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Review

The medicine of the past, present, and future generations: From Sir William Osler to ChatGPT

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ABSTRACT

Innovation and discovery are the drivers of progress in medicine, which is an ever-changing science. Core concepts in current medical practice include patient-centered and high-value care, evidence-based and personalized medicine, and digital health, that is gaining momentum. Rampant progress is seen in technology development, artificial intelligence, machine learning, large language models such as ChatGPT. Their use in medicine has promising perspectives, conditioned by adequate regulations, based on ethical principles and human-rights, to ensure safety of patient data, fact accuracy, and general applicability.

The future of medicine should aim for universal health coverage, facilitated by digital medicine and guided by empathy and compassion. Human interaction will remain a mainstay in medical practice, and ideally technology will provide the much-needed time for doctor–patient bonding. Climate change, cyber security, and access to basic care are some of the challenges to be resolved in the years to come.

Future medical care should find the balance between high tech and high touch and aim to for global availability.

La Medicina de las generaciones pasadas, presentes y futuras, desde Sir William Osler hasta ChatGPT

Palabras clave:
atención centrada en el paciente
medicina basada en evidencia
inteligencia artificial
ChatGPT
grandes modelos de lenguaje
empatía

RESUMEN

La innovación y los descubrimientos son los motores del progreso en la medicina, que es una ciencia en constante cambio. Los conceptos centrales en la práctica médica actual incluyen la medicina centrada en la persona, atención de alta calidad, medicina basada en evidencia, personalizada, y salud digital, que están ganando impulso. Se observa un progreso sin precedente en el desarrollo tecnológico, la inteligencia artificial, el aprendizaje automático, y los grandes modelos de lenguaje como ChatGPT. Estos usos en medicina tienen perspectivas prometedoras, condicionadas por regulaciones adecuadas, basadas en principios éticos y respetando los derechos humanos, para garantizar la seguridad de los pacientes, la exactitud de los hechos y la aplicabilidad general.

El futuro de la medicina debería apuntar a una cobertura sanitaria universal, facilitada por la medicina digital, guiada por la empatía y la compasión. La interacción humana seguirá siendo un pilar de la práctica médica e idealmente la tecnología proveerá el tiempo necesario para establecer el vínculo médico-paciente. El cambio climático, la ciberseguridad y el acceso a la atención básica son algunos de los desafíos que deberán resolverse en los próximos años.

La atención médica futura debería encontrar el equilibrio entre las nuevas tecnologías y el contacto humano, y apuntar a una accesibilidad global.

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Introduction

“Medicine is an everchanging science” is the first sentence in Harrison’s Manual of Medicine, that will ever stay true. The acceleration of expanding theoretical and practical knowledge, alongside constantly evolving and improving automation, computers, and mechanics in the fields of disease pathophysiology, diagnostics, and treatment, is rampant. Under these conditions, our mission is to align, adapt, and integrate innovation while preserving the core values inherited from previous generations of doctors.

In the beginning of the 20th century, Sir William Osler, the father of modern medicine revolutionized clinical practice and medical teaching by focusing his attention on each patient’s individualized profile, history, and clinical examination, by using close and direct observation, by integrating all the information to build the differential diagnosis, and by reaching his final diagnosis and treatment plan based on the available scientific evidence. One of his famous quotes was that “the good physician treats the disease; the great physician treats the patient who has the disease”. His innovative approach for that time became a century later the concept of patient-centered care that still governs our practice today.[1] In terms of outlook for the future and the dynamics of medicine, he stated that “The philosophies of one age have become the absurdities of the next, and the foolishness of yesterday has become the wisdom of tomorrow”,[2] foreseeing the evolving discoveries and advances that would change the face of clinical practice in the years to come.

In this article, we aim to look at preceding estimations of the future of medicine throughout the years, then discuss the current challenges of modern medicine and reflect on the prospective developments and transformations.

The medicine of the present

In 1988, R.H. Ebert and E. Ginzberg acknowledged the increasing importance of high-tech medical and surgical interventions and emphasized the role of clinical judgement, problem-solving abilities, computer literacy, technical competencies, as well as patient relations, and foremost continuous training and adaption to the expanding knowledge base and technology of medicine.[3]

In 1992, the **evidence-based medicine** (EBM) concept emerged, as a new paradigm for medical practice. It reflected the progress of medical literature and clinical research, the value of meta-analyses, and the development of practice guidelines based on critical appraisal of data and systematic evaluation of the available evidence.[4] The skills promoted by EBM included identifying the clinical problem, searching for evidence, evaluating the results, and then applying the scientific data at the bedside. EBM did not negate, but on the contrary, emphasized the need for compassionate care, and set the tone for transforming the training and practice of future physicians.[4] It was recognized once more that the quantity of emerging information was rampant, as was the development of innovative technologies, imposing the improvement of quality of medical care, and therefore, the future generations of doctors needed to adopt and master the necessary skills to implement EBM in routine practice.[4]

In 1993, the **patient-focused care** approach began to attract attention. The need to place the patient at the center of health services’ organization, by focusing the allocation of resources and personnel on patient-care needs was advocated by healthcare professionals in order to improve outcomes.[5] In 2000, Bensing discussed the discrepancies between the patient-centered care and evidence-based medicine, advocating that the challenge of the future was to integrate the 2 concepts, the key role attributed to communication and communication research.[6]

The answer to this issue was later solved by the introduction of the **shared decision-making** approach. In 2007, the concept of informed patient choice was introduced, supporting the use of decision aids in order to improve decision quality and patient adherence, as a potential standard od practice.[7] In 2012, a team lead by Elwyn introduced a 3-step model to guide implementation of shared decision-making in clinical practice, consisting of introducing the choice to the patient, describing the available options, followed by an open discussion, in order to facilitate the decision by exploring the patient’s preferences.[8]

Personalized medicine was first mentioned in 1971 and received increasing interest after 1999/2000. In 2013, a systematic approach was used to define the concept as seeking to improve stratification and timing of health care by utilizing biological information and biomarkers at the level of molecular disease pathways, genetics, proteomics as well as metabolomics.[9] It showcases the progress in biomedical, social, and economic sciences, alongside the breakthroughs of technology and informatics.[9] Undoubtably, its implementation in daily practice will be interdependent with and potentiated by digital science.[9] **Precision medicine** emerged in 2015, when USA’ President Barack Obama launched the Precision Medicine Initiative, a program aiming to generate a targeted approach to disease prevention and treatment, by integrating the genetic background, lifestyle, and environment characteristics of each patient, in order to generate focused diagnosis and management plans.[10] Personalized and precision medicine are terms used interchangeably, although there might be slight nuances to each concept. While precision medicine is generally assessing the biological characteristics of individuals, personalized medicine is considering the biological, psychological, and social determinants of health.[11]

A step further was the development of **longevity medicine,** a branch of personalized medicine, that uses medical and technological advances in the field of targeted prevention, driven by deep biomarkers of aging, at the crossroads of biogerontology, geroscience, and precision, preventive, and functional medicine.[12] The aim is the use of differentiated, precise, and comprehensive datasets unique to each patient, in order to prevent development of disease, to reduce the exposure to predisposing factors, to maximize health promoting behaviors, and to upgrade individualized treatment plans.[12]

Concurrently, the evolution of advanced diagnostic and therapeutic means lead to misuse and overuse in healthcare. **High value care** concepts emerged, and the **choosing wisely** campaign was launched in the United States and afterwards adopted worldwide.[13] The aim was to raise awareness about these habits and improve quality of medical care, underlining that apart from the economic burden, unnecessary procedures or treatments could be detrimental to patients, leading to suboptimal care.

Another pivotal step in the progress in contemporary medical practice was the **COVID-19 pandemic**. It incited accelerated development and implementation of digital methods including but not restricted to machine learning and big data analysis, that assisted medical professionals worldwide to track and anticipate the viral spread, to optimize diagnostic accuracy, and to improve prognostic prediction and drug discovery.[14] This unforeseen condition set the stage for digital health and artificial intelligence (AI) to gain its place in daily medical practice, and to prove its utility and importance.

Will the medicine of the future be high-tech?

In 2005, the World Health Organization (WHO) Member States made the commitment to aim for **universal health coverage** (UHC), acknowledging the expectation that all people should have access to the medical care they need without the risk of financial hardship or poverty.[15] Multiple factors play fundamental roles in achieving this aspirational objective, and one of them is digital health.

The Lancet Youth Commission identified 3 key aspects of a digitally transformed UHC. Digital technology implementation should facilitate the applicability, convenience, approval, and quality of health services. It should aim to aid and promote preventive, personalized, and mobile medicine that is easily accessible, and it should support the patients’ involvement and interaction with the health professionals and providers.[16]

Digital health spans across multiple domains from electronic Health (eHealth) to digital technologies, including artificial intelligence, big data, and multi-omics, in different fields of medical care.[17] **eHealth** was defined by the WHO as the use of information and communication technology in support of health and health-related fields, including healthcare services, health surveillance, health literature, and health education, knowledge, and research.[15] In 2016, more than half of the WHO Member States adopted an eHealth strategy in the strive to achieve UHC,[15] and undoubtedly, it will spread continuously, to become part of the daily routine of clinical practice in the future.

Telemedicine is another area of recent exponential growth. It was defined by WHO as the delivery of healthcare services by all types of healthcare professionals to distant individuals and communities, using data and digital technologies for the exchange of accurate information for diagnosis, treatment, and prevention of illnesses and injuries, research and appraisal, and as a means of delivering education to healthcare providers, in the scope of improving overall health.[18] Facilitating remote access to medical care, telemedicine has the potential to reduce costs, expedite medical contact, and improve health outcomes. Routine implementation of telemedicine as a complementary service in clinical practice will be a cost-efficient and time-saving method to optimize medical coverage, upgrade patient addressability, and follow-up.[19] Closely connected is the mobile health (mHealth) concept. **mHealth** is characterized by the utilization of mobile devices such as mobile phones, monitoring devices, wireless instruments, and others, for medical purposes.[15] Given the rising prevalence of the use of mobile phones internationally, their extended employment for medical use is easily achievable, and it offers numerous solutions for bidirectional communication between patients and medical staff, or between medical professionals, for monitoring different conditions, or for accessing medical information.[15] mHealth initiatives are currently implemented in more than 80% of WHO Member States[15] and we estimate that it will shortly expand further. The smart hospital concept is already being implemented. A digital ecosystem fosters the use of Big Data and advanced IT systems to analyze patient information in order to improve the accuracy of diagnosis and treatment, while enabling patients to easily access their complete medical history and treatment plans via smartphone or tablet and giving them the possibility to get in touch with specialists using chat.[20]

Machine learning, a form of artificial intelligence that analyzes, acquires and interprets data, is able to learn and predict patterns, without prior definition of information variability and interdependence. First employed in image analysis, its use expanded to diagnosis and prevention, moving from an abstract concept to clinical applicability. Its use aims to bridge the gap between large datasets like multi-omics and facilitate the implementation of precision medicine.[21] **Multi-omics** assessment through deep learning technology offers the opportunity to integrate multiple layers of data to better understand and characterize disease processes.[22] Multi-omics analyses will provide the means to approach complex illnesses and to explain intricate relationships between vast layers of information, however not without challenges. The high-dimensional, low-sample size data, model interpretation, and the integration of clinical and environmental exposure data are predicaments to be solved before large-scale implementation of deep learning and multi-omics use.[22]

Large language models (LLM) are AI algorithms that use computational technology and neural networks to generate language highly resembling human discourse, based on vast amounts of text, images, or sounds. **ChatGPT** launched by OpenAI emerged in November 2022 and immediately became the most popular LLM model. Its implementation in medicine was promptly assessed and its potential use in patient care, research, and education did not delay materializing. LLMs can conceivably improve patient care by delivering medical information in plain language adapted to each patient's understanding, facilitating doctor–patient communication by means of translations and synopses, and aiding medical professionals with bureaucratic tasks such as structuring data and documenting patients' files.[23] In medical research, LLMs could feasibly ease access to exponentially expanding scientific data and assist in extracting information and synthetizing content, as well as in meliorating scientific writing, and aiding computer programming for data visualization and processing.[23] The applicability of LLMs also extends to medical education, where evolving technologies triggered innovative approaches and integration of digital technologies alongside traditional methodology. With appropriate tuning, regulations and adequately adapted prompts and data selection, LLMs could be an adjunctive educational instrument, provided that its employment won't be taken for granted and used instead of analytical thinking and critical appraisal of information.[23] The pitfalls of using LLMs include appropriate prompting, updated inclusion of emerging medical data, risk of hallucinations of inaccurate information, misinformation, and biased results. Currently, although accuracy is increasing with evolving models of, for example, ChatGPT, in order to use the AI generated results and responses in medical practice, education, or research, the validity of information should be confirmed, and accuracy of sources verified. Before LLMs can be used on a larger scale, adequate guidelines and regulations should be implemented to ensure their safe and responsible use. Similar to any other technological development, the use of LLMs like ChatGPT in medicine requires a judicious, well-considered, standardized, and coordinated approach. Human involvement is of utmost importance in any direction of use, to safeguard digital implementation, to secure an ethical use, and to protect patients' data, exposure, and vulnerability.[24]

The use of **artificial intelligence**, as assessed by ChatGPT itself, holds promising and exciting prospects in different areas of medicine ranging from research to imaging and diagnosis, pharmacological as well as surgical therapies. The exponential development of such digital tools capable of analyzing and integrating vast quantities of data lead to expanding technologies capable of processing information such as medical information, investigation results, imaging tests, in order to identify patterns that might be missed by the human eye, and to predict high-accuracy patterns of progression of different conditions. Therefore, the system's own forecast is that its use will provide support for individualized and optimized patient care, from the diagnosis to the therapeutical plan and prognosis estimation.[25] Regarding the technology perspective, we can foresee that the future of medicine is highly probable a collaboration between medics and machines.[20] AI analysis of large datasets will aid refine value-based health care that will focus on patient outcomes while optimally employing resources. Targeted management of individual cases will be facilitated by integration of multilevel clinical, biological, genetic, and environmental information.[20]

Undoubtedly, parallel to the exponential technological advances, medical education will adapt and will adopt **innovative competencies** to assist the inclusion of computational innovations in routine medical practice. The 6 main AI-related clinical competencies for healthcare professionals identified by experts in the field include the basic knowledge of AI tools, capabilities and applications, the social and ethical implications of AI use, the opportunities for AI-enhanced clinical encounters, the evidence-based assessment of AI-derived instruments, the workflow evaluation and implementation of AI-derived tools, and the practice-based learning and optimization of AI-based tools.[26]

Will the medicine of the future be high touch?

Considering all these advances in technology and AI, a question may arise regarding the role of future human doctors in healthcare systems. Indeed, there is a trend among the developers of AI that there is no *a priori* insurmountable limit in the progress of programming and algorithms on which future AI robots may improve health care.[27] However, it needs to be reminded that health care is a complex concept that encompasses not only an efficient and correct way to make a diagnosis and consider a treatment but also the patient–doctor relationship and the mutual trust that needs to be maintained in time to achieve the best possible outcomes. And there comes into discussion the role of empathy. This is not a simple concept but a biological fact on which the human species ensures its survival and progress. One of the strengths of human evolution consisted in the tribal organizations which increased the chances of survivability from early ages, and this would not have been successful if not for the presence of empathy and its consequence, compassion.[28]

Empathy and **compassion** represent a cornerstone of the patient–physician relationship, especially in the modern view of patient-centered medicine. It is proven that the capacity of doctors to demonstrate empathy toward the patient has a great impact on the management of the patient. Patients are more likely to reveal more information about medical and social conditions and to have greater adherence to treatment proposals only if they consider the doctor is empathic and connected to their problems in real-time.[29–31] Also, it affects the capacity to receive bad news and cope with it to reach the best possible decision regarding the necessary steps to a potentially better result.[32]

This human trait is what will be necessary to be emphasized and trained to differentiate future human doctors from the simplistic view of the process of gathering data, considering a diagnosis, and making therapeutic recommendations based on more or less complex algorithms implemented in AI systems. Empathy and compassion are not simple concepts of the recent developing period, but the result of biological processes developed over millennia and hardwired in the human brain. Studies based on functional magnetic resonance imaging demonstrated there is a correlation between brain areas activated in empathic observers as well as in patients that are observed.[33,34] This neurobiological process is even more complicated as the emotional response in the observers' brain is attenuated which allows a doctor to be empathic but also not overwhelmed in such a manner to affect the decision-making process.[28,35]

Is it possible to implement empathy into robots? The answer is not simple. First, empathy is a complex process that does not involve simple understanding and reaction to a patient's declaration like "I feel a headache" but also analyzing several other components like mimics, posture, facial micro expressions, tone, etc. These interconnected processes perfectionated during human evolution are not easy, if not impossible, to reproduce. In 1988, Moravec stated that it is easier to create AI programs for abstract notions than motor skills.[36] Therefore, it may be a challenge for AI developers to implement true empathy in robots, especially taking into consideration it should be functional in real time and adaptive to the dynamics of relationships over time.

Second, we need to consider the various components of empathy, like emotion and cognition.[37] Emotional and motivational empathy are based on experience of emotions and that will trigger the compassionate act from the observer. Instead, cognitive empathy is the process of interpreting the various signals delivered by the observed person to imagine the emotional and mental state of that person.

Is it possible for AI to be trained in cognitive empathy? Maybe. But not the emotional components of empathy. This poses a risk. For example, psychopaths may be very good in terms of cognitive empathy, but the lack of emotional components will not trigger a compassionate reaction, or worse, it may lead to a manipulative response.[27] The empathy traits already present in the biology of humans may be enhanced during the formation of doctors and this would lead to a better relationship with the patients and better outcomes.[38] In fact, AI may variously help doctors starting with routine administrative tasks and continue with faster diagnostic processes and therapeutic decisions, therefore helping them to focus more on creating a trusting and durable relationship with their patients. Eric Topol eloquently describes the loss of true bonding with the patient due to the "business-fication" of medicine and the transformation of doctors into productivity tools.[39] The same author underlined how the recommended time to be reserved for a patient devolved in the last decades from 1 h for a new patient and 30 min for a return to an average of 12 min and, respectively, 7 min.[39] Future doctors should use the time and personal resources freed by the help of AI to reverse this process. There are also other concerns regarding AI use in the medical field. One is related to responsibility when the outcomes are negative. We already know the phenotypes of patients and diseases are extremely diverse and dynamic. In case of an AI decision with unfavorable results, the error may reside in in multiple implicated facets, such as the programming, the implemented algorithm, the data on which the algorithm were developed, the institution that may prefer one tool over another, the doctor who blindly follows the AI decision, or contrary, he overrides it.[40]

Another important issue is related to the patients' perception and trust regarding the AI interaction, including non-verbal communication, lack of showing emotions and empathy, or depersonalization through the loss of human contact.[41] The same features on which the doctors develop their empathy and attitude toward the patient are used by this to develop the relationship and trust with the doctors.[41] It is a bilateral communication deeply wired in our biology. Simply put, humans need humans for the best outcomes.[41]

The ideal doctor–patient interrelation is based on multiple principles beyond the theoretical knowledge and professional performance, relying heavily on **mutual trust, confidence, and understanding** of each other's values and requirements.[42] The patient's vulnerability facing illness, alongside their unique character and wide spectrum of attitudes toward their own health as well as toward the physician, the medical system, and the received recommendations are only few of the variables that profoundly impact the interaction between the 2, as well as the clinical course of the disease. Therefore, the patient's satisfaction is based on multiple elements which include trust, regard, loyalty, family, and other conditions integrated, besides knowledge and accurate diagnosis.[43,44] When one or more of such elements are lacking the patient–doctor relationship suffers and consequently the health outcomes[43]

The doctor's experience, personality, and ability to constantly adapt to the patient's needs differentiate a great physician and, moreover, determine compliance and adherence to the management plan, therefore establish the success of the interaction. Navigating modern medicine is an intricate challenge that requires the intertwining of scientific knowledge and fact-based decision frameworks, clinical applicability and adaptability, as well as compassionate and empathic care.[45] Following a multiple-choice algorithm, irrespective of its data complexity, cannot yet replace the **human interaction and interdependence** that defines the doctor-patient relationship.

Overcoming other barriers and optimizing the future of medicine

The future of medicine will intertwine opportunities and challenges, and inevitably, as knowledge, technology, and the world evolve, new provocations will arise.

Climate change will remain an important global medical concern for the upcoming years, with extreme weather events impacting not only incidence and patterns of diseases, but also the increase of climate migrants. Global warming will escalate the prevalence of respiratory and cardiovascular diseases, while displacement of specific populations will shift the types and sequences of atypical pathologies.[20] While our current actions will play an important role in this unpredictable and unprecedented situation, it is highly likely that AI will facilitate the development strategies to anticipate, improve and to adapt to this situation. Low-carbon health care will be part of the solution to this intricate problem.[46] We are broadening our understanding of the impact of our daily actions on the environment, with heightening emphasis on the low-value care and unnecessary overuse of resources in medicine.[47] The more we acknowledge the consequences of overuse and the more we can focus and adequately distribute our abilities and assets, the more we can contribute to a sustainable medical practice.[48]

eHealth will undoubtedly be the medicine of the future, however, an appropriate and adaptable environment is required to ensure optimal use in the scope of reaching UHC, while maintaining the privacy, confidentiality, and **safety of patient data**. Legal regulations, adequate education and digital skill development, definition of standards for implementation, development of technical infrastructures, as well as permanent surveillance and appraisal are required, and should be enabled worldwide.[15] In 2016, 78% of WHO member countries that responded to a survey reported the use of legislation regarding the privacy of personal information, and 54% confirmed the adoption of legislation to protect the privacy of electronically stored personal information.[15] **Ethical principles and human rights-based approaches** are of utmost importance to ensure that digital technologies will be used in accordance with social justice standards and with the scope of reducing health inequalities.[16]

Potentially one of the biggest challenges will be to **equalize the access and quality of medical** care worldwide. While some countries debate toward which high-tech medical project to direct their funds, others struggle to control communicable diseases and infant mortality, and to access basic care. Discrepancies are considerable, making the near future still seem distant from reaching the utopic UHC. Vulnerable or minority groups are still underrepresented and more predisposed to discrimination in different areas of the medical journey: from addressability to access, from prevention to treatment, from individualized care to populational interventions. Ideally, all patients should be able to reach fundamental health care. Moreover, inclusion in decision-making processes should be facilitated for representatives of diverse groups of people, including youth and marginalized communities.[16]

Closing remarks

When opinion leaders in health-related fields were asked, in 2019, to predict the progress of the next 25 years, the overarching ideas revolved around the inclusion of big data analytics in daily routine, the progress of gene and CAR-T therapies, geroprotective drugs, as well as vaccines expanding beyond infectious diseases to cancer, the use of precision medicine and genetic characteristics to prevent and/or detect early onset of illness, as well as to better target disease progression, and to address aging in the scope of improved quality, healthier and more active life.[49] The growing body of medical literature will be integrated into a scientific corpus easily accessible to both physicians and patients, shifting also the structure and core concepts of medical learning. They also emphasized the utmost importance of collaborations among science, innovation, and society, underlining the need for global accessibility to medical novelty, and the promotion of public-interest-driven health innovation.[49]

Predictions for 2030 include computer technology as an omnipresent facilitator of all facets of society, including health. Digitalization of medicine and integration of automated systems will simplify clinical practice and will increase productivity, under appropriate ethical and governing regulations, as well as privacy compliance. Optimal inclusion in daily practice will require adequate digital literacy and technological skills to integrate and interpret information.[50]

We highlight the necessity of a balanced education of the physicians in training beyond the theoretical medical knowledge, that will incorporate interpersonal skills as well as technological abilities that will enable us to maximize the use of computers while maintaining the crucial personalized relation with each patient.

Doctors are continuously learning, adapting to uncertainty in medical decision-making, relying on problem-solving abilities and interpersonal aptitudes, while trying to understand and incorporate the growing influence of technology and artificial intelligence. The future is personalized patient-centered precision medicine, and our education should balance the theoretical knowledge with the social and relational abilities and the computer-directed competencies to support the optimal navigation of this constantly evolving field. Considering all these, the advantages of rapidly developing AI should be used by doctors and health-related organizations and systems to bring more humanity back into health care, for a true patient-oriented medicine.

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Declaration of competing interest

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