

An Investigation into the State of the Art and Perspective for Medical Field in Reference with Artificial Intelligence

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Abstract

Scientists have been spurred by advances in computer innovation to build programs to aid physicians in making important decisions without contacting experts directly. Computer programming makes use of human intellectual abilities, including thinking, decision-making, and learning, among others. Although AI is not a novel idea, it has recently gained acceptance as a new computer engineering technique. It has been used in a variety of fields, including academia, commerce, medicine, and industry. The promise of AI approaches, especially for web-based clinical uses, is explored in this research. Also offered is a paradigm for web-based clinical diagnosis as well as forecasting. The lack of medical specialists in most growing nations has increased the fatality of individuals suffering from numerous ailments. The paper discusses the current trends in medicine and how Artificial Intelligence is being used to give better outcomes to patients.

Keywords: Artificial Intelligence (AI), Application of AI, Current Trends in AI/ Machine Learning (ML).

1. INTRODUCTION

Currently, Artificial Intelligence technologies have made vast impacts in the medical sector, making an intense discussion on if Artificial Intelligence clinicians would sometimes substitute human clinicians. Human doctors, people think, will not be substituted by computers in the near upcoming. Still, Artificial Intelligence may surely assist physicians in making much better clinical judgments or even substitute human expertise in some fields of health care [1], [2]. The current actual practices of Artificial Intelligence in health care have been made possible by the increasing accessibility of health records and the speedy advancement of immense data analysis methodologies.

Advanced Artificial Intelligence algorithms may reveal medically important knowledge buried in vast quantities of information, which can support medical judgment when directed by medical findings queries.

In the medical journals, the assistances of Artificial Intelligence have been completely studied. Artificial Intelligence can 'learn' characteristics from a big sum of health records using complex algorithms and then utilise the results to aid clinical practice[3].

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It might also include learning and self-correcting competencies to enhance reliability depending on the input. Physicians might take advantage of Artificial Intelligence technologies that deliver up-to-date clinical information from journals, textbooks, and medical care to assist them in providing successful patient care. Additionally, an Artificial Intelligence system may support the decrease of diagnostic and treatment mistakes [4], which are inevitable in human medical practice. Additionally, an Artificial Intelligence approach assembles usable information from a huge populace of patients to help in developing real-time conclusions for health hazard warnings besides forecasts.

Healthcare Data

Before Artificial Intelligence technologies are used in healthcare, they must first be 'educated' using data produced by clinical operations, including scanning, diagnosis, and therapy administration, to understand comparable groups of patients, relationships between patient traits, and desired results[5]. Such clinical evidence might take the form of medical reports, demographics, electronic records from medical equipment, physical exams, clinical laboratory tests, and photographs, among other things.

A significant %age of the Artificial Intelligence literature examines data from diagnostic imaging, genetic analysis, including electrodiagnosis at the early stages of the disease. Jha and Topol, for instance, recommended radiologists to use Artificial Intelligence technology when analysing diagnostic pictures that include a lot of data[6]

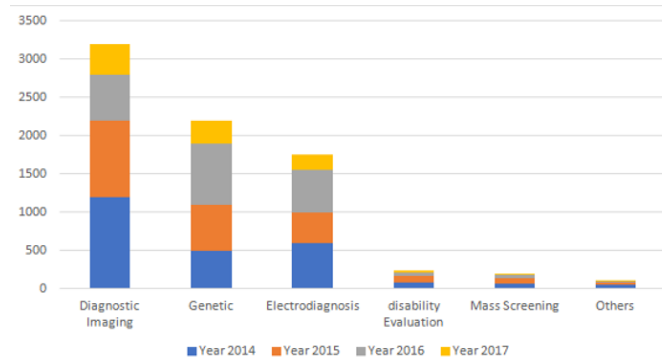


Figure 1: The data kinds that have been examined in AI research.

Another two key data streams are clinical assessment records and clinical laboratory findings. They differ from image, genetic, and electrophysiological (EP) information because they include huge amounts of unorganized descriptive materials, including medical documentation, that cannot be immediately analysed[7]. As a result, the associated Artificial Intelligence systems initially concentrate on turning unorganized text into machine-readable electronic medical records. Karakulah, for instance, employed Artificial Intelligence to extract phenotypic traits from published studies to improve the reliability of fetal anomaly detection.

Artificial Intelligence Tools

As per the preceding explanation, Artificial Intelligence

tools may be separated into two collections. ML approaches that assess organized information as genomics, imaging, and electrophysiological data fall under the first group. ML algorithms seek to cluster individuals' features in medical uses or estimate the likelihood of ill consequences. NLP technologies, which pull data from formless medical notes or medical journals to accompany and enhance structured medical data, fall under the second group. Natural language processing processes aim to convert texts into machine-readable structured information that may subsequently be analysed using ML approaches [8].

The flow chart in figure 2 depicts the path from medical information production to medical decision making, including Natural language processing data enhancement and machine learning data processing [7]. The route plan, we see, begins and finishes with clinical actions. As strong as they are, Artificial Intelligence approaches must be driven by clinical concerns and used to aid clinical practice in the end.



Figure 2: The path from medical information creation through data augmentation via natural language processing, ML data analysis, and clinical decision-making. EMR stands for electronic medical record, while EP stands for electrophysiological.

Disease Emphasis

Notwithstanding the growing body of Artificial Intelligence study in medical, it is mostly focused on three ailment forms: cancer, nervous systems illness, and cardiovascular ailment. We'll go through a few instances below.

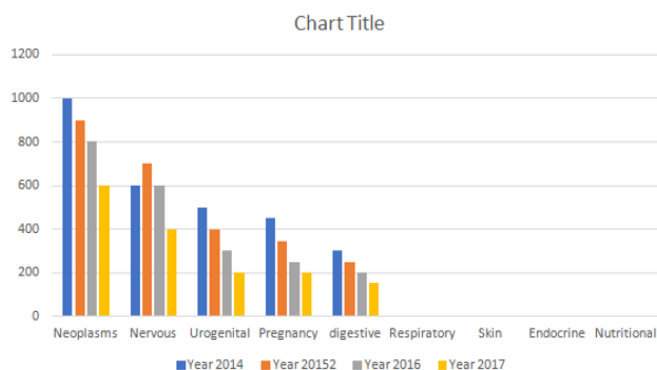


Figure 3: In the Artificial Intelligence literature, the top ten illness kinds are examined.

2. CURRENT TRENDS IN MEDICAL AI

Apart from establishing greater performance, innovative healthcare technology should also blend with established procedures, get governmental permission, and, maybe most crucially, persuade medical professionals and patients to engage in a novel worldview. As a result of these difficulties, a number of new Artificial Intelligence studies and acceptance initiatives have emerged.

Artificial Intelligence Excels at Jobs that are Well-Defined.

The emphasis of research has been on tasks in which Artificial Intelligence can successfully show its competence in comparison to a qualified practitioner. These jobs often have well-defined inputs as well as a binary result that can be readily verified. A digital image is used to assess suspected skin lesions, as well as the outcome is a basic binary classifier: benign or malignant[9]. Researchers just required to show that Artificial Intelligence had better specificity and sensitivity than dermatologists when categorising hitherto viewed photos of biopsy-validated lesions under such settings.

AI, Not Replaced By it Support Doctors

Because robots exhibit human characteristics, including sympathy and compassion, patients must think that human doctors supervise discussions. Additionally, patients cannot be supposed to trust artificial intelligence since it is a science that is fraught with scepticism. As a consequence, Artificial Intelligence is often used to undertake activities that are essential but restricted in possibility, leaving the main duty for patient treatment to a human doctor[10]. Clinical research is now underway to see whether AI can compute board regions for top and bottom radiation more exactly and faster than an individual. Although an interventional radiologist is still giving the medication, Artificial Intelligence plays a key role in protecting the patient from hazardous radiation.

AI Helps Under-Resourced Services

Because a single Artificial Intelligence system can sustain a vast populace, it is well adapted to circumstances where human knowledge is in short supply. There is a scarcity of

radiological competence in many places where tuberculosis is common. Radiographs uploaded from such centres may be evaluated by a single centralized system using Artificial Intelligence; according to recent research, Artificial Intelligence properly detects pulmonary tuberculosis with a sensitivity of 95 % and a specificity of 100 % [11]. Additionally, under-resourced activities with unpleasant latencies for patients appeal to Artificial Intelligence in the form of triage systems.

Artificial Intelligence is a Choosy Eater

Machine learning techniques need well-structured learning data regarding a phenomenon that is generally relatively stable to be developed. A deviation from this leads to 'over-fitting,' in which Artificial Intelligence attaches disproportionate weight to false correlations in previous data. In the year 2008, Google used solely the search phrases submitted into its web browser to forecast the periodic occurrence of influenza [12]. Since folk's search patterns vary substantially with each year, the model proved to be so inaccurate in forecasting the future than it has been swiftly phased out. Furthermore, data that has been anonymized and digitised at the origin is desirable since it promotes research and development.

3. EMERGENCE OF ARTIFICIAL INTELLIGENCE IN THE MEDICAL FIELD

Digitalization is altering healthcare, as it does in other industries, by allowing individuals to get convenient, inexpensive, and high-quality treatment. Thanks to Artificial intelligence technology, many nations are making headway in shifting their heritage models from physician-centric to patient-centric. Because of Artificial intelligence, the healthcare industry is experiencing tremendous change throughout the world. The following are among some of the aspects that are influencing this revolution:

Diagnosis

Artificial Intelligence has already been used to identify severe illnesses such as cancer in a few hospitals. This is useful since it improves the accuracy of early detection of the problem. Enlitic, a medical imaging firm located in the United States, is employing machine learning for tumour identification; their algorithms were developed to identify tumours in human lungs using a Computed Tomography (CT) scan.

Data Mining

Data mining of health information is now using Artificial Intelligence. IBM Watson Health is assisting healthcare companies in using cognitive technologies to unlock massive volumes of health data to improve diagnostic accuracy.

Health Assistants And Personal Trainers

Chatbots powered by artificial intelligence are being employed as health aides and fitness trainers. Arranging medical visits, delivering medicine reminders, and detecting the ailment based on indications are just a few of the

applications of chatbots in healthcare[13]. Well-known Artificial Intelligence-powered medical assistance software, such as Babylon Health and Your MD, aid doctors, patients, and caregivers in the functions mentioned above.

Surgical Robots

Numerous technological firms are presently developing Artificial Intelligence-powered surgical robots, using the skills of ML programmes such as Google DeepMind, IBM Watson, and others. The use of AI-enabled robots may result in less harm, improved accuracy, as well as faster restoration.

Drug Discovery

Drug research is another area where Artificial Intelligence is being more widely used. Helix, a ML start-up, employs ML to reply to conversational inquiries and demands, allowing researchers to boost productivity, enhance lab security, keep current on important research subjects, and handle inventories.

Drug Design

Because of Artificial Intelligence, medication development and chemical selection can now be computerized. Peptone predicts protein traits and features using artificial intelligence and Keras and TensorFlow interface, allowing researchers to simplify protein development, identify manufacturing and characterisation challenges, and uncover unique protein characteristics.

Clinical Trials

GNS Healthcare, which employs artificial intelligence to translate varied streams of biological and healthcare information into computer simulations, is one example of how artificial intelligence is frequently employed in clinical trials[14]. The models let physicians to predict how patients will respond to therapies depending on their traits, allowing for tailored medication and therapy to be delivered at scale.

4. ARTIFICIAL INTELLIGENCE IN HEALTH CARE SYSTEM: CHALLENGES AND OPPORTUNITIES

To improve the accuracy of Artificial Intelligence-assisted diagnosis, the industry should construct systems for each specialised field that use ML algorithms and many instances containing cultural and ethnic knowledge from patients. As additional learning examples are contributed by healthcare academics and practitioners, Artificial Intelligence systems like these may get wiser. Medical Artificial Intelligence systems' influence, like any other new technological application, has both utopian and dystopian components. Numerous great possibilities to cure infections more efficiently, offer higher quality of care and patient outcomes, inspire patients' involvement in the primary treatment, lessen healthcare inaccuracies and healthcare expenses, and enhance care providers' organisational effectiveness are included in the utopian point of view[15]. The dystopian viewpoint, on the other hand, brings with it a slew of additional obstacles. The growing use of patient data

for analytics may generate cybersecurity worries about security and privacy, medical error liability, and the possibility of job loss. Researchers feel that a few of the primary favourable and unfavourable concerns associated with the use of Artificial Intelligence-based innovations should be investigated to ensure that Artificial Intelligence is used wisely and widely in the healthcare business.

4.1. Artificial Intelligence Applications Possibilities

The growing deployment of Artificial Intelligence-based technology in the healthcare business has created many new prospects. Here are a few of the more essential ones.

4.1.1. Disease Remedies that are More Effective

The debut of IBM Watson was a watershed point in the era of data-driven medical study, piqued national benefit in the advantages of sophisticated digital technologies in improving public healthcare and patient safety quality. Sophisticated technology is becoming vital in complementing medical professionals in practically every aspect of patient therapy, as mentioned in the real-world instances of Artificial Intelligence uses in healthcare.

4.1.2. Increased Patient Involvement and Commitment

It's among the most famous smartphone-based healthcare counselling applications. "Companies work with clients all around the world to assist them in developing healthy habits, lowering their chances of chronic health issues, correct illness, and form stronger connections with themselves in the process," the firm says. The essential to attaining the objectives put out by an individual utilising this mentoring app is complete commitment to the programme. For proper illness diagnosis and patient protection, patient engagement in the medical care procedure is critical[16]. Furthermore, patients see their involvement in meetings with medical personnel as a worthwhile and rewarding event in and of itself. When patients are allowed to engage in their medical care, they are more likely to be completely involved in performing out their portion of the procedure, which improves their contentment with the level of care.

4.1.3. Enhanced Healthcare Service Quality As Well As Error Reduction

As a result, Artificial Intelligence technologies assist clinicians in removing troublesome tiny polyps that might lead to potential difficulties, increasing care delivery, and minimising the risk of medical errors. A study group at the "University of Tokyo Medical School " revealed the creation of an Intelligence framework based on novel algorithms and order parameters was revealed by a study group at the "University of Tokyo Medical School". The best success rate observed whenever this method was combined with a deep-learning Artificial Intelligence medical software was 83.5 % when deployed to a representative patient group. The prediction accuracy climbed to 87.3 % once the technology was reconnected with a deep-learning plus decision tree Artificial Intelligence system[17]. Recently emerging smart Artificial Intelligence systems may lower mistake rates much further, and they are predicted to

increase the quality of care services even more. Radiologists are often mentioned as the medical professionals most likely to be supplanted by Artificial Intelligence. This forecast is centred on the notion that a radiologist can view 50–100 X-rays each day, but an Artificial Intelligence-assisted computer can read 10–100 times as many. Additionally, the Artificial Intelligence system's efficiency is greater than that of radiologists.

4.1.4. Increased Operational Effectiveness and Cost Savings in the Medical Field

As previously said, AI-assisted medical systems can undertake a wide range of diagnostic tasks without the need for human participation. For example, an AI-enabled pill-cam may be used to screen for stomach cancer instead of the time-consuming standard upper endoscopy. Escalante demonstrated an innovative AI-based approach for evaluating the features of bone marrow structure in order to identify acute leukaemia, which might potentially replace expensive conventional treatments. All of these artificial intelligence technologies help to make diagnosis and treatment far more efficient and cost effective. Artificial intelligence (AI) technologies aren't just for medical use. Some Artificial intelligence solutions are built to help operational improvements that add or generate worth in a healthcare organization's value chain. Regular administrative duties, such as maintaining accounting, maintenance systems, and informed enquiry, are considerably better and quicker performed by Artificial intelligence systems than by human employees. Chatbots and nursing robots with artificial intelligence may considerably increase the effectiveness of administrative activities.

4.1.5. Productivity Gains and the Creation of New Jobs

Will Artificial intelligence and robotics eventually take over all that people do now? From the first through the 4th Industrial Revolutions, the background and progress of industrial growth have revealed that although many repetitive manual tasks were displaced by technology, numerous new jobs were developed to sustain productivity growth[18]. Although the hard-copy printing industry has declined significantly, new digital editing employment, including typography, has emerged. Several map publishers have shut their doors, but many new professions in navigation and geographic information systems have been established.

4.1.6. Healthcare Costs are Lower

The ultimate health system would comprise information plus evidence-based illness control, diagnosis, and medication using the most up-to-date technology, patient-centric personalised care, including high-quality care delivered with empathy by medical personnel. If Artificial Intelligence can be used widely to assist such an idealized upkeep facility, it may aid ensure both high-quality care and considerable cost savings. As per a survey by ABI Research, a marketing analytics advisory organisation, smart Artificial

Intelligence implementations in the healthcare business might save the US \$52 billion by 2021. According to ABI Research, prominent hospitals in the United States and Israel are already using Artificial Intelligence-based illness deterrence programmes[19]. In these two nations, the number of Artificial Intelligence-based tools for patient exercise to avoid chronic illnesses is predicted to rise from 53,000 in 2017 to over 3.1 million by 2021, a 176 % yearly growth. As a result, Artificial Intelligence implementations can be a huge player for lowering medical expenses, not just for individuals but for culture as a whole. These resources might be allocated to illness control at the national scale, improving the standard of life for all inhabitants.

4.2. The Difficulties of Artificial Intelligence Technologies

Although Artificial Intelligence applications provide new chances to enhance people's lives, they also provide new issues that must be carefully addressed. Since human lives are on the line, the problems are particularly formidable in the healthcare industry. The following are among the difficulties that must be addressed with understanding.

4.2.1. System Usage Responsibility

Whenever a Tesla Model S autonomous vehicle malfunctioned on May 7, 2016, killing a person, a huge debate arose: "Who really should be held responsible for the disaster?" Who must be held accountable if medical professionals employed Artificial Intelligence-based technology for patient care and an accident or mistake happened? Artificial intelligence programmes are built on a collection of ML algorithms created by humans. Hospital managers chose the system with the support of technology specialists or advisors and medical professionals because of its broad application possibilities. A hospital's medical staff used the system to give essential treatment for a patient. Why would the system design company, hospital, or medical personnel bear accountability for the problem? This is a challenging subject to answer since it touches on various technological, managerial, and ethical concerns. Even though Artificial Intelligence-related technologies are constantly evolving and their implementations are becoming more prevalent, there has been comparatively little study on the moral considerations of Artificial Intelligence[20]. According to Dr. Stephen Hawking, the world is rapidly nearing a stage when human power will be out of command due to the rapid expansion of Artificial Intelligence and smart robots. He also urged that a new global governing organisation be established to oversee the usage of Artificial Intelligence [21]. Lupton underlined the need of developing moral and ethical behaviour patterns for Artificial Intelligence in a manner that benefits society rather than harms it. Because Artificial Intelligence-based technologies/systems in numerous domains are projected to increase significantly in the future, they should be built to behave in accordance with societal norms and values while interacting with people. Responsibility for any negative consequences of Artificial Intelligence applications should be founded on societal commitments, particularly in the

transformational healthcare business.

4.2.2. Artificial Intelligence Division

Patients generally believe in health personnel wholeheartedly, which separates the healthcare business from another service sector. The placebo consequence describes this: whenever a patient unconditionally accepts a doctor's therapy and thinks their ailment will be treated, a medical impact is claimed to occur. In some other terms, physician-patient trust is critical since it aids in the treatment's efficacy. Suppose an Artificial Intelligence-based technology or system takes on the function of a doctor. In that instance, the patient will be a part of a healthcare service method that entails establishing a link with an artificial intelligence system other than a human doctor[22]. Trust is also necessary for the long-term success of this new relationship between a patient and an Artificial Intelligence-assisted device or system. Individuals who have no prior experience with digital technology, much alone Artificial Intelligence, would have difficulty believing in a machine learning system. This Artificial Intelligence gap may be bridged if the doctor can demonstrate to the patient how the technology will assist them in receiving better treatment.

4.2.3. Security and Privacy in Cyberspace

Because Artificial Intelligence-based technologies or systems rely on large information, privacy concerns about collecting and sharing emerge. Because patient records include personal details, it is very difficult to communicate and control disease-related data across several systems. This implies that software developers must follow strict secrecy guidelines, which might interfere Artificial Intelligence progress. Because Artificial Intelligence technology draws conclusions based on ML of the data collected, the decision-making system ignores the particular circumstances of particular patients, moral, raising ethical and legal concerns. As a result, it is important to talk about the rules and conventions that Artificial Intelligence technology should follow, like morals, regulations, and individual beliefs, which govern people's conduct in civilization.

4.2.4. Managerial Authority Loss

Numerous sectors are no longer separate silos in the digital world. There is no exception in the healthcare business. Previously, the healthcare industry was thought to be a location where physicians and nurses treated people for their illnesses. Nowadays, though, excellent well-being is the result of healthy living practices such as a balanced diet, frequent activity, and everyday well-being practices, as well as access to high-quality medical care. As a result, preventative medicine has become more crucial, blurring the lines between a healthy lifestyle, medication, and technology assistance[23]. Artificial Intelligence can transcend time and space. As a result, the conventional notion of a closed health service is obsolete. Numerous smartphone-based applications, for example, may assist in the integration of many elements of people's well-being. AI-

powered technologies remotely access, treat, diagnose, and maintain patients at home. With the extensive use of Artificial Intelligence technologies in the healthcare business, specialists, consultants, convergence, and ICT specialists, and HRM are becoming more important. As a result, providing care has become a team sport involving numerous internally and externally specialists. As a result, in contemporary hospitals, the conventional bureaucratic governance structure would be ineffective. Hospital management may feel a loss of administrative control as a result of the procedure.

4.2.5. Employment Damage, Education or Training Requirements, As Well As the Pain of Change

Amazon has stated that by 2025, it would re-educate 100,000 workers via new technology training programmes in order to formulate for extra extremely expert employment in the Artificial Intelligence age. "As technology alters work, people have the chance to develop in their profession as well as take full advantage of those changes," said Jeff Wilke, Amazon's global consumer CEO. Another example is the "Asan Medical Center's Health Innovation Big Data Center", which has recently launched education programmes for future Artificial Intelligence professionals who can create and market Artificial Intelligence algorithms. Many individuals predict that, in the future, radiography will be obsolete because Artificial Intelligence will be able to analyse diagnostic health images more accurately than humans. On the other side, the application of Artificial Intelligence is supposed to assist radiologists in providing more specialised diagnostic services to their patients[24]. Nevertheless, Artificial Intelligence-related technologies will undoubtedly render many repetitious tasks redundant. Although some employment may be lost as a result of the installation of Artificial Intelligence-based systems and gadgets, many more will be generated. It is predicted to enable for stronger ties between healthcare practitioners and patients in the long term by, for example, compensating for AI's faults. As a result, the medical school curriculum should include Artificial Intelligence-related teaching and technology efficiently. Furthermore, since medical Artificial Intelligence is constrained by historical information of patients, more precise Artificial Intelligence applications should be created. This progress necessitates the active cooperation of medical professionals from the start of the Artificial Intelligence development process[25]. To address this issue, it is critical to develop a highly-trained specialised league capable of reacting fast in the consumer-oriented health-care business by providing a number of advanced technological learning options, such as employing AI to collaborate with medical people. To generate new employment, we think that new curriculums in technological innovation and implementation, human-machine confluence, human-machine interaction, cyber ethics and responsibility, data analytics classes and so on should be introduced medical school curricula.

5. CONCLUSION

Artificial Intelligence-enabled wellness software can significantly improve patient outcomes, alleviate healthcare professionals' constraints, and increase healthcare management and delivery efficiency. Regional and national administrations and organisations have important possibilities and obligations to extract this value while protecting patients. First and foremost, digital information architecture is essential. Information should be organised and standardised, particularly information standards, for efficient design and usage of Artificial Intelligence-enabled technology. It should also be available to entrepreneurs. Government registries or other centralised databases may typically improve the quality of such goods by providing comprehensive longitudinal records[26]. At the same moment, privacy issues about digitising and combining health knowledge should be taken carefully, and data should be safeguarded from cyberattacks both legally and technically. All patient groups should have full and impartial health records, which should be given special care. Meanwhile, nations should fund research into how health records might be skewed so that stakeholders can consider this data when designing, testing, and evaluating Artificial Intelligence technologies.

A deep understanding of existing rules and procedures is another crucial necessity for securely installing this sort of revolutionary software. Regulators will require to specify how they handle risk when a product utilises black box algorithms in specific. The availability of appropriate legal and regulatory bodies and clear guidelines for how companies should classify the risk of their goods are critical, particularly because many product developers may lack considerable expertise in national healthcare product design[27]. This clarification will also assist users of these systems in determining what approvals they may anticipate and where their legal obligation may lie. This is especially true for Artificial Intelligence technologies that are designed to automate rather than educate decision-making. To implement Artificial Intelligence securely and use it to supplement human intellect, education on Artificial Intelligence in principle and how to assess Artificial Intelligence-enabled health care tools and suggestions will be critical.

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Authors' contributions

All authors contributed toward data analysis, drafting and revising the paper and agreed to be responsible for all the aspects of this work.

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Declarations

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REFERENCES

- Secinaro, S., Calandra, D., Secinaro, A. et al. The role of artificial intelligence in healthcare: a structured literature review. *BMC Med Inform Decis Mak* 21, 125 (2021). <https://doi.org/10.1186/s12911-021-01488-9>
- S. Sunarti, Rahman F. F., Naufal M., Risky M., Febriyanto K., Masnina R., Artificial intelligence in healthcare: opportunities and risk for future, *Gaceta Sanitaria*, Volume 35, Supplement 1, 2021, pp S67-S70, <https://doi.org/10.1016/j.gaceta.2020.12.019>
- Schirmmeister R T, Springenberg J T, Fiederer L DJ, Glasstetter M, Eggensperger K, Tangermann M Deep learning with convolutional neural networks for EEG decoding and visualization. *Hum Brain Mapp.* 2017;38(11):5391-420. <https://doi.org/10.1002/hbm.23730>
- Mirbabaie, M., Stieglitz, S. & Frick, N.R.J. Artificial intelligence in disease diagnostics: A critical review and classification on the current state of research guiding future direction. *Health Technol.* 11, 693–731, 2021. <https://doi.org/10.1007/s12553-021-00555-5>
- Birnbaum M, Rizvi A, De Choudhury M, Ernala S, Cecchi G, Kane J. Identifying psychotic symptoms and predicting relapse through social media. *Schizophr Bull.* 2018;44(01):S100. <https://doi.org/10.1093/schbul/sby015.246>
- Jha S, Topol EJ. Adapting to Artificial Intelligence: radiologists and pathologists as information specialists. *JAMA* 2016; 316(22):2353-2354 <https://doi.org/10.1001/jama.2016.17438>
- Birnbaum M L, Ernala S K, Rizvi A F, De Choudhury M, Kane J M. A collaborative approach to identifying social media markers of schizophreniz by employing machine learning and clinical appraisals. *J Med Internet Res.* 2017;19:8. <https://doi.org/10.2196/jmir.7956>
- Datta, S., Barua, R., & Das, J. Application of Artificial Intelligence in Modern Healthcare System. In (Ed.), *Alginates - Recent Uses of This Natural Polymer*. IntechOpen 2019. <https://doi.org/10.5772/intechopen.90454>
- De Choudhury M, Kiciman E. The language of social support in social media and its effect on suicidal ideation risk. *Proc Int AAAI Conf Weblogs Soc Media.* 2017;2017:32-41.
- De Choudhury M, Gamon M, Counts S, Horvitz E. Predicting depression via social media. *Seventh international AAAI conference on weblogs and social media (ICWSM) 2013*;8(13):128-37.
- Zhou W, Cheng G, Zhang Z, Zhu L, Jaeger S, Lure FYM, Guo L. Deep learning-based pulmonary tuberculosis automated detection on chest radiography: large-scale independent testing. *Quant Imaging Med Surg.* 2022 Apr;12(4):2344-2355. <https://doi.org/10.21037/qims-21-676>
- Dodge H H, Zhu J, Mattek N C, Bowman M, Ybarra O, Wild K V Web-enabled Conversational Interactions as a Means to Improve Cognitive Functions: Results of a 6-Week Randomized Controlled Trial. *Alzheimers Dement (N Y)* 2015;1(01):1-12 <https://doi.org/10.1016/j.trci.2015.01.001>
- Asgari M, Kaye J, Dodge H. Predicting mild cognitive impairment from spontaneous spoken utterances. *Alzheimers Dement (N Y)* 2017;3(02):219-28. <https://doi.org/10.1016/j.trci.2017.01.006>
- Tang F, Lin K, Uchendu I, Dodge H H, Zhou J. Improving mild cognitive impairment prediction via reinforcement learning and dialogue simulation. *arXiv preprint ar Xiv*, 2018. 1802.06428 <https://doi.org/10.48550/arXiv.1802.06428>
- Kumar S, Nilsen W J, Abernethy A, Atienza A, Patrick K, Pavel M Mobile health technology evaluation: the mHealth evidence workshop. *Am J Prev Med.* 2013;45(02):228-36.

- <https://doi.org/10.1016/j.amepre.2013.03.017>
16. Selter A, Tsangouri C, Ali S B, Freed D, Vatchinsky A, Kizer J An mHealth App for Self-Management of Chronic Lower Back Pain (Limbr): Pilot Study. *JMIR Mhealth Uhealth*. 2018;6(09):e179. <https://doi.org/10.2196/mhealth.8256>
 17. Zhan A, Mohan S, Tarolli C, Schneider R B, Adams J L, Sharma S Using smartphones and machine learning to quantify Parkinson disease severity: the mobile Parkinson disease score. *JAMA Neurol*. 2018;75(07):876-80. <https://doi.org/10.1001/jamaneurol.2018.0809>
 18. Turakhia M P, Kaiser D W. Transforming the care of atrial fibrillation with mobile health. *J Interv Card Electrophysiol*. 2018;47(01):45-50. <https://doi.org/10.1007/s10840-016-0136-3>
 19. Kumar S, Abowd G D, Abraham W T, al'Absi M, Beck J G, Chau D H Center of excellence for mobile sensor data-to-knowledge (MD2K) *J Am Med Inform Assoc*. 2015;22(06):1137-42. <https://doi.org/10.1093/jamia/ocv056>
 20. Yeung S, Downing N L, Li F F, Milstein A. Bedside Computer Vision - Moving Artificial Intelligence from Driver Assistance to Patient Safety. *N Engl J Med*. 2018;378(14):1271-3. <https://doi.org/10.1056/NEJMp1716891>
 21. Sulleyman, A. Stephen Hawking Warns Artificial Intelligence 'May Replace Humans Altogether'. 2017. Available online: <https://www.independent.co.uk/life-style/gadgets-and-tech/news/stephen-hawking-artificial-intelligence-fears-ai-will-replace-humans-virus-life-a8034341.html> (accessed on 15 November 2022).
 22. Cosselman K E, Navas-Acien A, Kaufman J D. Environmental factors in cardiovascular disease. *Nat Rev Cardiol*. 2015;12(11):627-42. <https://doi.org/10.1038/nrcardio.2015.152>
 23. MacNee W, Donaldson K. Exacerbations of COPD: environmental mechanisms *Chest* 2000;117(5 Suppl 2):390S-7S. https://doi.org/10.1378/chest.117.5_suppl_2.390S
 24. Tanner C M. The role of environmental toxins in the etiology of Parkinson's disease. *Trends Neurosci*. 1989;12(02):49-54. [https://doi.org/10.1016/0166-2236\(89\)90135-5](https://doi.org/10.1016/0166-2236(89)90135-5)
 25. Guloksuz S, van Os J, Rutten B PF. The Exposome Paradigm and the Complexities of Environmental Research in Psychiatry. *JAMA Psychiatry*. 2018;75(10):985-6. <https://doi.org/10.1001/jamapsychiatry.2018.1211>
 26. Boffetta P, Nyberg F. Contribution of environmental factors to cancer risk. *Br Med Bull*. 2003;68:71-94. <https://doi.org/10.1093/bmp/ldg023>
 27. Song Y, Wang F, Wang B, Tao S, Zhang H, Liu S Time series analyses of hand, foot and mouth disease integrating weather variables. *PLoS One*. 2015;10(03):e0117296. <https://doi.org/10.1371/journal.pone.0117296>