Strange Bedfellows. The Unlikely Alliance between Artificial Intelligence and Narrative Medicine

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ISSN 1989-7022

Extraños compañeros de cama. La improbable alianza entre la inteligencia artificial y la medicina narrativa

Abstract: Artificial intelligence (AI) is on the brink of revolutionizing medicine. New tools for dealing with medical data, based on deep learning and state-of-the-art data mining methods, have the potential to change medical practice significantly. The opportunities of AI for biomedical research as well as clinical practice are hotly debated. But there is one aspect that has been overlooked so far. Since AI-applications may deal with the time-consuming tasks of collecting and processing data, physicians could spend more time with their patients. This could be an opportunity to implement the principles of a more person-centered medicine, that advocates of narrative medicine have demanded for decades. At first glance, AI and narrative medicine are strange bedfellows, but I aim to show that this unlikely alliance might lead to a larger view of the medical profession, as outlined by the renowned physician Francis H. Peabody almost a century ago. This larger view implies that the very nature of medical practice is not the treatment of disease, but the care of the patient. And AI might just be the right tool to make this ideal a reality.

Keywords: artificial intelligence, data mining, digital health, medical ethics, narrative medicine

Resumen: La inteligencia artificial (IA) está a punto de revolucionar la medicina. Los nuevos instrumentos para tratar los datos médicos, basados en un aprendizaje profundo y en los métodos más avanzados de extracción de datos, tienen el potencial de cambiar significativamente la práctica médica. Las oportunidades de la IA para la investigación biomédica, así como para la práctica clínica, son objeto de acalorados debates. Pero hay un aspecto que se ha pasado por alto hasta ahora. Dado que las aplicaciones de la IA pueden ocuparse de las tareas de recopilación y procesamiento de datos que llevan mucho tiempo, los médicos podrían pasar más tiempo con sus pacientes. Esto podría ser una oportunidad para implementar los principios de una medicina más centrada en la persona, que los defensores de la medicina narrativa han demandado durante décadas. A primera vista, la IA y la medicina narrativa son extraños compañeros de cama, pero mi objetivo es mostrar que esta alianza improbable podría conducir a una visión más amplia de la profesión médica, tal como la esbozó el renombrado médico Francis H. Peabody hace casi un siglo. Esta visión más amplia implica que la naturaleza misma de la práctica médica no es el tratamiento de la enfermedad, sino el cuidado del paciente. Y la IA podría ser la herramienta adecuada para hacer realidad este ideal.

Palabras clave: inteligencia artificial, minería de datos, salud digital, ética médica, medicina narrativa

1. Introduction

Artificial intelligence (AI) is on the brink of revolutionizing medicine. From robotics to diagnostic tools and smart wearable sensors, AI-applications have already made an impact in clinical practice. The further implementation of these applications will challenge the ways of medical practice (Rajkomar et al., 2019). What health professionals do and how they do it will be transformed through these new tools for organizing, analyzing, and operationalizing medical data. At the same time, patients will be more and more able to take their health matters into their own hands. They will gain increasingly more access to their own health data through self-tracking and transparent electronic medical records. Apart from health benefits and cost savings these changes in medical practice are expected to bring with them, there will also be a transformation of the patient-doctor relationship. AI is expected to do most of the time-consuming administrative as well as diagnostic tasks of health professionals. Thus, health professionals could have more time available which they could invest in the encounter with their patients. The patient-doctor relationship is considered as the core of medical practice by followers of narrative medicine. Therefore, the implementation of AI may empower the implementation of principles of narrative

Received: 11/12/2019
Accepted: 12/01/2020

Giovanni Rubeis: "Strange Bedfellows. The Unlikely Alliance between Artificial Intelligence and Narrative Medicine", en Ricardo Morte Ferrer: *Debate: Digitalización y salud*
ILEMATA, Revista Internacional de Éticas Aplicadas, nº 32, 49-58

ISSN 1989-7022

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medicine as well. Also, the patient perspective will change. Patients are more and more capable of collecting crucial health information on their own. This fact may change their position in the clinical encounter, bringing the ideal of an encounter on an eye-to-eye level and thus the ideal of a participative medicine one step closer to reality. This transformed patient-doctor relationship could be a chance to implement a new type of medical practice in which health professionals do not only treat diseases, but patients. Instead of spending a big part of their time budget on painstakingly collecting and processing data, health professionals could spend more time with their patients. The implementation of AI-applications could thus be the opportunity for a renewed clinical encounter that follows the principles of narrative medicine.

In the following, I aim to show that the further implementation of AI in medical practice may imply a paradigm shift towards a narrative medicine. In a first step, I analyze the applications and perspectives of AI in medicine. In a second step, I briefly outline the principles of narrative medicine, focusing on the patient-doctor relationship. Finally, I demonstrate how the unlikely alliance between AI and narrative medicine may bridge the gap between medicine as art and medicine as science.

2. AI in medicine. Applications and perspectives

There are two major fields of application of AI in medicine, physical and virtual (Hamet et al., 2017). The physical applications of AI include robots and devices. Robots are used as surgical systems like Da Vinci of which an estimated 5000 are in use worldwide. The surgical use of robots ranges from assistant surgeons to solo performers and includes cardiac valve repair, gynecologic surgical procedures, and prostatectomies. Robots are also used in psychotherapy (softbots), nursing (carebots), and for drug delivery to target organs, tissues or tumors (nanobots) (Hamet et al., 2017). When it comes to devices, AI is used in smart wearable sensors that enable patients or health-conscious individuals to track their personal health data. These sensors can be used by health professions for telemedical purposes or by individuals who are interested in self-tracking for lifestyle reasons. Within the last years, self-tracking has become immensely popular. The fact that it allows individuals to take health matters into their own hands leads many to believe self-tracking to be a boost for autonomy (Rubeis et al., 2018).

Virtual applications include machine learning which is also referred to as deep learning. Deep learning systems are able to learn through experience by using adaptive evolutionary algorithms and state-of-the-art clustering methods like evolutionary enhanced Markov clustering (Hamet et al., 2017). As analytic tools, systems like IBM Watson Analytics, PEGA Analytics, or SAS Analytics Pro combine statistical methods with data mining (Marchevsky et al., 2017). These types of software are capable of providing predictive analytics and data visualization, thus allowing to analyze data fast and easy. Natural language as well as numerical data can be explored. These systems can analyze structured and unstructured data, e.g. electronic medical records or genomic data. They can also be used for knowledge-driven decision support through analyzing research papers, RCTs, meta analyses, textbooks, etc. Predictive analytics is the key feature (Nelson et al., 2019). The systems find statically significant associations, for example the correlation between a certain cancer diagnosis and the survival status. They also evaluate the quality of the data and measures the prediction strength. No professional statistician or complicated statistics software is needed. The results of an analysis can easily

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be shared via social media, thus enabling an easy communication and exchange of data between researchers. Analytic tools are easily accessible, easy to use, fast, and efficient. Therefore, systems based on deep learning can be applied in biomedical research (Yue et al., 2019). Their main use is in knowledge management, e.g. in drug discovery or genetics. In genetics for example, deep learning systems using adaptive evolutionary algorithms identify single nucleotide polymorphisms (SNPs) as indicators of pathogenic traits (Hamet et al., 2017).

But the truly revolutionary potential of AI lies in its clinical applications. AI-applications allow data mining of electronic medical records for the benefit of patients (Brenner et al., 2019). For example, some systems use algorithms to detect the augmented risk of a hereditary disease or a chronic disease. Also, these systems allow a faster sharing and application of health data. This enables a faster and better informed decision making, thus increasing the quality of care. Up to now, valuable data is mostly unused in today's medical records. The reason is that it is mainly unstructured and not easily accessible. If data was made more easily accessible, thus better utilizable for data mining, it could be instantly available in real time as point of care information. This would further increase the benefits for the patients. These benefits include a more personalized medicine as well as the early detection and targeted prevention of health conditions. Apart from the clinical value, a more efficient use of data could also lead to a cost reduction in the health sector.

One of the most promising areas in which AI is applied is diagnostics. IBM's Watson for Oncology (WFO) is the leading system in this field right now. This system uses natural language processing to provide evidence-based treatment options for cancer. WFO is trained with real as well as fictional cases and is capable of reading 800 million pages per second (Schmidt, 2017). When fed with patient data, WFO needs a median of 40 seconds to analyze the data, compare it with all the available evidence, and present a treatment option (Somashekhar et al., 2017). The treatment options are structured in three categories: 'Recommended,' 'For Consideration,' and 'Not Recommended" (Lim et al., 2017). Based on these options, clinicians are able to make an evidence-based decision that includes more data than a single individual could possibly have collected or processed.

WFO is already in use in several countries and has shown astonishing results. At the Oncology Department of the Qingdao Municipal hospital in Qingdao, China, WFO was used for a clinical trial. The retrospective data from 160 stage I-IV cancer patients suffering from breast cancer, colorectal cancer, gastric cancer, and lung cancer was processed. When comparing the decisions of the cancer board with those of WFO, the researchers found an average concordance in 95% of cases (98% in breast cancer, 96% in colorectal cancer, 93% in gastric cancer, and 87% in lung cancer) (Yue et al., 2017). A similar retrospective study at The Affiliated Hospital of Qingdao University processed data from 152 cancer patients (119 breast cancers, 33 lung cancers). WFO was concordant with the cancer board in an average of 79.0% of cases (94 of 119) of breast cancer and 96.9% cases (32 of 33) of lung cancer (Zhang et al., 2017). A large cohort study with 1000 patients at the Manipal Comprehensive Cancer Center at Manipal Hospital in Bangalore, India, showed an average concordance of 80% (Somashekhar et al., 2017). A trial with datasets from 370 patients at the Department of Obstetrics and Gynecology at the Gachon University Gil Medical Center in Incheon, Korea, also found an average concordance of 80% (Lim et al., 2017). Although these results are impressive, there are also challenges when it comes to using WFO. The contract between the University of Texas M. D. Anderson Cancer

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Center in Houston and IBM expired in 2017 due to several problems in implementing the system at the hospital (Schmidt, 2017). There were procurement issues, cost overruns and delays in implementation. None of these issues concerned the accuracy or safety of WFO, but mostly the processing of unstructured data such as doctor's notes or written case reports. Up to now, the system is not able to process these types of data equally good as data from electronic medical records. Also, the interpretation of medical language has proven to be difficult because sometimes terms and expressions are used differently depending on context (Schmidt, 2017). Apart from the implementation process, there are also unresolved issues concerning clinical practice. Some settings like recurrent tumors or cases with rare histology are not yet covered by WFO (Lim et al., 2017). Also, differences in clinical practice become apparent when WFO is used internationally. Since WFO was developed in the USA, it mainly focuses on US-American standards and doesn't include different practices. Another issue is site-preferred treatment which is not reflected upon by WFO (Lim et al., 2017).

Despite these issues, the advantages and benefits of systems like WFO are overwhelming. The main advantage is the increasing provision of patients with evidence-based treatment which diminishes variations in clinical decisions (Lim et al., 2017). Thus, analytic systems can be seen as ideal tools to fulfill the ideal of an evidence-based medicine. One of the crucial factors of evidence-based medicine are guidelines for clinical practice based on best evidence. There is, however, one disadvantage. The evidence is mostly drawn from large cohort studies and then statistically analyzed. Therefore, the evidence provides no specific recommendations for the singular case at hand and individual features of the patient are not covered. The refined data analysis of diagnostic tools such as WFO provide more specific options for the singular case at hand (Merchevsky et al., 2017). Also, these tools are especially important as assistants to clinicians with limited clinical experience (Yue et al., 2017). Furthermore, they are time-efficient compared to painstaking data collection and statistical analysis (Merchevsky et al., 2017).

The new tools for clinical practice that AI provides are in their early stages. Surely, they need refinement as does the environment they are supposed to be applied in. Not all health data is digitalized in a standardized way so that it is easily accessible. Only a small number of health professionals is familiar with analytic systems and diagnostic tools yet, and it will take some time to integrate these applications in the work flow of clinicians. But nevertheless, the opportunities are there and they are promising. The benefits that could arise from AI in medicine go far beyond a more efficient administration or cost-reduction in the healthcare system. They even go beyond the expected health benefits that could result from a digitally enhanced practice like a more personalized and more evidenced based medicine. Another crucial aspect is about to change, an aspect at the heart of the clinical encounter. The revolution that AI is about to bring will also transform the patient-doctor relationship. This change provides the opportunity to frame the new way patients and health professional will interact by the principles of narrative medicine.

3. Narrative medicine and the patient-doctor relationship

In 1926, the renowned physician Francis W. Peabody gave a remarkable talk at the Harvard Medical School (Peabody, 1927). In his talk, Peabody identifies a crucial flaw in the contemporary medical practice. He argues that medical school teaches young doctors a lot about the mechanisms of disease, but not how to take care of patients. Contemporary medical educa-

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tion is primarily focused on scientific concepts and methods, which are the essential tools of medicine. However, Peabody continues, the application of scientific principles is only one element of medical practice. The crucial aspect of the medical profession is the patient-doctor relationship, he claims. Medical practice is essentially personal, but especially hospital practice has become immensely impersonal. Yet, a personal relationship between patients and doctors is important regarding the success of the treatment. If the patient-doctor relationship fails, the treatment will fail too. A dysfunctional patient-doctor relationship makes treatment itself dysfunctional. Since the effectiveness of treatment depends on this relationship, it should play a more prominent role in medical education, which, according to Peabody, is simply not the case. Establishing a relationship between patient and doctor means listening to the patient and talk to him or her about other things than symptoms or biomedical data. It also entails to learn about the family and social background of the patient, his or likes and dislikes, personality, and values. Therefore, what is needed is a more holistic understanding of medical practice, or, as Peabody calls it, a "larger view of the profession". What is at stake here is the very nature of the medical profession. Peabody criticizes not only clinical practice itself, but a view of this practice that we have become accustomed to. Following this view, a knowledge-based intervention to counteract a specific biomedical event or dysfunctional process is the nature of clinical practice. It is simply what doctors do. This image stems from the understanding of medicine as a science, not an art. Its roots lie in the 19th century when modern medicine was founded on scientific principles. This scientific turn, linked to Rudolph Virchow's (1821–1902) cellular pathology and the works in microbiology by Robert Koch (1843–1910) and Louis Pasteur (1822–1895), changed the way health professionals deal with knowledge. From that time on, the only valid medical knowledge was science-based knowledge. As a consequence, medical practice itself changed. This had serious consequences for the patient-doctor relationship, and this is exactly where Peabody's critique sets in. Not only were diseases reduced to cellular processes, but patients were reduced to diseases too. On the one hand, this biomedical reductionism lead to an enormous progress in medicine. Treatments for various conditions became more reliable, successful or even possible at all. At the same time, however, the specialized approach that focused on cell interactions and biomedical data had a negative effect as well. The holistic view of patients as persons, Peabody's larger view of the profession, got lost. The result was the depersonalization of medicine.

Peabody's critique reverberated throughout the decades. It was renewed when evidence-based practice became the new paradigm of medicine. Starting in the 1970s, the evidence-based medicine movement demanded that all medical knowledge which directs clinical practice must be based on the best empirical evidence available (EBM Working Group, 1992, Sackett et al., 1996). The underlying assumption is that there is a hierarchy of medical knowledge, ranging from the expert opinion of doctors derived from their personal experience at the lower end of the scale to meta analyses of randomized control studies (RCTs) at the top. Evidence-based medicine became the gold standard in medicine in the 1990s. However, the new paradigm has been criticized ever since. Essentially, this critique repeated the claims made by Peabody decades earlier. Some commentators stated that there is an epistemic gap between the evidence provided by RCTs and meta analyses on the one hand and the individual patient on the other (Feinstein and Horvitz, 1997). Evidence-based medicine fails to acknowledge the particularities of the individual patient especially his or her preferences and values, according to this view. Personal clinical experience could be a way to bridge

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this epistemic gap because it focusses on the direct relationship between patients and health professionals (Tonelli, 1999). This debate still continues (Fava, 2017).

On the forefront of this critique stands the approach of narrative medicine. From the 1980s onward, the concept of narrative medicine was established as a counter-movement against the depersonalization of patients in medicine. It gained momentum with the increasing implementation of evidence-based practice in medicine. According to the exponents of narrative medicine, contemporary medical practice focusses on the universal instead of the particular, the corporate instead of the personal, and the mechanized instead of the intimate (Charon, 2017a). Contemporary medicine reduces individuals to bits of biological information and fails to recognize the complex interactions in which people live, supporters of narrative medicine claim (Garden, 2014). The communication between patients and health professionals which is the constitutive factor of their relationship, becomes increasingly dysfunctional in this setting. Therefore, proponents of narrative medicine propagate listening to patient's accounts in order to understand them as whole human beings instead of bundles of symptoms and biomedical data. In a way, narrative medicine follows Peabody's ideal of the large view of the profession. It is a holistic approach that focusses on the patient's narrative, his or her beliefs, preferences and values. Crucial to this approach are open-ended, non-directional clinical conversations which require attentive listening skills on behalf of health professionals (Charon, 2017b). This kind of communication with patients, referred to as close listening, can be trained in medical education (Charon, 2017a). An enhancement of attentive listening skills can be achieved through a training that focusses on close reading and creative writing. The underlying assumption is that stories provide the patterns to decipher intersubjective encounters and relationships. Through the reading and telling of stories, listening routines as well as the awareness of narrative forms and structures can be enhanced (Charon, 2017b). Thus, an awareness for subtle and ambiguous issues, detail, and the intricacies of human relations can be raised (Jones et al., 2014). Also, ethical issues can be addressed this way, for example the normative implications of disease and illness, issues of social justice, ethical implementations of the patient encounter, etc. A training based on narratives sharpens sensibilities through reflecting upon ethical complexities and can thus be seen as an enhancement of empathy and understanding. One of the key aspects here is taking a different point of view and empathize with the patient. The intensive study of narratives teaches to focus on meaning and the making of meaning. The same goes for creative writing. Thus, health professionals can be sensitized for the factors that constitute meaning in a patient's life, be it faith, family, his or her occupation or values. This understanding of what is behind the patient's opinions and decision is crucial for a functional patient-doctor relationship. As a result, what can be achieved is deep companionship, mutual investment, reciprocal clarity, and affiliation between patients and health professionals (Charon, 2017a).

Apart from the skill of close listening, the ideal clinic encounter propagated by narrative medicine requires something else: time. And this is one of the main arguments against this approach. Many health professionals, even those who are open to the concept of narrative medicine, think that their tight time budget won't allow it (Morris, 2008). According to this view, the principles of narrative medicine are extremely difficult to be implemented in clinical practice because the schedules of health professionals are already overloaded (Murphy and Franz, 2016). In fact, an increase in workload has been noted in recent years (Hobbs et al., 2016). Even if many health professionals are willing to implement narrative medicine, the

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time factor is a serious obstacle. Another form of criticism aims at the type of knowledge that is propagated by narrative medicine. This critique points out that the validity of narratives, its epistemological value, is questionable (Atkinson, 1997, Solomon, 2008). Following this critique, an illness narrative told by a patient doesn't hold the same validity as biomedical data does. Although narratives may have some merit for clinical practice, they are overrated and cannot replace empirical evidence, critics claim.

These two types of criticism seem to suggest that evidence-based medicine and narrative medicine are antagonists. The frontline between the two approaches could be identified with the distinction between medicine as science and medicine as art. It is exactly this antagonism which can be overcome through the unlikely alliance between AI and narrative medicine.

4. How AI may empower narrative medicine

At first glance, it seems unlikely that AI and narrative medicine would match. Some applications of AI in medicine like analyzing systems and diagnostic tools could rather be understood as the ultimate fulfillment of the ideals of evidence-based medicine. They enable health professionals to access the best available evidence in real time. To be more specific, all available evidence provided by meta analyses, RCTs and textbooks can be accessed and processed in a matter of seconds. Remember that WFO for example can read 800 million pages per second and comes up with a recommendation in under a minute. Obviously, no single human being is able to process such an enormous amount of data, especially not in such a short time. Considering that there is a myriad of research papers published each month, it is virtually impossible for health professionals to stay up to date in the way that evidence-based medicine demands. Systems like WFO however can manage that easily. When it comes to collecting and processing data, these systems surpass the abilities of any human being. That makes them the perfect tool of evidence-based medicine. But it also frees health professionals from time-consuming and rather tedious tasks. A big part of the diagnostic process could be delegated to analytic systems and diagnostic tools. As a result, the focus of the clinical encounter could shift from data collection and data analysis to the enriching the patient-doctor relationship through narratives. Medical practice could return to being an art again.

Does that mean that medicine should abandon its scientific basis, give up all the benefits that the scientific turn yielded? No one who wants medicine to be more beneficial for patients can seriously demand such a thing. It was Peabody who stated that medicine as science and medicine as art are not mutually exclusive. In fact, they are congruent and even supplementary. Science and science-based education are the necessary prerequisite for medical practice, but there's more to it. What Peabody calls the larger view of the profession entails that the patient-doctor relationship is the core element of medical practice. In other words, the very nature of medical practice is not the treatment of disease, it is the care of the patient (Peabody, 1927). With the broad-scale implementation of AI, this larger view of the profession could be made a reality. Within this larger view, there is no antagonism between medicine as art and medicine as science. The implementation of AI allows to integrate narrative medicine in an evidence-based setting without reducing patients to biomedical data. The key is delegating mechanistic and time-consuming tasks to machines. Administrative tasks as well as data research and processing can easily be done by AI and even better than by any human. In fact,

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it would be a waste of human resources to use a human for a such a task which is basically mechanistic. Humans should rather focus on tasks that demand specific human abilities and skills. That's the principle behind the process of digitalization we are witnessing in different fields at the moment. There is no reason why medical practice should be an exemption. On the contrary, especially medicine should be restructured so that mechanistic tasks are done by AI. Health professionals should use their resources for the clinical encounter instead of wasting them for tasks that machines can do better anyway. The further digitalization of medical practice would allow health professionals to focus on the patient-doctor relationship, thus returning to the larger view of the profession outlined by Peabody.

Oncology, where AI has made its deepest impact so far, is a good example here. Even for the standards of medicine, oncology is a highly complex field that demands a high level of specialization. Furthermore, oncological research is one of the most funded and therefore most thriving fields in biomedical research. There are thousands of research papers published each year. Practitioners in oncology have to be up to date which, given the huge amount of data generated by oncological research, is only possible through a narrow-focused specialization. At the same time, the clinical encounter in oncology requests a high level of social skills. Life and death decision-making, breaking bad news, explaining the very complex biomedical facts, dealing with anger, grief, and depression on behalf of the patients is very demanding. Therefore, especially in oncology it is crucial that health professionals understand disease experiences and needs of their patients (Yang et al., 2018). Thus, the two demands for oncologists, a narrow-focused specialization and broad social skills, are likely to conflict. Delegating the data search and processing, the mechanistic part of the diagnostic process, to AI wouldn't mean that oncologists have to be less specialized. But it would give them the opportunity to focus more on the patient-doctor relationship and the specific demands that are linked to it in oncology. With most of the mechanistic tasks done by AI, health professionals in oncology could focus more on ways to improve the communication with their patients. The importance as well as success of enhanced forms of communication with patients in oncology have long been discussed. Tools like patient-reported outcomes (PROs) have proven to be successful in this respect (Yang et al., 2018). PROs are standardized questionnaires for patients that include questions on symptoms, general well-being, quality of life or anxiety. The implementation of PROs has shown how important an intensified communication between patients and health professionals is in oncology. The implementation of narrative medicine could be a perspective for a further enhancement of this process. And the further digitalization of clinical practice through AI would give health professionals the opportunity to implement methods of narrative medicine.

5. Conclusion

At first glance, AI and narrative medicine are strange bedfellows. The data-driven analytic systems and diagnostic tools AI provides seem like the completion of the ideals of evidence-based medicine. The proponents of narrative medicine pledge for a view of medical practice that goes beyond applying scientific methods and processing biomedical data. But as Peabody stated more than 90 years ago, medicine as art and medicine as science don't necessarily contradict each other. Both concepts are crucial to medical practice. There is no need to choose one over the other as long as the focus is on the patient-doctor relationship.

The implementation of AI allows health professionals to maintain the quality standard evidence-based medicine demands without reducing the patient to a mere bundle of biomedical data. Of course, there are still challenges and obstacles. AI is only in its infancy. It will take an enormous research effort to refine the available systems and to expand the use of AI-based applications in medicine. Also, medical education will have to be redesigned and restructured. And finally the implementation of AI in clinical practice and the work flow of health professionals won't happen overnight or without difficulties. But the huge efforts that are linked to the implementation of AI are justified by the benefits that can be expected. Apart from efficiency and cost-effectiveness, the crucial benefit is the larger view of the profession which can be regained through the alliance between AI and narrative medicine.

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