FORENSIC SCIENCES RESEARCH
2021, VOL. 6, NO. 4, 292–294
https://doi.org/10.1080/20961790.2021.1977480

SHORT COMMUNICATION

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From research integrity to research relevance to advance forensic science

Research is essential for any field to move forward. It allows us to expand our body of knowledge and enables any discipline to advance its application and meet its overall purpose. This is of course also essential for forensic science, a fundamentally research-based discipline, to develop and validate detection or examination methods and gather data and establish frameworks to understand forensic traces and their value to relevant stakeholders, such as law enforcement and the courts.

There is no doubt that scientific research has delivered outstanding findings and breakthroughs to the benefit of society for centuries. These outcomes have primarily relied on exceptional researchers, robust research environments, critical collaborations and serendipity. The "organic nature" of research cannot be under-estimated. However, over the years, and in part due to a need for a response to uncommon but egregious cases of research misconduct, an area that has increasingly became a focal point for funding bodies, research administration and eventually researchers is *research integrity*. Under this umbrella, there is an expressed need for research to be conducted responsibly, ethically and with integrity. It does not necessarily mean that the overall conduct of research was previously rogue or unethical. It does, however, illustrate the growing interest in formalising solutions to mitigate the risk of poor research practices, sloppy science, and serious misconduct and ensure that research is trustworthy. As a result, many countries and organisations have developed codes and frameworks for the responsible conduct of research, outlining the shared responsibilities of individual researchers and institutions [1,2].

Some common elements of discussions about research integrity include:

- Honesty in development, undertaking, reviewing, and reporting of research
- Rigour and reproducibility in development, undertaking and reporting of research
- Transparency in declaring interests and reporting research methodology, data and findings
- Fairness in the treatment of others
- Respect for research participants, the wider community, animals and the environment
- Accountability for the development, undertaking and reporting of research
- Promotion of responsible research practices

In the spirit of these concepts, there has been an increasing demand for researchers to openly access their research methods, raw data, and findings. It has even been suggested that researchers should submit their methods for peer review first, before submitting their data, findings and final paper [3]. The assumption is that the research can be better evaluated and is ultimately more reliable when full disclosure occurs at all stages in the research process.

The requirement for forensic science research to adhere to principles of integrity is beyond debate. It would be foolish to accept a standard that is lower than that of the broader research community. However, we ought to ask the question, are these principles enough? Is adherence to integrity principles sufficient for forensic science to produce quality, valuable research? The answer is no. There are many examples of research papers that may easily pass the integrity test while being of little value to forensic science, let alone of dubious quality.

There have been ongoing calls for more research and more research funding for forensic science [4–8]. It is difficult to disagree. However, it is equally difficult to ignore the fact that forensic science papers have massively increased in the last few decades. We estimate (detailed findings to be published in future work) that the number of such papers published every year increased almost five-fold in the previous 20 years. This trend is correlated with the increasing number of specialised journals and compounded by the growing number of forensic science papers published in non-forensic science journals. This expansion attests to the growing interest in forensic science by various fields. It also reflects the familiar "publish or perish" pressure inherent to scientific research. It has become a daunting task to keep track of the relevant literature. This problem

takes on greater significance when we consider that researchers need to perform peer review while also conducting their own studies and focusing on their own manuscripts. In an environment of "big data" where many research papers seem to add their findings to the noise rather than delivering significant new knowledge, it becomes essential to discuss the feature of *relevance*.

Along these lines, let's consider emblematic research proposing a new method for the forensic examination of a given trace type. In many fields of forensic science practice, the trace of interest is examined using a limited number of well-accepted techniques. However, it is typical for the same trace type to see ample literature considering more advanced or high-tech solutions never used in casework. This situation illustrates a large gap between research and practice. This may be explained by the delay between proof-of-concept studies and their validation for practical implementation. This may also occur because many original techniques rarely add much more information of value about the trace being examined when considering the added cost of implementing them in routine practice. In other words, many forensic science papers stem from focused technical studies with a high probability of producing positive results rather than responding to a need expressed by forensic science practice. Thus, it is critical that researchers and funding bodies understand the importance of conducting research that is informed by practice and can be translated into practical applications. It makes little sense to fund and develop a body of research filled with proof-of-concept papers that never make it into the practice of forensic science. This is especially true when more critical and probably more complicated research questions remain unanswered about the generation, persistence, detection and recognition of forensic traces (including the more recent digital traces) and how best their informational content can be exploited and evaluated to benefit all stakeholders.

We argue that the most pressing challenge in forensic science research is to improve its relevance and quality rather than produce more research with greater novelty. Peer review remains an integral means of assessing research quality and relevance. Unfortunately, editors and competent reviewers are often overwhelmed by the exponentially increasing number of submitted papers. Further, many forensic science peer reviewers come from non-forensic disciplines or have little contact with forensic practice, causing variation in the assessment of relevance. For these reasons, individual researchers, universities and funding bodies should attempt to slow the pace of the frantic research race to excel primarily by using research quantity and novelty as measures. We should emphasise critical thinking to address longer-term, real-life challenges that are fundamental to our collaborative enterprise [9]. It may sometimes be helpful to stop and ask ourselves whether our research truly benefits society beyond the research grant narrative or media headlines.

Integrity is as essential for forensic science research as it is for all disciplines. Nevertheless, integrity without relevance will not advance forensic science. If we thoughtfully consider the relevance of our research, we are more likely to produce research that has greater value and improves the practice of forensic science.

Authors' contributions

Claude Roux and Céline Weyermann conceived the study, participated in its design and coordination and drafted the manuscript. Both authors contributed to the final text and approved it.

Compliance with ethical standards

The authors declare that they have no conflict of interest. This article does not contain any studies with human participants or animals performed by any of the authors.

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ARTICLE HISTORY
Received 15 August 2021
Accepted 3 September 2021