the team leadership generally or to the team collectively (LaFollette 1992).

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[13] This does not mean that effort and hard work are never to be acknowledged. It simply means that they are not considered in the specifics of authorship.

As previously mentioned, the distinction between merit and desert is that desert involves a choice. An individual researcher chooses to contribute and this decision confers a certain level of responsibility on that individual for his/her contribution to the research. Desert is based on actions that are the responsibility of the individual and excludes those elements that are solely based on natural endowment or social circumstances. This does not mean that choices are not influenced by external factors (e.g., financing, career advancement), but simply that the individual remains a free agent to a reasonable extent. It is in choosing to accept responsibility for a contribution that an individual deserves to be an author. For example, in a team project, a post-doctoral researcher chooses to participate in a research project and is responsible for data collection and analysis as well as a critical review of the final paper. If the paper is published, the post-doctoral researcher will be among the authors on the by-line. Because she was responsible for the contribution, she deserves authorship and the resulting merit (or credit). Moreover, because she was responsible for certain tasks, she remains accountable for that contribution. Since desert is based in part on individual responsibility, it confers a level of accountability that is highly valued and necessary in academia, as discussed in the RCR literature.

To promote integrity in research, it is necessary for individuals to always be responsible for their contributions; contribution and responsibility should never be separated. The notion of responsibility should not, however, be confused with stewardship or the role of "guarantor", concepts that refer to the leadership responsibility of certain individuals for the entire project, including the management of team competencies and resources (e.g., how all the pieces fit together, securing research funds) to achieve the research objectives. The role of steward, usually played by the Principal Investigator (PI), is often one of coordination, oversight, and leadership. This does diminish the responsibility of other members of the group; they are still responsible for a contribution in that they have an obligation to do specific tasks with integrity. Individuals are responsible for the quality of their own work even if they are in a large team and are not the only author named on the byline. When there are many responsible individuals, typically roles are defined such that some are assigned greater responsibility for certain tasks than others. In keeping with the notion of integrity, I will use the term *responsible contribution* as the desert base for authorship. Responsible contribution is

the outcome of choices regarding the research project, such as the methods applied, data included or excluded, or selection of concepts.

Responsibility for contribution is used in ranking individuals and is a precursor to future credit; the one who is responsible for the most contribution is often said to deserve the most authorship (usually expressed as first or last author), and thus greater credit and accountability. This conceptual clarification of the link between credit and responsibility (illustrated in Figure 1) is necessary because in the definition of authorship, key concepts such as responsibility, accountability, merit, and credit have generally been lumped together without clarification. Establishing a clear link from responsibility to contribution at the planning stage of research would arguably help to foster a more organized, collaborative team dynamic. In using the concept of desert, I distinguish two different types of responsibility; responsibility for the contribution (or the task of research) and accountability after publication. Individuals remain *accountable* for their contribution because they are *responsible* for their contribution. The link between the amount of contribution and the amount of accountability and merit is only possible if the individual deserved authorship. This makes the desert principle necessary but not sufficient to this conceptual approach to understanding authorship.

Figure 1: Using desert in relation to responsibility, contribution, authorship, credit and accountability
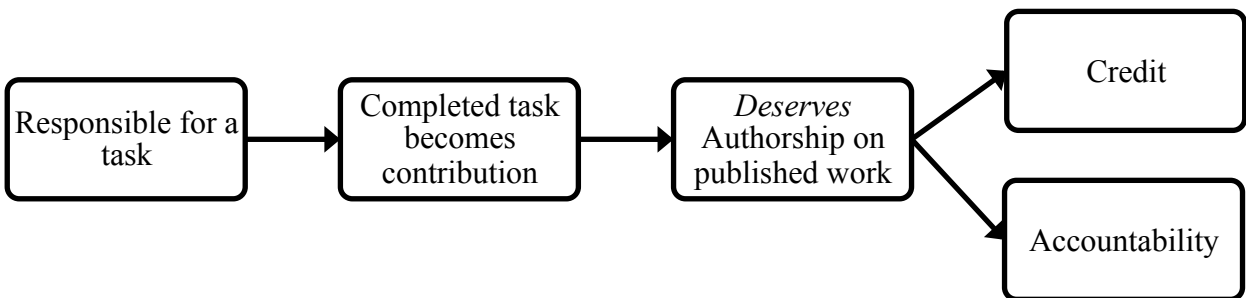
Another reason to consider desert is that it can help in determining choice of authorship order. If we state that authorship is linked to a certain amount of responsible contribution through desert, then the order could reflect this fact. If it is possible to appraise and thus differentiate contributions, one could use decreasing order of contribution to name authors.

98

This would also be reasonable since individuals who made the greatest contributions would be read first and receive the most praise; of course, this is particularly true when only the names of the first author (e.g., Smith et al.) or the first three authors (Smith, Hughes and Jones et al.) are cited in a text; this is clearly not an issue in numbered citation styles (e.g., Vancouver where no names are cited in the text). The concept of 'greatest contribution' remains vague and could be interpreted in various ways (e.g. the most cognitive change, the most labor intensive work, the most novel work). The interpretation of this notion will most likely align with the goal of the project. For example, if the goal of the research is predominantly to develop a novel method of inquiry, more value will be given to the tasks leading to this goal. Open discussion will most likely be necessary to understand the contributions of each individual (this will be discussed in greater length in the section on collegiality).

When many individuals contribute equally, they are said to deserve equal authorship. However, there can only be one first author on the byline (excluding alternate and non-standard presentation formats such as printing names in a circle or adding equal signs between authors (e.g., Mullen = Kochan = Kochan = Mullan 2001)[14]. In such cases we can use alphabetical order and then state clearly that all individuals contributed equally, e.g., in a note directly under the author list, or in a footnote, although these options also have their limitations (as we will see in the section on transparency). Transparency becomes increasingly important in such cases and thus is also considered as a necessary principle in the distribution of authorship.

A model that includes the notion of desert can serve as an effective appraisal mechanism in the ranking of authors. The desert base, which in authorship is responsible contribution, is, if not completely quantifiable, at least comparable and may also be valued in *relation* to the body of work or the project as a whole. For example, in a coded interview-based analysis where the interview process is of critical importance to the project as a whole – even more than the initial drafting of the paper – that process should be given higher value and weighted accordingly. In work of a conceptual nature, the contribution of a novel idea and its elaboration through articulation in the written text would be more heavily weighted or valued.

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[14] According to the authors, the equal sign (=) between author names promotes equity between authors.

Ultimately, we would compare the contribution of individuals relative to one another as well as relative to the project as a whole. Since only the desert base (e.g., contribution) is taken into consideration in the appraisal process, we might reach agreement regarding decisions on authorship more quickly than if multiple variables such as financing or effort are also considered.

A final argument in favor of distribution of authorship using desert is that it promotes the creation of knowledge. Recognition of research through authorship is at the center of the reward system of academia. This is not only reasonable, it is necessary. As noted by Lewis "It is not simply a question of pursuing excellence or of the rational utilization of resources; it is more basic and concerns the survival of universities *as* universities" (Lewis 1998, p.206). Desert is particularly relevant in that it rewards deserving individuals who contribute to the survival of the university through their work. The broader institution of science has the responsibility to identify the more competent and productive individuals and to then distribute credit (e.g., status, research funds) to those who have the best chance of producing good research.

Limitations of Desert

Distribution on the basis of deserved contribution is in no way a panacea and has limitations that, in certain cases, may render it unreasonable. Ranking may create an unhealthy level of competition among members and contribute to a hostile environment. As mentioned by Lewis, a meritocracy may create the "breeding of excessive competition" (Lewis 1998, p.202). Samuel Scheffler (2000) notes that desert is a very individualistic idea since it is tied to the actions of the individual, contrary to the more complete approach of social justice. While competition and individualism are realities that cannot be denied, it may be necessary to provide parameters as a counterbalance to also foster the productivity and synergy necessary in team collaborations. This will be discussed further in the section on collegiality.

As previously stated, the comparative assessment or quantification of contributions in relation to the project as a whole and relative to other team members is not a simple task, especially when the contributions are different in nature (e.g., technical and intellectual); it can be like comparing apples and oranges (Smith and Williams-Jones 2011). Open communication

and information sharing are thus essential to arrive at an understanding of others' contributions. Yet, while this might be easy for a relatively small team, communication among larger teams (e.g., 10-100 individuals), especially when they are in different geographic areas, can be an insurmountable obstacle. Therefore, where practicable, and in cases where the quantity and nature of different contributions are sufficiently well understood, authorship distribution to deserving individuals on the basis of relative contribution is recommended.

Fair Recognition

When thinking of methods to fairly distribute authorship, the first normative theories that come to mind are theories of justice. As previously mentioned, in political philosophy these are applied to the establishment of fair institutions and are not specifically applicable in the academic context; however, this is not to say that fairness is irrelevant in an authorship distribution framework. In his book *Inequality Reexamined,* Amartya Sen (1992) explains how all normative theories of social justice in the last century – liberal, utilitarian, rights-based – rely on equality of certain elements, including: equal liberty, equal income, equality of primary rights, equality of treatment, equality of capabilities. The elements that should be distributed equally in such theories are usually those valued by all individuals. In many of the theories analyzed by Sen, equality seems to have some type of intrinsic moral significance (Feldman 2003).

However, as Shelly Kagan argues, equality can be a consequence of desert in that it is justified by the judgment that individuals deserve some sort of equality (Kagan 1999). The intrinsic moral value should be in desert, not in equality, because according to Kagan and certain desert theorists (e.g., Feldman 2003), equality is simply overrated. Egalitarianism cannot redress all injustices or put aside the broad range of distinctive genetic, physical, intellectual, or social traits of individuals; and it does not make all contexts fair. In some cases, the application of equality may paradoxically result in inequity. For example, paying everyone equal wages would not account for different skills, competencies and social value attributed to certain forms of work, nor would it address the fact that people have different obligations with regards to healthcare bills or child care, for example. Equal wages for all, without other targeted unequal distribution would likely create highly problematic and inequitable outcomes.

In many cases of authorship, perfect equality in distribution may lead to significant injustices. The implication that all team members deserve equal authorship is that they should all receive equal credit and have the same responsibility for the work. This distorts the reality of the research and writing processes. In disciplinary or multidisciplinary research teams, individuals reasonably make different contributions and are consequently responsible to differing degrees for different tasks. Equal distribution of authorship fails to acknowledge the level or amount of contribution, and it renders meaningless the assignment of responsibility that is essential to research integrity. Individuals would ultimately be made less responsible and accountable for their work, and authorship distribution would be less meaningful. Equal authorship for all contributors is simply contrary to a quantification of contribution through authorship to differentiate the competent from incompetent, the productive from the unproductive and the deserving from the undeserving.

I do not think, however, that we should throw out the baby with the bathwater and omit fairness from ethical theory regarding authorship. Desert allows for the comparative assessment and ranking of individuals, and would benefit from a mechanism whereby each individual's contribution is evaluated in the same way. This equal treatment in the evaluation of contributions can promote greater fairness in authorship distribution. It is not necessary to choose between fairness or desert in the context of distribution of authorship in academia since these can and should coexist.

Why Use Fair Recognition of Individual Contribution as a Reasonable Principle?

I will argue that fair recognition of contribution is a reasonable and necessary principle for authorship distribution for one very important reason: it is important in promoting and ensuring a certain level of impartiality and non-discrimination. To this effect, Sen writes:

> Need for some egalitarian formula in defending a theory indicates the significance widely attached to non-discrimination, which can be seen as being motivated by the idea that in absence of such a requirement a normative theory would be arbitrary and biased. There seems to be a recognition here of the need for impartiality in some form for the viability of a theory (Sen 2009, p.293).

Fairness and justice are brought to bear in finding non-arbitrary ways to distribute goods, merit, and resources. An evaluation mechanism that considers individual contributions

in the same manner through an impartial lens could limit exploitation in authorship distribution while still promoting productivity in research. Although not every team member would be ranked equally, each individual would be treated fairly and measured in the same manner (through contribution).

Impartiality, neutrality and non-arbitrariness are elements of justice that are already considered valuable in academia. However, as previously mentioned, there exist important power dynamics and ranking in the academic hierarchical structure designed to recognize knowledge and learning, e.g., professor-student, senior researcher-junior researcher. Yet, it is important that rank (seniority) not be a factor in authorship distribution; rather, the focus should be on the link between responsibility and authorship. This would reduce the impediment to entry-level advancement in academia since students or technical staff do occupy a lower position in the hierarchy. The emphasis on responsibility and not rank could reduce exploitation of the less experienced and duly recognize the contribution of senior researchers. Using rank as a criterion would only serve to encourage an even more hierarchical environment where power would be concentrated within an established elite, arguably threatening the scientific process.

Limitations of Fair Recognition of Individual Contribution

Although fair recognition seems like a reasonable criterion to help in the distribution of authorship it has important limitations, most of which are practical in nature. Even well intentioned individuals may introduce bias by unconsciously favoring personal or professional interests instead of considering each contribution in an equal fashion. In weighing contribution, an individual may unconsciously be influenced by association, friendship or reputation and thus attribute a higher standing in authorship than deserved. The literature on conflicts of interest shows that, regardless of good intentions, favoring personal or professional interests is often unconscious (Chugh, Bazerman, and Banaji 2005). Managing such interests within the team becomes all the more important.

Cases where individuals contribute equally and consequently deserve equal authorship can also present real challenges. As previously noted, alphabetical order of authorship can be considered to be unfair in that individuals with a last name that starts at the beginning of the

alphabet will be favored, and those with a last name at or near the end disfavored. The alphabetical listing of names cannot reflect or represent equal contributions. As such, it would be important to provide a statement declaring that all individuals have contributed relatively equally. Individuals who work together often may change the authorship order in their next publication to share the opportunity to be named first and also add a declaration statement about equal contribution. The next section argues that transparency would represent or explain more accurately equal contributions and the associated responsibilities of team members.

Transparency

The contributorship model has been considered as an effective method of increasing transparency (Smith 2012; Smith 1997; Tice 2005). By disclosing the specific tasks of individual contributors, it serves to clarify individual responsibility and accountability for various tasks. For example, a fictional contributor statement might read as follows: *Mary Tomasson contributed to the project design and the writing of the article; Julie Madisson contributed to data collection, analysis and writing; and John James contributed to all steps of the research.* However, while contributorship does provide additional detail and a measure of increased transparency, it does not necessarily reveal who deserves the most merit and responsibility. We do not know who made the greatest contribution, did the most work or deserves first author? While data collection is mentioned, it might represent 50% of the work in one project and only 5% of the work in another project. An individual may have made numerous small contributions in all phases of the research, which amount to relatively little work or work of lesser qualitative value, compared to that of other individuals who have completed only one task that represents for example, the bulk of the data collection and analysis in a data intensive project.

In order to better reflect the reality of the collaborative enterprise in authorship order, transparency can be applied through explanatory notes or disclaimers. According to Akhabue and Lautenback (2010), the disclaimer that more than one individual has contributed equally has become a more common practice in medical journals. Clarity as to the amount of work or the level of contribution benefits deserving individuals in their career advancement. As I will discuss further, transparency disclaimers would be useful in explaining other types of distribution than equal contribution.

Why use Transparency as a Reasonable Principle?

Transparency can be considered a reasonable principle in the distribution of authorship for a number of reasons. First, it may limit confusion and misperception; declarations that state whether individuals are ranked in decreasing order of contribution, or are listed in alphabetical order and have all contributed equally, reveal more about the research. If we consider contribution to be linked to merit, responsibility and accountability through desert (as argued previously), transparency would further clarify and enhance these elements. If there is minimal or no transparency about authorship order, readers are left with their own individual assumptions which may be wrong.

Typically individuals tend to follow or be influenced by the prevailing norms of authorship within their respective discipline, field, or subfield. As a result, depending on their discipline, field or subfield, individuals may interpret authorship order differently. In a study of authors who published in the journal *Radiology,* authors were perceived to be named in decreasing order of credit in a majority of cases (70%); this leaves little or no recognition or prestige for the last author (Slone 1996). However, in a survey of promotion committee members at American Medical Colleges regarding perceptions about authorship order, the first author in a three person byline was seen to have made the most contribution, while the last author's contribution on a five person's byline was perceived to be the greatest (Wren et al. 2007). These two studies from different disciplines illustrate very different perceptions concerning the significance or importance of the last author. I suggest that competing or differing perceptions will occur with greater frequency in multidisciplinary collaborations where there are no agreed upon norms or standards of authorship, making it all the more important to consider reasonable, ethical practices for multi-authored multidisciplinary research.

Transparency is also a reasonable and practical concept for authorship because it could facilitate more representative and flexible blending of various methods of authorship ordering that better reflect the contributions within diverse types of research teams. At first glance, one might suggest using Occam's razor and imposing a single method of authorship order to simplify the process (Resnik 1997). However, a single method and order of distribution is simply not realistic since there is no one model for team research. Teams are incredibly

diverse in terms of size, discipline(s), organizational structure and epistemological background, and so a single approach to authorship distribution would likely lead to unfair situations. For example, a ranking order that fails to reflect the equal contribution of each member of a 5 person team would be unfair and misrepresent the work of the team members. In a large team of more than 500 individuals (e.g., in High-Energy physics), comparing the contributions of so many (besides maybe the first few or last authors) would be ridiculous; the difference between the 300th and 301st author is of no significance. However, listing individuals in alphabetical order might seem equally unjust to the individual who did considerably more work than the rest of the team. To avoid these impracticalities and injustices, an approach that blends or borrows from different practices may be more useful and effective. For example, noting that that all authors except the first few and last have contributed equally may provide a more accurate and fairer way of distributing credit to members of a very large team. With sufficient transparency, we may blend or apply different orders, as long as they are not seen as unreasonable from the viewpoints of the team members (e.g., first three authors in order of contribution, the rest in alphabetical order, supported by a clear acknowledgement).

If all individuals agree to greater transparency and multiple or mixed authorship orders, there is a better chance that this will carry over to the reward system in the field and a greater variety or mixed types of evaluations. For example, researchers working in multidisciplinary research teams may reflect these diverse orders in their CV, possibly with a section reserved for authorship in alphabetical order and another presenting authorship in ranked order. This would introduce greater precision and fairness in the assessment of authors engaged in multidisciplinary work and ultimately, would contribute to greater accuracy in the reward system.

Lastly, transparency may help foster fairness and ethical behavior since unfair or unethical behavior shuns discovery and publicity. For example, I mentioned that Biagioli (1999) explained how authorship has served to exploit certain individuals and minimize their contributions. This undermines the social dynamic which enhances team synergy and productivity. To reduce exploitation, authorship can and should reflect reality (as much as possible), and factor in both the social activity within a collective environment, as well as

acknowledge individual elements. While ill-intentioned individuals can always hide wrongdoing, the promotion of continuous transparency as a principle will invite individuals to better communivate how contribution is distributed.

Limitations of Transparency

It would be presumptuous to think that authorship order and transparent disclaimers would fully reflect all interactions involved in the conduct and publication of research; disclaimers can only tell part of the story. Individuals may be limited by journals that refuse to print or that minimize authorship disclaimers. Although I am unaware of journals openly banning disclaimers, the content and format requirements of journals can influence the communication of disclaimers. For example, a disclaimer written at the end of a paper (or even at the bottom of the cover page) in a very small font will draw less attention than one placed close to or directly underneath the authorship byline.

Collegiality

The notion of collegiality has not received much attention in the RCR literature, which is odd given the increasingly collaborative nature of research. When looking for a definition of collegiality in the university context, I came across certain organizational concepts for collegiality, especially in the fields of sociology (Lazega 2001; Crozier 1969; Smyth 1991; Waters 1989), management (Bess 1988) and higher education (Brett 1997; Nuttall 2012). These might have evolved to some extent as a result of Weber and Durkheim's debate on the sociology of organizations, where collegial models where discussed in detail. According to Waters (1989), Durkheim envisaged a normative function in an organizational form of collegiality where workers should share power in decision-making and thus promote a form of stability. Conversely, Weber saw collegiality as a negative element that would counter the bureaucratic, efficient and rapid decision-making, mainly in political affairs (Waters 1989). Regardless of whether it is welcome or not in an organization, shared decision-making is often considered as central to collegiality.

Since a research team may not exactly function as a highly structured organization but rather as a more organic, knowledge network of individuals, I have shied away from defining collegiality in strictly organizational terms. I will thus rely on a less known but I think more

fitting notion of collegiality, developed by John Bartholomew Cavanagh (2010): "collegiality relates to the right to be heard, implying voice and democracy, as well as both the right and duty to influence processes and decisions for the common good through participation and consultation in the given social context" (Cavanagh 2010, p.1). This definition emphasizes the individuals within a collective context, and as such can apply nicely to the distribution of authorship. This interpretation of collegiality fosters collaborative engagement, dialogue and shared knowledge, agreement, and research results. It is not an administrative procedure or an organizational protocol, but rather a continuous and more dynamic interaction that allows team members to address issues and achieve results collaboratively.

Why use Collegiality as a Reasonable Principle in Authorship Distribution?

I use collegiality as a reasonable principle in authorship distribution to offset individualism and promote a productive context wherein a healthy level of competition can flourish through collaboration. Earlier, I highlighted a paradox in research: in a world where competition and individualism have traditionally dominated, there has been an emergence of multidisciplinary research teams which necessitate collaborative teamwork and open communication. But if individualism is rampant and the "survival of the fittest'' attitude is overwhelming, teamwork and sharing of authorship becomes an almost impossible task. However, the quest for recognition in research and academia has also given rise to greater multidisciplinary collaboration, and productive teamwork has increasingly become the forum for innovation. As such, it is in most researchers' best interests to promote collegial relations (at least within their teams) while living with the reality of "publish or perish".

Individualism has received its share of criticism in various fields of research. Communitarian ethicists such as Alasdair MacIntyre (2013) or Micheal Walzer (1983) have criticized the individual ethics of much of liberal political philosophy, while Feminist ethics and Care ethics have been particularly important in countering the overemphasis of autonomy and individualism in bioethics (Friedman 2000). However, none of these perspectives have been applied to authorship or work in research integrity. As a result, the team as a collective entity and the collegial interrelations important to a cohesive, well-functioning group

108

(including decision-making regarding authorship distribution) have rarely been addressed in normative theory.

A second reason to consider collegiality is that it can help in recognizing that group dynamics and the interdependence of individuals in collegial relationships can contribute to the important personal and professional growth of each member. Teamwork and collaboration are central topics of discussion in organizational psychology (Baker, Day, and Salas 2006; DeChurch and Mesmer-Magnus 2010; Deutsch 2003) and management (West 2012; Galegher, Kraut, and Egido 2014). The concept of synergy suggests that an organization of many people (in our case, a research team) has the potential to be much more than simply the sum of its parts (Katzenbach and Smith 1993). Kurt Lewin, a pioneer of organizational psychology and action research states that the group creates a "dynamical whole that has properties of its own" (Lewin 1948, p.60). In a collegial team, individuals can and should recognize that the team dynamic (mainly the relations between individuals) can support and enhance their individual contribution beyond what they could achieve alone. This awareness of others and the value of collaborative relationships could also have a positive influence on negotiations or agreement regarding authorship distribution.

Lastly, collegiality will facilitate the creation of fair procedures[15] tailored to the team's context. As previously demonstrated, Scanlon's contractualism can help in identifying the wrong or unreasonable behaviors for distribution of authorship. However, research team members must agree upon one of the many available authorship distribution schemes, i.e., the one that is not only ethically reasonable but that also best applies to their situation. It is important that a collegial process of open discussion and negotiation engage all team members in arriving at satisfactory agreement. I submit that collegiality along with the principles previously discussed will indeed be useful to team members with differing perspectives and from various disciplines. A collegial environment would provide a more open forum for all members regardless of status, discipline, or country of origin; individuals would feel more comfortable in sharing knowledge, and in collaborating with less reservation or fear of

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[15] Since this paper focuses on theoretical elements of value in authorship distribution, I will not outline the procedures that are necessary in decision-making regarding authorship distribution since I consider it more of a practical consideration. A procedure will, however, be developed in my future work.

exploitation. When the arrangement or agreement among members is reasonable as well as mutually beneficial, individuals might well temper (not suppress) their personal goals, and competitiveness, in order to benefit the collective, i.e., the team.

Limits of Collegiality

Collegiality has some important practical limitations in team research. Understandably, it would be more feasible to implement a culture of collegiality in a small 5 person team than in large teams located in different geographic locations with different cultures, and social and professional norms. Greater effort is required for such large teams to make it possible for individuals to feel that they have a fair opportunity to be heard. As fictional (but realistic) examples, there may be team meetings in the different geographic areas where sub-teams exist; or, representatives may be elected to enable the representation of different individuals in the sub-groups. The notion of collegiality and the procedures appropriate to various types of group to distribute authorship will clearly need to be fleshed out in an eventual framework for it to be useful to practitioners.

Summary

The following table is a summary of the justifications and limitations of the conceptual principles proposed for ethical authorship distribution. It is important to note that while certain principles may be more important in certain contexts, principles suggested are not mutually exclusive and will most likely be more helpful when applied together. For example, in a large team setting individuals may agree to distribute authorship in decreasing order of contribution. They may consider that certain individuals deserve more credit and accountability then others. It is only through collegial conversation that individuals may arrive at such a decision. To limit discrimination, fair recognition is useful. Lastly, declarations may be used to give meaning to the order used. There will most likely be different processes that may be used to decide authorship and its order depending on the context of multidisciplinary research (type of team, size of team).

Table 1: Conceptual principles applied to authorship distribution in multidisciplinary teams

Principles	Interpretation in authorship context	Justifications	Certain limitations
Desert	• The worthiness that results from contributing to a research project.	• Links merit and accountability. • Merit promotes innovation and production. • Accountability promotes responsible research. • Facilitates the evaluation of contribution. • Appraisal helps in ordering authorship. • Promotes productivity and excellence in research.	• May create excessive competition. • Difficulty in appraising contributions of different natures (e.g., technical or intellectual)
Equality	• Each individual's contribution is evaluated in the same way through an unbiased lens.	• Promotes less partial bias and fairness. • Reduces discrimination. • Mitigates disagreement within teams.	• Unconscious bias due to conflict of interest of evaluators. • Equal contribution not represented through sequencing order of authorship.
Transparency	• Declaration to explain the meaning of authorship order.	• Clarity as to the nature and amount of contribution. • Provides flexibility for different orders to coexist. • May reduce incidence of unethical or unfair behavior which shuns discovery and publicity.	• Disclaimers are often brief and can only represent part of complex teamwork and contributions. • Journal content or formatting practices may undermine or negate the utility of disclaimers.
Collegiality	• The right to be heard through a democratic process and a right to influence said process for the common good.	• Counterbalances individualism and excessive competition. • Helps develop mutual recognition of perspectives and practices. • Openness favors negotiation and agreement in authorship decisions. • Contributes to team synergy. • Facilitates the creation of fair evaluation procedures.	• Geographic distance. • Size of teams.

Conclusion

At the outset of this conceptual analysis, I briefly described the context of authorship in academic research collaborations. I emphasized the critical importance of authorship in academia as it often defines the success of individuals in research; and I noted that the literature on authorship ethics has mainly discussed unethical practices such as guest, gift, and ghost authorship. I also discussed how the growing number of authors on papers creates general 'obfuscation' concerning who did the work, who is responsible and how authors are ordered. The norms and practices of authorship distribution and order vary considerably between fields of research and disciplines, raising particular challenges for individuals from multidisciplinary research teams who seek to publish together. Journal editor organizations such as ICMJE and WAME (and to a lesser extent, COPE) have taken the initiative and developed more specific authorship guidelines that are gaining increasing attention in the literature on authorship ethics. However, while they may prescribe exclusion and inclusion criteria for authorship in the biomedical or health sciences, the determination of authorship order (especially in multidisciplinary teams) remains particularly vague. Moreover, there are rarely any argued conceptual justifications to support the proposals in these guidelines. Without adequate, practical guidance that is based on sound theoretical grounds, individuals are left confused about the justifications for deciding authorship and its ordering.

I have argued that Thomas Scanlon's contractualism provides a useful theoretical foundation to justify principles that would contribute to the ethical distribution of authorship in multi-authored publications, and especially in multidisciplinary teams. Scanlon's theory states that the acts or behaviors in a given context are unethical if disallowed by principles that individuals would reasonably accept in a general agreement. In the specific context of authorship distribution in academia, contractualism allows us to justify a variety of principles such as desert, just recognition, transparency and collegiality. As Scanlon argues, the morality of an act must always be evaluated (deemed unreasonable or not) while also considering the circumstances (context) in which it takes place. Some of the principles conceptualized in this paper may have different interpretations depending on contextual specificities. For example, collegiality in a group of five individuals will no doubt differ from that in a team with 500 individuals spread around the world.

As with any theoretical or conceptual approach, contractualism and the ensuing four principles I examined (i.e., desert, just recognition, transparency and collegiality) have their limitations, as has been acknowledged throughout this paper. Moreover, I have not presented a detailed working ethical framework, procedure or process that could be used in practice by multidisciplinary research teams, as this is beyond the scope of this paper. Empirical data regarding the specificities for multidisciplinary team research and their impact on authorship issues is needed in order to better understand the diversity of team practices and contexts. Along with the detailed theoretical foundations provided in this paper, such empirical data would provide the basis for the development of a practical framework to support ethical and non-arbitrary decision-making concerning authorship distribution in multidisciplinary team publications. The result would be a decision-making framework that is sufficiently flexible so as to be meaningful to users across diverse contexts (e.g., field, size, methods), while remaining ethically reasonable.

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LINKING STATEMENT

Chapter 4 argued that the ethical reasoning of T.M. Scanlon's Contractualism can be effectively applied to develop a theoretical foundation for authorship distribution. Scanlon's Contractualism considers appropriate those rules, principles or values deemed to be justifiable and for which there may be *hypothetical* agreement among individuals. In short, individuals would agree where a particular principle is reasonable; a principle is considered unreasonable when refuted within this hypothetical agreement. Notably, contractualism includes mutual recognition, an awareness of others and their respective agreement; this is particularly relevant in multidisciplinary collaborations where dialogue and collegiality are important. As well, contractualism allows for a more flexible conceptual basis and applications suited to what is reasonable within a given context. Contractualism can thus serve in justifying principles that are necessary and reasonable in the development of models for the fair distribution of authorship. Four particular principles were considered in this chapter: *desert*, *just-recognition*, *transparency* and *collegiality*.

Flexibility will be essential to adapting and applying these principles to different types of multidisciplinary teams, different types of research, different contexts and different cultures. **Chapter 5** will provide an example whereby the principles developed in **Chapter 4** are applied in a process that engages team members in authorship decisions throughout the life of a research project. The goal is to arrive at a shared understanding and a consensus or agreement, to the extent possible, to promote fair distribution of authorship. Collegiality is key in fostering an open forum for discussion, shared understanding, negotiation and the agreement necessary in the decision-making process. Individual contribution is the metric used to convey just recognition; this comprises both responsibility for one's work as well as due credit (as in the principle of desert). Finally, the proposed process features increased transparency through disclaimers and the use of a contributorship taxonomy as a tool to distribute roles and responsibilities to researchers. This would result in a clearer understanding of authorship order and authorship decisions.

The contributorship taxonomies developed in 2014 were presented as means by which authorship disputes could be limited (Allen et al. 2014). More specifically, Allen and colleagues developed a taxonomy in which different research tasks are detailed (as shown in

Table 2). By declaring who did each of these specific tasks, it is argued that researchers would promote transparency. The article in **Chapter 5**, which is co-authored with Professor Zubin Master and under review at the *Accountablity in Research*, presents a critique of the literature regarding contributorship taxonomies to underscore the important limitations of this approach, and which have been understated in the academic literature. However, it is also acknowledged that the taxonomies can be beneficial at the outset in identifying and distributing responsibilities and roles in empirical research collaborations involving numerous individuals and tasks.

Table 2: Allen et al.'s (2014) "Contributorship taxonomy"

Taxonomy category	Description of roles
Study conception	Ideas; formulation of research question; statement of hypothesis.
Methodology	Development or design of methodology; creation of models.
Computation	Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms.
Formal analysis	Application of statistical, mathematical or other formal techniques to analyse study data.
Investigation: performed the experiments	Conducting the research and investigation process, specifically performing the experiments.
Investigation: data/evidence collection	Conducting the research and investigation process, specifically data/evidence collection.
Resources	Provision of study materials, reagents, materials, patients, laboratory samples, animals, instrumentation or other analysis tools.
Data curation	Management of activities to annotate (produce metadata) and maintain research data for initial use and later re-use.
Writing/manuscript preparation: writing the initial draft	Preparation, creation and /or presentation of the published work, specifically writing the initial draft.
Writing/manuscript preparation: critical review, commentary or revision	Preparation, creation and /or presentation of the published work, specifically critical review, commentary or revision.
Writing/manuscript preparation: visualization/data presentation	Preparation, creation and/or presentation of the published work, specifically visualization/data presentation.
Supervision	Responsibility for supervising research; project orchestration; principal investigator or other lead stakeholder.
Project administration	Coordination or management of research activities leading to this publication.
Funding acquisition	Acquisition of the financial support for the project leading to this publication.

The article presented in **Chapter 5** developed following discussions with Zubin Master, after the publication of Allen et al's articles on contributorship in 2014. The ideas for our paper were developed and discussed together, and a general outline was written by Zubin Master. I then conducted a review of the literature and further expanded the ideas in the outline to develop a first draft. The focus of the paper changed substantially during the research process. We both critically revised all subsequent drafts, agreed on the form and content of the final manuscript and on authorship order.

CHAPTER 5: A NEW PROPOSAL TO ORDER AUTHORS IN MULTIDISCIPLINARY BIOMEDICAL RESEARCH PUBLICATIONS

Authors: Elise Smith and Zubin Master

In review in *Accountability in Research*

Abstract

Background: Misunderstanding and disputes about authorship in multidisciplinary health research teams are commonplace. Left unmanaged and unresolved, such conflicts can undermine knowledge sharing and collaboration, obscure responsibility and accountability for research, and withhold due credit for individual contribution. Indeed, this would run counter to the norms, values, as well as the advancement of science. In an attempt to resolve authorship disputes, a number of researchers have suggested a system based on authors' self-reporting of contributions, thereby placing less reliance on, or complete abandonment of, authorship.

Discussion: We argue that contributorship is unlikely to replace authorship for several practical reasons and both will continue to coexist. Determining authorship order is a difficult discussion which researchers typically leave until manuscript preparation or just prior to submission, if at all. We outline a novel procedure to help health science researchers determine contributorship and authorship order in multidisciplinary biomedical teams were different disciplinary cultures present various authorship norms. The procedure is based on an open and collegial dialogue which is ongoing throughout the life of the research project, and ends with an explanation of individual contributions and a declaration to justify authorship order within the manuscript. The relatively small time required of researcher in this procedure is offset by its benefits, namely greater fairness, trust and collegiality among team members, reduced confusion, mitigation and prompt resolution of time-consuming disagreements.

Summary: In this debate article, we argue that contributorship and authorship can and should co-exist. To exemplify, we propose a procedure in which authorship order can be determined in a fair and transparent manner using contributorship (self-declared contribution).

Background

In recent years, there has been a significant rise in multi-authored publications in health science research (Weeks, Wallace, and Kimberly 2004; Baethge 2008), which has given rise to questions about the fair and equitable distribution of authorship (Master 2011). Specifically, the designation of a researcher as author, and the order in which their name appears on the author byline, may be sources of misunderstandings and disputes within collaborative teams (Wilcox 1998; Kwok 2005; Scheetz 1999; Marušić, Bošnjak, and Jerončić 2011; Dance 2012). In the contemporary system of science, authorship is an important measure of a researcher's responsibility and credit for their work. Consequently, researchers compete for high value authorship positions such as first, last, and corresponding author. Individuals on research teams may argue that they merit a particular authorship position based on the quantity and value of their work compared to others. It is also notable that unethical practices and grievances regarding the distribution of authorship are prevalent (Marušić, Bošnjak, and Jerončić 2011; Martinson, Anderson, and De Vries 2005). For example, Martinson and colleagues showed that 10% of the 3,247 NIH-funded researchers surveyed self-reported having engaged in, or had seen others engage in, unethical authorship practices (2005). Such high levels of unethical authorship practices is said to have a severe impact on the integrity of research (Marušić, Bošnjak, and Jerončić 2011). Even if empirical data on the subject remains heterogeneous, reports of the occurrence of authorship disagreements range from 27% (Sandler and Russell 2005) to 36% (Okonta and Rossouw 2013).

One salient response to authorship misallocation adopted by many health journals has been to include self-reported declarations where each author's contribution is listed promoting transparency and accountability (ICMJE 2013c; WAME 2007b). Previously, contributor lists mirrored international standards of authorship allocation explaining the general research tasks which each author contributed including: study design, data collection, analysis, and writing. Recent attempts however have expanded to provide more detailed taxonomies that further identify and clarify the different sets of contributions (Allen et al. 2014). For example, researchers could be named for such tasks as methodological design, data curation,

127

supervision, and project administration among others. Furthermore, each task category is to be linked via a "badge" to an online researcher identification website (Chawla 2014). This newer system of "contributorship" – an expanded update to more common modes of authorship order on the byline – is being touted as the answer to end authorship disagreements (Allen et al. 2014; Chawla 2014). Advocates maintain that this approach could be more important to researchers than authorship itself because it offers greater specificity respecting the nature of the contributions made by each individual. In this paper, we argue that contributorship is not likely to replace authorship because of several significant limitations. Instead, we propose a process which incorporates both contributorship and authorship, and a procedure in which authorship order can be determined in a fair and transparent manner through collegial decision-making.

Discussion

Guidance on Authorship Attribution and Order

International bodies consisting of academic journal editors have provided guidance as to who can and cannot be an author (ICMJE 2013c; WAME 2007b). The most widely adopted set of standards for attributing authorship in empirical health science publications are the recommendations from the International Committee of Medical Journal Editors (ICMJE), which state that: "authorship be based on the following 4 criteria:

1. Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
2. Drafting the work or revising it critically for important intellectual content; AND
3. Final approval of the version to be published; AND
4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved." (ICMJE 2013c)

While the ICMJE criteria provide guidance on which contributions merit authorship, little is said about authorship order (Smith and Williams-Jones 2011; Smith and Boulanger 2011). The meaning of authorship order is often heavily influenced by disciplinary culture or tradition. In the biomedical sciences, those who contribute most substantially to the paper are often named first (usually a graduate student or post-doctoral fellow), and the last author is

typically the Principal Investigator (PI) (Tscharntke et al. 2007). Often the remaining authors are ranked in decreasing order based on the importance and significance of their contributions. However, in other fields, researchers may be named in alphabetical order or be given equal authorship if they are deemed to have contributed similarly. A growing trend in the health sciences is to attribute equal authorship for publications by placing an annotation beside the authors' names explaining that they have contributed equally (Akhabue and Lautenbach 2010; Wang et al. 2012; Dotson 2013). The intense competition for sought-after authorship positions is further exacerbated by pressures placed on researchers by research institutions, funders and national systems to assess productivity. For example, PhD students may require a certain number of first author publications in order to graduate. Faculty members seeking tenure or promotion may need either first, last or corresponding author publications (Hundley, Teijlingen, and Simkhada 2013). Since health sciences have become increasingly multidisciplinary, it is important to reflect on how different cultures of ordering are to be addressed in the authorship allocation process. Since the health sciences have become increasingly multidisciplinary, it is important to reflect on how different cultures of ordering are to be addressed in the authorship allocation process.

Contributorship Lists and Their Impact on Authorship

The concept of listing each authors' contribution was first introduced in the mid-1990s by Rennie, Yank and Emmanuel as a means to enhance transparency and promote accountability (Rennie, Yank, and Emanuel 1997). They also suggested that one author be named "guarantor" to indicate overall responsibility for the research. The notion of contributorship has since been espoused by ICMJE and other international journal editor organizations (ICMJE 2013a; COPE 2011a; WAME 2007b). Given this top-down mandate, many medical journals have adopted contributorship lists that are included in the published manuscript (Rennie 2001).

Classically, contributorship lists have used basic categories presented in the ICMJE guidance explaining that an individual contributed to one or more of the following research tasks: conception or design, collection of results, data analysis, initial drafting of the manuscript or revision for important intellectual content. While such lists have been widely

adopted, they fail to sufficiently detail tasks and contributions of team researchers to justify authorship order. As biomedical research publications are team efforts, it is likely that most authors have contributed to several aspects of the project. However, this would not be captured in current contributor lists which simply explain that authors conform to ICMJE recommendations.

More recently, Allen et al. have suggested a detailed taxonomy of contributions, consisting of 14 different categories (2014). For example, they identify three different writing categories: 1) initial manuscript preparation or writing the initial draft, 2) critical review, commentary of revision, and 3) visualization/data presentation. They also introduce novel categories of contributorship, including supervision, project administration, funding acquisition, data curation, and the provision or resources i.e., reagents, biological samples, animals, instruments, and access to patients. The addition of more specific research contributions provides an additional level of transparency to previous contributorship declarations.

One notable strength of the detailed contributorship taxonomy is the inclusion of those tasks, which that have been traditionally omitted from authorship standards, including, project administration, funding acquisition, data curation, and the provision of materials and resources. With the increase of collaborative, multidisciplinary research arrangements, the expanding scope and complexity of data analysis and also the growing reliance on sophisticated computation and other specialized skills, such tasks are valuable contributions to be noted in scientific publications (Katz and Smith 2014). Such a taxonomy could highlight a researcher's skills and achievements to funding agencies and prospective employers.

While not explicitly calling for the elimination of authorship altogether, advocates of the new contributorship taxonomy nevertheless present it as a solution that would supersede authorship, noting that "[t]hrough the endorsement of individuals' contributions, researchers can start to move beyond 'authors' as the dominant measure of esteem" (Allen et al. 2014). Similar claims on the abandonment of authorship for contributorship models were made in the 1990s (Rennie, Yank, and Emanuel 1997; Smith 1997). Yet today, authorship continues to be a dominant form of credit distribution and recognition in academic science. In fact, both contributorship and authorship continues to coexist.

While the goals proposed by Allen et al. are laudable, but we remain skeptical that a detailed taxonomy of researchers' contributions can fairly and accurately measure and convey the value of their contribution as do many authorship distribution models. The importance of categories of contribution will differ depending on the type of project. For example, data collection and analysis may be relatively straightforward in one project, while considerable knowledge, effort and skill may be required in another context. While the detailed contributorship taxonomy provides greater clarity of particular research accomplishments, it does not offer a measure of the quantity or value of a contribution, which is often essential in ordering authors in the health sciences. In this respect, the detailed contributorship proposal is unlikely to adequately represent the contributions of researchers who did the bulk of the work or who contributed more significantly than others on a team, and who merit the more prominent authorship positions. Understandably, these researchers are likely to want key authorship positions and the associated credit.

A second shortcoming of the systematic taxonomy proposed by Allen et al. is that it still remains unclear how much an individual must contribute to be listed as a "contributor." Should contributorship categories be fully inclusive and provide lengthy lists of names of individuals who provide minor contributions? Or should individuals be listed when they have made substantial contributions that would otherwise permit them to be listed as authors? And this then begs the question, as many have asked about the ICMJE recommendations: *what constitutes a "substantial contribution?"* In this regard, a certain quantification of work remains necessary. While there has been criticism of the notion of "substantial contribution" in defining authorship, contributorship has not provided any more clarity, and it also lacks any measurement or ranking to value individual contributions.

Third, in absence of authorship, it remains unclear how citation and referencing would work. While citation styles could be created without individual's names placing greater emphasis on digital object identifiers (DOIs) as example, the entire referencing system would require substantial overhaul. Citing authors in a text like the Chicago reference style would not be possible. Even if articles are referenced in another manner, researchers must be named in the manuscript and they would be named in some order which in turn could serve as a potentially new metric to ranking authors. Undoubtedly, disagreements over authorship order

would arise and persist. In addition, institutions including funding agencies, university tenure and promotions committees, and dissertation committees would no longer be able to rely on authorship as a metric of performance. Institutions routinely place policies surrounding authorship in order to ensure a certain level of scholarly contribution and rigor necessary for graduation, promotion, and tenure. Funding agencies also require that publications be listed and peer reviewers examine authorship placement within publications during the review of grants and awards. It remains equally unlikely that colleges, universities, and funding agencies will abandon authorship altogether since contributorship does not clearly outline or measure the importance, value, and quantity of the work. For all of these reasons, both contributorship and authorship will most likely continue to coexist. In order to build on the strengths of both, we propose that authorship order and a detailed contributorship taxonomy be combined in academic publications. Below, we outline a process to help researchers in large multidisciplinary teams participate and effectively manage authorship decisions.

An Updated Proposal: Self-reported declarations as the result of consensual decision-making

It is not within the scope of this paper to develop a detailed ethical framework of norms and values to support either contributorship or authorship distribution. Rather, we propose a functional process based on reasonable values to facilitate consensus and decision-making regarding authorship in multidisciplinary research. While there have been certain processes for industry-sponsored clinical trial publications (Marušič et al. 2014) and for multi-centered publication (Devine, Beney, and Bero 2005) these do not include highly multidisciplinary contributions. The suggested process consists of the following six steps:

1. Outline roles and duties of individuals using Allen et al's taxonomy
2. Outline the magnitude and value of different contributions
3. Determine authorship order
4. Have continuous open dialogue about authorship and authorship order throughout the research process
5. Before the manuscript is sent to publication, decide authorship order in a final open discussion
6. Decide on a declaration regarding authorship order

ICMJE recommends that discussions regarding authorship distribution should start when individuals are "planning the work" (ICMJE 2013c). However, in practice this seems to occur as anecdotal evidence suggests a lack of discussion concerning authorship and authorship order at the outset of research. When individuals do talk about authorship, it is typically casual and unstructured, may not involve all members of a team, and when it seems to occur is during manuscript preparation or just before submission. This may be due to researchers feeling discomfort that it may be presumptuous to discuss authorship before the project has begun.

We suggest a gradual, non-controversial approach to initiating discussions on authorship. Step 1 begins by establishing the roles and duties of individuals involved in the project. The team determines and agrees as to *who will do what*, with the caveat that team members recognize that contributions will change as the research progresses. The list of tasks provided in the detailed taxonomy of contributorship would serve as a useful starting point in identifying and planning activities and outlining how work will be shared during the research process. At this stage, it is also important to establish leading roles e.g., the researcher who will do the bulk of the research (likely the first author) and the PI overseeing the project in order to help establish the key authorship positions. Moreover, a dispute resolution mechanism should also be agreed upon in case authorship disagreements persist by the end of the project. While outlining a process for handling disagreements is beyond the scope of this paper, the procedure can involve having a neutral third party (e.g., a researcher or an institutional administrator) as arbitrator and decision-maker.

Second, individuals must determine the magnitude or value of contributions; in other words, contributions must be weighted to the extent practicable and useful. Individuals who have done the most important work deserve the highest recognition; however, this is no small challenge. Considering the diversity of types of contribution in multidisciplinary research, there must be discussion as to limit unfairness based on one type of work or one field of research. It is important to remember that while the 14 item taxonomy of Allen and colleagues may be useful in describing who did what, it is not designed to reflect the *value and quantity of research contributions*. Elements of the taxonomy would rarely have equal or universal relevance or value across all research projects or even sectors of the health sciences. In some

projects, data collection may constitute more than 25% of the research effort while computational and statistical analysis takes up the bulk of effort. In other circumstances, we may find the reverse. While certain researchers have created quantified evaluation schemes (e.g. point systems) to rank authors making evaluation seem more 'objective' (Sheskin 2006; Clement 2014; Hunt 1991; Al-Herz et al. 2013), these will have significant limitations in multidisciplinary research because of the diversity of types of contributions. It is also unlikely that various contributions can be quantitatively measured with such accuracy that it truly captures both the magnitude of work (e.g., in time and effort), and its value and importance to the project. It is for these reasons why only through dialogue can individuals from different fields and expertise explain the value and importance of their work to others. It is understandable that this step will likely involve more difficult discussions and value assertions.

Third, based on the magnitude and value of each researcher's contribution, team members must determine the order of authorship. In biomedical research publications that consider process for distributing authorship, the authors are always named in decreasing order based on contribution (Marušič et al. 2014; Devine, Beney, and Bero 2005); however other types of order are possible. If contributions are relatively equal in quantity and value, then it would be logical to use an alphabetical author order with a declaration or an annotation mentioning that the authors contributed equally. By contrast, if contributions are unequal, then rank ordering by contribution would be the most representative. To explain authorship order, a declaration should be used. In multidisciplinary research it is important to consider different types of order (such as alphabetical) as to adapt to different ways of working which may be more egalitarian (individuals doing relatively equal amount of work) as opposed to more hierarchical teams.

Because the research project evolves, a fourth step involves continuous and open discussion about authorship among team members in order to address changes and agree upon an adjustment. Individual team members may leave and new ones join the project, the research may alter direction, and new skills and expertise may be required. As such, contributorship and authorship may have to be updated to reflect changes in work; everyone on the project should be informed by the project leaders. Such ongoing discussion and updates would allow team members to understand and adjust expectations regarding authorship order. A collegial

process involving open discussion and a degree of mutual respect would contribute to greater understanding and easier consensus on authorship order. Ultimately, this approach would serve to mitigate potential disputes and foster greater team synergy.

The fifth step involves a final discussion on contributorship and authorship order is required prior to submission of the manuscript for publication. In cases where a team member feels strongly that they deserve another position and the conflict is not easily resolved, the process of decision-making in Step 1 should be used to decide on a fair outcome.

Lastly, a declaration explaining the authorship order (e.g., in a footnote or in the Acknowledgements section of the manuscript) can be made to promote transparency. Because different norms may co-exist in multidisciplinary research contexts, the meaning of authorship order may be understood or interpreted differently, thereby leading to confusion. Declarations can add the necessary clarity to mitigate differing and erroneous interpretations of authorship order. For example, if a research team exceeds 50 or more individuals, it would be impractical to name individuals in order of contribution; individuals might well be named in alphabetical order, which can be stated in the declaration. However, in this example, the team might want to acknowledge or emphasize the work of one or more individuals who had contributed more significantly than others.

Important Limitations

There are three important limitations with regards to our process that merit discussion. First, some might find that the authorship scenario presented above is overly optimistic. Given the diversity of norms in multidisciplinary team collaborations, disputes may be unavoidable – especially in large teams – and may not always be resolved to the satisfaction of all authors. We do not suggest by any means that our proposed procedure is a panacea; rather, we suggest that in most cases, authorship disputes can be significantly reduced or alleviated when a process of open and collegial dialogue about authorship is established from the beginning and continued throughout the life of the project.

This dialogue is especially important when new collaborators join a project or more research is required. While Step 1 outlines a conflict resolution process within the research team, this may not result in an outcome that is satisfactory to all parties. In such cases, the

issue may need to involve institutional administration, including research ethics consultants, Research Integrity Officers, or administrators within research offices or even externally to the institution.

A second critique focuses on the amount of time and resources required of busy researchers who are already managing many duties and research ethics responsibilities. They could balk at participation in a procedure for ethical authorship, viewing this as yet another demand on their time. While we agree that there will be additional time required, it would likely not require much more than a few email or face-to-face group discussions. But more importantly, the idea of having an open discussion has tremendous value and is likely to help researchers save time in the long run. Undertaking this process will help ensure openness and collegiality, promote collaboration, and maintains trust among researchers within a team. Having an open dialogue can also prevent potential negative outcomes of authorship misallocation that could end collaborations, teach bad habits to trainees, create an unhealthy team environment, or alter one's perceptions of the norms and values of science.

A third critique is that our proposal, or any contributorship proposal for that matter, does not adequately consider those who have been left out of authorship and would otherwise be absent in our process. While contributor lists demonstrate accountability and transparency, these are passive instruments with the onus placed on authors to accurately self-report their contributions. Our mechanism does not sufficiently consider such cases where power dynamics may prohibit a researcher from deserved authorship. Here, different mechanisms need to be developed.

Summary

In this paper, we discuss the renewed interest in detailed contributorship taxonomies as a means to address disputes about authorship and so ensure fair recognition for contribution to the scientific endeavour. Such taxonomies are beneficial in that they increase transparency and acknowledge contributions previously disregarded for authorship credit. Yet, a taxonomy of contributorship is unlikely to replace authorship for many practical reasons, such as citation or the evaluation of scholars. We propose the following way forward. First we suggest that authorship and contributorship can and should coexist. Second, we outline a procedure for

determining authorship order through open discussion based on the detailed taxonomy of contributions. The procedure calls for continuous group dialogue where team members discuss their roles and contributions to determine and justify authorship order. Declarations should be used to outline contributions and explain order in the manuscript. It is our hope that the proposed process will be mandated by health science journals, and that contributorship and authorship order declarations become included as a standard part of the manuscript.

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CHAPTER 6: LIMITATIONS

The limitation of this thesis will be discussed in two parts. First, I consider the limitations regarding the content presented in specific chapters; this will be fairly brief as many of these limitations have already been discussed in the respective chapters. Second, I consider the more general limitations of this thesis, namely those: 1) based on individual interests, 2) linked to the system of higher education and 3) linked to the larger influences external to the system of science.

Specific chapters

The **first Chapter** presented a review of the literature relevant to the subject of authorship. In order to have a truly interdisciplinary approach that was more wide-reaching and diversified, three main areas of literature were considered, namely: 1) science and technology studies (STS), 2) responsible conduct of research (RCR) and 3) authorship guidance written by journal editor and publication ethics organizations. Because the object of this thesis was set within an interdisciplinary context, the literature review was not limited to one discipline; nor was a systematic review methodology employed. While the interdisciplinary nature of this review has its advantages, it also has important limitations because for example, another individual could not systematically replicate the review in **Chapter one**. In bioethics, some authors have argued that reviews should adopt a more systematic approach, in order apply methods for systematic argument-based clinical ethics literature (McCullough, Coverdale, and Chervenak 2007), systematic reviews of reasons (Strech and Sofaer 2012; Sofaer and Strech 2012), and systematic reviews in empirical bioethics (Strech, Synofzik, and Marckmann 2008). Yet, since literature on authorship ethics is extremely limited, I deemed it more useful to use a less systematic but more wide-reaching approach.

While **Chapters 2** and **3** consider the issues that may arise in authorship distribution in multidisciplinary health research, the lack of empirical data makes it impossible to truly know if *all* issues were considered and to what extent these issues have consequences for individuals, institutions and for the system of science itself. In **Chapter 3**, the issues in GHR partnerships were particularly difficult to map out, given the lack of contextualised

documentation on authorship in GHR. While the limited research that is available points to similar rates of misconduct in both LMICs and HICs, there are very different governing systems to mitigate research misconduct (Ana et al. 2013) and this most likely affects the culture of research. Our discussion was limited to four particular issues pertaining to authorship practices, but the selection of such issues was not directly linked to any systematic empirical review. Instead, the issues identified came from individual researcher experiences in GHR research, which were then backed up with different types of literature (e.g., cases and commentaries). While this literature is obviously limited, it does provide a necessary starting point to initiate a discussion about authorship distribution practices in global health research partnerships, which is a particularly informative example of the challenges raises in multidisciplinary health science research.

In **Chapter 4**, a number of relevant limitations are discussed. The most significant would be about the theory of Contractualism itself, because it affects the rest of the conceptual foundation of the authorship distribution principles and subsequent process. One major critique of Scanlon's contractualism is that certain central concepts remain vague (Hughes and De Wijze 2001). For example, Scanlon's contractualism is based on a hypothetical agreement in which principles could not be "reasonably rejected". There is indeed a level of vagueness in Scanlon's theory, but it also brings a degree of flexibility that is necessary for the various types of multidisciplinary research teams. While this vagueness may limit conceptual precision, conversely, it may also be an advantage in facilitating flexible applications of the theory.

Another important limitation of **Chapter 4** is that while certain actions may be deemed wrong because their guiding principles are not reasonable, there are still many "right" possibilities. This is not precise or in any way absolute. Once again, this can provide flexibility in authorship decision-making which is necessary to adapt to the diversity of teams; it makes many outcomes (including authorship orders and distribution types) possible. The downside (and in a way an important limitation of this conceptual approach) is that, in practice, it will be necessary to arrive at a selection of one among many possible fair solutions. The hope is to achieve consensus through open discussion and negotiation; however, this is limited in that consensus is only achievable to the extent practicable and possible. Indeed, individuals may

hold intractable positions that require a process of resolution and ultimately, decisive leadership to arrive at a decision. It is important in such situations that all participants are consulted and perceive the process to be fair and accessible.

As an example of consensual decision-making, a process was outlined in **Chapter 5**, inspired by the principles of desert, just recognition, transparency and collegiality. The article was originally intended as a critique of contributorship taxonomy, which was geared mainly to empirically-based research. Consequently, the proposed process will also likely be best suited to that type of research (whether it is multidisciplinary or not). In the case of more conceptual research, this or a similar process to promote fair distribution of authorship could be adopted; however, the use of the contributorship taxonomy – which is based on many empirical tasks – may be less important or even moot. Nonetheless, the main elements of the process would remain the same if used in conceptual research, including such elements as: open dialogue, the delimitation of responsibilities and roles, the valuing of research and the choice of order.

General Limitations of the Thesis

Although this thesis ended with a process for fair decision-making that is more applied and practical than a purely conceptual dissertation, there are still significant practical limitations to the principles and process promoted in this thesis. Admittedly, authorship decision-making can be a difficult process regardless of the ethicality of the procedures and the principles at work. Knowing exactly who is more or less responsible for different aspects of research work and what work is most valuable is often difficult to determine, qualify and quantify. Simply put, it is often not cut and dry and most likely, never will be. The conceptual research in this thesis might indeed give us knowledge of justifiable "right" ways of distributing authorship, but that does not make them easy to apply. Conceptually, the argumentation in this thesis is coherent and based in realistic and valued principles of science; it does stand on its own. However, since its inception it was always meant to be the basis of practical methods to help researchers distribute authorship minimizing conflict while promoting fairness. Seen in this manner, the practical limitations of this thesis are important and necessary to consider for the next steps of research on authorship distribution.

This thesis is a conceptual exercise that examined a specific problem – the distribution of authorship in multidisciplinary collaborations. While some contextual elements were addressed (especially during the first three chapters), the scope was limited from the outset; while this was necessary, it did invariably narrow examination of the many different factors that could adversely impact or influence authorship distribution. Certain real-life contextual considerations were outside the scope of this thesis and therefore, the research is limited in its applicability. It does not address the full range of interests and priorities of individuals, because of strong and complex power relations in higher education and because of the wider contextual considerations outside the system of science.

Individual Interests

Individuals could agree that principles in this thesis are considered fair and ethical. However, individuals may not assign high priority to their role in an authorship decision-making process in light of other obligations. As mentioned in certain chapters of this thesis (especially **Chapters 2** and **5**), researchers are already very busy with a diversity of responsibilities such as supervision, teaching, administrative functions, committee meetings, conferences, research, publication, etc. So while fair authorship distribution may reduce long-term disputes, some individuals might decide that in specific situations, authorship discussions would be too difficult or time-consuming. In some cases, individuals might simply want to avoid disagreement or discussion without intending to distribute authorship unfairly. In other cases, individuals may know that they *should* distribute authorship fairly but *choose* not to do so. This is not necessarily the result of malicious intent, but rather it depends on whether an individual has the moral motivation or intent to value 'fair authorship'.

Chapter 4 mentioned that theoretically, individuals could find moral motivation on the base of Scanlon's contractualism. This motivation comes from the fact that an individual in a similar situation would act in respect of certain principles; since agreement was hypothetically set, mutual recognition would ideally push an individual to act in accordance with such principles. In other words, an individual agrees to respect a set of principles because others – who should be respected – will do the same. But this could be seen as a kind of coercion, a co-opting mechanism. In practice, individuals do not all share the same moral positions or perspectives. Some may have already distributed authorship unfairly and thus 'mutual

agreement' is to some extent already broken or unachievable. As mentioned in **Chapter 3**, researchers often want to do good research and advance knowledge; however, their priority is not to redress systemic injustices in authorship. As such, they might think that because other people act in a certain way, or cut certain corners, they can also act in a similar fashion; further, they may not perceive any direct or significant harms as resulting from such actions.

While moral motivation in Scanlon's theory rests on the notion of agreement and common good, moral motivation can also have various other theoretical groundings that might be interesting to consider. For example, moral motivation or intent can also be defined as the prioritization of moral values that are more important than one's own personal values (Rest 1984). While this thesis did at times mention certain conflicts of interest that occur in authorship decisions, it did not consider authorship decision-making in relation to the many individual values that could influence individual behaviour. The moral motivation of researchers, which includes an understanding of psycho-behavioural aspects, has just recently been mentioned in the literature on RCR (Gordon 2014) and has not been considered at all in relation to authorship issues or distribution.

No matter what ethical models, procedures and principles are promoted and rationally justified, authorship decisions remain difficult and often complex; the individuals who make such decisions will *directly* bear the consequences. It has been mentioned throughout this thesis that optimally, the group or team decides authorship collectively, which is true in a number of cases. This collective notion might imply that individuals do not have different views within the group or team, but this would be a mistake. Many if not all contributing members may be authors; as such, each has a stake and a vested interest in the authorship distribution. Ultimately, there is subjectivity and it should not be surprising that self-interest and emotions may cloud judgment.

In addition, simply because we can rationally acknowledge the presence of such factors (e.g., emotions, bias, and self-interest) does not mean that we can ultimately remain detached, neutral and escape their influence. While researchers may be experts in their field and know the most about their own research, they may not always be best positioned to comparatively assess their own work or that of others. These realities need to be acknowledged and managed

within a research team. If this is not possible, a third party may be called upon to help manage or adjudicate such situations.

Influences from the System of Higher Education

The system of science and the system of higher education often overlap. One of the influences present in practice is the power struggle inherent in the enterprise of higher education. Although not all research is done with an educational purpose, many academic research projects have an educational purpose making supervisory relationships necessary. Such relationships involve power differences based on authority and knowledge. Ideally, such supervision would take the form of mentorship that teaches "attitudes, traditions, values and other things that cannot be learned in formal courses" (Shamoo and Resnik 2009, 68). The mentor has a certain responsibility to promote RCR and integrity in practice and lead by example, which includes fair authorship practices. However, in a competitive environment like academia, self-promotion (necessary to survive in academia) and fairness may be difficult to balance.

Students who are new to research will most likely have very little knowledge of ethical authorship practices. Certain individuals, especially those in a more junior position, may have more self-doubt about their capacity, competencies and ultimately the weight that they give to their contribution. They may wonder if they are worthy of merit through authorship. Or, some may think that research is *only* an educational vocation and thus they should be satisfied to have gained experience and knowledge. Students may refrain from questioning authorship decisions especially when collaborating with a direct supervisor or superior because of power differences, as briefly mentioned in **Chapter 2**.

Certain students may also simply not be used to debating or negotiating. Negotiation is a skill that is developed and that is not given to everyone. In this thesis (mainly in **Chapters 4 and 5**), it was argued that we can all have a voice in a collegial forum and that negotiation should be a positive experience. However, negotiation can be seen by some as a form of unethical manipulation, often a game of deceit and power (Bazerman et al. 2000). It is easy to overlook or ignore the voices of individuals who do not speak up or voice their concerns because they feel somewhat less powerful or uncomfortable; but that does not mean that they

145

should not have the opportunity or the setting in which to share concerns. While this thesis did not address the educational responsibilities of mentors, the subject of authorship distribution should be part of the educational experience, especially in the context of graduate studies.

It would be interesting to explore the responsibilities of mentorship with regards to authorship. At the moment, in the US "responsible authorship" remains one of the elements that are obligatory to teach in RCR (Committee on the Responsible Conduct of Research 1989, 36). However, it is not clear whether a mentor is responsible for facilitating access to research opportunities and ensuing authorship for their students. It is not clear to what extent a research director should stand up for her/his students. These elements point to important limitations of this research. While it was justified to limit the scope of this thesis to a specific type of research and exclude the educational vocation of universities, it is something that must be taken into consideration in a practical framework for fair authorship.

External Influences

Authorship is an important part of the reward system of science, as mentioned in the review of the literature in **Chapter 1**. The theoretical basis for fair authorship was elaborated so as to take into consideration the values of the system that is already in place. However, it is important to remember that science is not a closed system impervious to all externalities. Instead, science is continuously influenced by various other external factors, be they financial, political, social, and cultural. For example, in performance-based research funding systems, diversity and equity seem to be minimized in favour of a narrow focus on the notion of 'excellence' (Hicks 2012). Those who do research that may not yield a high publication rate might be discarded even if that research may be extremely innovative. In such highly competitive environments, assigning a research opportunity as a learning initiative may well be seen as unproductive. In a fiercely competitive workplace, the opportunity for research acknowledgement through authorship would be harder to come by.

In this thesis, the promotion of fairness within the institution of science is possible because it is institutionalised and contained within a system. Fairness, as argued in this thesis, is expressed in the accurate and transparent acknowledgement of research production and responsibility through authorship. Obviously, research production is also linked to research

opportunity. However, it is important to acknowledge that individual opportunity is determined in large part by factors that are not within the system of science. An individual may have been born into poverty, never had access to education and certainly, never even thought about contributing to research. Some may have considerable financial wealth, an education, and excellent opportunities but they may decide not to contribute to research. Although opportunity does not *de facto* lead to contribution to research it definitely makes it easier for those willing to make the effort. Such considerations were excluded from my analysis because they are outside the scope of this thesis. Nevertheless, it is important to acknowledge that the wider social justice context influences which individuals have access, opportunities and the resources to succeed in science and which do not. We can distribute authorship with as much fairness as possible, but we must also acknowledge the broader social injustices that shape human endeavours, including the scientific process.

CONCLUSION

In health sciences, there has been significant debate regarding authorship, specifically relating to ghost authors who hide their contribution so as not to reveal a conflict of interest (often associated with the interests of the pharmaceutical industry interests). The solution to this particular problem has been fairly straightforward; contributing researchers must be named as authors, regardless of their links with industry, and any conflicts of interest must be stated in a transparent manner in their publication. However, more difficult questions remain unanswered: Which contributions merit authorship? Are authors responsible for the work in its entirety? And are they responsible for their bias and their colleagues' biases? With the significant increase in multidisciplinary collaborations, there has been a concomitant increase in multi-authored publications and this has further complicated authorship distribution. Team members come from various disciplines with their respective, often differing and potentially conflicting norms and authorship practices; these differences can cause disputes and result in conflict that may negatively affect the integrity of the research process (Marušić, Bošnjak, and Jerončić 2011).

As mentioned in **Chapter 1**, authorship is prized as a measure of value and achievement in the contemporary system of science and innovation. However, authorship is also a complex and multi-faceted subject that has evolved as academic research itself has progressed over time; and it has been defined differently by thinkers from various disciplines. Bourdieu would say that authorship is a form of 'symbolic capital' to be exchanged in the science system, as currency is in the economic system. Latour sees authorship as a measure of credibility, while Biagioli sees authorship as intellectual property that may not be determined by, or imply, a contribution to the creation of knowledge.

Scientific authorship has evolved to recognize responsibility and credit for one's contribution to research; the scientific literature also recognizes that many factors may unduly influence the distribution of authorship such as, power, credibility, gender, seniority and disciplinary norms. While post-publication injustices (e.g., obliteration by incorporation, the Matthew effect) have been discussed in science and technology studies (STS), there has been little said about the normative or ethical considerations regarding authorship. While the

literature on the responsible conduct of research (RCR) is more normative, it is also relatively recent and much less developed than the STS literature. RCR has focused principally on authorship relating to such unethical practices as gift, ghost and guest authorship; however, it also discusses important notions of responsibility and accountability linked to authorship. Yet, RCR is not a normative system with a coherent theoretical foundation. As mentioned by Comstock, "The RCR field – if it is a field – is confused and muddled. Instructors in the area have not paid adequate attention to its foundation" (Comstock 2013, 4).

Journal editors in the biomedical sciences (e.g., ICMJE, WAME) have developed more practicable authorship guidelines and these have played an important role in shaping contemporary authorship practices in the health sciences. However, while general definitions and certain criteria are set out in authorship guidance, recommendations regarding authorship order and distribution are vague or absent. Further, there is little or no conceptual basis or rationale to underpin the principles (e.g., fairness, transparency) put forth in these guidance documents; ultimately, the principles are interpreted and implemented differently depending on the disciplinary culture and prevailing norms. In response to these practical and conceptual weaknesses, this thesis sought to answer the following question: ***What would constitute a theoretical grounding for the fair distribution of authorship in multidisciplinary health science collaborations?*** This question was broken down into four sub-questions:

1) *What issues do researchers come across when distributing authorship in different multidisciplinary health research team contexts?*

2) *What theories and concepts may be used to define fairness in authorship distribution?*

3) *Based on such fairness, what values and guiding principles may be applied to help in the distribution of authorship?*

4) *Based on such a conceptual consideration, what could a fair authorship distribution process look like in multidisciplinary health science collaborations?*

Question 1 (***What issues do researchers come across when distributing authorship in different multidisciplinary team contexts?***) was dealt with in **Chapters 2** and **3**. **Chapter 2** presented the diversity of authorship orders currently in use in multidisciplinary health

sciences research (e.g., alphabetical, ranking based on contribution), and noted that there are also preferred, tacit or traditional practices adopted in respective fields (e.g., corresponding author first, Principal Investigator last). In the health sciences, authorship distribution in decreasing order based on contribution is typically the prevalent model. However, in multidisciplinary health research, contributions may be quite diverse. Comparing different types of contributions (e.g., technical and intellectual) may be difficult to measure and weigh comparatively, and to rank in determining authorship order; this can create conflict among team members. Most often, intellectual contributions receive greater acknowledgement and value than do technical contributions. Accordingly, individuals that do most of the "intellectual" contribution are typically ranked higher in the authorship order while technical contributions are secondary. This undervaluation of technical work is worrisome and may be unwarranted given the increasingly important and even critical role that such contributions make to the success of contemporary health sciences research.

Chapter 3 explored a particularly challenging context of multidisciplinary health sciences research and authorship, namely, global health research (GHR) partnerships wherein researchers from low/middle income countries (LMIC) collaborate with researchers from high income countries (HIC). The promotion of equitable collaboration is a central preoccupation in these partnerships, and so some have advocated that this should be reflected in authorship distribution. The emphasis on greater equity is an attempt to redress injustices and biases that undervalue the contribution of LMIC researchers in GHR collaborations. While the same authorship guidelines used in mainstream health sciences research are applied (e.g., ICMJE) in GHR collaborations, they may have unintended and problematic outcomes. For example, authorship guidelines typically emphasize and attach importance to participating in the writing or critical revision of an article. This creates a systemic injustice towards individuals who do not speak English, as is often the case with many researchers in LMIC. Also, LMIC researchers are often responsible for important patient recruitment and data collection activities because of their unique knowledge of the local customs and language; however, this important technical contribution is often minimized in authorship distribution based on contribution. Also, financing is often obtained by researchers from HIC and LMIC researchers have lesser access to funding; these potential power differences are significant and difficult to

overcome. It is therefore not surprising that authorship may be distributed based on power. Systematic injustices seem to be commonplace in GHR. The RCR literature and existing guidance do provide examples of 'injustice,' but there is no explanation or definition of what is 'just' or 'fair' in the distribution of authorship in multidisciplinary collaborations, whether in GHR partnerships or in health sciences research more generally.

In response to Question 2 (***What theories and concepts may be used to define fairness in authorship distribution?),*** **Chapter 4** presented Scanlon's Contractualism (Scanlon 1998) as a good theoretical basis upon which to develop principles for the fair distribution of authorship. Contractualism holds that principles are considered fair if they are not deemed unreasonable in a hypothetical agreement. Scanlon argues that the morality of an act must always be evaluated (deemed unreasonable or not) while also considering the circumstances (context) in which it takes place. Such an approach allows for the possibility of many possible 'rights', thus ensuring flexibility and openness in any process while still admitting that 'wrongness' does exist. This theory provides an approach to determine and justify the principles and values that could apply to authorship distribution in the context of multidisciplinary collaboration.

In answering Question 3 (***Based on such fairness, what values and guiding principles may be applied to help in the distribution of authorship?***), Scanlon's theory of contractualism was applied to develop four basic principles to promote the fair distribution of authorship in multidisciplinary health sciences collaborations. First, it is argued that *desert* is fundamental as it is directly linked to actions that are valued and for which individuals are responsible. Merit, through authorship, is a consequence of this desert and the basis of scientific research. Such a principle is paramount in ensuring that authorship remains linked to responsibility and accountability. In deserving and receiving authorship, individuals receive merit that is acknowledged and rewarded within the system of science. Second, the principle of *fair recognition* is promoted to ensure a level of impartiality to mitigate the influence of discriminatory factors such as gender, power, or seniority when ordering authors. Third, the argument is made that *transparency* is necessary to ensure that the meaning of an authorship order is understood clearly across disciplines and cultures with a multidisciplinary collaboration. Lastly, *collegiality* is justified as a key principle to ensure that all individuals

participating in the research project have a say in the process of authorship distribution. This principle allows for more communal values to be promoted and consequently, it may counterbalance individualistic tendencies commonplace in academic research.

These four principles are promoted in a consensual decision-making process outlined in **Chapter 5**, and thus serve to answer Question three (***Based on such a conceptual consideration, what could a fair authorship distribution process look like in multidisciplinary health sciences collaborations?***). A caveat is needed at the outset: while principles may be considered ethically sound, their successful implementation depends largely on the willingness of team members, whose actions will in large part determine the outcome. The proposed process is designed to facilitate a constructive dynamic that leads to the implementation of the recommended principles. For instance, throughout the process individuals are called on to distribute authorship based on contribution alone. This would mean that authorship is based on *desert* for specific contributions. Comparative assessment based *only* on contribution would help minimize judgements based on discrimination, and so promote fair recognition. In order to increase transparency and understanding, declarations are recommended to provide an explanation and clarify the meaning of a particular authorship order. Throughout the process, collegiality is promoted through ongoing dialogue in an open forum to ensure shared understanding and consensual decision-making, to the extent possible.

The theoretical foundation, the ensuing principles and the process developed in this thesis provide a conceptual basis with which to promote fairness in authorship distribution in multidisciplinary health sciences collaborations. While there is still much more work to be done prior to the implementation of this process, it is arguably an important step in the right direction. The development of a reasoned and practical ethical framework would help to mitigate the general confusion regarding authorship (which norms and practices are 'appropriate'?) while also guiding researchers in the fair distribution of authorship.

Future Research on Authorship

Roles and Responsibilities in Authorship Distribution

Researchers play key roles and have primary responsibilities in the fair distribution of authorship; in short, the distribution of responsibility and credit is awarded *to researchers by*

researchers in the context of collaborative group research. However, research into the topic must also take into account the broader system as a whole in which many other actors and institutions (e.g., researchers, research centres, universities, funding institutions, students, peer-reviewers, mentors) also influence research integrity, including fair authorship practices. As mentioned in the review of the literature in **Chapter 1**, editors must sometimes deal with authorship disputes after the manuscript is sent to the journal or even sometimes after a manuscript is published. While editors often refer disputes to academic institutions, this tactic may not resolve a dispute; indeed, it may be that more than one institution is involved. Unfortunately, institutional mechanisms to manage authorship (and integrity more generally) are quite diverse and not well documented in the academic literature.

Interestingly, there has been recent research on cooperation between journals and research institutions in cases of misconduct (Wager and Kleinert 2012). This research shows, for example, how institutions (via research integrity officers) can work in collaboration with journals (via journal editors) to promote research publication integrity. It would be useful to explore in future empirical research the manner and extent to which responsibilities regarding integrity could be shared to effectively mitigate or resolve authorship issues. It would be important to clearly delineate the role and interactions of the respective actors within this "shared responsibility" in order to facilitate the distribution of tasks, establish realistic expectations and empower the various actors. At this point, research on such role-sharing is usually limited to situations of misconduct defined as FFP and excludes any broader application to authorship. In addition to failing to provide effective guidance, this shortcoming could signal that inappropriate authorship practices are not serious, somewhat tolerable, and so do not warrant redress.

In the past, RCR has often put the onus of research misconduct on individual researchers by dismissing misconduct as the work of "a few bad apples". If this were accurate, banishing or punishing these few individuals would greatly reduce or eliminate incidences of misconduct; however, the rate of misconduct has not decreased and shows no signs of slowing.[16] Recently, several scholars have suggested that universities and funding bodies

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[16] It should, however, be noted that rates of misconduct are difficult to evaluate empirically, as described in the introduction of this thesis.

should play a more important role by implementing good RCR guidance and providing the necessary resources to support students and researchers (Otto, Bradley, and Newby 2015; Redman 2013). This would not only help in managing cases of misconduct associated with FFP, it would also promote RCR values and norms more broadly, including issues related to authorship, such as collaboration in research, conflict of interest, redundant publication, etc.

Research organizations (e.g., universities, research centres) establish and foster norms that have an important influence on individual's actions, including the distribution of authorship. However, the norms of the respective disciplinary cultures within this network differ markedly. Indeed, researchers are typically educated within one discipline or field. The respective disciplinary cultures exhibit their own epistemological, theoretical, methodological or technical preferences regarding the value of different research activities (Lamont 2009). This thesis sought to identify ways to promote dialogue between individuals from different disciplines, including quantifying and qualifying the nature of the research conducted by different team members. However, there was limited discussion as to how institutions could help bridge different disciplinary norms. Multidisciplinary research in the health sciences is promoted by funding councils and research institutions; however, the institutions are structured to address and manage issues within their respective disciplines. Accordingly, they do not speak to matters related to multidisciplinary research. Yet, if multidisciplinary research is to remain self-regulated and continue to flourish, institutions must promote and engage in open discussion about the norms and issues relevant in such research.

Understanding the influence of institutional priorities, responsibilities and cultures on the conduct of researchers is fundamental to eventually design and implement practical models to deal with authorship in universities. Research into the role of institutions should address basic, practical questions: How should institutions address concerns regarding authorship? What complaints concerning authorship should research institutes investigate? What factors should be weighed in defining the nature and extent of issues? What response is appropriate to address particular issues? What, if any, could be the role of the institution in arbitration as well as enforcement?

154

Contributorship and Badges

In **Chapter 5** of this thesis, I critiqued the hype around the taxonomy based on contribution. Regardless of the shortcomings of this system, it will be interesting to monitor the nature and extent of its impact on the research community. The taxonomy was initially proposed by Allen and colleagues. and was recently refined by Project CRediT (Contributor Roles Taxonomy) (Brand et al. 2015) which is funded (and led) by very important actors in science (e.g., The Wellcome Trust and Digital Science, as well as the Science Europe Scientific Committee for the Life, Environmental and Geo Sciences) (CRediT 2015). This prominent backing may go a long way to facilitating the implementation of the taxonomy. The research team that developed this taxonomy has maintained that contributorship can reduce disputes and promote collaboration (Brand et al. 2015; Allen et al. 2014). Future research could evaluate the impact of this approach on research. For example, it would be interesting to determine whether researchers feel more accountable or that they perceive worthy credit when listed in contributorship models as opposed to authorship. Accountability can promote a sense of responsibility and integrity for research. Conversely, does listing researchers in relation to discrete tasks make them feel less responsible for the research as a whole, or indeed, for any other tasks for which they are not listed? In the latter case, a researcher might observe inappropriate activity in some other task for which they are not listed and feel no compulsion or obligation to address the issue.

If this detailed contributorship taxonomy is widely adopted, it will also be possible to analyze available data and so examine how research tasks are distributed (or are declared to be distributed). Contributorship involves the systematic categorizing of the same 14 tasks and as a result, metadata can be collected. Research using this data may provide a better understanding of how research tasks are distributed amongst individuals. It would also be interesting to track contributorship tasks in terms of rank in authorship order to uncover any pattern of systemic preference for particular tasks. Research using taxonomy does, however, have serious limitations; for example, tasks are not identical from one research project to another and thus are not necessarily valued in the same manner, which limits comparability. Nonetheless, research on contributorship can provide a degree of insight for a limited but

relatively homogeneous population (e.g., within a discipline, or sub-field) where tasks are similar from one research project to the next.

In conjunction with a detailed taxonomy, science, publishing and software groups are now developing digital 'badges' that illustrate the contributorship categories of Allen and colleagues' taxonomy (2014) (See Figure 2). These badges would not only explain the contribution of each author, but would also function as electronic links to personal profiles on a separate identification site, such as ORCID ("ORCID" 2014). Using these badges, authors would be highlighting the different types of contributions they made to research, rather than simply listing the number of papers to which they had contributed, as is currently the case in academic CVs. The colourful, bright, artfully conceptualized badges differ from the traditional academic reward system by introducing a trendy, up-to-date technological application. One could arguably view this as a type of 'gamification' that is, "the use of game design elements in non-game contexts"(Deterding et al. 2011). Often, gamification is used to engage and motivate through a score system, points, levels or rewards (Nicholson 2012), which in the case of academic authorship involves colourful badges. However, the reward system of science has many concomitant scoring systems, such as the impact factor of journals, citation indices (e.g., h-index, i10-index) a researcher's score on ResearchGate (www.researchgate.net) or a researcher's influence on Altmetrics (www.altmetric.com). It would be interesting to examine further how and why these various types of reward systems are valued by researchers, as well as their broader significance on the research system, and science and innovation more generally.

Figure 2: Contributorship Badges (Mayes 2014)

Empirical Research on Authorship Distribution Practices

The subject of this thesis – the distribution of authorship – has obvious practical and concrete implications on researchers and their work, especially when distribution is unfair. As previously mentioned, the negative consequences of unfair authorship practices, including the creation of hostile work environments, can lead to more systemic problems involving research misconduct (Marušić, Bošnjak, and Jerončić 2011). It would be important for future research on research integrity to explore how the theoretical framework proposed in this thesis could be applied in practice to help researchers mitigate such issues. During the last few decades, many scholars have come to the conclusion that "the structures and norms of scientific community don't reflect the reality of doing science" (Redman 2013, xvi). This gap between ethical norms of science and science itself is important to understand if we are to define and implement useful regulations and practices. While this would apply to various questionable behaviours in research, I will limit the discussion to authorship. Although this thesis was limited to conceptual work, it was intended as a precursor to further empirical research.

First, it would be interesting to develop a broad view of the practice of authorship distribution in teams. A survey-based quantitative research project has already been developed, and I hope to begin data collection in late 2015; this empirical project would capture data on the general practices and perceptions of researchers concerning the allocation of authorship. The survey population will include individuals who have published multi-authored papers within the last five years in order to examine the contemporary context of authorship distribution. Using the Thomson Reuters database of research publications, I will identify individuals working in disciplinary and multidisciplinary health research teams for comparison purposes. The disciplinarily and multi-disciplinarily nature of publications will be evaluated using bibliometric analyses based on the field of the journal, the departmental affiliation of researchers, and the diversity of references in the papers.

It would also be interesting to compare that empirical work with the conceptual work presented in this thesis, in order to examine significant similarities and discrepancies between empirical data, authorship guidelines, and normative aspects. The goal of such research would be to delineate the key differences between an 'ideal' fair authorship allocation and what actually occurs in practice. Understanding the gap between ideal models of authorship and

157

actual 'real life' practices can serve to increase awareness and understanding of a problem. In his work on the place of empirical data in bioethics research, Kon (2009) illustrated this using the case of racial discrepancies in health care. He noted that there is considerable empirical data that demonstrates racial and ethnic minority patients receive less quality care in the US (Fiscella, Franks, Gold, and Clancy 2000; Gibbons 2005). This contradicted the ethical norms in North America and helped to establish and promote a notion of "equality of care" (Satcher 1999). Highlighting the gap between the ideal (equality of care) and the reality (racial and ethnic inequities) pointed to an ongoing problem. According to Kon (2009), exposing and communicating such discrepancies serves to promote change in our society. Implementing change requires new or modernized policies, and reformed or improved methods and practices. Understanding contextual realities that prevail in authorship and perceptions by authors of what is ethical would be an essential element in the development of a useful and practical framework or process for fair authorship distribution.

Qualitative research could also be undertaken to understand the differences between empirical reality and conceptual constructs. This would involve analysis of the relevance and meaning of discrepancies between the empirical reality and conceptual base for researchers in the field. Interviews or focus groups would help in obtaining and exploring a range of differing points of view from various participants and serve to deepen our normative understanding of authorship distribution. This notion of diversification of viewpoints is central in qualitative research (Pires 1997). Such research may show the diversity of values, meanings, and disciplinary specificities that researchers link to authorship and its order.

Authorship Research in Disciplinary fields

From the outset of this thesis, I focused on multidisciplinary teams in the health sciences because there were and are interesting ongoing debates, conflicting norms and disputes in this sector. Moreover, the co-existence of different norms can force individuals to question existing practices and challenge the *status quo*, which can then be an impetus for change. As such, this thesis on the distribution of authorship in multidisciplinary health sciences research was necessary and timely. However, the lack of debate in disciplinary fields, particularly outside the health sciences (e.g., humanities, social sciences, business, management), does not mean that authorship is necessarily distributed fairly in disciplines. As

158

a result of discussions with researchers from various fields, I observed considerable dissatisfaction and dispute in practice, while conversely, finding little similar concern or discussion in disciplinary circles. Given the lesser occurrence of scandals regarding authorship in comparison to biomedicine, any serious questioning of the *status quo* might seem unnecessary. A preliminary inquiry in various disciplinary circles (e.g., in the humanities, social sciences, applied sciences) could be undertaken to investigate the incidence and severity of authorship issues. If authorship is so problematic in health sciences, why would it not be the same in other areas of academic scholarship? Are there factors unique to health sciences that somehow has created more authorship disputes? Do other fields of research simply ignore or overlook questionable research practices, such as authorship? At this point, it is necessary to understand why certain disciplinary contexts or fields have glaring authorship issues, and others apparently do not. This could lead in turn to interesting comparative work between different fields and disciplines, employing different types of analysis to test conceptual models. Such empirical and conceptual work is necessary, I suggest, to build fair authorship models that are not only based on sound ethical justification and reasonableness, but that are also are useful, adaptable and practical.

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