Scientific Integrity in the Digital Age: Challenges and Responsibilities for Oncology Research

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Integridade Científica na Era Digital: Desafios e Responsabilidades para a Pesquisa Oncológica

Integridad Científica en la Era Digital: Desafíos y Responsabilidades para la Investigación Oncológica

Ricardo Limongi[1]; Carina Munhoz de Lima[2]; Patricia da Silva Costa Gross[3]

Scientific communication in oncology is beneficial to cancer studies and treatments, which are based on the reliability of published evidence. Each clinical decision, from choosing a therapeutic protocol to recommending population screening, in addition to requiring complex studies, is grounded in data produced and disseminated by the scientific community.

In this context, research integrity does not represent only one abstract ethical imperative, but constitutes the very foundation on which the oncological practice is based. Yet, scientific literature faces threats that compromise its credibility, and it is important to distinguish phenomena that are frequently confused with each other: fraudulent publications and fake news. The former arises within the scientific system and includes plagiarism, data fabrication, and falsification, while the latter spreads mainly in the public and media sphere. Moreover, digital technologies and generative artificial intelligence (AI) increase the challenges in traceability and verification, which may distort the production and circulation of knowledge, affecting its translation into guidelines and therapeutic decisions.

Even so, both can have a devastating impact in oncology, since fraudulent articles can fuel misinformation narratives that appear to be evidence, and fake news can distort legitimate findings, compromising clinical decisions, treatments, and trust in science and healthcare systems.

Ethical challenges have always existed; however, new obstacles have been imposed by digital technologies and generative AI that threaten and compromise even further the credibility of oncological research.

Recent data reveal the magnitude of the problem. A bibliometric analysis identified that oncology presents the highest number of retractions among other scientific subjects, with 2,373 articles retracted between 1990 and 2022[1]. The Retraction Watch database has recorded, until June 2024, 2,874 retracted oncology articles, most due to fabrication, falsification, and plagiarism[2]. A seminal study by Fang et al.[3] demonstrated that 67.4% of retractions in biomedical research are due to scientific misconduct, not honest mistakes. In 2023, over 10 thousand articles have been retracted worldwide, a historical record boosted mainly by the activity of the so-called paper mills[4].

Paper mills, organizations that commercialize/produce fabricated/fraudulent manuscripts, have emerged as one of the greatest threats to scientific literature. Estimates suggest that over 400 thousand articles in scientific literature present textual similarities with products from these organizations, which represent between 1.5% and 2% of articles published in 2022[5]. A cross-sectional analysis of retractions originated from paper mills revealed that 92.3% of the authors belonged to Chinese institutions, and oncology was among the most affected subjects[6]. The International Journal of Cancer formally reacted to this threat by publishing an open editorial warning about false data and paper mills[7]. In January 2024, the United2Act coalition was launched to systematically counter this problem[8].

Image manipulation constitutes another prevalent form of misconduct. Bik et al.[9] examined 20,621 biomedical articles and identified problematic figures in 3.8% of them, and at least half presented characteristics suggestive of deliberate manipulation. The Reproducibility Project: Cancer Biology assessed 193 experiments from 53 high-impact articles and found that 67% needed modifications in the protocols due to insufficient methodological details[10]. These findings show not only deliberate fraud but also systematic deficiencies in the transparency and reproducibility of oncological research.

[1]Universidade Federal de Goiás (UFG). Goiânia (GO), Brasil. E-mail: ricardolimongi@ufg.br. Orcid iD: https://orcid.org/0000-0003-3231-7515
[2]Instituto Nacional de Câncer (INCA), Coordenação de Ensino (Coens), Revista Brasileira de Cancerologia (RBC). Rio de Janeiro (RJ), Brasil. Universidade Federal Fluminense (UFF), Programa de Pós-Graduação em Ciência da Informação (PPGCI). Niterói (RJ), Brasil. E-mail: carina.lima@inca.gov.br. Orcid iD: https://orcid.org/0000-0002-1615-9177
[3]INCA, Coens, RBC. Rio de Janeiro (RJ), Brasil. E-mail: patricia.gross@ensino.inca.gov.br. Orcid iD: https://orcid.org/0000-0003-3653-1148
Corresponding author: Ricardo Limongi. UFG. Avenida Esperança, s/n – Campus Samambaia. Goiânia (GO), Brasil. CEP 74690-900. E-mail: ricardolimongi@ufg.br

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With the advent of generative AI, new ethical challenges arose. Tools such as ChatGPT may legitimately help with scientific wording, but also enable the fabrication of data, synthetic image generation, and the production of texts without appropriate supervision.

An analysis of 15,553 abstracts submitted to the American Society of Clinical Oncology (Asco) demonstrated that works from 2023 presented a significantly higher probability of containing AI-generated content (adjusted odds ratio of 1.79 to 2.37)[11]. In view of this scenario, the main editorial organizations have established specific guidelines.

The International Committee of Medical Journal Editors (ICMJE) updated their recommendations in January 2024, stating that AI tools may not be listed as authors and their use must be declared in the Acknowledgments[12]. The Committee on Publication Ethics (Cope) has made an official statement: "AI tools cannot meet the requirements for authorship as they cannot take responsibility for the submitted work."[13]. The World Association of Medical Editors (WAME) published five key recommendations: chatbots cannot be authors; transparency is mandatory; authors are responsible for AI-generated content; editors and reviewers must declare the use of AI[14]. *Nature*[15] and *Science*[16] journals have established clear policies, forbidding authorship to AI tools and demanding that their use be declared.

In the international sphere, the Singapore Statement on Research Integrity was issued in 2010, with four fundamental principles: honesty, accountability, professional courtesy, and good stewardship[17]. The Montreal Statement complemented these principles in 2013, specifically addressing transnational and inter-institutional collaborations[18]. Cope's guidelines on retraction, updated in 2025, include new sections on batch retractions to stand up to paper mills' products[19].

Brazil has developed a robust institutional framework for scientific integrity. In 2011, the Brazilian National Council for Scientific and Technological Development (CNPq) published the Basic Guidelines for Integrity in Scientific Activity, updated in 2016, including citation practices, authorship criteria, ethical conduct, and self-plagiarism prevention[20]. The São Paulo Research Foundation (Fapesp) released, in 2011, the *Code of Good Scientific Practice*, the first document of its kind from a Brazilian funding agency, structured on three pillars: education, prevention, and fair and rigorous investigation and sanctions[21]. The Coordination for the Improvement of Higher Education Personnel (Capes) established the 2024-2025 Integrity Plan with 33 specific actions[22]. The seventh edition of the Brazilian Meeting on Research Integrity, Science and Publication Ethics (Brispe) from 2024 was dedicated to the theme "Integrity in research and generative artificial intelligence"[23]. In 2024, the book *Diretrizes para o uso ético e responsável da inteligência artificial generativa*[24] (Guidelines for the ethical and responsible use of generative artificial intelligence) presented generative AI tools and how to use them in different knowledge production steps, a way of guiding researchers' actions and the elaboration of institutional guidelines.

The prevention of scientific misconduct requires a multifaceted approach. To reviewers and editors, it requires vigilance in the detection of fraud signs, the use of plagiarism and image manipulation detection tools, and adherence to Cope's guidelines. For institutions, it means promoting integrity culture through continuous education, establishing effective Research Ethics Committees, and implementing clear investigation and sanction policies.

For authors, it means learning and following integrity guidelines, declaring conflicts of interest, ensuring originality and proper attribution, and transparently documenting the use of assistant technologies. Moreover, they must ensure that the references used in their research are extracted from reliable sources and presented in compliance with predetermined rules.

References constitute the fundamental basis for every scientific work since they provide the necessary evidence to support a study's arguments and analyses. Building a theoretical framework is an essential process that occurs from the early stage of information collection, going through critical selection, and finally to the stage of proper data notation and filing, which enables the researcher to articulate their ideas in a well-founded manner[25]. The use of reliable and well-documented references ensures the research is well-founded in solid evidence and verifiable sources, avoiding any risk of data distortion or manipulation[26].

Moreover, they work as a verification and traceability mechanism for scientific information. From them, it is possible to track the origin of data, verify the methodologies used, and understand the context of the findings, which prevents bad practices. The appropriate use of references enables other researchers to identify and replicate the studies or identify methodological flaws, contributing to a science auto-correction system[12].

As previously mentioned, reproductions and retractions of fraudulent articles have increased[4], and the process of verification through references allows such flaws to be quickly identified and corrected. Academic and ethical rigor in the use of sources is a quality control strategy that confers transparency and credibility to scientific research.

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The challenges are complex, but not insurmountable. The detection of paper mills has significantly improved, with the identification of "tortured sentences", meaningless paraphrases like "counterfactual conscience" meaning "artificial intelligence", as markers of fraudulent products[27]. AI detection tools, although imperfect, are being incorporated into editorial processes[28]. The international collaboration between editors, institutions, and funding agencies is progressively strengthening.

The *Revista Brasileira de Cancerologia* reinstates its commitment to scientific integrity and ethics and warns that fraudulent articles may lead to harmful clinical decisions, waste resources in fruitless research lines, and ultimately harm patients. The construction of an integrity culture requires collective engagement: researchers committed to honesty, institutions that advocate for best practices, vigilant editors, demanding funding agencies, and an informed civil society.

In the digital age, in which the ability to produce and disseminate scientific information expands, the responsibility for the quality and veracity of this information also grows. It is up to all actors in the scientific ecosystem to make this commitment, ensuring that oncological research keeps fulfilling its fundamental mission: advancing knowledge to benefit patients and society.

CONTRIBUTIONS

All the authors have substantially contributed to the study design, data acquisition, analysis, interpretation, wording, and critical review. They approved the final version for publication.

DECLARATION OF CONFLICT OF INTERESTS

The authors Carina Munhoz de Lima and Patricia da Silva Costa Gross declare a potential conflict of interest due to being part of the editorial team of INCA's *Revista Brasileira de Cancerologia*. The other authors do not have any conflict of interest.

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All the contents associated with the article are included in the manuscript.

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Scientific-editor: Anke Bergmann. Orcid iD: https://orcid.org/0000-0002-1972-8777

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