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APPLICATION OF AI IN BIOTECHNOLOGIES: A SYSTEMATIC REVIEW OF MAIN TRENDS

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ABSTRACT

The developed method can aid in segmenting all knee tissues with a higher accuracy. Musculoskeletal imaging can be more effective for using a deep learning approach. The use of image guidance and robotic systems in spine surgery. The authors described the benefits of using these approaches, such as reducing occupational exposures for medical specialists and patients and supporting the simultaneous introduction of both methods into spine surgery, to improve treatment accuracy. The artificial neural networks application of ANNs for the diagnosis of liver fibrosis using duplex ultrasonography. The quantitative diagnosis of liver disease is based on the developed approach with good sensitivity and specificity is effective and can be applied for treatment.

KEYWORDS: AI, Deep Learning; Health; Machine Learning

INTRODUCTION

Investigated the possibility of using deep learning techniques in computed tomography to detect liver fibrosis [1]. The developed model with moderate performance demonstrated that deep learning can be applied for the diagnosis of fibrosis in hepatology. Another important and main area of AI application is neurology. aging-related neurological problems using examples of neurodegenerative Alzheimer's disease. The combined use of positron emission tomography and magnetic reson- ance imaging is a helpful and promising approach in the field of neurological imaging [2]. AI assessment can accurately diagnose dementia in its early stages. AI-based tools based on machine learning methods, such as online assessment tests, allow the application of earlier treatment, prevent diagnostic errors, and reduce the cost of secondary healthcare for neurological diseases. The development of AI-powered neurological issue detection tools has made it easier to treat physical and mental disorders. The application of artificial neural networks for response assessment in neuro-oncology can be introduced to diagnostic processes using magnetic resonance imaging [3]. Furthermore, the authors proposed an effective framework that reflects the replacement of complicated manual disease assessment by automated quantitative magnetic resonance imaging analysis in neuro-oncology [4].

After reviewing numerous studies, it was found that data collection, analysis, and active treatment are stages of the general treatment process. Clinical imaging collection/processing, machine learning methods, and AI algorithm development for disease and disorder classification (prediction) are involved in each general treatment stage [5].

Table 1. Definition of main medical areas for AI application.

Area of Medicine	Definition
Oncology	A branch of medicine that studies cancer tumors from occurrence period, treatment methods, and approaches including ways of prevention [6].
Pulmonology	A branch of medicine that studies methods of diagnosis and treatment of lungs, bronchi, and trachea diseases [7].
Cardiovascular	A branch of medicine that studies the methods of diagnosis and treatment of circulatory system diseases including the heart and blood vessels [8].
Orthopaedics	A branch of medicine that studies the methods of diagnosis and treatment of the skeletal system disease including surgery [9].
Hepatology	A branch of medicine that studies the methods of diagnosis and treatment of the liver disease (for example, hepatitis, cirrhosis, cancer, immunology problems, and transplantation process) [10].
Neurology	A branch of medicine that studies the methods of diagnosis and treatment of the nervous system disease including problems with the brain and nerves [11].

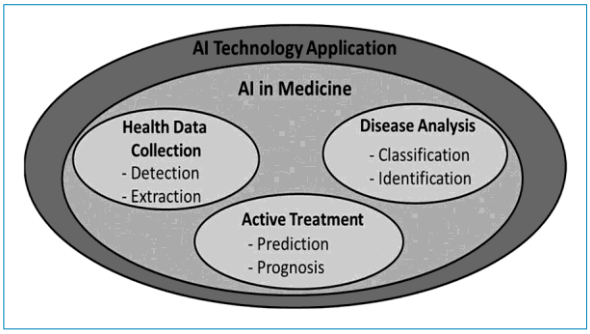

Figure 1. Extracted medical AI application areas by functionality.

OVERVIEW OF ARTIFICIAL INTELLIGENCE MOBILE AND WEB APPS FOR MEDICAL APPLICATIONS

According to the World Health Organization, eHealth (electronic health) is a special

system for increasing cost efficiency and securing information used during the health- care and treatment processes. The eHealth system can improve the healthcare experience by reducing the distance, time, and effort between treatment participants (users) [12-21]. Each area of eHealth (monitoring, communication, recording, and management) includes different number of users and consequently, different technology nodes. Communication technologies and methods can be improved through eHealth applications in health studies, research, and knowledge delivery. Mobile and Web AI Apps (Apps, AI Apps) are a special issue in medical devices and general medicine with an orientation to usability and user experience. Apps are part of the electronic health (eHealth) system [22]. A summary of previous research results on eHealth system elements is shown in Figure 1.

Figure 1 shows the basic nodes of a general eHealth system, and a review of the literature shows that most of the current references are related to two eHealth nodes of post-treatment management and communication technologies. Moreover, previous studies have shown that the main AI app application areas are surgery, and user-oriented problems are satisfaction and usefulness in post- treatment management and communication technologies [23].

To support the study summarized in Figure 1, it is necessary to provide a brief overview of previous research. The application of apps for patients after total knee replacement surgery for pain reduction and information perception. It was observed that AI apps for patient self-care can aid in reducing pain and increasing the quality of life and physical functioning. Additionally, the study supports the hypothesis that post- operative care education apps increase satisfaction with information and perceived healthcare. Introduced app-based instructions for patients after neuro-surgery and proved that AI apps are useful in neurosurgical care to improve user experience and satisfaction with medical care. Apps for adjusting the personalized convalescence plan and developing a recovery schedule for each patient after laparoscopic abdominal surgery were tested. The authors suggested the use of electronic health interventions in treatment in further studies. Patient-centered mobile applications for monitoring the post-surgery state during the first few weeks, which is critical for patient recovery, have been investigated. Using the smartphone application, doctors were able to monitor patients' states through periodic online surveys [24-39]. This study illustrated the positive role of an AI app and patient satisfaction with the online system.

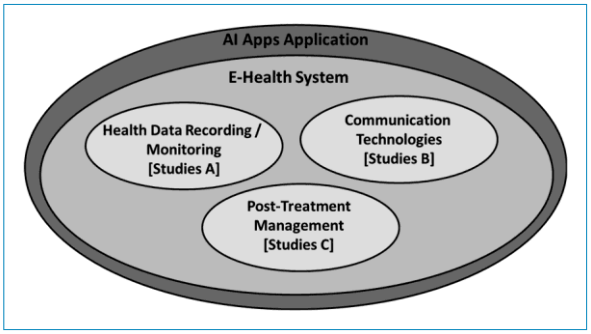

Figure 2. Main extracted elements of an e-health system.

Apps for patients receiving kidney transplants that aided in understanding the name of medication received after surgery with dose, effects, and interactions with other medicines. Hence, most of the patients correctly answered the control medication survey, and the tested app was helpful in educating users about post-surgery care. The prospect of using apps for home care after medical procedures and surgery. The results suggest that users (patients) have positive attitudes toward the telemedical method with apps that transfer safe health data to the hospital [40].

The usability of mobile health application apps for diabetes, depression, and caregiving to improve and develop further eHealth applications. It was suggested that app developers consider the lack of confidence in technology, frustration with design and navigation, and increase in self-management features. These characteristics are helpful in improving app usability and user satisfaction. Apps for monitoring the recovery process in the post-discharge period. It was observed that monitoring apps for the post-discharge drainage period can be used with high user satisfaction. The usability of medical apps is an important factor in ensuring the success of health and well- ness of users (doctors, patients, and other professionals). Satisfaction with the app is ranked by users as the main usability characteristic that provides the best user experience. However, negative user expectations are linked to charges of apps and advertisements [41]. Moreover, this type of app can aid in improving surgical care in eHealth. eHealth apps among Bangladeshi users and found that the usability of these apps is unsatisfactory and can cause problems for eHealth service consumption.

Based on the studies reviewed in this section, the use of apps facilitates communication between healthcare professionals and patients. However, lack of user satisfaction and app usability can be the main issues in AI apps' perceptions and adoption of new electronic technology. As primary users, patients demonstrate satisfaction and positive attitudes towards online and electronic healthcare applications. Furthermore, it was reported that e-health is gaining popularity, but is still underutilized. Further implementation of new online technologies is required to improve the user experience and patient satisfaction with healthcare services [42-54].

DISCUSSION

Artificial intelligence is attracting increasing attention in all fields, including medicine. Although medical AI applications are expanding, there are still limitations and biases. Summarizing all reviewed research by the treatment process, the main areas of AI engagement include oncology, pulmonology, cardiovascular medicine, orthopedics, hepatology, and neurology. Artificial intelligence can be applied in each step of the treatment, but its main electronic applications are clinical imaging collection/processing, machine learning methods, and AI algorithm development for disease and disorder classification (prediction) [Figure 2]. Figure 3 contains groups of representative studies of each AI sub-area – Studies of Machine Learning and Mobile/Web Apps.

Different machine and deep learning methods, together with neural networks (neural networks), can be grouped into AI analytic machine-learning clusters. AI analytics is described as a cluster of approaches and methods for analyzing big data to reduce the time and effort of researchers and analysts [55-67]. Most common machine learning methods are logistic regression, support vector machines, decision trees, convolutional neural networks, and naïve Bayes classifiers. Figure 2 shows that the AI approaches of machine and deep learning, neural nets, and various AI apps can be successfully applied to clinical imaging improvement (e.g. ultrasound, MRI, X-ray), detection of the presence/ absence of a disease, disease onset prediction, management of treatment process, and medication prescription.

Additionally, it can be observed that AI trends in Figure 3 can be randomly combined, and these combinations can lead to separate important functions during the treatment process. Previous studies show AI as an advanced medical technology, which can serve as a treatment process with data collection, data analysis, and monitoring functions to improve the treatment process. It is evident that AI introduction has a large number of barriers and suspicions on the part of users, including the medical staff and patients. Based on this, there is a huge layer of medicine where artificial intelligence is either not used at all or is used minimally. This lack of AI use is felt especially in surgery and direct intervention in the organs, joints, and tissues of patients. Since AI is used in various areas of surgery, including laparoscopy, organ and tissue transplantation, abdominal and neurosurgery, special attention deserves surgery and surgical intervention using AI. Study[79] shows a method to evaluate organs of liver donors in transplantation surgery based on a deep learning approach using image information.

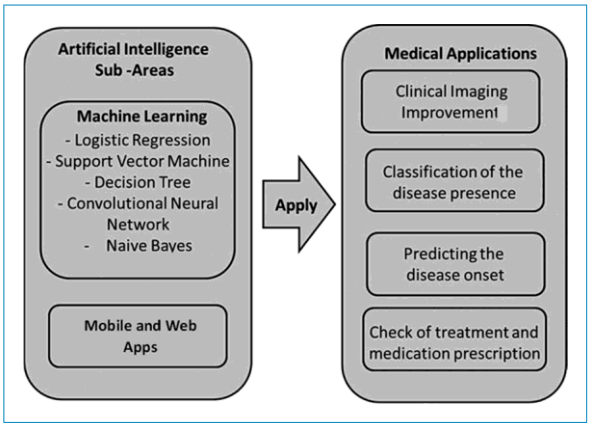

Figure 3. AI electronic trends in medicine

The proposed model has accuracy over 90% and helps perform non-invasive organ assessment. An AI model was developed to detect anatomic regions in laparoscopic cholecystectomy with high performance to avoid biliary duct injury. To make AI in medicine more effective, it is necessary to clarify the definition, classification and role of AI-based healthcare methods. Computer vision and imaging are also important and promising AI-based approaches which can be helpful to screen diseases effectively. Radiomics as a method for effective lung cancer detection. Authors discuss ability of this method to detect tumors non- invasively [68-74]. Although this is an emerging field based on AI, it has great potential in diagnosing diseases. The computer vision role in autonomous surgery. It was found that digitized visual information is the living application of computer vision in surgery, but further development of medical imaging will be helpful to improve treatment efficiency and decrease invasive interventions. The article also shows that further development in this direction will lead to an increase in autonomous actions in treatment. However, for significant improvement in this area, it is necessary that surgeons recognize the importance and possibilities of AI and improve their skills in communicating with such technologies. An introduction to the concept of artificial intelligence surgery and demonstrates that AI in surgery should also include robotization, and not just machine/deep learning and computer vision. Authors believe that robotic surgery will provide a base for autonomous actions during intervention that will improve surgery results, connection between doctor and patients in pre-operative, intra-operative, and post-operative treatment stages. This medical issue is connected with a research question about autonomy in surgery. The issue of distrust and wariness associated with the use of AI-based devices in surgery. This study distinguishes six levels of autonomy, ranging from the level “0” without the use of AI to the level “5” of full autonomous surgery; and separates a few AI types of machine learning, deep learning, and computer vision.

A clearer understanding of AI levels and types is necessary for surgeons to do their job more efficiently and safely for patients. The positive result of AI application corresponds to an increase in productivity, accuracy (efficiency) of diagnostics and treatment, reduction in treatment time and costs, and improvement in post-treatment care [75-84].

In the field of medical imaging (including data collection tasks for future treatment), the use of AI technologies can improve the accuracy of the recognition of foci of disease and neoplasms, which is comparable to the work of a medical expert. Conversely, the best results are obtained when the AI and healthcare professional's assessment work together.[45] Furthermore, machine learning, deep learning, and algorithms developed on this can aid in increasing the efficiency of predicting the occurrence of a disease, classifying an existing disease, and checking the prescribed treatment method and medications (including dosage). It is also easier to manage big health data when there is an AI algorithm for collecting, evaluating, and analyzing data [85-90].

Another problem associated with the introduction of AI medical technologies and healthcare data management is the method of medical AI verification, as well as AI-based research replication. The main problems are the lack of standards and regulation in the collection and processing of medical data; the secrecy of AI algorithms due to which the multi-level data analysis processes are not obvious to users and it is difficult to understand how artificial intelligence mathematic- ally processes the data and analysis. For the same reason, replication of AI studies is difficult. Replication of studies is important especially in medicine to prove the results obtained. This process also requires a large data set, which is also a problem in medicine, since the use of patient data must have increased security and integrity. Basically, these data cannot be disclosed due to the need for patient privacy. Based on this, a previous study proposes a validation model for AI in precision medicine using the example of oncology treatment. The proposed algorithm contains the following steps: determining the application of AI and the target medical group; the AI technology analysis period and data set used; ensuring the security of the data used; AI evaluation criteria and metrics; ensuring the transparency of the AI functioning. This study shows that due to a lack of understanding of deep and multi-level processes, medical professionals still have mistrust in healthcare AI since this is connected with the life and health of people. Authors studied techniques of explainable machine learning and discussed importance of AI transparency for medical purposes as well as some limitations of existing AI methods. The authors proposed an algorithm for encrypting private data. This method is based on the approach and encrypts patient data before it enters the cloud, generating secure keys. The proposed method is cost-effective as it minimizes the time spent on encryption and access to

data, increasing confidentiality. The authors presented the main data integrity problems, methods and techniques in the field of medical data security, as well as the challenges and future in this area. One of the main and promising data integrity techniques has been identified as blockchain. Based on previous research and considering the importance of research on AI safety and validation, the proposed results can help in understanding which deep learning and machine learning methods can improve the patient data processing and how best to use them.

Although the use of artificial intelligence facilitates and improves the process of providing medical services, there are a number of problems and barriers to the widespread adoption of AI. One limitation is the high cost of the devices with AI elements. This corresponds to the paradox that occurs very often the use of these technologies should reduce the cost of treatment. However, artificial technologies are quite expensive. Second, there is still a lack of user trust in AI. This is due to the fact that information processing in AI devices is hidden from the doctor and patient, and there is also a paucity of long-term research plans for the development and improvement of AI technologies. The combination of these factors leads to suspicion and lack of trust in artificial intelligence. The ethical aspect of the use of artificial intelligence is also a challenge to the expansion of clinical AI. This involves two aspects: work with big medical data and introduction of AI into controversial medical areas, for example, related to the study of genes and their modifications. To address this problem, it is necessary to develop a clear set of legislative regulations for genetic engineering as well as improve the reliability of AI software to avoid the leakage of patient personal data. Another limitation is related to the ease of use of AI equipment or devices by doctors (especially in high-precision surgical areas) as well as the responsibility for medical errors during or after AI use. The solution to these problems is also associated with the legislative consolidation of responsibility for clinical errors in relation to doctors, AI developers, or AI providers (identification of responsible AI agents). Additionally, developers should provide a user- centric AI interface and system to reduce usage time, complexity of use, and physician fatigue, and improve the interpretability of the obtained AI results.

Based on previous studies user experience and usability are discussed in the fields of medicine and medical AI related to the aforementioned barriers. A few usability characteristics, which are especially important in medical AI, including error prevention via system feedback, medical AI intervention should be clearly understood in terms of comparison with the usual medical care process, and a connection system between medical users, disciplines, and sectors should be established to provide the most useful treatment system. In this study, the authors explained the usability concept of medical device assessment based on the following principles. First, usability can be evaluated as a subset of the medical user experience. Second, medical

devices and consumer goods must be evaluated using different criteria. Third, the medical usability evaluation approach is dependent on the type of product in the expert and medical systems. Summarizing the aforementioned studies, it should be noted that the use of medical devices and systems, including artificial intelligence, is a separate concept, and the approach to assessing medical user experience should differ from that of other services and products. Despite the presence of all the barriers and problems in the clinical use of artificial intelligence, this area is promising for improving the diagnosis of diseases, treatment process, and post-treatment care. Developers should pay particular attention to expanding the scope of AI in medicine such as surgery.

LIMITATIONS OF STUDY

Despite the results and findings obtained, the presented article has a number of limitations. Firstly, the concept of artificial intelligence is rather vague even with an encyclopedic definition. Accordingly, when reviewing the existing literature, it must be understood that each author has his own final understanding of this field. Based on this, the review includes previous AI research, but adjusted for the individual perceptions of the authors and this cannot be unified at the current moment. Secondly, a literature review, even in the presence of a specific methodology, always has an omission of literature sources, since they are updated every day and it is impossible to fully follow this. Third, despite the abundance of literature in the area under discussion, the number of published studies in the presented topic is still not enough and the selection of resources requires increased the attention and time.

CONCLUSION

In the present study, we identified the main areas of application of artificial intelligence in medical technologies, the problems associated with its implementation, and potential ways to accelerate and expand the use of clinical AI. This study can contribute in the various fields of medicine, AI, user experience, and human factors. Based on the extracted findings, AI application in the medical and health- care area can be improved by understanding the technical, partially legal, and ethical issues in the collaboration between medical professionals and AI technologies. Based on the extracted AI application focus, it can be expanded through accounting for less involved medical areas to increase healthcare service quality. User experience can be improved from both sides of healthcare professionals and patients. Doctors and other professionals in future can have benefits of an increase in the understanding of the functioning of new devices and a subsequent increase in the speed of medical care and the accuracy of treatment, as well as a decrease in workload. In turn, patients can experience immediate improvements in the health care and quality of life. The field of human factors can also be further developed by improving the principles of

functioning and using AI not only for medical purposes, but also to alleviate the physical, emotional, and workload in various areas, such as those associated with physical or other monotonous work. Moreover, the improvement of the ethical and legal conditions for the use of AI will help expand its implementation in society with an understanding of the potential risks. The findings will be useful for healthcare professionals, AI engineers, AI developers, AI providers, and medical and AI researchers to improve the circulation and use of medical AI at all stages of its lifecycle.

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