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A Review On AI Technology Used In Health Care

Mr. Datta Mule[1], Mr. Pramod Mapari[2], Dr. Sunil Jaybhaye[3].

Institute of Pharmacy, (NKSPT) Pathrikar Campus, Badnapur, Jalna. 431202

1 Student of Bachelor in Pharmacy, Dr. Babasaheb Ambedkar Technological University, Raigad, Lonere

2,3 Department of Pharmacy, Faculty of Pharmacy, Dr. Babasaheb Ambedkar Technological University, Raigad, Lonere

ABSTRACT:

Artificial Intelligence (AI) is transforming the healthcare sector by improving diagnostic precision, personalizing treatment plans, and simplifying administrative workflows through advanced algorithms and machine learning techniques. This review highlights AI's growing influence in key areas such as medical imaging, diagnostics, individualized therapy, drug development, patient monitoring, and surgical support. By analyzing large and complex sets of medical data, AI enhances clinical decision-making, forecasts health outcomes, and strengthens hospital management systems.

AI delivers numerous advantages, including fewer diagnostic mistakes, faster processing of clinical information, and reduced healthcare expenses. Looking ahead, AI is expected to drive further breakthroughs such as robot-assisted surgeries, virtual healthcare through remote consultations, and sophisticated health tracking using wearable technologies. The integration of AI not only improves patient outcomes but also advances medical research and boosts operational efficiency, contributing to a more accessible and effective global healthcare ecosystem.

To fully realize the benefits of AI in healthcare, continuous research, strong regulatory frameworks, and strict adherence to ethical guidelines are necessary to safeguard patient wellbeing and maintain trust.

KEYWORDS:

Artificial intelligence, AI-led drug discovery, AI-assisted clinical trials, patients Care,drug discovery, drug development, Robotics. Scope of AI.

I. INTRODUCTION:

The healthcare sector is undergoing a major transformation driven by rising healthcare costs and a growing shortage of medical professionals. To address these challenges, the industry is increasingly turning to information-technology-based innovations that can reduce expenses and offer practical solutions[1].Globally, healthcare systems continue to struggle with issues such as limited access to services, escalating costs, inefficiencies, and the pressures of an aging population. Public health emergencies—such as the COVID-19 pandemic—have further strained these systems, leading to shortages of protective equipment, unreliable diagnostic testing, overwhelmed medical staff, and inadequate information sharing. Crises like COVID-19 or earlier epidemics such as HIV have exposed serious weaknesses in existing healthcare structures[2].As these challenges intensify, they also create opportunities to rethink and redesign models of care and administrative processes. Persistent problems such as unequal access to healthcare, limited availability of ondemand services, high treatment costs, and poor price transparency highlight the urgent need for system-wide improvements.

A major advancement of AI In healthcare is its use in diagnostics and medical imaging. AIpowered systems can examine X-rays, CT scans, MRIs, and other medical images to identify abnormalities, tumors, and various conditions with remarkable precision[3]. This capability supports earlier and more accurate diagnosis, ultimately improving patient outcomes and treatment effectiveness.

Artificial intelligence (AI) is evolving rapidly, and its influence on the healthcare sector is increasingly significant. Modern AI tools have the potential to transform patient care by enhancing the efficiency of medical services, enabling personalized treatment approaches, and strengthening diagnostic capabilities. These innovations can be seamlessly integrated into traditional healthcare systems. This paper explores the current applications of AI in healthcare, outlines the benefits and challenges associated with its adoption, and considers future possibilities for improving patient outcomes through AI-driven advancements.

The integration of AI technologies into healthcare is no longer a future concept—it is a rapidly unfolding reality. This shift is fueled by the explosive growth of healthcare data, advancements in computing capabilities, and major progress in machine learning techniques. In modern healthcare, AI is applied in numerous areas, including medical image interpretation, pattern recognition, and the delivery of personalized treatment plans derived from patient records and genetic profiles. Machine learning models can forecast patient outcomes, streamline hospital workflows, and support drug discovery by analyzing large and complex datasets that would be impossible for humans to process efficiently.

While AI can analyze massive amounts of information that would be overwhelming for humans to process manually, its integration into healthcare is not without challenges. Key concerns include protecting patient data, upholding ethical standards, and ensuring that AI-based diagnostic and treatment tools are accurate and trustworthy[4]. Nevertheless, with continued research, technological advancement, and strong regulatory guidance, AI has the potential to greatly enhance patient outcomes, lower healthcare costs, and transform the future of medical practice.

In practice, physicians may at times rely too heavily on their personal observations, leading them to believe a diagnosis is accurate or a treatment is effective even when scientific evidence or data from large patient populations suggests otherwise. In some cases, clinicians may simply be unaware of newly developed diagnostic tools or updated treatment pathways emerging from recent research. Additionally, the pressures of the modern healthcare system—where providers are often required to see a high volume of patients to maintain reimbursement—can further limit their ability to stay current with evolving medical knowledge.

The rapid growth of biomedical sciences—such as genomics, digital health, artificial intelligence (AI), and its branch machine learning (ML)—is driving a major transformation in healthcare. These emerging

technologies are reshaping clinical practice and creating the need for a new type of skilled workforce and updated standards of care. Innovations in genomics, biometrics, tissue engineering, and vaccine development are enhancing and redefining diagnostics, therapeutics, care delivery, regenerative medicine, and precision healthcare approaches[5].

II. APPLICATIONS OF AI IN HEALTHCARE:

Below are several ways in which medical artificial intelligence is applied within the healthcare sector.

1. AI for Drug Discovery :

AI technologies are significantly accelerating the drug discovery process in the healthcare and pharmaceutical sectors. These systems can automatically identify potential biological targets and analyze off-target interactions, enabling efficient drug repurposing . As a result, AI-driven drug discovery reduces repetitive tasks, streamlines workflows, and shortens the timeline required to develop new therapies .

Several leading biopharmaceutical companies have already adopted these innovations. Pfizer, for example, uses IBM Watson—a machine learning–based platform—to support its search for immuno-oncology treatments . Sanofi has partnered with Exscientia to utilize its AI platform for developing metabolic disease therapies, while Genentech, a subsidiary of Roche, is collaborating with GNS Healthcare to apply AI tools in cancer drug research.Many major pharmaceutical firms now maintain similar partnerships or in-house AI programs.

If advocates of these technologies are correct, AI and machine learning will usher in a new era of drug development that is faster, more cost-efficient, and more productive. Although some remain cautious, most experts agree that AI will play an increasingly central role in future drug discovery. This shift presents both challenges and new opportunities for scientists, especially as AI approaches are combined with laboratory automation [7].

2. AI for clinical trials:

Clinical trials involve administering newly developed treatments to volunteers in order to evaluate their effectiveness and safety. Traditionally, this process requires considerable time and financial investment, yet the overall success rate remains relatively low. In this context, automating clinical trial processes has become a major advantage for the healthcare industry, with AI playing a key role. AI technologies help reduce the burden of time-consuming data monitoring tasks, manage large and complex datasets, and generate highly accurate insights[8].

3. Intelligent clinical trials:

Traditional clinical trials, which follow a linear and step-by-step structure, remain the gold standard for evaluating the safety and effectiveness of new medications. These well-established randomized controlled trial (RCT) phases were originally designed for large-scale pharmaceutical development and have changed very little over the years. However, artificial intelligence offers the potential to significantly shorten clinical trial timelines while improving efficiency and overall clinical development outcomes. This discussion forms the third report in a series examining AI's influence on the biopharmaceutical value chain .

In recent years, biopharmaceutical companies have gained access to growing amounts of scientific and research information from many sources, commonly referred to as real-world data (RWD). Yet many organizations still lack the specialized tools and expertise needed to extract meaningful value from this data. By applying predictive AI models and advanced analytics, researchers can better understand disease patterns, identify suitable patients and key investigators, and design innovative clinical studies [9].

4. Clinical Trial Cooperation and model sharing:

Researchers across multiple disciplines have been working at unprecedented speed to support the global response to COVID-19, demonstrating an exceptional level of scientific collaboration. Achieving large-scale impact with AI tools, however, requires robust strategies for sharing data, models, and code, as well as adapting these tools to local contexts and promoting international cooperation .

AI systems depend heavily on high-quality data. Currently, numerous COVID-19–related datasharing initiatives exist globally, nationally, and locally. These efforts involve resources such as genetic sequences, genomic analyses, protein structures, clinical patient data, medical imaging, epidemiological information, mobility data, social media discussions, news reports, and scientific publications. However, the fragmentation of these initiatives poses a challenge, as it can restrict progress to isolated projects or communities. Developing scalable frameworks for sharing data, models, and code could greatly accelerate the creation and dissemination of impactful AI applications. Open, comprehensive, comparable, and verifiable global data-sharing systems are essential for strengthening collaboration across regions and research communities [10].

III. CURRENT APPLICATIONS OF AI IN HEALTHCARE:

Machine learning is a field within artificial intelligence that enables computer systems to learn patterns from data and improve their performance without being directly programmed for every task. In healthcare, machine learning has become especially valuable, supporting areas such as medical image interpretation, disease diagnosis, and personalized treatment planning[11].

In medical imaging, machine learning models are trained on large collections of labelled MRI, CT, and X-ray images. Through this training, they learn to recognize abnormalities—such as tumors, lesions, or fractures—with impressive accuracy. These systems can detect subtle patterns that may be difficult for human specialists to notice, allowing radiologists to make faster and more reliable decisions.

Beyond image analysis, machine learning also helps predict how diseases may progress and how patients might respond to specific treatments. By examining clinical data, genetic profiles, and biomarkers, predictive models can highlight risk factors and classify patients according to their likelihood of developing complications. This supports early intervention and helps clinicians tailor treatment strategies to individual needs. For instance, in cancer care, machine learning can estimate the chances of recurrence and suggest treatment pathways that fit a patient's unique profile.

Machine learning also enhances clinical decision-making by analyzing large amounts of patient records, treatment outcomes, and medical guidelines. These insights can lead to more informed recommendations and help doctors choose the most effective therapies.

In research, machine learning plays a major role in discovering new patterns within genomic, proteomic, and other biological datasets. Such analysis can reveal genetic indicators, biomarkers, or drug targets that may not be detectable through traditional methods, accelerating drug discovery and enabling more precise medicine.

Despite these advantages, applying machine learning in healthcare comes with challenges. Issues such as data accuracy, patient privacy, and ethical considerations must be addressed carefully. Additionally, the success of machine learning systems depends on access to diverse, high-quality datasets and close collaboration between medical experts and data scientists[12].

IV. ROLE OF AI IN HEALTH CARE:

1. Medical Imaging and Diagnostic Services

AI has become a highly effective tool for interpreting medical images, and radiology professionals increasingly rely on it to support early disease detection and reduce diagnostic errors. Similarly, AI systems are proving valuable in analyzing ECG and echocardiography data, helping cardiologists make more accurate clinical decisions. One example is the Ultromics platform used in an Oxford hospital, which employs AI to study echocardiography scans, identify heartbeat patterns, and detect ischemic heart disease.

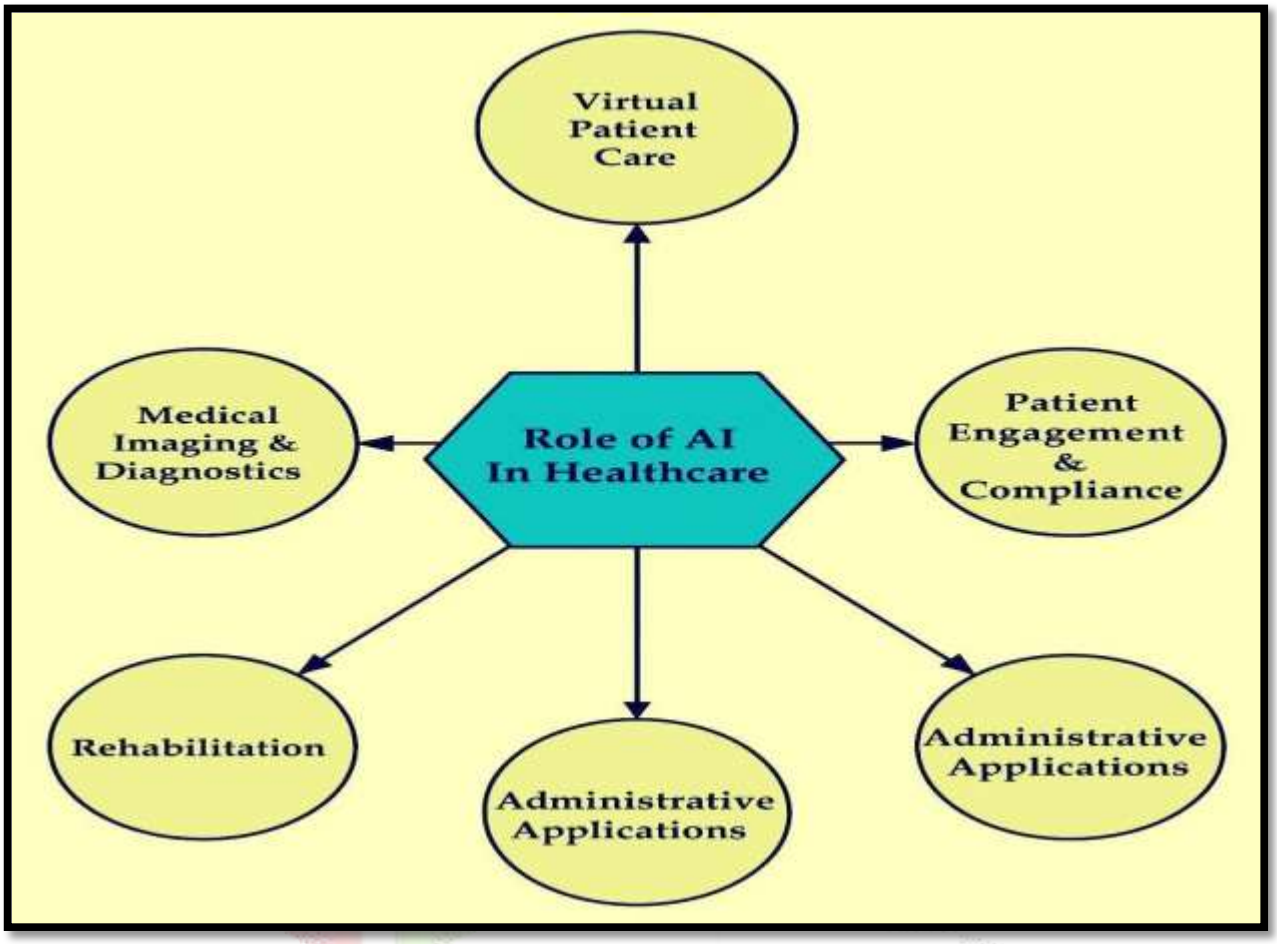

Figure No 1: Role of AI in Healthcare

AI-based methods have shown strong performance in identifying conditions such as breast cancer, skin cancer, eye diseases, and pneumonia through various imaging techniques. Beyond imaging, AI algorithms can evaluate speech patterns to predict potential psychotic episodes and recognize characteristics of neurological disorders like Parkinson's disease. Machine learning models have also been used to forecast diabetes onset, with a two-class augmented decision tree emerging as the most effective model for predicting diabetes-related variables.

Research by Gudigar and colleagues highlighted that AI-enhanced imaging systems—including X-ray, CT, and ultrasound—played an important role in the early detection of COVID-19. They found that handcrafted feature learning approaches, deep neural networks, and hybrid models all had strong predictive capabilities. A separate review discussed how CT, X-ray, MRI, and ultrasound were applied to diagnose COVID-19, emphasizing the significant role AI played in the global response.

Deep learning architectures such as transformers are now widely used in medical imaging tasks, including registration, detection, classification, segmentation, image translation, and video analysis. Studies have demonstrated that transformer-based models can distinguish COVID-19 from pneumonia using X-ray and CT images, helping meet the urgent need for rapid diagnosis during the pandemic. Other research used a pretrained Vision Transformer (ViT-B/32) model with X-ray image patches to identify COVID-19 cases.

Wang and colleagues developed a hybrid CT-based AI method that automatically detects COVID19. Their approach integrates wavelet Renyi entropy (WRE), a feedforward neural network (FNN), and a three-segment biogeography-based optimization (3SBBO) algorithm. In this system, WRE extracts features, the 3SBBO algorithm optimizes the network's parameters, and the FNN performs the classification. Their technique outperformed several traditional machine-learning models. Additionally, Gheflati and co-authors reported that ViT models can effectively classify normal, benign, and malignant breast tissues from ultrasound images, showing superior performance compared to conventional convolutional neural networks[13].

2. **Virtual Patient Care:**

Virtual patient care refers to healthcare services delivered remotely through digital tools such as video consultations, mobile apps, and other online platforms. Instead of traveling to a clinic or hospital, patients can connect with healthcare providers from their own homes. The concept of "virtual care" covers a broad range of methods used to deliver medical support from a distance.

The main goal of virtual care is to strengthen healthcare systems—meaning the people, organizations, and resources that work together to meet a population's health needs—while also helping control rising medical costs. Virtual care is not meant to replace in-person visits or traditional telehealth but to complement them. It offers patients more flexibility in choosing when, where, and how they receive care based on their personal needs.

To truly benefit from virtual care, the focus must shift from theoretical ideas to practical implementation. This means building a healthcare system that actively supports, adopts, and integrates virtual care into everyday practice.

3. **Health Monitoring**:

A major challenge in healthcare today is ensuring proper and continuous health monitoring. Many patients experience serious complications because they do not have access to reliable monitoring systems. Although several internet-connected devices exist to track health data, consistent and accurate monitoring is still lacking.

AI-powered health monitoring uses intelligent technologies to observe and analyze a person's health in real time. Artificial intelligence can process information collected from wearable devices—such as smartwatches and fitness bands—that record heart rate, sleep quality, physical activity, and other vital signals.

We propose an automated system designed to track key health indicators, including body temperature, heart rate, blood pressure, and body movements. In addition to monitoring, the system can analyze these parameters along with additional symptoms to predict the potential presence of chronic diseases or other health conditions. This enhanced approach aims to support early detection and improve patient care[14].

4. Medical Research and Drug Discovery:

AI is highly effective for examining the vast and complex datasets commonly used in medical research. It can also help researchers search scientific literature, merge multiple forms of data, and accelerate the development of new drugs. Many pharmaceutical companies now rely on AI to make the drug-development pipeline more efficient. Through predictive analytics, scientists can identify suitable candidates for clinical trials and build more accurate models of biological mechanisms.

Machine learning (ML) supports several stages of clinical trials, including the pre-trial phase, selecting participant groups, coordinating trial activities, and processing collected data. These technologies can improve patient-centered outcomes, overall trial effectiveness, and the likelihood of successful study completion. Despite these strengths, ML still faces practical and conceptual challenges that need further attention in the context of clinical trials.

Natural language processing (NLP) has also demonstrated usefulness for tasks related to participant management, yet its influence on trial quality and participant satisfaction remains unclear. More comparative research is required to determine the best strategies for improving trialrelated processes.

In medical research, generative AI can produce synthetic datasets to increase data volume and diversity. Additionally, immersive digital environments—often referred to as the metaverse— allow researchers to conduct experiments in a controlled virtual space, enabling collaboration even when team members are geographically separated.

5. Administrative Applications :

AI can help ease administrative workloads by automatically filling structured fields from clinical notes, pulling important information from previous health records, and organizing documented patient interactions. In many healthcare settings, a significant amount of time is spent on paperwork—for instance, nurses in the United States reportedly devote around one-quarter of their working hours to administrative and regulatory activities. Tools such as voice-based documentation can help reduce this burden for both nurses and doctors.

While traditional rule-based systems connected to electronic health record (EHR) platforms are widely used, their accuracy often falls short when compared to machine-learning-driven approaches. Wang et al. reported that Amazon is developing an advanced ML system designed to extract meaningful insights from unstructured EHR data and clinical notes.

Li et al. introduced BEHRT (Bidirectional Encoder Representations for Transformers in EHR), a deep learning model that treats EHRs as sequential data. BEHRT uses multiple types of embeddings—including age, temporal order, visit information, and clinical events—to represent a patient's medical history. The model can predict the likelihood of more than 300 different conditions in upcoming patient visits and demonstrates stronger precision across multiple tasks compared with existing EHR-focused deep learningmodels. Its flexible design allows it to incorporate diverse clinical concepts such as assessments, diagnoses, and medications, resulting in more accurate predictions.

A more recent development, the hierarchical BEHRT (Hi-BEHRT), uses a transformer-based hierarchical structure for risk prediction. Studies have shown that Hi-BEHRT performs significantly better than other deep-learning approaches when used to predict health risks for patients with long-standing conditions such as diabetes, stroke, heart failure, and chronic kidney disease[15].

V. SCOPE OF AI IN HEALTH CARE:

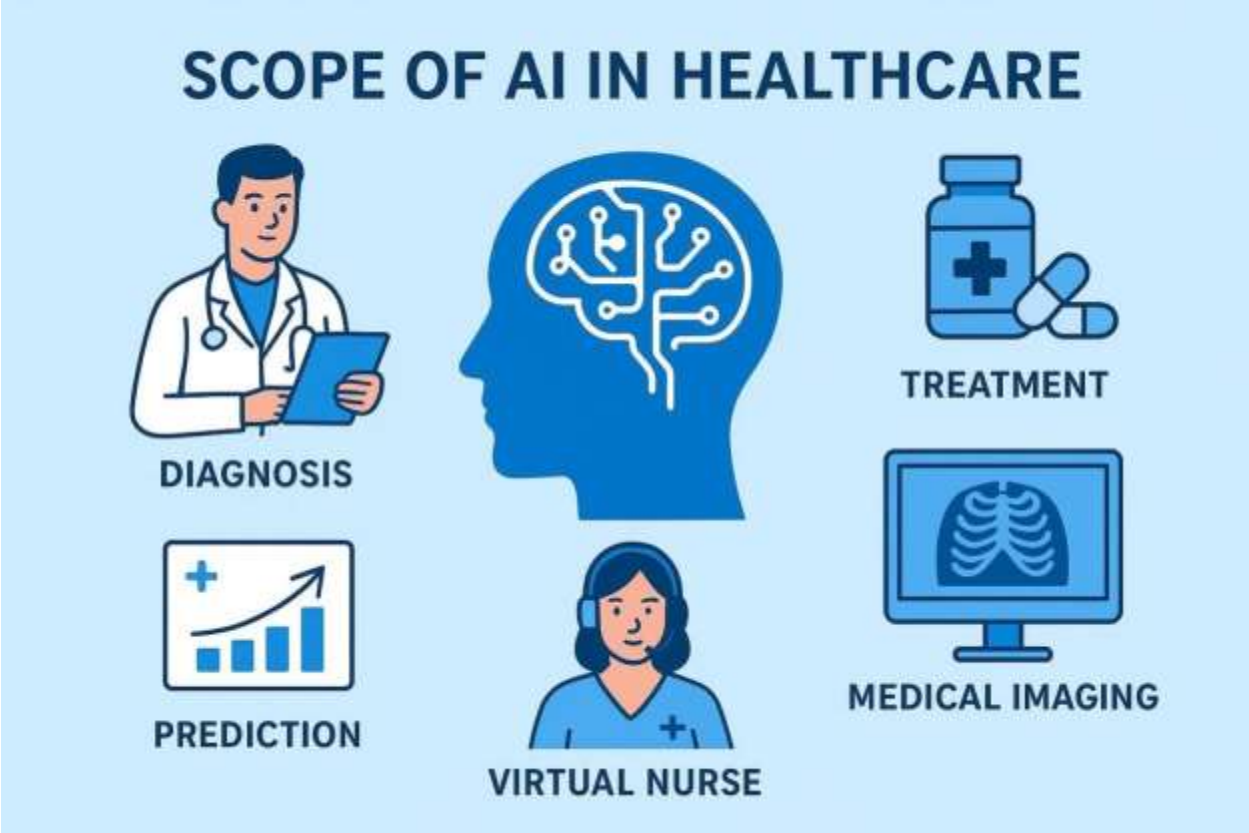

Figure No.2 : Scope of AI in Health care

As AI technologies continue to evolve, future systems are expected to become even more sophisticated, capable of performing a broader range of tasks with minimal or no human intervention. In healthcare, such advancements offer significant benefits for both patients and medical professionals. However, overseeing and regulating these systems remains a challenging responsibility.

Artificial intelligence is rapidly advancing in the medical field and is poised to influence every aspect of primary care. With AI-powered tools, healthcare providers will be better equipped to identify patients who require additional evaluation and to design personalized treatment plans. The growing fields of genomics, digital health, machine learning, and other biomedical innovations are driving major changes in healthcare systems and practices[16].

As these technologies expand, there is an increasing need for a new type of workforce and updated professional standards. Innovations such as genomics, biometrics, tissue engineering, and vaccine development are expected to transform diagnostic methods, therapeutic approaches, care delivery models, regenerative medicine, and precision healthcare. Together, these advancements lay the foundation for a more efficient, accurate, and personalized healthcare system[17].

VI. ROBOTICS IN HEALTH CARE:

What is a Robot?

The word robot originates from the Czech term “robota,” which means forced work, servant, or drudgery. The modern use of the word first appeared in the 1920s in Karel Čapek’s play Rossum’s Universal Robots, where it referred to artificial, human-like machines. Today’s understanding of robots, however, is shaped by advancements in artificial intelligence and mechatronics.

In modern terms, a robot is a mechanical, physically present intelligent system capable of moving through its environment and performing complex tasks. Devices that lack physical movement or mechanical action are generally not classified as robots. Based on this definition, most robots are designed to perform three main functions—either autonomously or with limited human assistance:

- Perceive their surroundings,

- Process information to make decisions, and

- Carry out mechanical actions in the real world.

These functions form a continuous loop of sensing, thinking, and acting that enables robots to operate effectively.

Robots are commonly grouped into two major categories: industrial robots and service robots. Industrial robots are used primarily in factory automation, while service robots operate in personal, domestic, and professional environments. Healthcare robots represent a branch of service robots designed specifically to assist with medical tasks—such as diagnosing diseases, supporting individuals with disabilities, assisting in rehabilitation, and helping with patient care and medical procedures[18].

Unlike industrial robots, which are mainly created to perform hazardous, or physically demanding tasks without human involvement, healthcare and service robots must work safely alongside people in hospitals, clinics, and homes. They are built for environments where direct human interaction is unavoidable

Today, more than eight million robots operate worldwide. Although healthcare robots are still emerging and many are in experimental or developmental stages, their use is expected to expand rapidly due to aging populations, increasing healthcare demands, workforce shortages, and the need to provide high-quality care at lower costs.

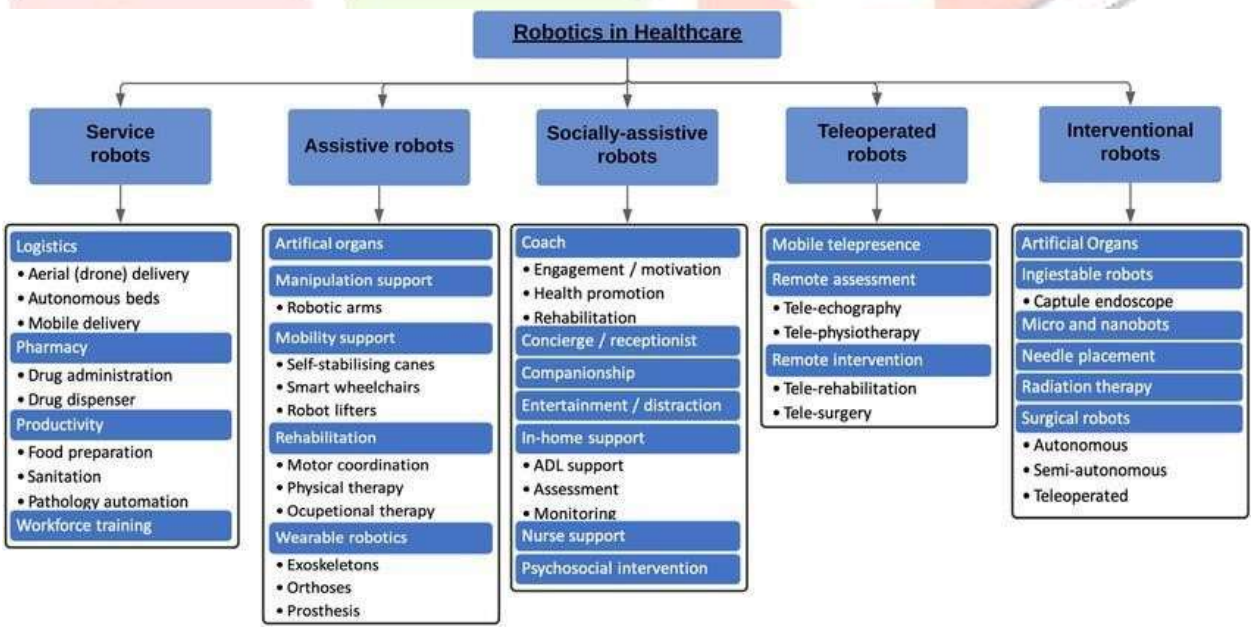

Figure No.3 : Robotics in Healthcare

1. Global Drivers of Robotics in Healthcare:-

The use of robotics in healthcare is strongly influenced by societal needs, public acceptance, and user satisfaction. Robots are introduced into healthcare primarily because they can add significant value—by improving the quality and affordability of care, enhancing access to medical professionals, and supporting caregivers through safer, more efficient workflows that reduce mistakes and workplace injuries.

This section outlines the major factors driving the growth of robotics in healthcare, highlighting two key categories: societal drivers and technological drivers.

2. Societal Drivers:-

Societal factors driving the use of robotics in healthcare are mainly centered on three needs: expanding access to medical services, lowering healthcare labor costs, and improving patient outcomes. These challenges are expected to intensify as the global population continues to age and as the number of people living with chronic illnesses or disabilities increases.

The world is experiencing rapid population ageing. Because of the post–World War II baby boom and advancements in healthcare and living conditions, the proportion of individuals aged 65 and older is steadily rising. With an ageing population comes a higher incidence of injuries, health conditions, and degenerative diseases. In addition, across all age groups, a significant portion of the global population—nearly 90%—faces some form of physical, cognitive, mental, or behavioral health difficulty.

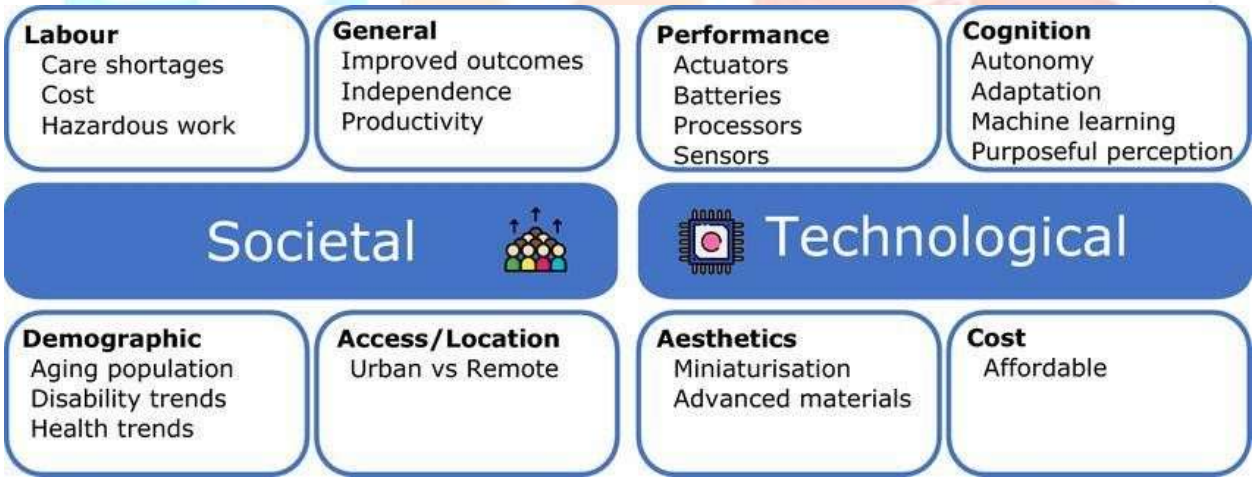

Figure No. 4: Main drivers for the Implementation of robots in Healthcare

If current trends in chronic disease and population ageing continue without intervention, the number of individuals living with long-term conditions—such as diabetes, obesity, and cancer— is expected to rise sharply. These demographic shifts create major challenges for healthcare systems, including significant workforce shortages and a decline in the availability of informal caregivers, such as family members. Forecasts indicate that the healthcare sector, especially nursing, will face severe staffing gaps in the coming years. As demand increases, healthcare professionals are exposed to more demanding and often hazardous work environments, placing them at greater risk of injury and long-term disability.

The shortage of nurses, doctors, and specialists also means that many people may not receive timely or adequate care. This issue gained increased attention during the COVID-19 pandemic, which placed extraordinary pressure on healthcare workers worldwide. As a result, supporting long-term independence and reducing dependency on the medical system have become important societal goals.

Helping older adults and individuals with chronic illnesses remain healthier at home for longer can decrease the need for specialized healthcare services and improve the well-being of caregivers. Additionally, enabling informal caregivers and people with chronic conditions to enter or remain in the workforce could help counterbalance the projected decline in available workers.

Access to effective healthcare is also closely tied to affordability, efficiency, and resource limitations. Although the need for medical care is immense, the resources available to meet that need are finite. This often results in treatment being prioritized for urgent or severe cases. Technological advancements—such as robotics—can make medical procedures less invasive, more cost-effective, and associated with fewer side effects. Improved training methods for healthcare professionals can also help reduce medical errors. Moreover, there is a growing push to make certain procedures safe to perform in less specialized settings and by professionals with lower levels of formal training, further expanding access to healthcare[19] .

3. Technological Drivers :-

Technological drivers behind robotics in healthcare mirror those influencing other advanced technologies. These include decreasing hardware costs, better and more accurate sensors, faster processors, expanded storage capacity, ongoing miniaturization of electronic and mechanical components, and improvements in battery and communication systems. Progress in artificial intelligence, autonomous operation, and advanced materials also plays a significant role.

In healthcare, robots must interact physically and safely with both patients and caregivers. Because these interactions are two-way, robots need the ability to sense, interpret, and understand their surroundings so they can provide meaningful assistance. Recent advances in sensors and machine learning—especially deep learning—have greatly improved robotic perception, making tasks like object identification, scene interpretation, and activity recognition increasingly reliable. These capabilities allow robots to move through real environments and engage with people safely and effectively. By combining information from multiple types of sensors, robots can form richer and more accurate perceptions than by relying on a single data source.

4. Landscape of Robotics in Healthcare :-

Healthcare robotics covers a wide and varied field. Robots can assist with both physical tasks and cognitive functions, and they are used across many stages of care—from prevention and diagnosis to treatment, rehabilitation, and long-term support. They can also help clinical teams with administrative duties and hospital operations.

In this context, the manuscript identifies five key application areas for robotic technologies in healthcare. This section outlines each of these areas, offering examples of current commercial systems, highlighting ongoing developments, discussing major challenges, and exploring future opportunities for innovation[20].

5. Service Robots :

Clinicians often spend a large portion of their time on tasks that take them away from direct patient care—activities that are repetitive, unpleasant, physically demanding, or simply timeconsuming. These include transporting equipment, supplies, or patients, as well as waiting for medications or materials to arrive. The burden of such duties can contribute to errors, stress, and professional burnout.Service robots in healthcare support clinicians by carrying out various routine tasks. Since these robots are designed to operate safely near medical staff and patients, they typically require minimal supervision. As a result, they generally present very low risk to the individuals around them. Robots are particularly effective in handling logistics and transportation tasks within healthcare settings. When the environment is suitable, they can perform these duties with a high level of accuracy. For instance, autonomous mobile robots can pick up and deliver items such as linens, laboratory samples, medicines, and meals. By automating these

routine deliveries for departments like pharmacies, nursing units, kitchens, and laboratories, hospitals can streamline workflow with minimal disruption to staff or patients[21].

Robot name	Company	Application
Robotmat	Omnicell	Drug dispenser
CONSIS.B	Willach	Drug dispenser
PathFinder	Aim Lab	Pathology automation
AutoMate	Beckman Coulter	Pathology automation
Model B/C	UVD Robots	Sanitation
C-Astra	Invento robotics	Sanitation
Akara	Akara	Sanitation
TUG	Aethon	Mobile delivery
Moxi	Diligent	Mobile delivery
RobotT1	Keenon Robotics	Mobile delivery

Table No.1: Examples of commercially available service robots in logistics, pharmacy and productivity.

VII. AI IN CLINICAL TRIALS :

In clinical trials, participants are given newly developed medicines to test how well they work. These studies require significant time and financial investment, yet the overall success rate remains low. Because of this, the digital transformation of clinical trials has become highly beneficial for both AI applications and the healthcare sector. Artificial intelligence helps reduce the burden of manual data monitoring, efficiently handles large volumes of information, and produces highly accurate insights, improving the overall effectiveness of clinical research.

1. Smart clinical trials :

Traditional “linear and sequential” clinical trials remain the most dependable approach for evaluating the safety and effectiveness of new drugs. These long-established protocols—structured into distinct phases of randomized controlled trials (RCTs)—were originally designed for largescale medications and have changed very little over the years. However, artificial intelligence now offers opportunities to streamline these processes, enhance clinical outcomes, and shorten overall trial timelines. Recent studies by Angus (2020) and Lee (2021) highlight how AI is reshaping key stages of the biopharmaceutical value chain.

Biopharma companies today have access to enormous amounts of real-world data (RWD) from numerous theoretical and practical sources. Despite this abundance, many organizations have struggled to fully utilize these datasets. By applying predictive AI models and advanced analytics, researchers can identify suitable participants and investigators, gain deeper insights into diseases, and design more innovative clinical trial structures .

AI systems, when combined with strong digital platforms, can also help clean, organize, code, and store clinical trial data more effectively. Enhanced electronic data capture (EDC) tools support smoother system integration and help reduce human-related errors in the data collection process[22].

2. Collaboration on clinical trials and sharing of models:-

Researchers across multiple scientific disciplines are collaborating intensively to strengthen the global response to COVID-19. For AI tools to make a meaningful worldwide impact, effective data sharing, open frameworks, accessible code, localized applications, and international cooperation are essential . Because AI relies heavily on data, numerous global, national, and regional initiatives have emerged to share COVID-19-related datasets. These include genetic sequences, genomic analyses, protein structures, clinical records, medical images, case reports, epidemiological statistics, mobility data, social media posts, news updates, and scientific publications.

However, these data-sharing efforts are often fragmented, with innovations confined to specific groups or platforms. Establishing scalable approaches for sharing data, tools, and code could accelerate the development and deployment of new AI applications. Broad international collaboration, supported by open, reliable, and coordinated data repositories, can help connect diverse communities and regions[23].

VIII. PATIENT CARE:

Artificial intelligence is increasingly shaping patient outcomes within the healthcare sector. Many medical AI companies are developing systems designed to support patients throughout their entire care journey. Clinical intelligence tools, in particular, evaluate a patient's health information and generate meaningful insights that can guide better decision-making and improve overall quality of life. Below are several key clinical intelligence solutions that contribute to enhanced patient care[24].

IX. MATERNAL CARE :

A possible approach to identifying mothers at high risk and lowering maternal mortality and postdelivery complications includes the following:

1. Using electronic health records and AI to forecast whether a pregnant woman is likely to experience complications during labor and delivery.

2. Applying digital tools to improve access to routine and specialized care throughout pregnancy, ensuring timely support for those who require closer monitoring.

Research shows that high-risk pregnant women who give birth in low-acuity facilities—where resources and clinical expertise are limited—face a greater chance of serious maternal complications compared with those delivering in higher-acuity centers equipped for complex cases[25].

X. CHALLENGES :

While robotics offers significant advantages in healthcare, several challenges must be addressed before these technologies can be fully and effectively integrated:

1. High Costs:

Purchasing, maintaining, and updating robotic systems can be expensive. These financial barriers make it difficult for many healthcare facilities to adopt robotic technologies widely.

2. Safety and Dependability:

Robotic tools used in medical settings must be extremely safe and dependable, especially during high-risk procedures. This requires extensive testing, strict validation processes, and compliance with regulatory standards to prevent errors, failures, or patient harm.

3. **Training Requirements:**
   Healthcare staff need specialized skills to operate robotic systems confidently. Learning to use these technologies can be demanding and requires continuous training to keep pace with advancements.

4. **Integration Challenges:**
   Incorporating robotics into existing healthcare environments is complex. Smooth communication between robotic systems, electronic health records (EHRs), and other digital tools is necessary to maintain efficient workflows and accurate data sharing.

5. **Ethical and Legal Issues:**
   The use of robots in healthcare raises concerns around patient privacy, informed consent, and reduced human interaction. Clear ethical guidelines and legal frameworks are needed to ensure trust, safety, and responsible use.

6. **Acceptance and Resistance:**
   Some healthcare workers may worry about job displacement or feel that robots reduce the personal touch in patient care. Addressing these concerns and encouraging teamwork between humans and machines is essential.

7. **Regulatory and Reimbursement Barriers:**
   Policymakers may need to establish new rules tailored to robotics in healthcare. Payment models may also require updates so that robotic services are properly reimbursed and more widely adopted.

8. **Limited Evidence Base:**
   Although robotics has great potential, more long-term research and clinical data are needed to confirm its effectiveness and cost-benefit in various medical specialties.

9. **Data Quality and Privacy Issues:**
   AI systems depend on accurate and complete data, yet medical data often contain gaps or biases. Protecting patient privacy while using data for AI analysis remains a major concern.

10. **Ethical and Regulatory Challenges for AI:**
    AI algorithms must be transparent, fair, and accountable. Regulatory bodies need to create clear standards to prevent bias, discrimination, and unsafe use of AI in healthcare.

11. **Adoption and Workflow Integration:**
    Incorporating AI tools into current medical workflows can be complicated. Providers must be trained to use these systems effectively, and resistance to change may slow adoption.

12. **Liability and Responsibility:**
    When AI systems cause errors or harm, determining who is legally responsible can be difficult. Clear rules around liability are necessary to safeguard patients and guide safe implementation[26].

XI. FUTURE POSSIBILITIES OF AI IN HEALTH CARE:

The future of artificial intelligence in healthcare is full of promising opportunities. One of the most transformative areas is personalized medicine, where treatments are tailored to an individual's genetic profile, lifestyle habits, and environmental exposures. By analyzing large and complex datasets, AI can help develop treatment plans that better fit each patient's specific needs.

Another major direction for AI is in predicting and preventing diseases. By integrating information from genetic tests, medical histories, wearable devices, and environmental factors, AI systems can identify people who are likely to develop certain conditions. This allows healthcare providers to take early action and design preventive strategies that reduce disease burden.

AI also has the potential to reshape drug discovery. Advanced algorithms can sift through enormous volumes of biomedical data to uncover new drug targets, design more effective molecules, and streamline the research process. AI can also help optimize clinical trials, lowering costs and speeding up the development of new therapies.

However, as AI capabilities grow, so do concerns about fairness and ethics. If algorithms are trained on biased datasets, they can produce biased outcomes that disproportionately affect certain groups. Ensuring that AI systems are trained on diverse, representative, and high-quality data is essential.

Regulation is another critical challenge. AI tools used in healthcare must be closely monitored to ensure they are safe, reliable, and effective. Understanding how algorithms make decisions— known as explainability—is especially important. Explainable AI (XAI) allows clinicians and patients to understand the reasoning behind a recommendation, helping build trust and accountability.

Looking ahead, several key advances are expected to shape the future of AI in healthcare:

- **Precision Medicine:**

  AI can greatly enhance precision medicine by analyzing genomic information, electronic health records, and other clinical data to highlight risks, detect disease patterns, and guide individualized therapies. This leads to more accurate treatments with fewer side effects.

- **Drug Discovery and Development:**

  AI can speed up the creation of new drugs by processing vast scientific datasets, predicting the usefulness of potential compounds, and improving their design. This can significantly shorten development timelines and increase the success rate of new medications.

Figure No.5 :- Future of AI in health care

- **Advanced Imaging and Diagnostics:**

  AI-based image analysis can improve the accuracy of interpreting X-rays, CT scans, MRIs, and other imaging technologies. These tools support clinicians in detecting diseases earlier and providing more reliable diagnoses[27].

- **Intelligent Imaging and Diagnostics:**

  AI-based image analysis tools can greatly improve the accuracy and efficiency of medical imaging and diagnostic processes. Using machine learning techniques, AI can interpret various types of scans—including X-rays, CT images, and MRIs—to identify abnormalities, support early detection of diseases, and offer precise quantitative measurements. These advanced systems assist radiologists and other clinicians in making faster and more reliable diagnostic decisions, ultimately enhancing patient care and outcomes.

XII. CONCLUSION :

Artificial Intelligence (AI) is transforming healthcare in many positive ways. It supports doctors by improving the accuracy of diagnoses, creating personalized treatment plans, and simplifying routine hospital operations. From enhancing medical imaging to assisting in surgery and enabling online consultations, AI is reshaping modern medical care.

While challenges such as data privacy and regulatory oversight still exist, AI holds great promise for reducing healthcare costs and improving patient health around the world. As AI technology progresses, it is expected to make healthcare more efficient, more accessible, and more patientcentered, opening the door to innovative advancements in medicine.

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