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A Review Paper on Artificial Intelligence in Healthcare

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ABSTRACT
In recent years, artificial intelligence (AI) has advanced fast in terms of software algorithms, hardware implementation, and applications in a wide range of fields. Several forms of AI are already being used by payers and providers of care, as well as life sciences firms. Diagnose and treatment recommendations, patient involvement, adherence, and administrative operations are the most common types of applications. Even thoughthe goal of this study is to maintain track of current scientific achievements, comprehend the availability of technology, appreciate the tremendous potential of AI in biomedicine, and inspire researchers in related disciplines.New advances and breakthroughs continue to push the boundaries and scope of AI applications and are expected to grow rapidly shortly. This review summarizes the latest developments in AI applications in health care.Ethical issues in the application of AI to healthcare are also discussed.

KEYWORDS
Artificial intelligence; Digital health; Natural language processing; Machine learning; Deep learning; Robotic process automation; Precision medicine; Healthcare applications

I. Introduction

Artificial intelligence (AI) has gone beyond the realm of science fiction. It is regarded as the most revolutionary technology of the twenty-first century and beyond, having enormous societal and economic possibilities.Artificialintelligence and related technologies are becoming more and more common in business and society and are beginning to be used in healthcare. Many elements of patient care, as well as administrative operations within providers, payers, and pharmaceutical organizations, have the potential to be transformed by these technologies[[1],[2]].

Several research studies have already found that AI can perform as well as or better than humans in crucial healthcare activities such as illness diagnosis. Algorithms are already surpassing doctors in detecting dangerous tumors and advising researchers on how to build cohorts for expensive clinical trials. However, for a variety of reasons, we believe that it will be many years before AI replaces humans in medical process domains. In this review, we describe both the potential that AI offers to automate aspects of care and some of the barriers to the rapid implementation of AI in healthcare.

Figure 1

The growing availability of multi-modal data (genomics, economic, demographic, clinical, and phenotypic) combined with technological advancements in mobile, internet of things (IoT), computing power, and data security herald a moment of convergence between healthcare and technology that will fundamentally transform healthcare delivery models through AI-augmented healthcare systems.

In medical industries, AI is not applied to replace human interactions, but to provide decision support for clinicians on what they are mode modeled.Healthcare's objective is to become more personal, predictive, preventive, and interactive, and AI can make significant contributions in these areas. Based on an analysis of the accomplishments gained, we believe AI will continue to evolve and mature as a valuable tool for biomedicine. The remainder of this paper focuses on the most important AI applications.

Here, we summarize current advances in the use of AI in healthcare, present a road map for developing effective AI systems, and speculate on the likely future path of AI-augmented healthcare systems[[3]].

Figure 2

II. AI relevance to healthcare

AI is gradually changing thehealthcare landscape.There have been significant demonstrations of the potential utility of Artificial Intelligence approaches based on deep learning for use in medicaldiagnostics, and other various applications.It has been employed primarily for signal and image processing, as well as the prediction of function changes in areas such as urinary bladder control, epileptic seizures, and stroke prediction.

Because of the rising complexity and volume of data in healthcare, artificial intelligence (AI) will be used in various fields. Payers and providers of care, as well as life sciences corporate, ions, are already using AI in various forms.

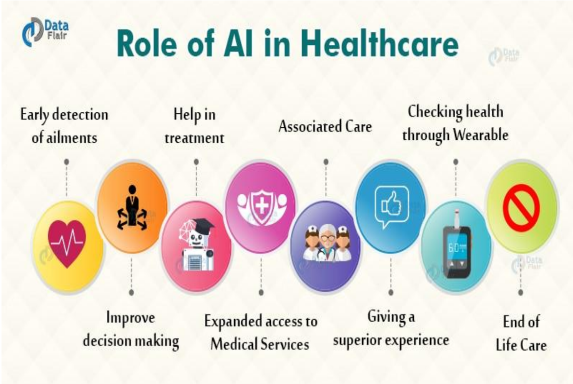

Figure 3

2.1Natural learning processing

AI researchers have been trying to understand human language since the 1950s.NLP applications include speech recognition, text analysis, translation, and other language-related aims. There are statistical NLP and semantic NLP approaches. Statistical NLP is based on machine learning (particularly deep learning neural networks) and has led to a recent boost in recognition accuracy. It is necessary to have a substantial 'corpus' or body of language from which to learn [[4]].

The most common uses of NLP in healthcare include the production, understanding, and classification of clinical documents and published research.NLP systems may analyze unstructured clinical notes on patients, create reports (for example, on radiological exams), transcribe patient conversations, and perform conversational AI.

Natural language processing can be structured in a variety of ways based on the data being analyzed, utilizing various machine learning algorithms. It might be as basic as the frequency of use or sentiment connected, or it could be more sophisticated. Whatever the application, an algorithm must be developed. The Natural Language Toolkit (NLTK) is a Python-based bundle of modules and applications for symbolic and statistical processing of the English natural language.It may aid in a variety of NLP activities such as tokenization (also known as word segmentation), part-of-speech tagging, text classification dataset creation, and much more.

These preliminary tasks in the word-level analysis are used for sorting and refining the problem and the code required to solve it. Syntax

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analysis, often known as parsing, is the process of determining the exact meaning of a phrase based on its structure using formal grammar principles. The semantic analysis would assist the computer in learning about less literal meanings that exist outside of the regular vocabulary. This is frequently associated with sentiment analysis [[5],[6]].

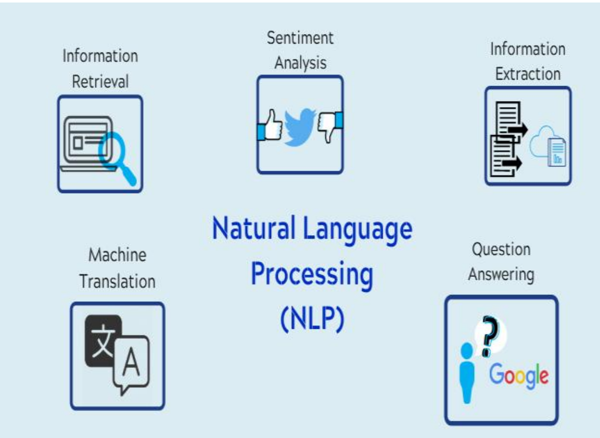

Figure 4

Real-world applications and use of cases of NLP include:

- Alexa, Siri, and Cortana are examples of voice-managed assistants.
- Customer support chatbots use natural language generation to answer questions.
- Using sites like LinkedIn to streamline the recruiting process by screening through people's listed talents and expertise.
- Grammarly, for example, uses NLP to assist detect mistakes and give suggestions for streamlining difficult text.
- Language models, such as autocomplete, are taught to anticipate the next words in a text based on what was previously input.

2.2 Machine learning – neural networks and deep learning

Machine learning, in its most basic form, provides a collection of approaches used to address a range of real-world problems using computer systems that can learn to solve a problem rather than being explicitly programmed. In general, there are three types of learning: supervised, unsupervised, and reinforced. Supervised learning is a set of strategies and algorithms for learning the mapping from input to output.

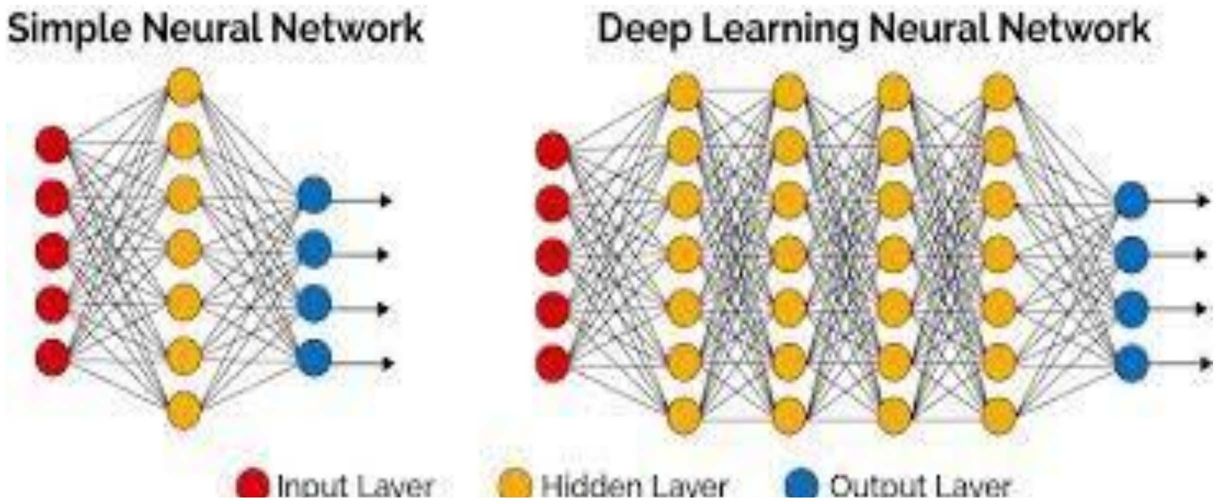

Figure 5

ML is a statistical approach for fitting models to data and 'learning' from data through training models. One of the most prevalent types of AI is machine learning. The most prevalent use of classical machine learning in healthcare is precision medicine, which predicts which treatment protocols are likely to be successful on a patient based on numerous patient traits and the treatment environment. The vast majority of machine learning and precision medicine applications require a training dataset with known outcome variables (for example, illness onset); this is known as supervised learning.

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The neural network is a more complicated kind of machine learning that has been accessible since the 1960s and has been well established in healthcare research for several decades and has been used for categorization applications such as identifying whether a patient would get a specific illness.
Deep learning, or neural network models with many layers of features or variables that predict outcomes, is one of the most sophisticated types of machine learning. The quicker processing of today's graphics processing units and cloud systems may reveal hundreds of hidden characteristics in such models [[7]].
Deep learning is also increasingly being utilized for voice recognition, and as such is a kind of natural language processing (NLP), which is discussed more below. In contrast to previous kinds of statistical analysis, each character in a deep learning model usually has little relevance to a human observer. As a result, explaining the model's conclusions may be extremely difficult or impossible [[8]].
Detecting potentially malignant tumors in X-ray images is a typical application of deep learning in healthcare.Deep learning is rapidly being used in radionics or the discovery of clinically significant patterns in imaging data that go beyond what the human eye can see. Oncology-oriented image analysis frequently employs both radionics and deep learning. Their combination looks to offer more diagnostic accuracy than the previous generation of automated image analysis techniques, known as computer-aided detection or CAD.

2.3 Physical robots – Autonomous robot surgeries

In medicine, robots are revolutionizing surgery, speeding up care and cleaning, and allowing doctors to focus on connectingand caring for their patients. Intel has a varied portfolio of medical robot technologies, including surgical assistance, modular, and autonomous mobile robots.

Figure 6

- Physical robots are now well known, with over 375,000 industrial robots installed worldwide each year.

- First approved in the United States in 2000, surgical robots give surgeons "superpowers" to improve vision, make precise, minimally invasive incisions, suture wounds, and more...

- Common surgeries using robotic surgery include gynecological surgery, prostate surgery, and head and neck surgery.

Likely, the same advances in intelligence found in other fields of AI will be implemented into physical robots throughout time [[9]].

Figure 7

The discipline of surgical robotics is growing to make more use of artificial intelligence.

2.3.1 Computer vision

Computer vision allows surgical robots to distinguish between different kinds of tissue within their range of view. Surgical robots, for example, may now assist surgeons in avoiding nerves and muscles during procedures. High-definition 3D computer vision may offer surgeons detailed information and improve operational performance. Under the careful eye of the surgeon, robots will eventually be able to take over tiny sub-procedures such as suturing or other prescribed activities.

CNNs are increasingly being used in medical image interpretation, for example, to distinguish between chest X-rays with and without cancerous nodules. In this case, a series of labeled or annotated chest X-rays areutilized to train neural networks to calculate characteristics that are trustworthy indications of malignancy or lack thereof.

Robotics is very important in surgeon education. AI and virtual reality are used in simulation platforms to give surgical robotics training. Surgeons may practice treatments and enhance abilities utilizing robotics controls in the virtual environment.

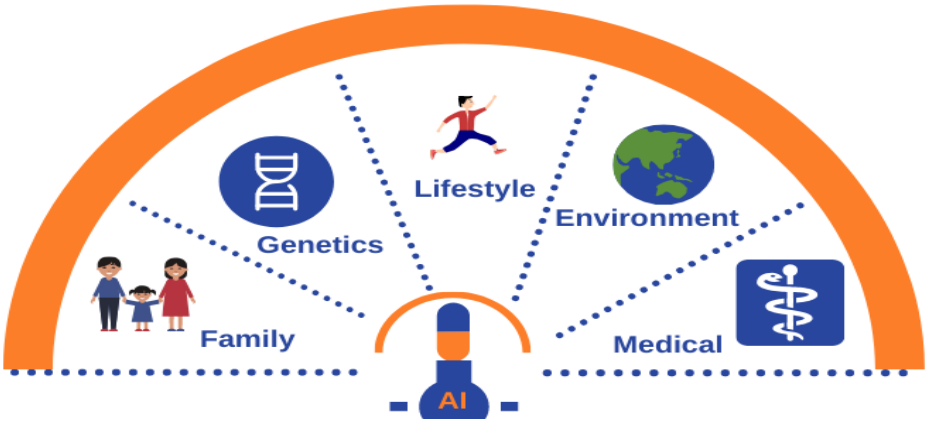

Figure 9

2.4 Robotic process automation

This technology conducts organized digital administration duties, such as those involving information systems as if they were human users following a script or set of rules. When compared to other types of AI, they are less costly, easier to develop, and more transparent in their activities. Robotic process automation (RPA) does not include robots, but rather acomputer application running on servers. To operate as a semi-intelligent user of the systems, it combines workflow, business rules, and 'presentation layer' interaction with information systems. They are employed in healthcare for repetitive operations such as prior authorization, updating patient information, and billing. They can be used in conjunction with other technologies, such as image recognition, to extract data from faxed photographs and feed it into transactional systems [[10]].

Simply said, RPA employs software to do activities that formerly needed human intervention, including data extraction, form filling, and file sharing, providing a cost-effective alternative to traditional process techniques. This may seem dull or thrilling depending on whom you are, especially when compared to genuine robots cleansing hospitals and aiding nurses, but it is by design. Often, the most significant inventions begin tiny and basic. RPA is concerned with automating monotonous and repetitive work fororganizations to enhance their processes, boost efficiency, and, eventually, decrease costs.

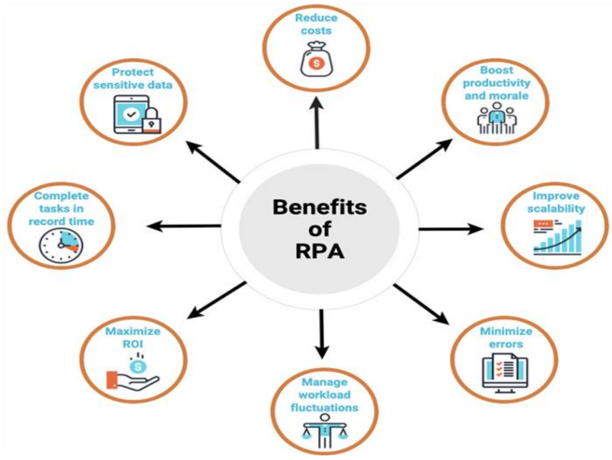

Figure 8

Patient onboarding, scheduling, referral management, billing, and claims administration are just a few of the repeated operations and choices in healthcare that rely on the availability of reliable data. While effective data processing and data exchange are critical, human data entry may be time-consuming, error-prone, and expensive.

Healthcare organizations are well positioned to profit tremendously from RPA, given the need to reduce costs and streamline operations.RPA is portrayed in current literature as the future of automation for all corporate enterprises[[12]].

All data input for the Agency will be automated in the near future. RPA will be used to manage all computer operations that are regulated by a set of protocols. Furthermore, it can improve analytics for numerous organizations that provide web services. In the next years, more and more businesses will become aware of the benefits of RPA, leading to rapid and consistent adoption of RPA[[11]].

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III. Precision medicine

Precision medicine, a patient-centered approach based on tailored medicines, is another field ripe for AI advancement. This medical strategy, also known as personalized medicine, mixes genetics, behavior, and environment to personalize therapy intervention to a specific patient or group — providing an alternative to traditional medicine's one-size-fits-all approach.

Doctors are increasingly embracing AI to develop precise therapies for difficult diseases, allowing them to evaluate massive datasets that were previously too convoluted to provide useful insights. Researchers may facilitate the creation of new treatments, uncover new applications for current drugs, recommend individualized combinations, and even anticipate illness risk using fresh insights into what keeps patients healthy at the individual level.

We should anticipate seeing a rise in the usage of tiny biosensors and devices, as well as mobile applications with more advanced remote monitoring capabilities, in the future years, providing physicians with even more goldmines of data to work with. Aside from offering patients more control and boosting the efficacy of their therapy, the use of AI technology may boost R&D while also lowering expenses.

3.1 Environmental considerations in therapy planning

Incorporating environmental issues into management plans necessitates adequate personal and environmental information, which may influence a patient's risk of a bad result, knowledge about treatment choices, and the conditions under which each alternative may be ideal.

One such example is the difficulty in diagnosing homelessness in some patients. These patients may require care in several sites over a short period of time, necessitating frequent revaluations of patient demographic data. Transportation, the provision of drugs that require refrigeration, and the use of diagnostic modalities that require power (for monitoring) must all be changed properly.

Another environmental factor to consider is the availability of knowledge in remote places, especially skilled specialists at the moment of need. AI has produced multiple examples of boosting diagnostic capacities in resource-limited settings, which may result in improved patient categorization and, as a result, more tailored therapy planning. Deep learning has been used to identify patients with malaria and cervical cancer, as well as forecast infectious disease outbreaks, environmental toxin exposure, and allergen load [[13]].

3.2 Clinical trials

Machine-learning algorithms can improve clinical trial research in a variety of ways. For example, powerful predictive analytics may help researchers discover candidates for clinical trials by analyzing a wide range of data such as social media presence, interactions with GPs, and how their genetic information relates to a certain target group. The expenses of recruiting for clinical trials might be enormous, but AI technologies can drastically cut them.

Researchers can maintain a closer eye on biological changes and detect if a person is reacting negatively to therapy thanks to real-time data access and remote monitoring of individuals.

3.3 New curative treatments

Synthetic biology has delivered breakthroughs such as CRISPR gene editing and several personalized cancer medicines during the last decade. However, the life cycle for creating such sophisticated medicines remains inefficient and costly.

With improved data access (genomic, proteomic, glycolic, metabolomic, and bioinformatic), AI will be able to manage significantly more systematic complexity in the future, transforming the way we study, discover, and alter biology. This will improve the efficiency of the drug discovery process by allowing researchers to better predict which agents are more likely to be effective early on, as well as better anticipate adverse drug effects, which have frequently stymied the further development of otherwise effective drugs at a costly late stage in the development process. As a result, access to breakthrough sophisticated medicines will become more affordable [[14]].

IV. Medical diagnosis

Medical diagnostic is a type of medical testing used to diagnose infections, illnesses, and disorders. Unsurprisingly, several of the tech titans have jumped right in. In 2016, IBM Watson Health collaborated with Quest Diagnostics to introduce IBM Watson Genomics, which seeks to provide highly tailored cancer therapy by merging cognitive computing with cutting-edge genetic tumor sequencing.

4.1 Medical imaging

Clinical Imaging is defined as the collection of methods that provide images of the inside of the body. The process and cycles are used to photograph the human body for clinical applications such as detecting, analyzing, or inspecting an injury, brokenness, or disease. CT scan outputs are excellent examples of useful indicative imaging that enables precise conclusion, mediation, and assessment of harms and dysfunctions that actual advisers deal with on a regular basis, further considerations suggest overuse of imaging, such as X-rays or magnetic resonance imaging (MRI), for intense and demanding tasks [[15]].

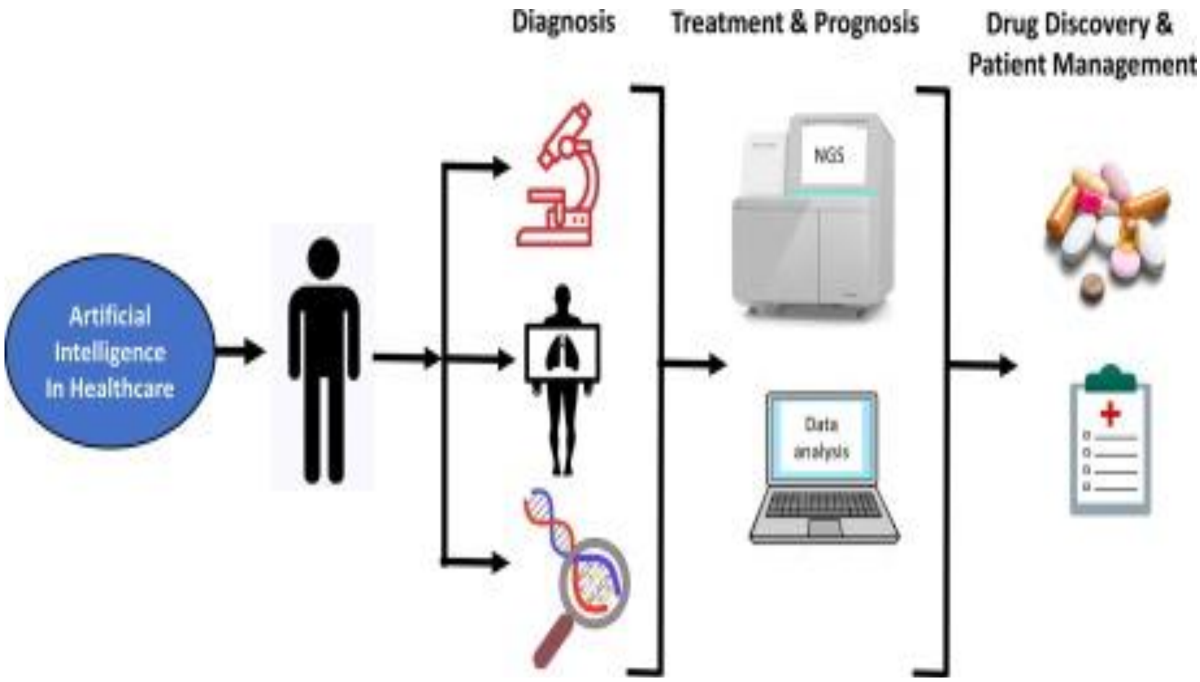

Figure 10

4.1.1 Interventional radiology

Interventional radiologists are doctors who utilize imaging to guide procedures such as CT, ultrasound, MRI, and fluoroscopy. When placing catheters, cables, and other

small objects and devices inside the body, imaging help doctors. This usually results in lesser incisions (cuts). Instead of peering into your body with a scope (camera) or performing open surgery, doctors may utilize this technology to identify or treat diseases in practically any region of your body [[16]].

Interventional radiologists frequently treat malignancies or tumors, artery and vein obstructions, uterine fibroids, back discomfort, liver disorders, and renal difficulties. The doctor will make no or only a minor incision. After the surgery, you rarely need to stay in the hospital.

4.2 Diagnosis and treatment applications

- Disease diagnosis and treatment have been at the heart of AI since at least the 1970s.

- IBM's Watson has received significant media attention for its focus on precision medicine, especially cancer diagnosis and treatment.

- Many of these findings are based on radiological image analysis, though some involve other types of images such as retinal scanning or genomic-based precision medicine.

- Since these findings are based on statistically driven machine learning models, they usher in an era of evidence-based and probabilistic medicine, which is often seen as positive but comes with many challenges.

- For example, Google is working with healthcare delivery networks to create predictive models from big data to alert clinicians to high-risk conditions, such as infectionsand heart failure.

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V. Administrative applications

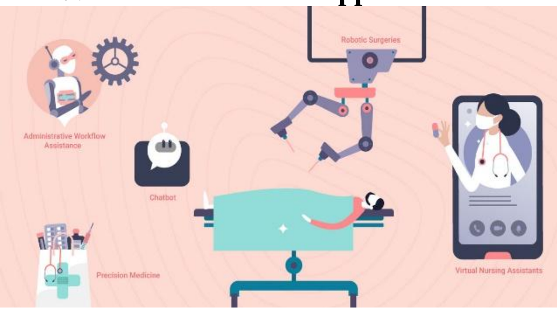

Figure 11

There are several administrative applications in healthcare. In this arena, the application of AI is less potentially revolutionary than in patient care, although it can generate significant efficiencies.

- It can be used for a variety of healthcare applications such as claims processing, clinical documentation, revenue cycle management, and medical records management.

- Healthcare businesses have additionally experimented with chatbots for affected person interaction, intellectual fitness and wellness, and telehealth.These NLP-based apps can be useful for simple transactions like refilling prescriptions or booking appointments.

- Another AI technology with relevance to claims and payment administration is machine learning, which can be used for the probabilistic matching of data across different databases.

- Reliably identifying, analyzing, and correcting coding issues and incorrect claims save all stakeholders – health insurers, governments, and providers alike – a greatdeal of time, money, and effort [[17],[18]].

VI. Challenges of AI in healthcare

We recognize that widespread adoption and implementation of AI in healthcare systems will present substantial obstacles.

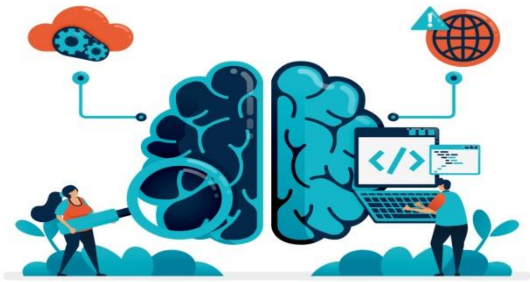

Figure 12

These problems include but are not limited to, data quality and availability, technical infrastructure, organizational capability, ethical and responsible behaviors, and safety and regulatory considerations [[19]]. Some of these concerns have been addressed below:

- Many AI algorithms, especially deep learning algorithms used to analyze images, are nearly impossible to interpret or explain.
- AI systems inevitably make mistakes in diagnosing and treating patients, and it is difficult to establish accountability.
- Needs human surveillance
- Transparency
- Inaccuracies are still possible
- Susceptible to risk
- May lead to unemployment
- Integration issues
- Data exchange
- Privacy and security
- Development costs

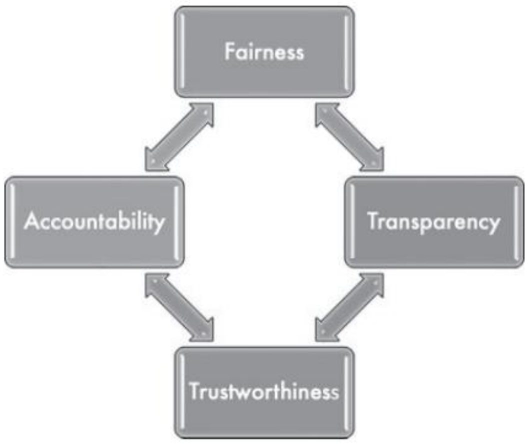

Figure 13

While these are substantial barriers to AI acceptance and application in health, they are not without answers. Most medical DL models are tiny and focused on medical image interpretation, which has fewer structural and repeatability difficulties [[20],[21],[22]].

VII. Conclusion

AI advancements have the potential to alter many aspects of healthcare, providing a more personalized, accurate, predictive, and portable future. It is unknown whether we will see gradual or dramatic adoption of new technologies, but the influence of such technologies and the digital renaissance they offer compels health systems to evaluate how best to adapt to the changing landscape.

It is the key capacity driving the development of precision medicine, which is universally acknowledged to be a much-needed enhancement in treatment. Although early efforts to provide diagnostic and treatment suggestions were difficult, we anticipate that AI will eventually master that domain as well. Given the fast advancements in artificial intelligence for imaging processing, it is likely that most radiology and pathology pictures will be analyzed by a computer at some time. Speech and text recognition are being used for activities such as patient communication and clinical note recording, and their use will grow.

It is becoming increasingly clear that AI systems will not completely replace human doctors but complement their efforts in patient care. Human therapists may eventually turn to activities and work designs that require distinct human talents such as empathy, persuasion, and holistic integration. Those healthcare practitioners who refuse to collaborate with artificial intelligence may be the only ones who lose their employment over time.

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