AI in Healthcare: from Fiction to Faction

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Every day we face the truth of aging population, new infectious diseases, shortage of medical staff, economic stagnation and devaluation of healthcare. To that end, global inflow of Artificial Intelligence (AI) into healthcare system all over the world, has turned into a necessary solution to these increasing challenges. The authors will briefly look into the status of AI from the angle of literary and cinematographic creations to prove its initially understood fictitious nature, and prognostic risks of its integration into everyday life and work. However, the fast process of technological evolution has made AI become an inevitable assistant in daily living and care. Theorists as well as practitioners have already written dozens of papers about benefits and risks of applying autonomous systems into healthcare. Likewise, the authors of this paper intend to contribute to the general debate over the effects of AI on the healthcare system by first introducing obvious advantages and befits of applying the autonomous system, such as efficiency of treatment, more personalised health services, increased precision in diagnostics, economic development and innovation in medical science, leading to general improvement of human health. This shall be made evident through positive examples of the USA and China. Next, the authors shall brought into light the harmful risks of applying AI in healthcare, starting from those in concreto, such as algorithmic errors and mismatch, false positive or negative representation, the risk of cyber attack, black-box effect, through legal difficulties of establishing liability and allocating the burden of proof in cases of medical malpractice as a result of the use of AI, the ethicality of applying AI in healthcare, to more prospective in abstracto expectations of polarisation of healthcare into non-affordable Advanced Medical Service based on AI, reserved for the rich (highly developed countries, such as Germany, the USA and China) and affordable Complementary/Adjuvant medicine, meant for the poor (underdeveloped or developing countries, such as Montenegro and Bosnia and Herzegovina). Prognostically, the authors expect complete change of the healthcare concept due to massive migration trend, which brings along new self-diagnostic and treatment approach, which further boosts the mega software companies to create highly sensitive autonomous systems that ultimately might replace a traditional/conservative medicine.

Keywords: AI, healthcare, patient, clinician, autonomous system,

Introduction

Let's stop calling it Artificial Intelligence and call it what it is: Plagiarism Software. It doesn't create anything, just copies existing works from artists and alters them sufficiently to escape copyright laws. It's the largest theft of property since Native American lands by European settlers. " -- Noam Chomsky

A recent study issued by the European Parliament states that the health sector is facing increasing demands on medical services due to issues such as an ageing population, an increase of chronic and new diseases, budgetary constraints, lack of sustainability and a shortage of health personnel.[1] Many works of SF literature have put into focus the general fear of fast developing partnership between humans and AI. However, intensive developments in the field of robotics and AI have proven very optimistic by offering numerous opportunities for addressing the existing challenges in healthcare, resulting in necessary and significant cost and time savings. Various studies have confirmed that the application of robotics and AI could lead to improvements in fields such as medical diagnostics, surgical intervention, prevention and treatment of diseases, and support for rehabilitation and long-term elderly care. They could also contribute to more effective and automated work management processes, while offering continuous training for healthcare workers. It is estimated that the market for AI in healthcare will grow from $16,3 billion in 2022 to $173.55 billion by 2029, with significant cost savings for healthcare systems.[2] According to a recent study on AI healthcare in France, government investment into AI-based personalised medicine and predictive health analytics would make France a leader in AI-driven medical innovation.[3]

However, the urge for technological advancement of healthcare has its side effects. In spite of potential advantages of AI in health sector, there are challenges to be dealt with. One of the largest challenges is ethicality of application of AI in healthcare. AI algorithms can be partial if trained on data not representative for the population (false positive or negative results). That

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[1] Karim Lekadir, Gianluca Quaglio, Anna Tselioudis Garmendia, Catherine Gallin, *Artificial Intelligence in Healthcare: Applications, Risks, and Ethical and Societal Impacts,* study ordered by the European Parliament, EPRS, STOA, PE 729.512, June 2022; https://www.europarl.europa.eu/RegData/etudes/STUD/2022/729512/EPRS_STU(2022)729512_EN.pdf [accessed on 4 October 2024]

[2] Ross Chornyy, „Artificial Intelligence in Healthcare: Market Size, Growth, and Trends", online article, *Binariks*, 16 August 2024; https://binariks.com/blog/artificial-intelligence-ai-healthcare-market/ [last accessed on 11 October 2024]

[3] Rachid Ejjami, "AI-Driven Healthcare in France", *International Journal for Multidisciplinary Research (IJFMR240322936),* volume 6, issue 3, May-June 2024; doi:10.36948/ijfmr.2024.v06i03.22936; ʰttps://www.researchgate.net/publication/381478873_AI-Driven_Healthcare_in_France [last accessed on 11 October 2024].

can lead to disparity in the outcomes of healthcare protection for different groups of patients. Another challenge is the need to protect privacy and confidentiality of patients when AI is used for the analysis of patients' data. AI systems pose a significant challenge to fault-based medical liability systems. The particular characteristics of AI, such as learning ability, limited predictability, complexity, opacity, and openness create insurmountable evidentiary obstacles for the patient, as the injured party. In order to succeed in bringing a successful liability claim, the injured party has to overcome the "black-box effect" obstacle and prove a specific fault of the physician/healthcare institution.

Unfavourable economic status of developing country, such as Bosnia and Herzegovina and Montenegro, that hinders investment in the modernisation of national healthcare, has additionally contributed to the already existing challenges of introducing AI into health sector. This study will show that in spite of all potential advantages of applying AI in modern healthcare system, it can easily turn into a silent enemy if its autonomy is empowered and left unsupervised by a human agent.

Benefits and Risks of AI through Fiction

Determining whether AI is a threat or a benefit is entirely a human responsibility. One could easily agree with Karl Schroeder's assumption that there is an exaggerated anxiety focused on losing control of the machine.[4] The notion of replacement is inherent in the concept of value. A human could be replaced by a computer that has more commercial success, but this reasoning is only valid if commercial success prevails in the value system. Schroeder further rationalises that society must make the right decisions for the implementation of AI. If one day the products of AI become independent, then it is the responsibility of a human creator to instil positive values into them. Through Science Fiction, Schroeder has been advocating that no new technology can be implemented in any field, including healthcare, without first identifying its social impact, its use and its legal framework.

An advance in technology can change people's sense of what it is to be human. Kazuo Ishiguro's awarded SF novel *Klara and the Sun*[5] deeply tackles the problem of long-term care for those in need through writing the entire book in the voice of a machine imitating human speech patterns, personified in the character of Klara, an artificial friend (AF) of a genetically enhanced ("lifted") sickly girl Josie. With the introduction of AI in long-term care, the society is

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[4] Karl Schroeder, *Lady of Mazes*, Tom Doherty Assocites, 2005;
[5] Kazuo Ishiguro, *Klara and the Sun,* Knopf Doubleday Publishing Group, 2021;

gradually abandoning any clear distinction between the artificial and the real. Artificial friends (AFs) are becoming popular because they are meant to help combat person's loneliness, to act as the companions that elderly people otherwise lack. However, Ishiguro's final altruistic note, with Josie choosing to renew friendship with her human friend Rick, and Klara ending up in a yard for scrapped AFs, reveals his not being at peace with the enforced partnering impact of AI in human life.

The same positive humanistic message is cradled in Spike Jonze's SF romantic comedy-drama film *Her*[6], which follows a man who develops a relationship with an artificially intelligent virtual assistant personified through a female voice. The man eventually realises that AI agent cannot replace a human, especially in matters of the heart, but can only help him complete certain tasks more efficiently.

We see that writers and film makers have taken a rather pessimistic approach to the prospective process of integration of AI into human life and healthcare. Such dark prognoses can be partially justified if the value system is wrongfully set, making AI the aim rather than the means. However, the need to generate extensive and intricate healthcare datasets unconditionally pushes AI into healthcare system.

Benefits of AI in Healthcare

In recent years the use of artificial intelligence (AI) in medicine and healthcare has been praised for the great promise it offers. Numerous interdisciplinary studies by AI delevopers, public agencies, expert leaders, clinical researchers, healthcare professionals and social scientists have shown that AI has a potential to revolutionise healthcare sector by increasing the efficiency of clinicians, improving medical diagnosis and treatment, reducing costs and optimising the allocation of human and technical resources. Some of the main applications of AI in medicine include medical imaging, automated analysis of genetic data, disease prediction, medical robotics, telemedicine, and virtual (intelligent) doctors. Based on this application many improvements in healthcare system have been recorded.

Precision in diagnostics

The potential for the application of AI in the clinical sector is enormous and ranges from the automation of diagnostic processes to therapeutic de-

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[6] *Her,* produced by Megan Ellison, Spike Jonze and Vincent Landay, Annapurna Pictures, 2013;

cision making and clinical research. The data necessary for diagnosis and treatment comes from many sources including health records, laboratory tests, pharmacy data, medical imaging, and genomic information.[7] One of the most prospective applications of AI in healthcare is medical imaging. Medical imaging is one of the key technologies for diagnosis and treatment of various diseases and conditions. Interpretation and analysis of images such as X-rays and CT scans require a high-level expertise, can be long-term and prone to errors. According to Topol, imaging technology supported by AI systems can help radiologists identify abnormalities in medical images with greater precision and efficacy.[8] For example, segmentation with limited human supervision has been achieved by using deep network models, which enable to automatically localise and delineate the boundaries of anatomical structures or lesions.[9] Thus, AI algorithms can segment brain images in order to identify specific structures for surgery planning[10], or AI can detect early signs of lung cancer on X-rays and CT scans, which helps establish early diagnosis leading to better outcome for the patient.[11]

Integration of AI in the field of medical imaging has a potential to change the way radiologists and other healthcare professionals diagnose and treat diseases. These benefits can be seen in various phases of medical imaging starting from image analysis. AI algorithms can analyse medical images, such as X-rays, CTs and MRs, in order to detect and diagnose abnormalities with greater precision and efficacy. AI-powered medical imaging helps enhance patient care, define new healthcare standards, streamline processes, and foster a more efficient, responsive, and technologically sophisticated healthcare system.

In the field of image registration, AI algorithms can compare more images from the same patient, scanned at a different time or with different imaging modalities, in order to provide a more comprehensive review of the patient's condition. This can be very useful in monitoring progression of the disease and creating a treatment plan.

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[7] Supra note 1, 5.
[8] EJ. Topol, "High-performance medicine: the convergence of human and aritficial intelligence", *Nature Medicine*, 25(1), 44-56, 2019.
[9] Jialin Peng, and Ye Wang, "Medical Image Segmentation with Limited Supervision> A Review of Deep Network Models", *arXiv> 2103.00429v1* [cs.CV] 28 Feb 2021; https://arxiv.org/pdf/2103.00429 [accessed on 4 October 2024]
[10] Nestor Maslej et al, "The Artificial Intelligence Index 2024 Annual Report", AI Index Steering Committee, Institute for Human-Centred AI, Stanford University, Stanford, CA, April 2024, chapter 5, 307.
[11] Senad Burak, "Umjetna inteligencija (AI) u medicini", online article, MEDEX.EMIS, 28 April 2023; https://medex.emis.ba/blog/umjetna_inteligencija/ [accessed on 4 October 2024]

AI-based image enhancement can contribute to greater precision in diagnostics and better treatment planning. Concrete improvements can be recognised in the reduction of sounds or enhancement of contrast.

AI also helps in reducing workload from medical professionals by automating routine tasks, such as data processing and *image analysis*. Such automation can enable healthcare providers to pay attention to more complex tasks and thus directly contribute to the patient's care. In addition, the application of AI can significantly reduce the length of time patients are forced to wait for diagnostic tests and treatments such as surgery and cancer care.[12]

More and more studies prove that AI can have a similar level of accuracy to that of a healthcare professional[13], and even improve their diagnostic performance when used jontly.[14]

Further development of medical AI systems can lead to enhancing their prognostic capacities, such as predicting disease diagnosis and prognosis, evaluating disease severity and outcome and using assays to predict response to therapy. An American study has shown that the use of AI in diagnostics can reduce costs by ten times. Thus, the cost savings in diagnosis are USD 1666.66 per day per hospital in the first year and USD 17,881 per hospital in the tenth year.[15]With great certainty it can be said that AI-based technologies improve diagnostic accuracy, tailor treatment approaches to particular patient's needs, and anticipate patient outcomes with surprising precision.

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[12] Shez Partovi, "Bridging Gaps in Healthcare: three key takeaways from the 2024 Future Health Index", online article, *Royal Philips*, 19 June 2024;
ʰttps://www.philips.com/a-w/about/news/archive/blogs/innovation-matters/2024/bridging-gaps-in-healthcare-three-key-takeaways-from-the-2024-future-health-index.html?utm_source=search&utm_medium=paid&utm_campaign=fhi-search-artificial-intelligence&utm_content=rsa-ad-1&utm_term=artificial-intelligence-us&gad_source=1&gclid=CjwKCAjw9p24BhB_EiwA8ID5Bpuf-NJahczd70XiaSrV7Uzuep-LZZM2GBGUPqJe6q36tGnrHPcC5BoCQ0EQAvD_BwE [last accessed on 10 October 2024].

[13] Faes L. Liu X, AU Kale, SK Wagner, DJ Fu, A Bruynseels, T Mahendiran, G Moraes, M Shamdas, C Kern, JR Ledsam, MK Schmid, K Balaskas, EJ Topol, LM Bachmann, PA Keane, AK Denniston., "A comparison of deep learning performance against health-care professionals in detecting diseases from medical imaging: a systematic review and meta-analysis", Lancet Digit Health.1(6):e271-e297, 2019; Bejnordi B Ehteshami, M Veta, Johannes van Diest P, B van Ginneken, et al. "Diagnostic assessment of deep learning algorithms for detection of lymph node metastases in women with breast cancer' JAMA.;318(22):2199-2210., 2017.

[14] DF Steiner, R MacDonald, Y Liu, P Truszkowski, JD Hipp, C Gammage, F Thng, L Peng, MC Stumpe, "Impact of Deep Learning Assistance on the Histopathologic Review of Lymph Nodes for Metastatic Breast Cancer*", Am J Surg Pathol.* ;42(12):1636-1646, 2018.

[15] Narendra N. Khanna et al, "Economics of Artificial Intelligence in Healthcare: Diagnosis vs. Treatment", *Healthcare*, 2022, 10, 2493. https://doi.org/10.3390/healthcare10122493.
ʰttps://www.ncbi.nlm.nih.gov/pmc/articles/PMC9777836/pdf/healthcare-10-02493.pdf [last accessed on 10 October 2024].

More personalised treatment

AI can also be used for additional personalisation of patient's care. Traditional approaches to medicine often assumed a generalised methods of treatment for all patients suffering from the same kind of disease. However, it has become increasingly clear that individual variations in genetics, lifestyle, and environment significantly impact an individual's response to treatment. This realisation has influenced the emergence of personalised medicine – an approach that adjusts medical interventions to the unique characteristics of each patient. The AI analysis of patient's data such as family anamnesis, lab results or lifestyle factors, can help medical professionals develop personalised treatment plans adjusted to individual patients, with better treatment outcomes. Such AI-helped personalised approach to healthcare can be very useful in the field of emergency medicine, where fast access to the patient's clinical history is of vital importance. For example, AI can help identify patients who are under high risk of developing chronic diseases such as diabetes or cardiovascular diseases, thus helping develop personalised preventive care plans in order to reduce the risk. According to Kirubarajan et al, AI-related research is rapidly increasing in emergency medicine. There are several promising AI interventions that can improve emergency care, particularly for acute radiographic imaging and prediction-based diagnoses, and in certain aspects even outperform clinicians.[16]

Another side of personalisation in healthcare is the increase of patient's autonomy via advanced technologies. Namely, technological advancements, with AI leading the way, are empowering patients with unprecedented access to their health data. Wearable devices, genetic testing, and electronic health records (EHRs) are revolutionising care delivery creating a proactive patient who can now manage his health with high level of precision and personalisation. According to a study by Simon-Kucher agency, in the US, the wearables market size amounted to 17.2 billion dollars in 2022 and is forecasted to reach a value of over 23 billion dollars by 2026.[17] The company Arterys recently announced the first FDA-approved AI-based application to be used in facilitating clinical diagnoses and to help choose the right intervention.[18]In addition, early identification helps medical professionals imple-

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[16] Kirubarajan A, Taher A, Khan S, Masood S. 'Artificial intelligence in emergency medicine: A scoping review', *J Am Coll Emerg Physicians Open*.;1(6):1691-1702, 2020.

[17] C. Rebholz and Susan Huang, "Monetizing wearables: Unlock opportunity in a competitive market", online study by Simon-Kucher, 3 August 2023; https://www.simon-kucher.com/en/insights/monetizing-wearables-unlock-opportunity-competitive-market [accessed on 4 October 2024]

[18] Marr B, „First FDA Approval For Clinical Cloud-Based Deep Learning In Healthcare", *Forbes*, New York: Forbes Publishing Company, 2017.

ment preventive measures and interventions, reducing the risk of a disease and improving overall human health.[19]In recent years, China has implemented a variety of policy measures to address healthcare challenges, focusing on personalised treatment for an aging population. Thus, China has attracted global attention showing a significant interest in the transformative potential of Personalised Medicine for healthcare improvement, with a focus on the elderly population. [20]

Advanced and efficient rehabilitation and long-term elderly care

Rehabilitation and long-term care are an important and necessary part of local and global healthcare services along with treatment, prevention of disease, and promotion of good health. The rehabilitation process helps the elderly who are experiencing cognitive decline through some kind of neurocognitive or neurodegenerative disorder become as independent as possible in activities of daily life. Many activities related to rehabilitation and long-term care have been getting benefits from using AI technology. Studies have shown that virtual therapy sessions using AI chatbots or virtual reality platforms have given promising results in providing accessible support to patients with cognitive impairments.[21] A good example is *Tessa*, a social, assistive robot developed by a Dutch startup company GKT, and designed to support people with early-to-moderate-stage dementia and other mild cognitive impairments. Studies have shown that the use of Tessa by care organisations saves physical minutes of care, up to 132 minutes per week.[22] According to Alzheimer Nederland, with the staff shortages in the health sector and the expected rise of people with dementia from 290.000 in 2021 to 620,00 people in 2050[23], use of AI-based health solutions like *Tessa* will

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[19] Rubio, "The Role of Artificial Intelligence in Personalised Medicine", online article by Rubio, https://www.laboratoriosrubio.com/en/ai-personalized-medicine/ [accessed on 4 October 2024]

[20] Marzia Di Marcantonio, Flavia Beccia, Alessandra Maio, Lili Wang, Wenya Wang, Walter Ricciardi, Stefania Boccia, „Personalised medicine in China: An overview of policies, programs, and actions in China", *World Medical and Health Policy*, 27 May 2024, https://doi.org/10.1002/wmh3.616, [accessed on 24 October 2024]

[21] Umamah bint Khalid et al, "Impact of AI-Powered Solutions in Rehabilitation Process: Recent Improvements and Future Trends", *International Journal of General Medicine*, 943-969, DOI: 10.2147/IJGM.S453903, https://doi.org/10.2147/IJGM.S453903, [last accessed on 11 October 2024]

[22] Rosa Elfering, *Adapting care robot Tessa for early-stage dementia: with implementation through general practitioners,* master thesis, March 2022, 5.

[23] Alzheimer Nederland, *Feiten en cijfers over dementie,* online article, February 2021, httttps://www.alzheimer-nederland.nl/dementie/feiten-en-cijfers-over-dementie , [last accessed on 11 October 2024].

become inevitable. The pilot study showed that care provision at a distance works well against loneliness that significantly impacts the quality of life of the elderly. The robot makes people feel less lonely, prompts them to eat again, take their medication on time, exercise more and become more active.[24] For robots to work with the elderly, they need to be much more like humans. Thus, engineers at the University of Tokyo have developed artificial skin for robots which is sensitive to pressure and temperature thanks to a large number of sensors. This E-skin, especially if AI-powered, opens the way for much more sensitive robots that would be capable of imitating more complex human actions. Skin-interfaced electronics is gradually changing rehabilitative medical practices and long-term care by enabling continuous and non-invasive tracking of physiological and biochemical information.[25]

We can agree that AI tools are already integrated into our healthcare set-up and will continue to improve its applications in health-related aspects. Similarly for rehabilitation and long-term care, AI is being employed for personalised treatment regimes, injury prevention, remote rehabilitation, patient monitoring, and the automation of many rehabilitation tasks. These technologies offer efficiency for practitioners, improve patient rehabilitation process, and enhance care access.

Automated work management processes

The application of AI in the healthcare industry has enabled faster and more efficient accessing, sifting through and analysing enormous volumes of health data - from health records and clinical studies to genetic information.

Healthcare workers spend a lot of time doing paperwork and other administrative tasks. AI and automation can help perform many of those mundane tasks, freeing up personnel time for other activities and giving them more time spent with patients. Hence, generative AI can help medical professionals with note-taking and content summarisation that can help keep medical records as thoroughly as possible. Promising AI-solutions, such as big data apps, machine learning and deep learning algorithms, can help humans analyse large data sets for better clinical and other decision-making. According

[24] Madeleine van de Wouw, "Meet 'Tessa' the little robot helper", *healthcare-in-Europe.com*, online article, 17 March 2021, https://healthcare-in-europe.com/en/news/meet-tessa-the-little-robot-helper.html, [last accessed on 11 October 2024].

[25] Changhao Xu, Samuel A. Solomon and Wei Gao, "Artificial Intelligence-powered electronic skin", *Nat Mach Intell,* 5, 1344-1355, 2023, https://doi.org/10.1038/s42256-023-00760-z, [last accessed on 11 October 2024].

to Edgeworth, AI is focused on giving flexibility and assigning staffing to patient volume to create additional capacity and efficiencies.[26]

AI might also help with accurate coding and sharing of information between departments and in medical insurance claims processing. Insurance companies worldwide have had to deal with an unexpected surge in health and medical claims in recent times. The overwhelming increase in the data flow from healthcare systems has led to numerous operational issues, further aggravated by inadequate human resources to handle the necessary paperwork. The delays and human errors caused by stressed workflows have disrupted timely and efficient claims settlement. According to WNS study, AI can enable the extraction of patient information from documents with unmatched speed and precision. AI platforms could process unstructured data generated during customer interactions and convert it into a structured format.[27]

The autonomous systems have shown how to turn weaknesses in healthcare, such as reduction of workforce, into strengths.

Innovation in Medical Science to boost Economic growth

Innovative approach to healthcare largely influences the economic potentials and challenges any country is bound to face with a fast increase of chronic diseases, an aging population, lack of funds, and shortage of hospital staff. To prove the fact, Chinese researchers have developed an AI hospital town, similar to Stanford's AI town, featuring virtual patients treated by AI doctors, which are designed to autonomously evolve and improve their medical expertise. According to the team, AI doctors can treat 10.000 patients in just a few days, a task that would take human doctors at least two years. Such treatment in a simulated environment helps AI doctors further evolve and improve their ability to treat disease.[28]According to Liu, the potential for high-quality, affordable and convenient healthcare services for the public is

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[26] Dave Fornell, "AI takes on hospital staffing to help battle burnout", *Health Exec,* 25 September 2023, https://healthexec.com/topics/healthcare-management/healthcare-staffing/ai-optimizes-hospital-staffing , [last accessed on 13 October 2024]

[27] WNS Triange, „Intelligent Automation Transforms Claims Processing for a Leading US Insurer", online article, https://www.wns.com/perspectives/case-studies/casestudydetail/1011/transforming-claims-processing-with-intelligent-automation [last accessed on 13 October 2024].

[28] Ursula O'Sullivan-Dale, "World's first AI hospital with virtual doctors opens in China", *Robotics and Automation,* online article, 30 May 2024, https://www.roboticsandautomationmagazine.co.uk/news/healthcare/worlds-first-ai-hospital-with-virtual-doctors-opens-in-china.html [accessed on 5 October 2024]

on the horizon, as the diagnostic capabilities of AI doctors evolve from the virtual world to the real world.[29]

We can say that economic growth depends very much on health improvements achieved through medical AI-powered innovations. According to Omran's five-stages epidemiological transition theory, positive impact of AI-based innovative healthcare on economic growth is observed in countries that have surpassed the 2nd stage and still have not reached the 4th stage. In other words, with fast development of innovative medical technology life expectancy is rising, influencing the workforce growth (decline in degenerative, stress and man made diseases).[30] However, with the negative demographic picture, mortality rising, birth rates declining, the world has faced a serious reduction of manpower including health sector, while retaining the same or increased economic demands. AI systems have proven very beneficial in making a fine balance between the need for capable workforce and expected economic growth.

Risks of AI

In previous chapters we have established that AI has the potential to make substantial progress toward the goal of making healthcare more personalised, predictive, preventive, and interactive. However, many challenges can be identified on that innovative path. Primarily, AI-based healthcare systems raise concerns regarding data security and privacy. There is an ongoing debate about how far artificial intelligence may be utilised ethically in healthcare settings since there are no universal guidelines for its use. Additionally, maintaining the confidentiality of medical records is crucial. In the context of application of AI in diagnostics and treatment with harmful outcome for the patient's life and health, the question of fault-based liability arises. All these questions represent a valid concern and deserve further study and elaboration.

Black-box effect and false representatives

Inspired by the theory of human intelligence, AI creators and designers have used the same pattern to operate this autonomous system. The problem

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[29] Xu Keyue and Du Qiongfang, "China's first AI hospital town debuts", *Global Times*, online article, 29 May 2024, https://www.globaltimes.cn/page/202405/1313235.shtml, [accessed on 5 October 2024]

[30] Michael Kuhn, Antonio Minniti, Klaus Prettner and Francesco Venturini, "Medical innovation, life expectancy, and economic growth", 7 May 2024, https://dx.doi.org/10.2139/ssrn.4491818, [last accessed on 13 October 2024]

arises when deep learning system produces unwanted outcomes detrimental to human life and health, leaving the cause intractable. This inability to decipher the inner operations of deep learning systems is known as the "black box problem". Since the system is learning empirically, it is very unlikely that it can be trained on data that cover every single situation. This problem of robustness of the AI system deeply affects the sense of trust in the system in the context of safety. Additionally, the application of AI in healthcare can reflect unwanted biases from out human world, adding an ethical dimension to the already recognised problem. If a human is needed to feed the system with necessary training data, there is a very high risk of manipulative input of data, resulting in false positive or negative outcome. Such moral and legal challenges have triggered two suggestive approaches. According to prof. Rawashdeh, the primary solution is to put a label of risk on high-stakes applications.[31] This could prohibit the use of deep learning systems in areas where the potential for harm is high, including some healthcare areas. The second approach is to try to decipher the internal operations of the system. According to AI experts, creating "explainable AI" is very much an emerging field, but computer scientists have already been working on it for quite some time. The resolving options include either involving classical data science methods that look for correlations or involving bigger neural nets, or neural nets with side tasks, so that data visualisation is created.

Difficulty in Establishing Liability

AI systems pose a significant challenge to fault-based medical liability principle. It is a general rule that in case of damage sustained due to medical error the burden of proof lies on the injured party. Henceforth, the injured party is required to prove the facts that form the minimally required factual content of the legal rule upon which their claim is based. According to the fault-based principle, they must prove the specific human error in the use of the AI system, and who committed it, and the causal link between the error, the output of the AI system and the damage sustained.

On the one hand side, this fault principle provides sufficient protection of the patient as it imposes increased duties of care on the physician/hospital in relation to the autonomous system (AI). However, the particular characteristics of AI (learning ability, non-transparency, limited predictability, openness) represent a huge evidentiary obstacle for the injured party. In addition,

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[31] Lou Blouin, "AI's mysterious 'black box' problem, explained", *UMD News*, 6 March 2023, https://umdearborn.edu/news/ais-mysterious-black-box-problem-explained, [last accessed on 13 October 2024]

it is very difficult to accurately separate the areas of responsibility of the various subjects associated with the autonomous system (AI) in question. Having in mind that the injured party (patient) has an obvious knowledge deficit in relation to both medical and technical matters, they cannot adequately meet the burden of proof principle risking to lose the suit. As Maroudas suggested, to bypass such an unfavourable legal obstacle, a possible solution could be replacing the purely subjective fault principle with liability for a presumed fault, leaving to the plaintiff (physician/hospital) to prove otherwise, having the necessary medical knowledge and access to technical resources that provoked the error that eventually led to harmful outcome.[32]

Ethicality of Disposing of personal data to feed the AI System

Massive datasets are required for ML and DL models to generate more refined and accurate algorithms, and healthcare sector has proven very complex in terms of information accessibility. Since patient records are often regarded as confidential, institutions are very reluctant to exchange health data. Patient consent is a key component of data privacy issues since medical professionals may allow wide usage of patient information for AI research and learning without requiring specific patient approval. In 2015 Google's AI firm DeepMind was given the personal records of 1.6 million patients at the Royal Free London NHS Foundation Trust, to construct its algorithm, the Streams, an application with an algorithm for treating patients with acute renal impairments, which came under heavy criticism.[33] Google Project Nightingale also stirred a lot of commotion when partnered with Ascension, the second largest health system in the United States, and gained access to over 50 million patients' medical records without any prior knowledge of Ascension health care providers or consent of the patients.[34]

In order to prevent patient data abuse and further breaches of personal data privacy regulations, WHO spent 18 months deliberating with leading experts in ethics, digital technology, law, and human rights and various Ministries of Health members to produce an Ethics and Governance of Artificial

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[32] Vasileios P. Maroudas, "Fault-Based Liability for Medical Malpractice in the Age of Artificial Intelligence: A Comparative Analysis of German and Greek Medical Liability Law in View of the Challenges Posed by AI Systems", *Review of European and Comparative Law,* vol. 57, no. 2, June 2024, 135-169,

[33] Bangul Khan, Hajira Fatima, Ayatullah Qureshi, Sanjay Kumar, Abdul Hannan, Jawad Hussain, Saad Abdullah, "Drawback of Artificial Intelligence and Their Potential Solutions in the Healthcare Sector", *Biomedical Materials and Devices,*8 February 2023, https.//doi.org/10.1007/s44174-023-00063-2, [last accessed on 13 October 2024].

[34] Kate Brush, "Project Nightingale", *TechTarget*, February 2020, https://www.techtarget.com/searchhealthit/definition/Project-Nightingale , [last accessed on 13 October 2024]

Intelligence for Health Guidance. This Guidance identifies ethical challenges to using AI in healthcare, identifies risks, and outlines six consensus principles to ensure AI works for the benefit of the public: protecting autonomy, promoting human safety and well-being, ensuring transparency, fostering accountability, ensuring equity and promoting tools that are responsive and sustainable. The WHO Guidance also provides recommendations that ensure governing AI for healthcare both maximises the promise of the technology and holds all stakeholders accountable and responsive to the healthcare workers who will rely on these technologies and the communities and individuals whose health will be affected by its use.[35]

As of 2018 European regulatory bodies have offered a set of laws restricting uncontrolled collection, use, and sharing of personal information. However, user data is needed for further development of AI applications. This can be obtained by working better with users, properly regulating permission for data sharing in the process, and working on responsible data concepts.

AI-based healthcare in Bosnia and Herzegovina

Bosnia and Herzegovina has still not been recognised as a strategic partner in the field of development of innovative technologies and AI in healthcare industry, in spite of its global recognition. National experts agree that digital transformation of medical data without which it would be impossible to apply AI technologies in the health sector must become a strategic goal of Bosnia and Herzegovina. Although one of the least developed countries in Europe, Bosnia and Herzegovina has a potential for innovation and digital transformation. BiH bioengineers and IT experts are already recognised among members of the international scientific community, as leading BiH experts in the fields of AI and clinical engineering. Their studies have been published by renowned scientific journals, such as MT Medizintechnik, Psychiatria Danubina, Technological Healthcare, Biomedical Signal Processing and Control, or BMC Medical Genomics. Recently, AI experts from Verlab Institute in Sarajevo have been engaged in a WHO-funded project on AI-powered computerised systems that will in future operate medical devices.[36]

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[35] WHO, *Ethics and Governance of Artificial Intelligence for Health: WHO Guidance,* Geneva, WHO, 2021;

[36] Alen Bajramović, "Sarajevo domaćin dvije međunarodne konferencije: vještačka inteligencija je alat koji će u mnogim oblastima donijeti revoluciju", *Avaz,* 27.8.2023, https://avaz.ba/vijesti/bih/851839/sarajevo-domacin-dvije-medjunarodne-konferencije-vjestacka-inteligencija-je-alat-koji-ce-u-mnogim-oblastima-donijeti-revoluciju , [last accessed on 14 October 2024].

BiH medical and IT sectors are aware that AI is a tool that will revolutionise many fields, including medicine, by significantly enhancing processes that require numerous repeatings. According to Gurbeta Pokvić, advanced data analytics is an advantage of AI. It can recognise data patterns which human limited cognitive capacities cannot.[37]

For now, national health sector is experiencing certain ethical constraints for the application of AI, but there is an obvious breakthrough in the field of medical diagnostics, due to personalised approach. Even in Bosnia and Herzegovina, COVID 19 pandemics has proven the importance of medical technologies. It is necessary to establish evidence-based management of all devices, to individualise their approach since devices are not used under same conditions and at the same dynamics, which greatly affects their characteristics and performance. Gurbeta-Pokvić strongly believes that AI will never be able to replace a human physician but will help him consider many more factors when establishing diagnosis or treatment.[38]

There are many undefined ethical and regulatory issues related to the application of AI in the BiH healthcare system, which must be accorded with the European ethical and legal standards on the application of tools based on AI.

Bosnia and Herzegovina is legging behind Europe and the region in the process of development of AI technologies and their application in medicine, and it is necessary to expedite the process of digital transformation with decision makers giving their unconditional support.

In September 2023, Bosnia and Herzegovina hosted a world congress on medical and biological engineering gathering more than 300 experts and other interlocutors from the fields of digitalisation, healthcare, AI and innovations. Representatives of WHO shared information on trends in the application of AI-powered medical devices. There were also talks about the first European AI Act. Studies have shown that in the next 10 years, generative AI will help GDP growth by 7%. This means that AI should not be treated as an enemy as long as it is well regulated.[39]

Introduction of AI into BiH health sector requires time, infrastructure, trained medical staff and regulatory framework in order to secure safe and efficient usage. Having in mind fast technology advancement and global tendencies, it is expected that AI will become a global trend in this region in

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[37] A. Badnjević, H. Avdihodžić, L. Gurbeta Pokvić, "Artificial Intelligence in Medical Devices: Past, Present, and Future", *Psychiatria Danubina*, volume 33, no. 3, 2021, 336-341, https://hrcak.srce.hr/file/374406, [last accessed on 14 October 2024].

[38] *Ibid.*

[39] Almir Badnjević, Lejla Gurbeta Pokvić (eds.), *MEDICON '23 and CMBEBiH '23,* IFMBE Proceedings, 93, Springer, 2024,

order to enhance healthcare, reduce costs and increase high-quality health-care service.

The application of AI largely depends on the availability and quality of digital data. Data digitalisation is a key assumption for successful implementation of AI in healthcare. Hence, the application of AI in the health sector would not be possible without prior digitalisation and creation of digital infrastructure for storage, management and exchange of data.

BiH is far below European standard and is facing a series of challenges in the process of digital transformation of medical data. On the one hand side, creating and according regulatory framework on digital transformation, providing harmonisation and protection, is seen as a serious challenge. There is a limited access to technology and internet, especially in rural and less developed areas, resulting in unequal access to digital services. A study on digital transformation in BiH has shown that many companies did not transfer to digital technologies due to lack of personnel skills, and high financial investments that were required.[40] In order to successfully deal with these challenges comprehensive policies, significant funds and strategic initiatives that would support digital transformation process in BiH, are needed.

Finally, a global migration trend has also affected the health sector in Bosnia and Herzegovina. Currently, there is a significant rise in number of foreign students of medicine in Bosnia and Herzegovina (e.g. Turkey, India, Pakistan, Syria). Their professional future has not been determined yet, but many of them are looking forward to staying and practicing in Bosnia and Herzegovina. Looking long-term, new healthcare visions are bound to influence the traditional concept of treatment, which either may expedite the process of medernisation of medicine or slow it down, giving advantage to complementary/adjuvant healthcare protection.

AI-based healthcare in Montenegro

The application of AI in healthcare is at its beginning, but its potential is enormous. With a fast advancement of the AI technology, greater integrations of AI in all aspects of healthcare, from prevention to rehabilitation, could be expected in near future. Like other developing countries, Montenegro is ready to invest into technological development and education in order to exploit all the advantages of AI. Having in mind all the challenges that Montenegrin healthcare system has been experiencing, such as long waiting

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[40] Darijo Jerković, Tanja Gavrić, Jelena Ljubas Ćurak, "Digital Transformation in Bosnia and Herzegovina Companies:Analysis of the Degree of Integration and Impact on Business", *Economy and Market Communication Review,* vol. XIV, no. 1, 2024, 116-139.

lists and limited resources, AI could be playing a key role in enhancing efficacy and quality of healthcare service.

With proper streaming, AI could not only accelerate medical research but also reduce costs of healthcare protection, enabling wider distribution of quality care. AI in healthcare cannot be seen solely as the technology of the future, but as an integral part of the current transformations of the health sector.

As part of the project "AI4Healthcare: Promotiving Medical Excellence through AI" Montenegrin AI Association (MAIA) has launched an educational programme for students of medicine and practitioners in the field of intelligent specialisation in Montenegro. The aim of the programme is to offer to participants knowledge on the application of AI in medicine. The educational programme is followed by a conference on the potentials of application of AI technology into healthcare of Montenegro. It is the first project of a kind in Montenegro and should represent the basis for further education and implementation of AI systems into health sector.[41]

Reflecting on the distopian representation of AI technology in works of SF, the Montenegrin general public has initially been very sceptical of introducing AI into the health sector. Thus, a series of articles have warned of the side effects of integration of AI technologies in the medical sector. It is taken for a fact that certain fields of medicine are predestined for automation and efficacy improvement, such as radiology, pathology and dermatology. Illustratively explained, IBM Watson offers equally good services like an average radiologist by possessing the capacity to analyse an image and define diagnosis of the patient. Furthermore, Watson can do the analysis faster than any human by disposing of a greater amount of information.[42]

Montenegrin government has recognised a growing tendency of digitalisation of many spheres of life, including medicine. As part of the project "E-services and digital infrastructure as an answer to COVID19" financed by EU, and realised in partnership with UNDP and Ministry of public administration, a Meet up was organised dealing with "The influence of AI on everyday life" in Podgorica. The MN government is interested in providing safe, ethical and responsible use of AI. The participants were informed about the basics of AI, ethics and trust, public and information safety, and abuse

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[41] MAIA, *AI4healthcare,* brochure, October 2024, https://www.ucg.ac.me/skladiste/blog_1285/objava_170360/fajlovi/AI4Healthcare%20-%20Bro%C5%A1ura.pdf, [last accessed on 14 October 2024].

[42] Enterpreneur, "Vještačka inteligencija preuzima i dobro plaćene poslove u oblasti finansija, prava, medicine", *bankar.me*, 8 September 2017, https://bankar.me/vestacka-inteligencija-preuzima-i-dobro-placene-poslove-u-oblasti-finansija-prava-medicine/, [last accessed on 14 October 2024]

and resposiblity of the use of AI. This project resulted in a strategic plan that defined the road to development of AI in MN.

In September 2024, Montenegrin Ministry of Health presented to the general public a draft National Strategy for the Development of E-health 2024-2028, and the subsequent Action plan 2024-2025. The Stategy has foreseen several measures and initiatives that will modernise Montenegrin healthcare system, make it more efficient and accessible to its citizens. Digital transformation has been marked as a top priority for the MN government, in hope for improvement of general health. The Strategy supports reform of primary healthcare protection. This means that by introducing a modern integrated information system, better accessability and improvement of quality of healthcare services will be provided, including reduction of complex red tape for the physician. In the sphere of pharmacy, the Strategy shell introduce rationalisation and control of drugs usage, which corresponds to ensuring a stable and accessable healthcare system for all citizens.[43]

We can say that Montenegro has easily identified great benefits from digital transformation and integration of AI in healthcare. These benefits include better accessability and quality healthcare service, and reduction of complex red tape, which is forcing physicians to spend less time with patients and more time filling in forms. The application of AI systems in Montenegrin health sector is followed by certain risks and challenges which can be bypassed only through education and proper regulation.

The questions remains, whether Montenegro will be able to provide sufficient human and financial resources for the modernisation of healthcare based on AI technologies or it will let AI companies take over the healthcare market and eventually succumb to E-doctor platforms more affordable to patients.

Conclusion

Looking ahead, the future of AI in the medical field appears bright, with the rapid advancement of artificial intelligence technology. We cannot deny that AI healthcare can surpass human physiological and intellectual limits in certain aspects, enhancing the precision and efficiency of healthcare services. However, one thing is certain – AI can never replace humans. In medical practice, uncertainty is the norm, with each healthy individual and patient being unique. Even if they have the same disease, the course of the

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[43] Vlada Crne Gore, *Nacionalna strategija razvoja digitalnog zdravlja, 2024-2028*, septembar 2024, https://www.gov.me/clanak/nacionalna-strategija-razvoja-digitalnog-zdravlja-2024-2028, [last accessed on 14 October 2024].

disease, as well as psychological and sociological characteristics of the patient, varies significantly. These uncertain events ultimately need to be handled by humans. Medicine is a humane science, while AI healthcare remains "cold". It cannot provide personalised care and compassion. Moreover, any legal responsibilities that may arise during the treatment process should be borne by real human doctors. Socially engaged literature, especially SF, provides an insight into the prospective dystopian future of AI-based healthcare if not controlled by a human. Another rising challenge is the migration trend that strongly affects the current nationalised healthcare service, which is bound to change if foreign medical professionals decide to remain in the country of education (Bosnia and Herzegovina). That could transform the traditional concept of healthcare provision, prevention, diagnostics, treatment and rehabilitation. Unequal opportunities for investment in the modernisation of the healthcare sector, could additionally divide the world into countries that can offer highly advanced medical service to their citizens (France, Germany, US, China) and those countries that cannot afford AI-based healthcare (Montenegro), leaving their citizens to the uncertainties of low-quality E-healthcare systems.

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