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Convergence of AI and Healthcare: A Review of Machine Learning Applications

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ABSTRACT

The integration of AI and healthcare can act as the foundation for improving the medical business and the diagnosis and treatment process, as well as patient throughputs. Guided by the following objectives: the current review seeks to discuss what can perhaps be considered as the most revolutionary aspect of care: namely, use of the ML. Software such as the radiology algorithms as well as the prediction tools in healthcare are already narrowing down the error margin. This shifting of life through the practice of genetics by the improvement of AI in managing genetics as the world turns to individualized approach of patients. However, there is a list of challenges that arise when applying AI in the healthcare industry: Data protection and Algorithmic or and The question of who or what is responsible for the AI applications. Clinical decision involving the use of AI has ethical and regulatory issues that need to be addressed therein. But AI does hold a massive amount in advancing the clinical results, in reducing the costs and in making the health care system much stronger, proactive, personalized and efficient. As to the future trends for the use of AI in health care; it will be employed in pharmacology and drug development; in surgery through robot control; and patient management through tele monitoring; as well as in precision care and health information analytics and forecasting. New solutions to still pending issues in data protection, data sharing and objectivity will be important in the future of AI in health care. In sum, this paper proposed that AI is an innovative tool in healthcare's, that has the potential to redefine the possibilities of how patient care can be delivered, and clinical work can be done, provided the steering wheel of ethical and regulatory burdens is pulled well.

INTRODUCTION

AI in context to a healthcare domain refuels to a revolution in the delivery, management and experience of medical services. AI and even further, ML has been developing over the last decade and is still awaiting to revolutionize several aspects within the sphere of healthcare. The second AI type is supervised learning, which also remains closer to the algorithms that help systems learn from the data and can change and improve in time — all of this is quite relevant when it comes to healthcare [1]. In healthcare, the need for AI is driven by several key challenges: the constant increase in the volume of medical information, the increasing demand for individual treatment methods, the demand for increased efficiency of health care organizations or care, and of course, the permanent need to reduce expenses while achieving a higher level of patient outcomes. All these challenges are compounded by disparities in healthcare throughout the Globe hence making AI appealing as a means to establish a try and attempt formulation to eliminate disparities in healthcare provision and facilities [2].

Applying AI is useful for both diagnosis and improving results of treatment in case of numerous diseases. Undoubtedly one of the most well-known areas is in diagnosis and analysis of medical images that may use machine learning to classify images and diagnose diseases beyond the capability of radiology professionals. AI is also central to the prescriptive analytics due to its ability in projecting rates of disease occurrence, chances of outcomes and therapy effectiveness. Since AI employs big data then it holds the potential of recognizing patterns or association that researchers employing conventional techniques rarely observe [3]. Apart from diagnostics, a second key application of AI is in personalizing an individual's equitable experience. Through the combination of the patients' genes and their medical history, the machine learning models pre diagnosing tools can be used to recommend specific medical care plans that meets the patients' profiles. The promises that may come with this change from an earlier form of generalized model of care delivery include: improved patients' care, reduced and milder sized incidences of patient's reactions to medications and improved medication therapeutic response.

CDS is also in need of AI in a means through which the providers use evidence based information clinical decision support system. They can hence convert patient data into knowledge and proposed decisions to the doctors and nurses in real-time. In the field of oncology in particular, AI presents suggestions of the treatment according to genomic characteristics

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and medical history of the patient obtained with the latest information. But as with any market, there are challenges that surround the use of AI in the healthcare field even as everyone touts it as the solution to the problems of its sector [4]. Potential challenges that also have to be acknowledged are the inherent complexity of medical data; the need for large high quality data sets; legal and ethical issues of privacy and security and an indication of algorithm bias. Besides this, health care and its incorporation of artificial intelligence vowed to the ethic and regulatory measures for the functioning of the programs mentioned above. AI is in the list of the most promising technologies to transform the health care system, outcomes, diagnosing and treatment methods. However, these technologies will enjoy a center of gravity and will need a communal approach in addressing the technical, ethical and regulatory parts before these technologies could attain the optimum stage. Therefore, it can be concluded that the advancement of AI in the future will again open favorable possibilities for the further improvement of qualitative effective and equitable health care system globally [5].

PERSONALIZED MEDICINE MODEL MACHINE LEARNING

Machine Learning AI has recently uptake popularity and is widely used in healthcare, mostly diagnostics and physicians prescribing medicine based on an individual patient. Big data with integration of complicated algorithms in machine learning models enable the assessment of large medical data to support the doctors' diagnostic work and suggestions on treatments [6]. This ability is revolutionizing the health care system in modern society and improving health care dilemma solving as well as engaging patients.

Machine Learning in Diagnostics: Especially, authors paid attention to the opportunity of utilizing machine learning algorithm for diagnose as very efficient for the medical imaging, diseases diagnose, and risk assess. One of the breakthroughs of the use of ML in diagnostic systems is integrally associated with medical imaging. Models of deep learning to handle a large amount of medical images of different formats of X-rays, magnetic resonance images, CAT scan etc; are fair in diagnosing tumors, fractures, organ diseases, etc. In some instances, the designed machine learning systems are better in diagnosis of diseases including lung cancer, breast cancer, and diabetic retinopathy than the human radiologists [7]. It may help doctors by help out with the second opinion to pattern that cannot easily be picked by the human eye, as well as speed and accuracy.

Other benefits include; the time taken to analyses and process the images is short since it would be of great help in emergency situations. Another of the other areas that ML performs well on is diagnostics prediction. Namely, those historical medical records including patient's age, gender, prior diseases, life styles, etc. help establish the machine learning algorithm which predicts the trend to more illnesses. For instance, one is able to determine at what time, the individual is likely to develop, and is thereby advised to avoid, heart diseases, diabetes or Alzheimer's diseases. Combination of screening with early-outcome prediction improves the management of the disease and is less expensive in the medical field than when diseases have turned into chronic [8].

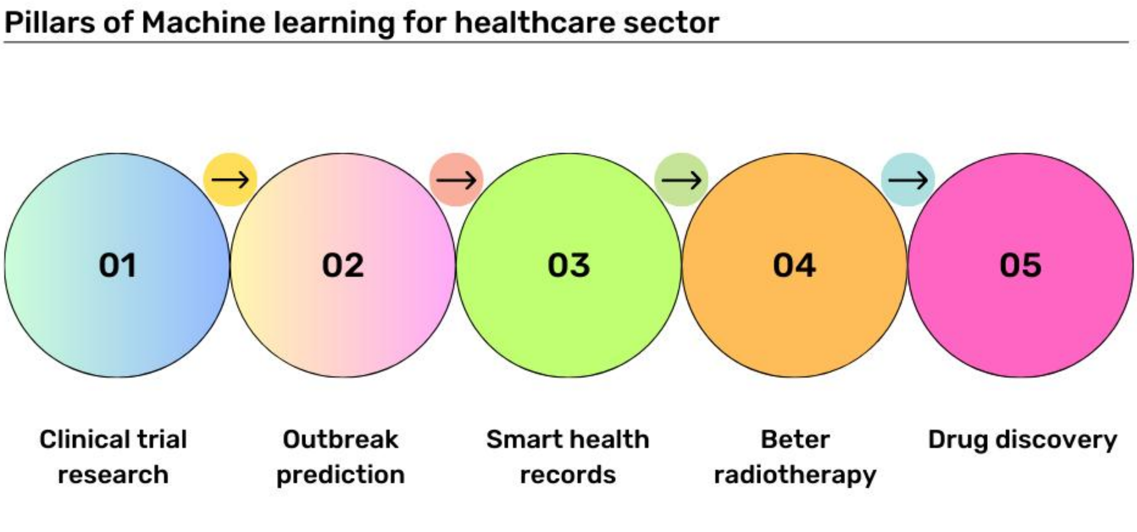

Figure: 1 showing pillars of machine learning for healthcare sector

Machine Learning in Personalized Medicine: Machine learning is also being adopted in the health care field of personalized medicine which focuses on the genetic typing of the patient and his lifestyle. Originally, treatments were contingent on availabilities of a population which is why treatment plans have been designed to suit most but one or two people. Prescriptive is also referred to as personalized medicine and the intention to put into practice more effective treatments. If diseases, the machine learning models can draw attention to such genetic mutations or biomarkers by analyzing genetic data so that patients can systematically develop their treatments [9]. For instance, in oncology, with the help of the ML algorithms, it will be possible to identify such features of the participant as genetic makeup and the nuances

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of the specific type of cancer in order to choose the therapy regimen for the patient. It is also useful in improving the chances of getting a good result of the treatment as compared to the side effect because it only allows treatment which is compatible with the patient's biological makeup of the body.

In pharmacogenomics-that is the study of how a given drug will affect a given patient depending on their genotype, machine learning has the ability to make predictions of a patient's response to a certain drug. This can be used to ensure that the right drug is prescribed together with the right dosage to be given to the patient this reducing on cases of hasty prescription of medicines to the patients. Gradually AI is being incorporated into diagnostics and individualized medicine leading to a progressive enhancement of the effectiveness of medicine [10]. The great advantage of using ML in the medical field is the ability to use certain symptoms and other characteristics to diagnose the patients and help them create the most suitable individual plan, patients' success rates will be higher and health care costs – lower, generations of fair and efficient health care system. AI and ML are still an unceasing process of creation and development; consequently, the enhancement of these tools within the healthcare industry will presumably be an increase in difficulty [11].

INTERPLAY OF ARTIFICIAL INTELLIGENT IN CLINICAL DECISION SUPPORT AND PATIENT SURVEILLANCE

Implementation of AI in clinical solutions and patient analytics to improve medical care delivery systems in structures is transforming the nature of practice for healers through increasing the probability of right decisions for better lives of the clients. The given approaches are important particularly in the context when, as the healthcare becomes more complicated as for the amount of information regarding patient, as well as for the number of specific possibilities for treatment. Health technologies enhance also the aspect of clinical decision support and the patient's management in order to contribute to the rate of timely interventions and partial treatment [12].

AI in Clinical Decision Support Systems (CDSS): CDSS is decision support systems that are designed for use in the decision making process regarding patients. In the case of AI based CDSS, the machine learning algorithms harness on what is available in the big data repositories like EHR, diagnostic test, imaging and the patient's records ,to provide patient specific decision support capable of meeting the patient's needs. This is very efficient data when analyzed by the artificial intelligence and is quite useful in clinical practice. Another area of advantage of incorporating AI in CDSS is the matters concerning the patient care since it becomes possible to provide in real manner a CDSS based on the state-of-art for the particular disease. For example, it can be applied to identify diseases, cures or the nature of a disease, or side effects [13]. In oncology, functions include analyzing data coming from the cancer patients in order to recommend potential treatments based on genetic profiles and clinical histories. In the same way, in cardiology, artificial intelligence can help ascertain odds of the disease with the help of records and phenomena of a patient. However, the CDSS supported by Artificial Intelligence can enhance the utilization of knowledge derived from the current research and recommendations included in the decision support tool. This means that the health care givers gets the best information as they are practicing as they make their decisions and due to the right decisions, they serve the interests of the patient [14]. AI is also capable of addressing with high efficiency the failures of people – in highly risky situations, this could be critical, for instance, in emergency and critical care departments.

AI in Cardiac Monitoring: Artificial Intelligent application has been stretched up in the field of cardiac health and especially in the areas of predictive modeling and continuous streams of monitoring through wearable devices. It is getting common for predictive models to help identify patients who are most likely to have complications and improve outcomes while being treated especially after Cardiac surgeries. These models also allow monitoring essential variables that define metabolic disorders or performance recovery, including blood lactate, to intervene when necessary [15]. The digital approach towards the prediction of heart diseases is complemented by wearable devices that are built with AI integration for real time monitoring of cardiac health. It also constitutes these devices, which permanently monitor the patients' vital signs including heart rates, blood pressure, and oxygen levels that can be accorded individualized, consistent care [16].

The gathered data is processed by the AI algorithms in these devices to identify first signs of possible problems, including arrhythmias or hypertension that can be reported to the healthcare professionals before complications appear. Such incorporation of AI and wearable device guarantees that patients get the right type of care at the right time which results to better post-surgical care and possibly longer effective cardiovascular disease management. Combined, predictive AI modeling and wearable monitoring devices present an enormous advancement in the paradigm for cardiology, focusing upon preventive and real-time, customized healthcare approaches [17]. To this synergy, however, patient health is improved not only, and unnecessary re-admissions are decreased, which helps contribute to the decentralization of health services.

AI in Patient Monitoring: Regarding the patient monitoring AI is another one of the radically innovative aspects of healthcare systems. As those patient monitoring that has been in practice before encompasses does not include the data analytic aspect, they mostly focus on the capture and presentation of real-time data such as pulse, blood pressure, or oxygen saturation. However, current AI systems amp it up by also interpreting this data in terms of patterns, potential courses by which these serious issues may become even worse, and what should be done to attempt to quell or prevent such a deterioration [18]. For example in the managing of chronic diseases such as diabetics or hypertension AI applications can help remind the healthcare provider of changes in the health state that are likely to require attention.

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These systems can be used to monitor patients in hospital or those on home care and reduce frequent actual visits, yet care can be given as frequently as possible.

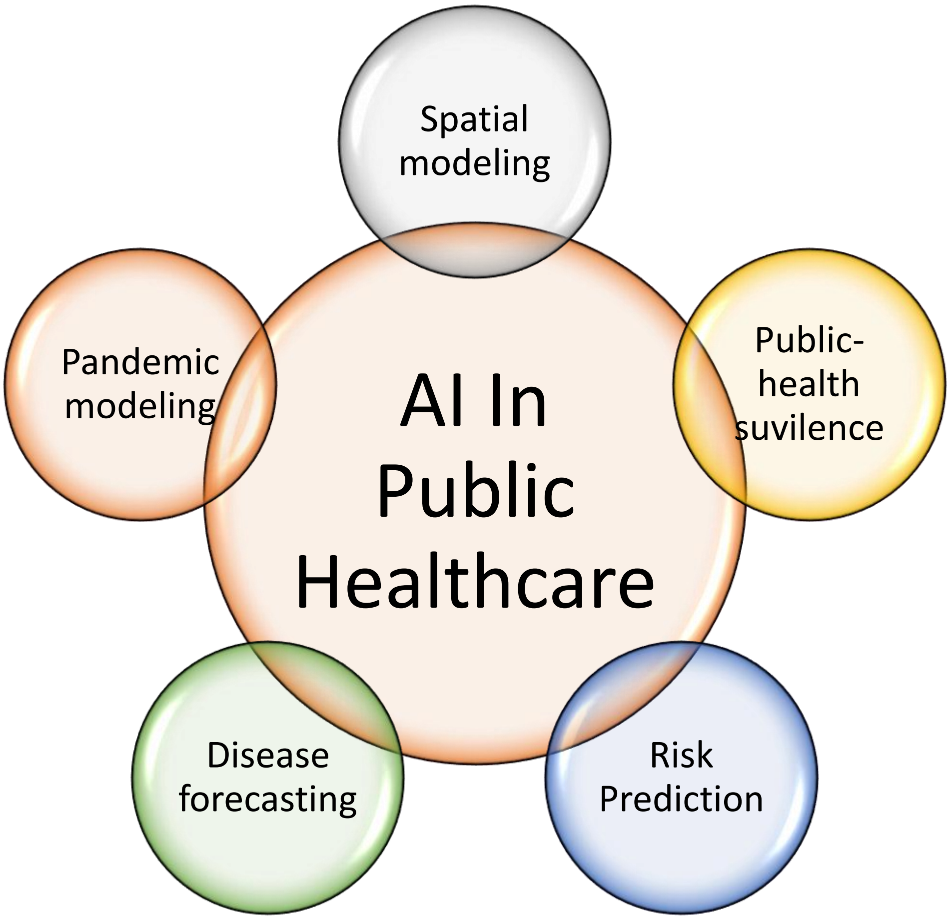

Figure: 2 showing Ai in public healthcare

Sharing kin shields adopted through use of artificial intelligence in remote care of the patients is another strategy among them. From wearable's and home health devices that continually feeds data of the patient, such as; pulse rate, blood sugar levels, and SpO2 (Oxygen saturation level). Such data being used in AI speeds up providing values that characterize the state of a patient and identify whether he/she had some sort of aggravation of the disease, which the latter and/or relatives may not immediately notice. For example, using cloud AI applications, the radiology department can inform the physician or clinician that a patient is likely to have a heart attack, stroke, or sepsis, before the crisis worsens [19]. It also has immense value in the prescriptive context and makes use of data generated from monitoring processes in the identification of potential unfavorable outcomes. For instance AI can be used to predict the probability when a certain patient is likely to have sepsis; a condition that needs to be treated as soon as possible. Similarly, it can quantify the possibility of being readmitted to a hospital – beneficial in enabling the health care providers alter the approaches used in the treatment of patients with a view to achieving better outcome [20].

Integration of Artificial Intelligence in the aspects of clinical decision support and patients update enhances the efficiency of the service delivery system and the general quality of healthcare services. By applying AI in the care of patient, such questions as decrease of the number of mistakes, better organization of interactions and greater chance for individual approach to the treatment, as well as constant, real–time surveillance of the patient are solved by helping the clinicians make better decisions. Therefore, as such AI tools as these become more sophisticated, knowledge of how and when to apply them becomes increasingly crucial to the creation of patient-centered and data-driven health care systems [21].

TENTATIVE DISCUSSION MY SECOND AREA OF PROPOSED FOCUS IS CHALLENGES AND ETHICAL CONSIDERATIONS

While the application of the concept of AI has shown a high degree of effectiveness in enhancing productive capacity in the healthcare industry, it is accompanied by inconvenience. Machine learning and AI in particular raise many technical, ethical, and regulatory issues that are necessary to solve to have sufficient and effective use of new technologies in the healthcare systems [22]. Among them are; Data Security/privacy, Biases, Responsibility, and Governance of the AI processes.

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Data Privacy and Security: Their security can be discussed as one of the largest problems in the sphere of healthcare, as well. Artificial intelligence systems use big data therefore need large volumes of patient data some of which are very private including medical history, lab results and gene information. They recall that such information comes at a price of procuring additional local storage, which is easily vulnerable; because health information falls under the class type of information, there is need for organization's health information to be protected from the fraudsters, cyber criminals and hacker [23]. Patients need to be assured that their data will not be breached, meaning that health care organizations have to meet certain requirements as require by the Health Insurance Portability and Accountability Act (HIPAA) in America and the General Data Protection Regulation (GDPR) in the EU.

Algorithmic Bias and Fairness: The second crucial area involves algorithmic bias – which means it is based on data that was fed to the training algorithms which then yields some very unfair or discriminative results As the AI systems work on previous data collected in medical fields existing biases in this information such as race, gender, social status, etc. may be amplified or even repeated by the algorithm. For instance, if the system has been developed to work for a specific demographic group, the performance will be poor out of the set demographic [24]. There are likely to be higher possibility of health disparity which means that some people receive less attention than others. But these bias needs to be addressed by effectively attaining the right proportions of choosing between some balanced data set more along with the constant update of weights in the AI systems [25].

Transparency and Accountability: Another issue is connected with the openness of many of the AI algorithms that are used in the systems of today. These deep learning models which are subcategory of machine learning, the reasoning of which can often be very difficult to articulate. This is however lack of disclosure which is unfavorable and creates relevant questions similar to when the health industry is unfavorable where mistakes can be fatal. I think there should be a method of showing how the AI process arrived at the current precise recommendation or analysis for the clinician, the health care provider or the patient [26]. They have thus called for explainable AI (XAI) systems – systems that produces easily human interpretable outputs for Clinicians on which the decisions of such system will be based. The question of accountability arises: Who is held responsible when an AI system emanates an error that leads to a harm to a patient? They should also be known to have perceived laws that define the accountabilities in existence with pinpoint clarity [27].

Regulatory and Legal Challenges: As such, the authorities face the challenge of regulation on the utilization of Artificial Intelligence in the health sector. In many healthcare systems, the healthcare institutions are also in the process of trying to enshrine protective measures that can surround the AI solutions. AI systems in many territories need to be validated for use in clinical practice; however, the current legal frameworks have insufficient ability to identify probable AI issues arising from such advancement. Moreover, the longer it takes the regulatory authorities to be set up to respond appropriately, the quicker the Artificial Intelligence tools can evolve [28]. A new risk focus area of AI tools that can be identified is the failure to adequately address the change of accuracy in the AI system or changes that make the AI system clinically non-compliant. Thus, allowing many opportunities to the healthcare business, further application of AI must be exercised taking into account the threats and ethical considerations described above. Whereby a proper scrutiny of aspects like privacy of the data, the algorithms, transparency and regulation can be understood as important to the direction of the right AI in health care with a view to promoting better patient care and the elimination of health disparities [29].

FUTURE DIRECTIONS

It is clear that AI in medical has promising future and concerning machine learning and artificial intelligence new technologies and advancement in medical research is entering to change the medical practice. However, application of AI in health care, clinical analysis, and or patient care delivery in clinical practice, and in health care management is still in the process of being developed. In the next few years the beauty we are yet to witness is such developments that are liable to change the delivery of the health care leading to patient mileage and complete elimination of vices of the health care system [30]. The following are some of the major aspects which have been identified to be suitable for future development through use of AI They include;

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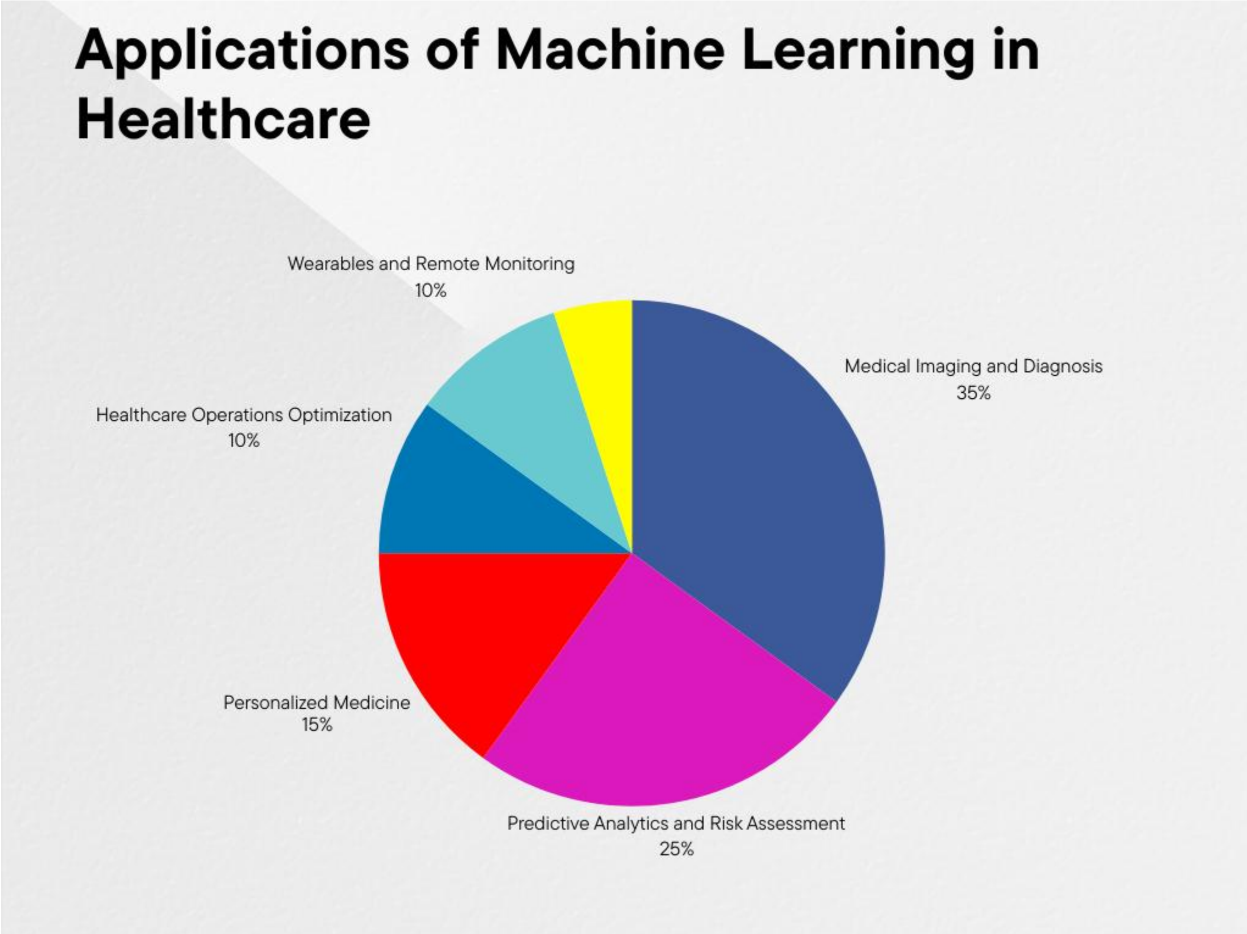

Figure: 3 showing applications of machine learning in healthcare

Advancements in Precision Medicine: Quite likely, one of the most promising future trends in AI usage in medicine may be the further development of the refinement of the concept of precision medicine. This has been described as precision medicine referring to the ability to give the right remedy regarding the genetic peculiarity of an individual, and other characteristics for instance the lifestyle and the existing intricate environment. Some of these areas that have already feel will-actively observed implementation in genetic studies and specially designed drug delivery, are most likely to experience future growth most with machine learning technique [31]. New developments in AI assist in reshaping the genomic sequences; therefore, adoption of AI in the genomic data is likely to provide new cures in treatment and diagnosis of genetic diseases as every person is different. The massive scale data from genetics recorded clinical data and the data from the environment and analysis of the same is going to be tremendously useful for AI in disease risk assessment for acute conditions such as cancer, heart diseases, diabetes and many more. Like virtually all of the sequencing systems, there is a definite indicator that with the new systems in biotechnology the prices of the genomic data analysis are set to tumble and make tom stand out as the best solution for personalized treatment [32].

AI-Powered Drug Discovery and Development: Of course, there are many more other fields talking about numerous possibilities to apply AI, but let's focus on one of the most perspective and essential for now – one is the drug discovery and development. The inherent problems with this model are numerous, such as high likelihood that an identified compound will not be amenable to commercialization or that such compounds will not be effective in treating diseases. It is still a slow process as one has to screen substances in order to arrive at the most effective ones; but with the help of AI; the identification of lead compounds, the prediction of the substances behavior in the biological environment, as well as the selection of trial protocols is done much faster [33]. AI and machine learning are at the moment useful in developing drug combinations & designing molecular structures, besides predicting drug efficacies & safety in the trail before the test AI has over time become more efficient for the drug producers to develop the drugs to cure ailments though discovering treatment of various diseases or ailments which were of less concern in earlier years. There is likelihood of enhancing the organization of these medicinal development processes better with the application of AI, this will help to cut costs of the development, release the products to the market much earlier as well as make the products available to save people out there [34].

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Integration with Wearable's and Remote Monitoring: The technologies incorporate the new possibility to other patient care, this is through the use of wearable health devices and remote monitoring. Today the use will be relevance with communication and health data culled from wearable such as smart watches, fitness trackers and other health monitoring frameworks with patient status in real-time. Thus, patients are often revealed by AI systems as having symptoms of a disease, as experiencing an upcoming deterioration of a chronic disease, or as in need of critical help before a key event unfolds [35]. For instance, AI can wear biosensors to monitor brief and constant changes in cardiac arrhythmia using people with a variety of chronic ailments such as diabetes, hypertension, or asthma, blood pressure, glucose level, or oxygen saturation. Once it grows more complex models, the tool will not only be used in preventive medicine but also use the data to help in providing the best treatment regimens for the patients. AI can be included in the telemedicine applications, which will eliminate the need for successive individual's face-to-face meetings thus improving healthcare access especially in rural areas [36].

AI in Robotics and Surgery: Another rather a rather a fast growing area is the application of robotics in the healthcare industry with the assistance of artificial intelligence. Surgical robots controlled by Artificial Intelligence have proved that it is possible to perform very accurate surgeries and do little or no harm to the patients' tissues thus short recovery time, fewer risks of complications. This therefore means that self-sustaining robotics is going to an increasingly common feature and will be able to undertake operations of the human body that are serious in nature. Such developments may enhance value in complex procedures, reduce the risk of errors and improve patient's utility of life [37]. In addition, the twelve fields of relevance also comprise reactivation through a robot-mediated approach from the standpoint of AI. For instance, AI robots applied in an exoskeleton that is used by disabled people as well as artificial legs. In the future, such devices will become more centered on the user and his or her motion, and that will be helpful with regard to rehabilitation [38].

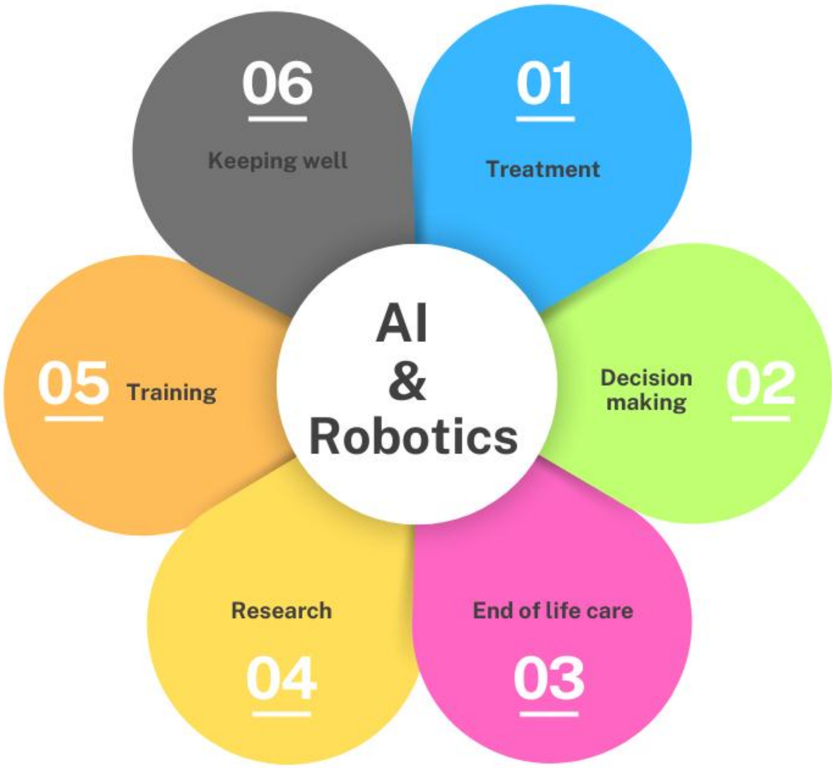

Figure: 4 showing AI and robotics

AI for Predictive Analytics in Public Health: At a big picture level, AI would provide insights to patterns that would improve public health systems based on the strengths of the ability to predict. Using AI on big data in relation to environment, health and disease statistics, disease surveillance, and social; determinants of population, AI can forecast, track, simulate and distribute health care associated with spread of infection diseases. AI can therefore aid in the fight against global health crises by definitely locating places that maybe prone to recurrent outbursts of certain diseases like COVID-19, influenza and vector borne diseases like malaria and dengue fever [39]. Moreover, population health may also be managed by AI because it can also identify the groups that have to receive more attention, and it can also indicate the approaches which should be applied to support those groups. Applying such capacity can be important in saving lives, preventing disease epidemics, reducing costs per treatments, and generally, in the best ways of distributing scarce resources within the existing conditions of most health systems of developing nations [40].

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Ethical and Regulatory Advancements: AI is still rather young and as it continues to advance the rules and regulations that govern its use and its fairness and decency, especially in relation to the HCA, will also need to evolve. A general line of improvement about AI in healthcare is the explainable AI (XAI), the process of how to make the AI models generated from machine learning more interpretable for the givers in the healthcare industry [41]. Doctors and even patients before accepting the proposed diagnostic measure or course of action require to know how an AI came up with the recommendation. To do this, there will be the need to fashion new rules that govern its use especially as the technological€' advancement proceeds to rise exponentially. Increased reliance on AI solutions shall prove possible only if those solutions are efficient and simultaneously moral and prejudice-free in the sphere of healthcare. The prospect of AI in the healthcare is likely to grow very bright in the future, while research may include the use of medicine, drug discovery, wearing devices, surgical robot and Analytics all in the pipeline. However, these advancements are going to favor continued work to respond to technical, ethical, and regulatory surmountable tasks [42]. Its use in health care grows and as means of enhancing, facilitating and optimizing, patient experience, outcomes, and cost containment, AI is one that is poised for future growth in the health care setting.

CONCLUSION

Thanks to AI, HLT has turned into one of the most successful interdisciplinary fields and is in a high-speed progress. Diagnostic and treatment technologies utilizing machine learning and artificial intelligence are integrated little by little, calling for individualized treatment, support to practicing clinicians in decision making, and continuous check in on patients. They are also participating in improvement in healthcare efficiency, accuracy, and access. But with the integration they also come with complex issues such as; security of data, biased algorithms, and regulation of those algorithms. Going forward and in the future over the next few years more doors are open for AI in health care with further breakthroughs in personalized medicine, New drug identification, tele-medicine and robot assisted surgery. It is equally going to remain instrumental in the increase in the uptake of individualized patient treatment, better patient outcomes from better clinical analytics. Second of all, it is possible to extend/ redefine the understanding of public health with the help of deep learning AI systems as well as improve diagnostics of the health state and outcomes prediction for the user as well as advance the systematic disease asymptote tailored for the user.

However, there are so many opportunities but achieving effectiveness in the utilization of AI in healthcare will have to deal with some challenges; ethical concerns, legislation, and fairness in AI models. But all the same looking at the future of artificial intelligence in the healthcare sector the outlook is bright towards improving and making the delivery of healthcare all over the world better, and more fairly and efficiently. Significant changes in the healthcare industry are not just an evolution it has become intelligent and a patient-centric data-driven industry. In the future or when advanced AI is applied in health care industry it will come up with efficient measures to handle diseases hence better models of health care being cheaper to handle patients.

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