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Perspective

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The emergence of medical futures studies uncovers medicine and healthcare's untapped potential

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Analyzing the future of medicine and healthcare, especially during the rise of digital health and artificial intelligence, should rely on established futures methods that the discipline of futures studies has been using for decades. By employing such methods, healthcare professionals, policymakers and patient leaders could better navigate the complexities of modern healthcare, anticipate emerging challenges, and shape a future that is not just awaited but actively constructed.

The history of the future

Historically, esteemed academics and recognized opinion leaders have frequently been invited or have felt compelled to participate in the analysis of future developments in fields like cardiology, cancer treatments, or healthcare administration, particularly concerning their progression in the near term.

The medical literature is rich in such research papers, opinion pieces, and qualitative studies dedicated to exploring "the future of" a given topic. Every field from cardiology[1] and oncology[2] to digital health[3] and artificial intelligence (AI)[4] features such examples.

In addition, most studies and original research papers typically conclude by outlining future directions and potential areas for further exploration. This practice not only underscores critical gaps in knowledge but also encourages other research groups to build upon these findings, fostering continued innovation and discovery.

However, all these papers dedicated to the future, and all the concluding sections about future directions in studies are merely the authors' own opinions, visions, perspectives, and commentaries related to the future of those fields. Researchers, policymakers and editors make crucial decisions based on highly subjective analyses.

Given the importance of anticipating the future of medicine and healthcare, especially now when rapid social and technological advancements are taking place in this very decade, it becomes clear that a more systematic approach to exploring the future is essential. This is where futures studies, an interdisciplinary field rooted in the social sciences, can offer significant contributions.

For decades, future studies has been an academic discipline with a focus on exploring and formulating alternative futures primarily applied in business management and economics, but its methods—such as trend analysis, the Delphi method, backcasting, policy analysis, horizon scanning, or scenario analysis—hold great potential for use in medicine and healthcare as well[5,6].

Analyzing the future of medicine and healthcare should rely on the systematic exploration of future scenarios through well-defined guidelines and established methodologies in futures studies that medical professionals, life science researchers, healthcare, and patient leaders can adopt and use. Such methods could get integrated into medical curricula, and adopted by policymakers and medical journal editors, which would be for its widespread instruction.

In response to this need, the establishment of a new subfield within the life sciences, termed "Medical Futures Studies" is both timely and essential.

This is particularly relevant in the fields of digital health, digital medicine, and AI, where rapid and sometimes unpredictable advancements frequently outpace the changing needs and regulation of healthcare delivery.

This paper seeks to outline the historical context, and the rationale for this emerging discipline while also providing practical examples and case studies.

The first scoping review of futures methods in healthcare

To underscore this hypothesis, our research team performed the first scoping review to date about the application of futures methods such as foresight and found that its use has been successfully demonstrated in a wide range of fields, including national strategies, policy formulation, global threat preparedness, and technological advancements[7]. While 8 different futures methods have already been used in medicine and healthcare, there are more than 50 futures methods available.

Based on these findings, we concluded that the field is unexploited. Medical futures studies would focus on the analysis of emerging technological trends, the evaluation of policy implications, and the proactive anticipation of potential challenges. Whether doctor shortages, the impact of AI on the doctor–patient relationship or the rise of AI-based patient services get into the spotlight, futures methods can help detect potential

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challenges and advantages, as well as allow decision makers to prepare accordingly.

The ongoing cultural transformation characterized by digital health, the evolution of patient empowerment, and the emerging yet profound impact of AI on the core values of practicing medicine all underscore the critical need for this initiative.

The principles of futures studies

Two major principles of futures studies are particularly relevant to digital medicine. The first is to enhance anticipatory consciousness which can help to act faster or earlier, thereby making organizations or individuals more effective in dealing with change. This confronts the general belief that spending time thinking about the future causes anxiety; and also how anxiety can impact future thinking[8].

However, overly positive or negative visions, if not tested and validated by futures analysis, can be destructive by leading people toward unattainable goals or unrealistic schedules. For example, visions about the future of work in the 1960s depicted offices with technologies that did not exist back then such as telephones, fax machines or computers, but featured no women at the workplace[9]. Ignoring the use of established futures methods led to forecasting technological progress well but ignoring important cultural transformations.

The other principle concerns the idea of multiple futures. In almost every language, including English, where we speak of "the future", as well as in Spanish ("el futuro") and German ("die Zukunft"), the word for future is typically used in its singular form. This reflects how the future is often perceived as a unified entity rather than a multiplicity of possibilities: there is only one future—a predetermined, singular timeline on which futurists aim to predict events, milestones, and trends. In contrast to that, multiple futures exist, and futures methods can help discover, observe, and analyze a variety of possible, probable, plausible, and preferred futures.

Due to this opportunity, as the largest comprehensive handbook on futures methods stated[5], humans will have more influence on the future than they did in the past. This also sheds more light on the importance of making futures methods widely accessible in practice.

Using futures methods in medicine and healthcare

Here is a summary of some of the most used futures methods with examples of their use in the medical and healthcare domains.

Forecasting is one of the easiest methods to practice due to the existence of The Good Judgment Project (GJP), a free community site with not only thousands of properly designed forecasting questions but a community of helpful individuals too[10].

The GJP was originally launched as a research initiative in 2011 by Philip E. Tetlock, along with Barbara Mellers and Don Moore, as part of a US government-sponsored forecasting tournament. The goal was to see how well ordinary people could predict world events, such as political outcomes, economic trends, and conflicts. The project involved tens of thousands of volunteers who made predictions on various global events and consistently outperformed professional analysts.

Forecasting in this sense is making predictions based on past and present data. What we could mean by forecasting in healthcare is answering a specific question with a probability. Essentially, we design and ask a specific question, and then try to provide a probability between 0 and 100% for the outcome of the question (how likely you think the answer will be yes). Questions could include:

Will the United States' Food and Drug Administration's official database contain more than 1500 AI-based technologies by the end of 2026?

Will the global market for wearable health monitoring devices exceed $50 billion by the end of 2026?

Will there be a lawsuit about an AI-based medical technology leading to a patient's death in any country before 2026?

By performing the so-called environmental scanning (Fig. 1), we can look for studies, reports, news, articles, analyses and data to back our initial probability, which we are always encouraged to regularly reassess based on new findings.

The Delphi method was originally developed as a systematic, interactive forecasting method that relies on a panel of experts without the negative impact of seniors' authority on other participants' opinions. The use of Delphi is prevalent across health sciences research, and it is used to identify priorities, reach consensus on issues of importance, and establish clinical guidelines[11].

This method can be particularly useful when analyzing the future of certain medical fields or domains. It has been employed to anticipate the role of AI in pathology within the next decade and primary care in 2029; as well as what digital health competencies should be included in future medical school curricula[12–14]. By iteratively refining expert insights, the Delphi method can also help build consensus on regulatory frameworks for new medical technologies or strategies to address anticipated workforce shortages.

Using fiction to imagine future possibilities offers a powerful, creative lens for exploring potential futures—even for participants who have never written stories before. Vision writing fosters empathy by immersing individuals in the lives of people living in future scenarios. Through imaginative storytelling, it encourages critical thinking, enabling exploration of the interactions between technological, social, and environmental changes. This method not only broadens perspectives but also deepens understanding of the complex dynamics shaping future possibilities.

Writing a news headline in 2034 about a medical technology going berserk; or a press release in 2034 about a medical breakthrough; penning a fictional diary entry from the perspective of a medical student in 2040 using a new technology; and even writing a speech for a politician in 2032 advocating for or against a controversial health policy could all contribute to that by bringing these futures to life. By engaging with these narratives, participants not only envision different scenarios but actively shape their understanding of the possible futures they may one day inhabit.

The Futures Wheel is designed to explore the possible consequences of an event or trend. his method uses a visual map to lay out both the direct and indirect effects of a single decision (Fig. 2). The process begins by identifying a central event or issue—like the rise of remote work or a breakthrough cure for Alzheimer's. From there, primary consequences are mapped, representing the immediate outcomes of the event. These consequences form the first ring of the wheel. The next step involves exploring secondary consequences—outcomes that stem from the primary effects—which create a second, broader ring. To deepen understanding, categories like social, legal, or technological impacts can be applied. Best conducted as a group brainstorming activity, the Futures Wheel systematically identifies risks and opportunities, offering a holistic view of potential futures.

It was used to find the primary and future effects of COVID-19 on eight important dimensions of the health system[15]. That paper highlighted disruptions in service delivery, medical education and non-communicable disease prevention and treatment; the physical and mental exhaustion of the healthcare workforce; decreased capacity of intensive care units; and increased reliance on telemedicine with a shift in healthcare delivery from hospital to outpatient settings, among others.

Trend analysis refers to the prevailing directions or patterns of change, and entails assumed developments in the future with a long-lasting effect and impact on a given field. Trends can be identified through data analysis, expert forecasts, and studying historical patterns in medicine and healthcare to help shape future strategies and provide insights into potential developments.

It can be expanded through horizon scanning that provides strategic foresight through identifying emerging trends, technologies, and potential challenges in healthcare to anticipate future developments (Fig. 3). It involves gathering and analyzing data from a wide range of sources to spot early signs of significant change, also called "weak signals", and evaluating the implications of these changes for healthcare systems and policies. It can also help identify wild cards which are low-probability, high-impact events

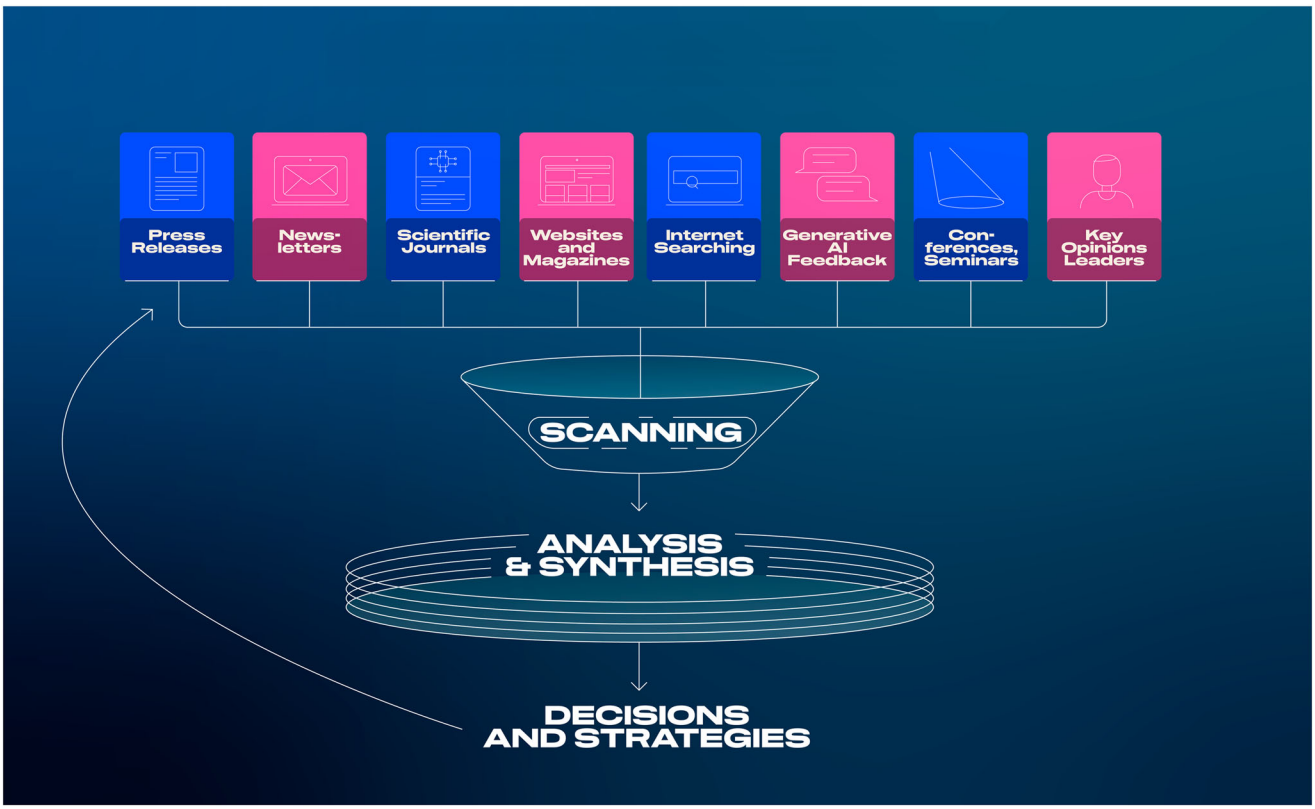

Fig. 1 | A schematic framework of all the potential sources used during environmental scanning. The process involves scanning the sources, analyzing and synthesizing the data, trends, and examples identified from the sources that lead to decisions and strategies.

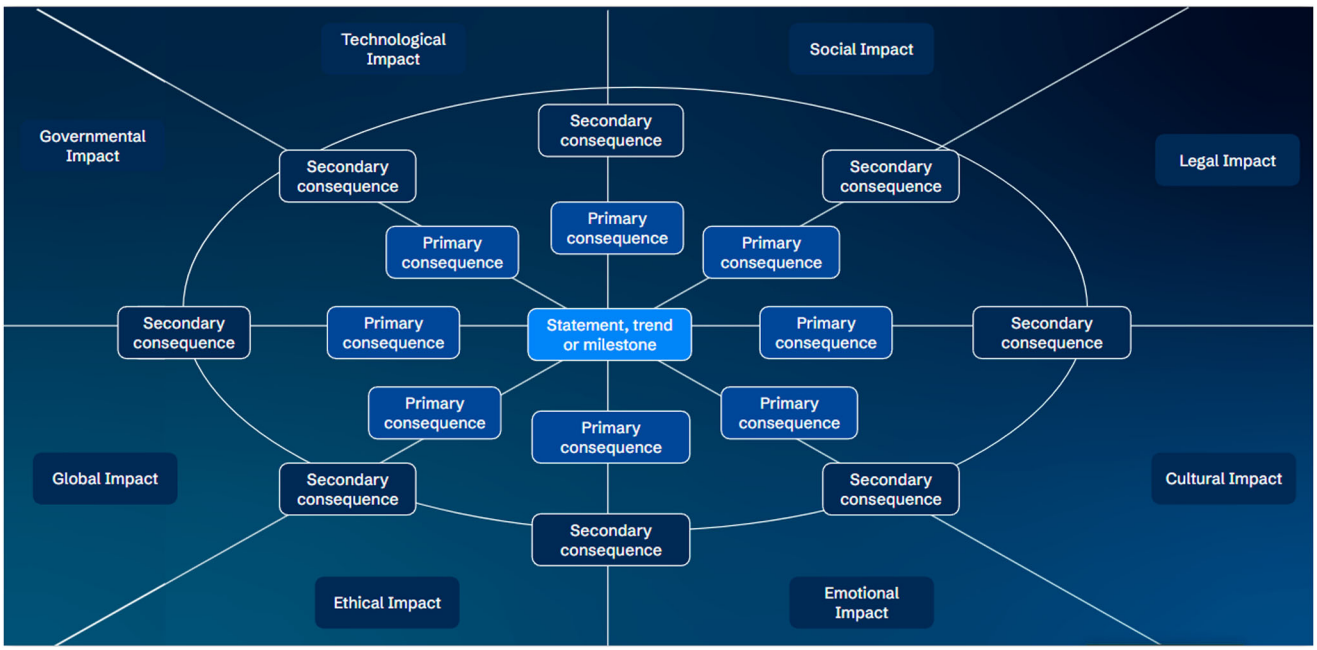

Fig. 2 | An example of a futures wheel. Primary and secondary consequences surround the central event, statement, or issue.

that can cause significant disruptions. The COVID-19 pandemic or the release of large language models would be typical examples.

Its role in preparing health systems for the uptake of new and emerging health technologies has been discussed in the literature[16].

Finally, there are multiple interpretations of scenario analysis, one being the "fairy-tale exercise" (Fig. 4). It helps explore future scenarios by defining a core value that should be maintained throughout scenario development. For instance, when considering the future of medical education in 2040, the value could be the collaboration and partnership between students and professors. A scenario in which this value flourishes is referred to as a utopia (or an idealized, highly favorable future), while its erosion leads to a dystopia (or undesirable future).

In this exercise, participants describe the characteristics of both utopia and dystopia, emphasizing that one person's utopia could be another's

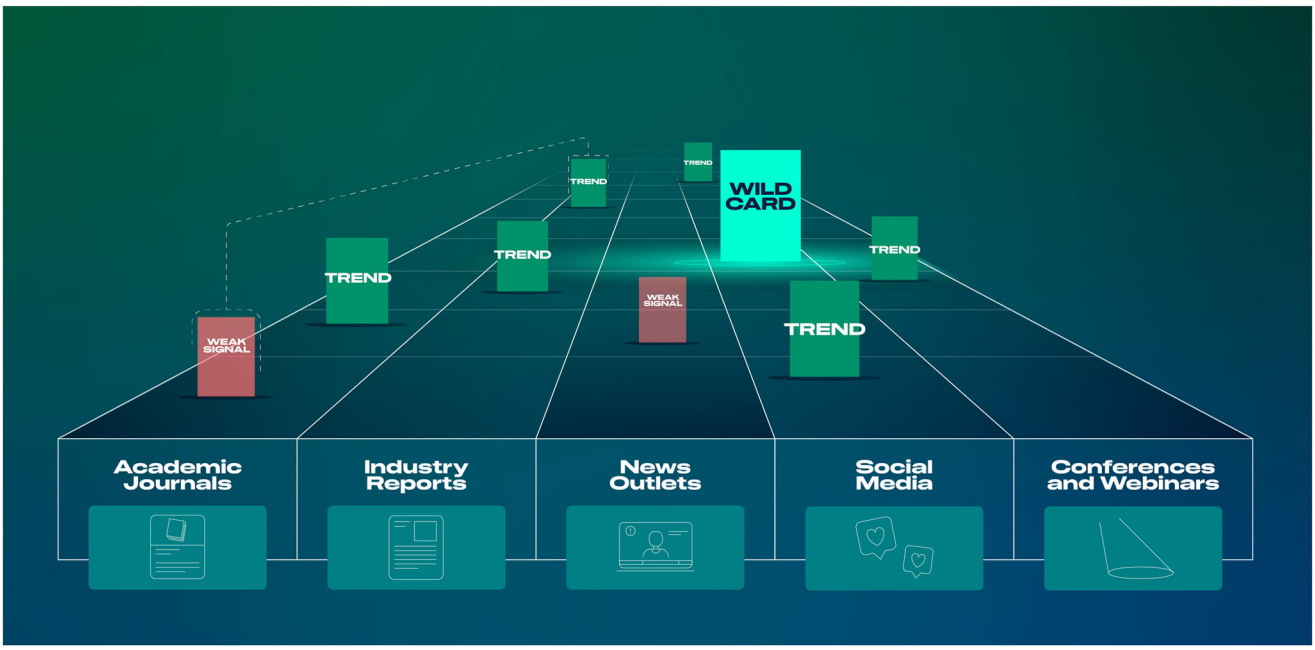

Fig. 3 | An outline of the major elements of horizon scanning. While it can be used to find trends, it also helps identify weak signals of change that might happen on longer time frames, as well as wild cards which are low-probability, high impact events of disruption.

Fig. 4 | An outline of the practice of scenario analysis with the fairy tale exercise. It helps create extreme scenarios, as well as the ideal or optimal, the practically achievable future. Through backcasting, it can help identify those steps that are required to have a higher chance of leading to the desired future.

dystopia. The predefined value—in this case, the student–professor relationship—serves as the guiding principle for all scenarios. After establishing the extreme scenarios, the next step is to define a middle ground, often called the "optimistic realistic scenario" or ideal future. This scenario represents the desired outcome, but it must be grounded in practical realities. If it too closely resembles the utopian scenario, the features of the utopia were likely not defined with sufficient precision.

The process concludes with backcasting. Participants work backward from the desired scenario to the present day, identifying the regulatory, legal, cultural, technological, or social changes necessary to achieve the ideal future. This method encourages proactive thinking about the steps required to shape desired futures and ensures that the scenarios are not purely speculative but anchored in actionable pathways. This method has been used in the Netherlands for anticipating future pandemic scenarios[17].

These are only some of the examples of the over 50 methods medical and healthcare professionals and researchers could use to better foresee how their respective fields will change, what challenges and potential opportunities might arise, and in general, how they can better prepare for the future. Table 1 summarizes ten groups of futures methods and their potential applications in medicine and life sciences.

Table 1 | A summary of ten groups of futures methods and their potential applications in medicine and life sciences

Category	Futures method	Potential application in medical and life sciences
Visioning and imagination	Vision writing	Exploring long-term goals and empathizing with future stakeholders.
Consequences	Futures wheel	Focusing on primary and secondary consequences of events or statements of the future.
Scenario development	Scenario analysis, backcasting	Developing alternative paths for medical innovations or health policy.
Trend analysis	Trend extrapolation, environmental scanning, megatrends	Identifying emerging trends in healthcare technologies or disease patterns.
Participatory methods	Delphi method, focus groups, brainstorming	Achieving consensus on research priorities or ethical guidelines.
Quantitative forecasting	Simulation modeling	Predicting outcomes of public health interventions or treatment plans.
Policy analysis	Foresight-based policy analysis	Evaluating the effectiveness of policies and their potential impacts.
Game-based methods	Serious games, role-playing simulations	Testing strategies for pandemic preparedness or resource allocation.
Technology assessment	Technology sequence analysis, relevance tree	Assessing the potential impacts of new technologies.
Evaluating long-term possibilities	Horizon scanning	Identifying emerging trends, threats, and opportunities in the form of weak signals and wild cards.

Why healthcare, why futures studies, and why now?

Among a multitude of fields, healthcare stands as the prime candidate for the incorporation of futures methods, and conversely, futures methods are paramount for understanding the directions of the cultural and technological evolution of healthcare.

First, strict healthcare regulations would benefit from anticipating future challenges and opportunities in science, technology, and culture. This proactive approach can ensure timely regulations that allow innovations such as AI to reach the market efficiently. Second, futures studies aim to foster futures literacy, enabling the development of policies that lead to preferred futures. In addition, healthcare has a profound impact on people's lives, from well-being to economic contribution, and futures studies can help design healthcare systems that are more efficient, cost-effective, and accessible, while also being flexible and adaptive to emerging changes.

The rapid pace of technological advancement, aging populations, and workforce challenges also call for future-oriented strategies. Futures studies can anticipate the impact of emerging technologies such as AI, gene editing, and telemedicine on healthcare delivery and policy. Moreover, foresight can help healthcare systems prepare for global threats like pandemics, and breakthroughs in medical technologies, while addressing the growing burden on healthcare professionals.

While the future might seem like an unpredictable force beyond our control, established futures methods provide the tools and specific research design that could improve how the research and implementation of digital health are guided. This capability is especially crucial in an era marked by rapid technological progress and the cultural transformation we call digital health.

By employing these methods, healthcare professionals, policymakers, and leaders could better navigate the complexities of modern healthcare, anticipate emerging challenges, and shape a future that is not just awaited but actively constructed. Medical futures studies could empower us to transform uncertainty into strategy, unknown risks into scenarios, fear into emotional resilience, and blind spots into visions.

Therefore, when it comes to important questions such as whether AI will replace physicians, if wearables will diminish the human touch, or whether administrative tasks will continue to burden the healthcare workforce in the future, we will know which methods to use. We could cultivate anticipatory consciousness and ensure that the healthcare systems of tomorrow are both thoughtfully structured and responsive to the changing needs of all.

Data availability

No datasets were generated or analysed during the current study.

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Author contributions

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Competing interests

The author declares no competing interests.

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