Ethical reproducibility: towards transparent reporting in biomedical research

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Optimism about biomedicine is challenged by the increasingly complex ethical, legal and social issues it raises. Reporting of scientific methods is no longer sufficient to address the complex relationship between science and society. To promote 'ethical reproducibility', we call for transparent reporting of research ethics methods used in biomedical research.

Reporting of scientific methods has received much attention in the last 15 years. Reporting of research ethics methods, by comparison, has received very little. In a letter published in *Nature*, we argued for detailed reporting of research ethics methods in published scientific reports and a commitment to what we called—by analogy with scientific reproducibility—ethical reproducibility[1]. Research ethics methods are the features of study design conceptualized and undertaken for ethical reasons. In animal research, these include alternatives to animal use; details concerning housing and husbandry; steps taken to minimize the number of animals used in a study; procedures developed to minimize pain, suffering and lasting harm; and techniques for euthanasia. In research involving humans, research ethics methods include procedures for obtaining informed consent such as audio-visual communication aids and age-appropriate language guides, tools for assessing capacity, adaptive dose-escalation schemes, equipoise requirements, monitoring procedures, stopping rules, post-study debriefing strategies and provisions for post-study access. In this paper, we argue that the justification for scientific reporting extends to research ethics methods and that reporting of these methods will enhance the review and conduct of biomedical research. Furthermore, in light of ongoing concerns about the efficiency and efficacy of both institutional animal care and research ethics committees (ACCs and RECs) charged with reviewing biomedical research[2–7], improved transparency should be a priority.

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Transparent reporting

The research community has witnessed a proliferation of scientific reporting guidelines across the biomedical sciences, starting with the publication of the consolidated standards of reporting trials (CONSORT) guidelines for reporting of randomized controlled trials in 1996 (ref. 8). Since then, more than 100 reporting guidelines have been published (http://www.equator-network.org/resource-centre/library-of-health-research-reporting/), and adherence to these guidelines is increasingly a condition of publication. The CONSORT Statement, for example, is now endorsed by close to 450 medical journals.

Though guidelines with research ethics reporting requirements exist—notably, the animal research: reporting of *in vivo* experiments (ARRIVE) guidelines (http://www.nc3rs.org.uk/page.asp?id=1357) and the International Committee of Medical Journal Editors (ICMJE) uniform manuscript requirements—they are insufficient for the purposes of critical assessment and replication. With respect to research ethics, both the ARRIVE and ICMJE guidelines require authors to indicate that their research was approved by the appropriate review body and was conducted in accordance with the relevant ethical standards. However, the guidelines do not require researchers to indicate how they dealt with the ethical challenges posed by their research. As a consequence, descriptions of research ethics methods in published papers are minimally informative. Although authors may report ethics approval, details about the methods used to manage complex ethical issues are not required and are rarely published[9–12].

The lack of research ethics methods description in the scientific literature might be less troubling if this information were openly available through the review system itself. But this system is also notoriously opaque, notwithstanding the extensive discourse around it[13]. Both ACCs and RECs function independently and behind closed doors, and information concerning the review process is not routinely made public[14–16]. Even within institutions, information is hard to come by, as few committees have an explicit, searchable mechanism for archiving decisions in a cumulative fashion[17,18].

This situation affects researchers and reviewers. Because researchers do not have access to past decisions about similar research studies, they are often forced to reinvent the wheel when they are designing studies or preparing protocols for review. Similarly, because reviewers do not have access to previous reviews, they cannot consider and align their judgments with prior decisions.

Ethical reproducibility

Ethical reproducibility mandates transparent reporting of, and critical engagement with, the research ethics methods used in

Table 1 | Reporting guidelines for ethical reproducibility

Research involving animals	Research involving humans
1. Report strategies used to avoid or replace the use of animals in research that has the potential to cause them harm.	1. Report methods for obtaining informed consent and determining decision-making capacity.
2. Report improvements to procedures and husbandry that minimize actual or potential pain, suffering, distress or lasting harm and/or improve animal welfare in situations in which the use of animals is unavoidable.	2. Explain steps taken to minimize risk and burden for primary participants and third parties, as appropriate.
3. Report methods that minimize animal use and enable researchers to obtain comparable levels of information from fewer animals.	3. Explain steps taken to maximize benefits for current participants and downstream beneficiaries of the research.
	4. Document steps taken to address issues of justice and access.

biomedical research[19]. The overall goals are the expansion of ethics knowledge and sharing across the scientific community and the improvement of both the review and conduct of biomedical research.

In practice, ethical reproducibility requires reporting the concrete features of study design that deal with the specific ethical challenges of a research study. Because these challenges will vary across studies, the research ethics methods reported will also vary. Two principles should guide ethics reporting: (i) transparency, i.e., reporting sufficient detail to enable readers to assess and reproduce the research ethics methods used, and (ii) proportionality, i.e., providing detail at a level that is proportional to the ethical complexity and risk to participants (animal or human).

Benefits of reporting research ethics methods

Ethical reproducibility has multiple direct benefits. The first relates to learning and internalization. By reporting on research ethics methods in peer-reviewed publications, researchers enable other investigators engaged in similar research—and committee members reviewing this research—to learn from their ethics decisions and experiences. Further, by incorporating research ethics methods into standard practice, ethical reproducibility fosters the internalization of ethics by the scientific community: ethics is treated as part of the scientific process rather than an external addition, or even an impediment, to it.

The second benefit relates to critical assessment and ethical accountability. The methods used to address ethics issues are currently a black box: by failing to report on their treatment of the ethical dimensions of their work, biomedical scientists hide from view the care and concern they bring to these issues. By reporting on research ethics methods, scientists enable critical assessment and enhance the accountability of their research. By insisting on such reporting, journal editors enhance the ethical accountability of biomedical research as a whole.

The third benefit concerns replication, validation and progress. Access to detailed information concerning the research ethics methods of other researchers allows independent scientists to identify novel approaches and to test them. If these approaches are seen to improve the ethical quality of studies, as judged by funders, reviewers, participants and scientists themselves, the validity of these methods will be confirmed. If, by contrast, these approaches diminish the ethical quality of studies, their validity will be disputed. In this way, transparent reporting of research ethics methods fosters convergence on best ethics practices across the scientific community in a transparent, efficient and cost-effective manner.

Putting ethical reproducibility into practice

As a starting point, we provide high-level reporting guidelines for ethical reproducibility in **Table 1**. For animal research, the guidelines follow the 'three Rs' of animal research (replacement, reduction and refinement)[20,21]. For research involving human subjects, the guidelines echo the principles of biomedical ethics[22]. Additional items could be included. These guidelines are intended to be illustrative, not exhaustive.

A commitment to ethical reproducibility will require reporting that is as varied as the ethical challenges posed by the range of possible research studies. The pages of specialist journals devoted to animal welfare (such as *Laboratory Animals*, *Lab Animal* and *ALTEX*) and to the ethics of research involving humans (such as *IRB* and the *Journal of Empirical Research on Human Research Ethics*) are filled with analyses of such challenges for scientists and ethicists alike—and with the research ethics methods for managing these challenges. Many, if not all, research ethics methods will be reportable under the general guidelines offered here. In some ethically complex or contentious areas, however, more tailored and detailed reporting may be required. Developing domain-specific reporting guidance of this kind is a task for future research.

Conclusion

Transparency has been central to the scientific method since the 17th century, when Robert Boyle argued that the reporting of scientific methods would increase the reliability and credibility of scientific findings by enabling independent readers to learn, critically assess and replicate the experiments that produced them[23]. The scope, complexity and power of contemporary science would be almost unrecognizable to Boyle and his peers today. What is more, the relationship between science and society has changed profoundly. Contemporary biomedical scientists are faced with an array of complex ethical challenges and regulatory hurdles unimaginable in the 17th century. Scientific skills alone are no longer sufficient for success: biomedical researchers must also possess ethical know-how[24]. By promoting transparent reporting of, and critical engagement with, the research ethics methods used in biomedical research, ethical reproducibility situates ethics directly within scientific practice. Research ethics is treated as a set of obligations internal to science rather than an externally imposed barrier.

We do not underestimate the logistical challenges associated with this proposal, but we argue that the opportunity costs for researchers are minimal. Although it is possible that some researchers will see this proposal as another example of ethics 'mission creep'[25], we suggest the contrary: by reporting the research ethics methods we apply in our work, researchers will take a leading role in the ethics of biomedical research.

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AUTHOR CONTRIBUTIONS

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