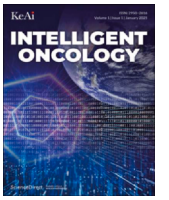
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Commentary

We need intelligent oncology everywhere

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1. Advances in cancer care

Since the beginning of the 21st century, our understanding of the biology of neoplastic diseases has advanced substantially, leading to considerable improvements in cancer prevention, early diagnosis, and treatment. These advances have been particularly notable in the therapeutic field, where targeted therapies and various immunotherapeutic modalities have led to important breakthroughs, even in some tumors (e.g. lung cancer), where progress had previously been minimal. A much more refined approach, based on a deeper biophysical understanding and more precise calculations, along with ever-more powerful equipment, has also markedly improved the outcome of radiotherapy, a fact that has resulted in a resurgence of interest in this treatment modality.

2. The limitless nature of artificial intelligence (AI) in cancer care

By allowing a more personalized approach thanks to its capacity to personalize and evaluating a huge amount of data, AI will play an increasingly pivotal role in shaping progress in cancer care. At present, numerous studies, some including huge trials, based on data generated by so-called intelligent oncology are ongoing in many countries. Although some of these studies focus on prevention, many others center on early diagnosis and treatment. Early detection remains the most important step for improving the cure rate of most neoplastic diseases. In this respect, a revolutionary technology for detecting circulating tumor DNA (ctDNA) known as a liquid biopsy is extremely important and is currently being evaluated in many trials. Recently, AI has demonstrated its potential even in the very complex situation of early radiological detection of prostate cancer.[1] The possibilities for intelligently personalizing therapeutic approaches are almost limitless. One of the most recent and innovative developments in this regard is represented by trials evaluating personalized mRNA cancer vaccines.[2]

3. Global disparities in cancer care

Advances in cancer care, however, seem to be largely confined to high and upper-middle income countries. For this reason, in 2012, together with the European School of Oncology, we decided to organize the first World Oncology Forum (WOF), a gathering of

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100 leading international experts, who convened in Lugano, Switzerland, to discuss the following question: "Are we winning the war against cancer?" The expert consensus was that, despite substantial achievements, we are not really winning the battle. Indeed, the number of cancer-related deaths has increased by about 40% in just over a decade, mainly in low- and middle-income countries (LMICs), which have limited resources for cancer care.

4. The challenges in current cancer care

This rather sobering assessment of the global disparity in cancer treatment and care formed the basis for launching the "Stop Cancer Now!" appeal in 2013, in which we proposed concrete and proven interventions that should be implemented as soon as possible to avoid worsening of the overall situation in the global fight against cancer.[3] Ten years later, in September 2023, we convened another gathering in Ascona, Switzerland, bringing together 80 experts from across five continents to assess the global response to the 2013 appeal. The consensus among the participants at this fifth round of the WOF was that the implementation of the previously recommended interventions had markedly lagged behind in most parts of the world, including many countries with a high Human Development Index (HDI).[4] The failure to implement these interventions in a timely manner has contributed to an increase in disparities in cancer incidence and mortality between countries. According to projections from the GLOBOCAN statistics, the number of new cancer cases worldwide is expected to increase significantly, from 19.3 million in 2020 to 30.2 million by 2040.[5] Most of the projected increase in new cancer cases is expected to occur in countries with a low or medium HDI. In addition, cancer-related mortality is anticipated to rise significantly, from 10 million deaths in 2020 to 16.3 million by 2040, with a 99% increase in mortality projected for low-HDI countries.[5] Despite these concerning trends in global cancer incidence and mortality, the WOF welcomed reports of numerous initiatives that had been launched or are ongoing. In particular, since the introduction of the WHO Framework Convention on Tobacco in 2003, successful initiatives in tobacco-related deaths globally have been reported. In the past 5 years, the WHO has also launched three important initiatives in cervical cancer, childhood cancer, and breast cancer, which many countries are now implementing.[6–8]

5. Bridging the gap using digitalization and AI

In amplifying the previous appeal in the global fight against cancer, the participants of the 2023 WOF underlined that steady advancement in technology offers unprecedented opportunities to accelerate progress to solve some of the more difficult problems, for which solutions have so far lagged drastically behind. Digital technologies, including AI, are creating new intelligent avenues to meet the demand for increased access to cancer care, particularly among those residing in remote areas and LMICs. For example, telepathology and teleradiology can strengthen access to health care everywhere and solve some of the problems, mainly related to the huge lack of skilled human resources in LMICs, a problem that so far has been considered to have no solution. The development of AI technologies is also promising to transform drug discovery, reduce administrative costs, provide alternative access to expertise, and address substantial educational needs in an intelligent way. AI technologies are already starting to be used to extend access to AI-based high-quality radiotherapy planning from high-income countries to LMICs and address a major barrier to cancer services provision. In parallel, rapid advances in the use of digital technologies in the fields of early detection, personalization, and response assessment are taking place that will shape cancer control in the future. Currently, one of the best tools for future breakthroughs in many of these fields is represented by an extensive use of the ctDNA technology (liquid biopsy).

6. AI technologies in cancer care

AI technologies enable the creation of more precise and personalized care plans for patients through advanced methodologies. Medical image processing, leveraging deep learning frameworks, including convolutional neural networks, U-Net, recurrent neural networks, and vision transformers, rapidly analyze medical images, such as X-rays, CT scans, and MRIs. These technologies assist oncologists in accurately detecting, diagnosing, and segmenting small cancerous lesions, thereby enhancing diagnostic accuracy. Natural language processing (NLP) technologies automatically extract key information from natural language texts, such as medical records and patient feedback, assisting clinicians in developing tailored care plans and promoting communication between doctors and patients. Additionally, multi-omics big data analytics integrate genomic, transcriptomic, and proteomic data to uncover the molecular mechanisms underlying cancer, providing a solid scientific basis for precision medicine. By analyzing clinical data from numerous patients, AI can identify potential therapeutic targets, facilitating the development of novel drugs. Multimodal fusion technologies combine data from various sources (images, text, and genetic information) through cross-modal learning, which yields comprehensive insights and accurate decision support for cancer care. Furthermore, the next generation of AI, particularly generative AI (GAI) and large language models (LLMs), opens new pathways for personalized cancer treatment. GAI can simulate real-world data distributions, generate synthetic data or predictive models relevant to cancer, address data scarcity, and accelerate drug development and clinical trials. LLMs, trained on extensive datasets, can understand and generate natural language, providing intelligent support for knowledge queries and health consultations in cancer care. These models can also assist physicians in drafting medical reports and care plans, thus promoting operational efficiency.

7. The need for international collaboration

Care must be taken to prevent these advancements from further increasing the global divide. Despite the fact that the cancer community has well-defined solutions to address the global cancer challenge, there is still a considerable lack of political will and

financial support. Therefore, advocacy is urgently needed at major international meetings. The participants at the last WOF clearly defined the utmost importance of organizing an international and multipolar investment plan to foster a digitally based transformation of public health systems in LMICs. Clearly, the WHO should take the lead in this process, which should yield substantial international developmental projects. Only in this way will we be able to exploit the huge possibilities of intelligent oncology for individuals worldwide.

CRediT authorship contribution statement

F. C.: Conceptualization, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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