



ENVIRONMENTAL STUDIES & LIFE SCIENCES

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Artificial intelligence in Diagnosis Applications Challenges

Disease Management and IPR - AI in Diagnosis

Artificial intelligence (AI) - an interdisciplinary science

- AI is a wide-ranging branch of computer science concerned with building smart machines capable of performing tasks that typically require human intelligence.
- It is widely accepted that the term AI was first coined in 1956 when American computer scientist John McCarthy *et al.* organized the Dartmouth Conference.
- Prior to that, work in the field of AI included the Turing test proposed by Alan Turing as a measure of machine intelligence and a chess-playing program written by Dietrich Prinz.

Artificial intelligence (AI) in Diagnosis

- Healthcare is shaping up in front of our eyes with advances in digital healthcare technologies such as artificial intelligence (AI), 3D printing, robotics, nanotechnology, etc.
- Digitized healthcare presents numerous opportunities for reducing human errors, improving clinical outcomes, tracking data over time, etc.
- AI methods from machine learning to deep learning assume a crucial function in numerous well-being-related domains, including improving new clinical systems, patient information and records, and treating various illnesses



“Artificial intelligence (AI) is a multidisciplinary field of computer science that deals with the creation of systems, algorithms, and software capable of simulating human intelligence...”

Source: Kumar et al., *Artificial intelligence in disease diagnosis: a systematic literature review, synthesizing framework and future research agenda*. *J Ambient Intell Humaniz Comput*. 2023;14(7):8459-8486.

Image source: <https://www.impactqa.com/blog/artificial-intelligence-ai-and-its-assistance-in-medical-diagnosis/>

Image source: <https://www.revechat.com/blog/what-is-ai/>

Artificial intelligence (AI) in Diagnosis

- The AI techniques are also most efficient in identifying the diagnosis of different types of diseases.
- The presence of computerized reasoning (AI) as a method for improved medical services offers unprecedented occasions to recuperate patient and clinical group results, decrease costs, etc.
- The models used are not limited to computerization, such as providing patients, “family”, and medical service experts for data creation and suggestions as well as disclosure of data for shared evaluation building.
- AI can also help to recognize the precise demographics or environmental areas where the frequency of illness or high-risk behaviors exists.



Source: Kumar et al., *Artificial intelligence in disease diagnosis: a systematic literature review, synthesizing framework and future research agenda*. J Ambient Intell Humaniz Comput. 2023;14(7):8459-8486.

Image source: <https://www.theengineer.co.uk/content/in-depth/how-ai-is-powering-a-revolution-in-medical-diagnostics/>

Artificial intelligence (AI) in Diagnosis

- Artificial intelligent systems in healthcare have the following typical pattern.
- Such a system starts with a large amount of data, on these data machine-learning algorithms are employed to gain information, this information is then used to generate a useful output to solve a well-defined problem in the medical system.

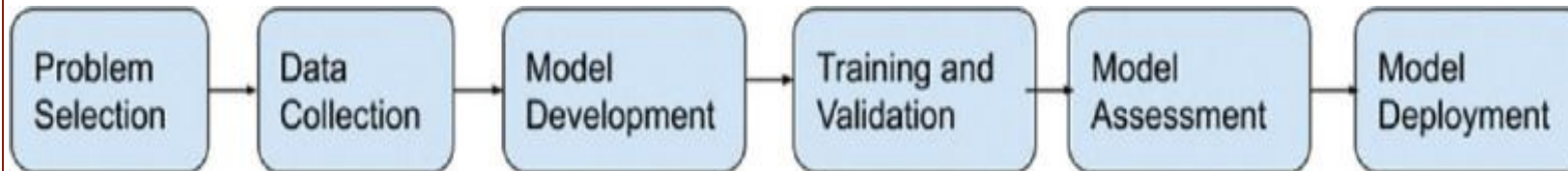


Illustration outlining the development of an artificially intelligent model

Applications of AI in diagnosis / biomedical engineering

- The integration of AI in medicine is revolutionizing healthcare by enhancing diagnostic accuracy, personalizing treatment, and improving patient outcomes.
- As technology advances, the potential for AI to transform various aspects of healthcare continues to grow, promising a future of improved efficiency, accessibility, and quality of care.
- This paradigm shift requires collaboration between technologists, healthcare professionals, and policymakers to address ethical concerns and ensure that AI benefits all stakeholders involved.
- Ongoing collaboration among engineers, clinicians, & researchers is essential to address challenges and maximize the benefits of AI technologies in biomedical applications.

Applications of AI in diagnosis / biomedical engineering

1. Medical Imaging

- **Image Analysis:** AI algorithms enhance the accuracy of image interpretation (e.g., X-rays, MRIs, CT scans) by identifying abnormalities such as tumors, fractures, or lesions.
- **Early Detection:** AI systems can detect diseases like cancer at earlier stages, improving prognosis and treatment outcomes.
- **Radiomics:** AI extracts large amounts of features from medical images that may not be visible to the human eye, aiding in more personalized treatment strategies.

2. Predictive Analytics

- **Risk Assessment:** AI tools analyze patient data to predict the likelihood of developing conditions like diabetes, heart disease, or sepsis.
- **Outcome Prediction:** Machine learning models can forecast patient outcomes, helping clinicians make informed decisions about treatment plans.

Applications of AI in diagnosis / biomedical engineering

3. Personalized Medicine

- **Genomic Data Analysis:** AI processes vast amounts of genetic information to identify mutations linked to specific diseases, leading to targeted therapies.
- **Tailored Treatment Plans:** By analyzing patient-specific data, AI helps devise individualized treatment strategies based on genetics, lifestyle, and environmental factors.

4. Drug Discovery and Development

- **Molecular Screening:** AI accelerates drug discovery by predicting how different compounds will interact with biological targets, reducing the time and cost involved.
- **Clinical Trial Optimization:** AI identifies suitable candidates for clinical trials and can predict patient responses to drugs, enhancing trial efficiency.

Applications of AI in diagnosis / biomedical engineering

5. Clinical Decision Support Systems (CDSS)

- **Evidence-Based Recommendations:** AI systems provide clinicians with evidence-based treatment suggestions, improving decision-making and patient safety.
- **Alerts for Potential Issues:** These systems can flag potential drug interactions, allergies, or deviations from best practices.

6. Robotic Surgery

- **Precision and Control:** AI-powered robotic systems assist surgeons in performing complex procedures with enhanced precision and minimally invasive techniques.
- **Learning from Data:** Robotic systems continuously learn from surgical outcomes to improve performance and technique over time.

Applications of AI in diagnosis / biomedical engineering

7. Telemedicine

- **Virtual Health Assistants:** AI-driven chatbots provide patients with immediate responses to health inquiries, triaging them before they see a healthcare provider.
- **Remote Monitoring:** AI systems analyze data from wearable devices to monitor patient health in real-time, alerting providers to any concerning changes.

8. Natural Language Processing (NLP)

- **Clinical Documentation:** AI helps automate the transcription of clinical notes, making documentation more efficient and reducing administrative burdens.
- **Information Retrieval:** NLP tools can sift through vast medical literature, extracting relevant information for clinicians, aiding in research and patient care.

Applications of AI in diagnosis / biomedical engineering

9. Behavioral Health

- **Mental Health Monitoring:** AI applications can analyze speech patterns and facial expressions to assess mental health status and provide timely interventions.
- **Chatbots for Therapy:** AI chatbots can offer cognitive behavioral therapy (CBT) techniques, providing support for patients outside of traditional therapy sessions.

10. Administrative Workflow Optimization

- **Scheduling and Resource Management:** AI optimizes appointment scheduling and resource allocation, enhancing operational efficiency in healthcare settings.
- **Claims Processing:** AI automates the processing of insurance claims, reducing errors and speeding up reimbursements.

Applications of AI in diagnosis / biomedical engineering

11. Patient Engagement and Education

- **Personalized Health Content:** AI tailors health education materials to individual patient needs, enhancing understanding and compliance.
- **Health Reminders:** Automated systems send reminders for medication adherence, follow-up appointments, and preventive care, improving patient outcomes.

12. Epidemiology and Public Health

- **Disease Outbreak Prediction:** AI analyzes patterns in health data to predict and monitor outbreaks of infectious diseases, aiding public health responses.
- **Population Health Management:** AI identifies high-risk populations, guiding interventions aimed at improving community health outcomes.

Applications of AI in diagnosis / biomedical engineering

13. Wearable Health Technologies

- **Continuous Monitoring:** AI processes data from wearables to provide insights into vital signs, activity levels, and overall health, alerting users to potential issues.
- **Lifestyle Recommendations:** Based on user data, AI can suggest personalized lifestyle changes to improve health and prevent disease.

14. Biomedical Signal Processing

- **Noise Reduction:** AI enhances the quality of signals from various biomedical sources (like EEG or ECG) by filtering out noise and artifacts.
- **Pattern Recognition:** AI identifies patterns in biological signals, aiding in the diagnosis of conditions such as epilepsy or cardiac arrhythmias.

Applications of AI in diagnosis / biomedical engineering

15. Social Determinants of Health

- **Data Analysis:** AI analyzes social determinants (like socioeconomic status, education, and environment) to better understand their impact on health outcomes.
- **Targeted Interventions:** AI helps design interventions aimed at addressing these determinants, promoting equity in healthcare access and outcomes.

16. Chronic Disease Management

- **Monitoring and Alerts:** AI systems track chronic conditions (like asthma, diabetes, and hypertension), sending alerts for necessary interventions based on real-time data.

AI in diagnosis presents several challenges

1. Data Quality and Availability

- **Incomplete Data:** Many healthcare datasets are incomplete or inconsistent, which can lead to inaccurate AI models.
- **Bias in Data:** If training data is not representative of diverse populations, AI systems may perform poorly for underrepresented groups, leading to biased diagnoses.

2. Interpretability and Transparency

- **Black Box Problem:** Many AI models, especially deep learning algorithms, function as "black boxes," making it difficult for clinicians to understand how decisions are made.
- **Trust and Acceptance:** Clinicians may be hesitant to rely on AI recommendations without clear explanations, impacting the adoption of AI tools.

AI in diagnosis presents several challenges

3. Integration with Clinical Workflows

- **Compatibility Issues:** Integrating AI tools into existing healthcare systems can be complex and may require significant changes to workflows and infrastructure.
- **User training and Adoption:** Clinicians and staff need training to effectively use AI tools, which can be time-consuming and costly.

4. Regulatory and Ethical Concerns

- **Regulatory Approval:** Navigating the regulatory landscape for AI in healthcare can be challenging, as there are varying standards and requirements across regions.
- **Ethical Considerations:** Issues around patient consent, data privacy, and the potential for AI to replace human decision-making raise ethical questions.

AI in diagnosis presents several challenges

5. Reliability and Generalization

- **Overfitting:** AI models trained on specific datasets may not generalize well to new or varied patient populations, leading to unreliable diagnoses in different settings.
- **Performance Variability:** The performance of AI systems can vary based on the quality of input data, making it crucial to validate models in diverse environments.

6. Cost and Resource Allocation

- **Implementation Costs:** Developing, validating, and implementing AI systems can be expensive, posing a barrier for some healthcare organizations.
- **Resource Limitations:** Smaller practices may lack the resources to invest in AI technology, leading to disparities in access to advanced diagnostic tools.

7. Liability and Accountability

- **Legal Responsibility:** Determining liability when AI systems provide incorrect diagnoses can be complex, raising questions about accountability among developers, clinicians, and institutions.

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Around the world using artificial intelligence in medical sciences

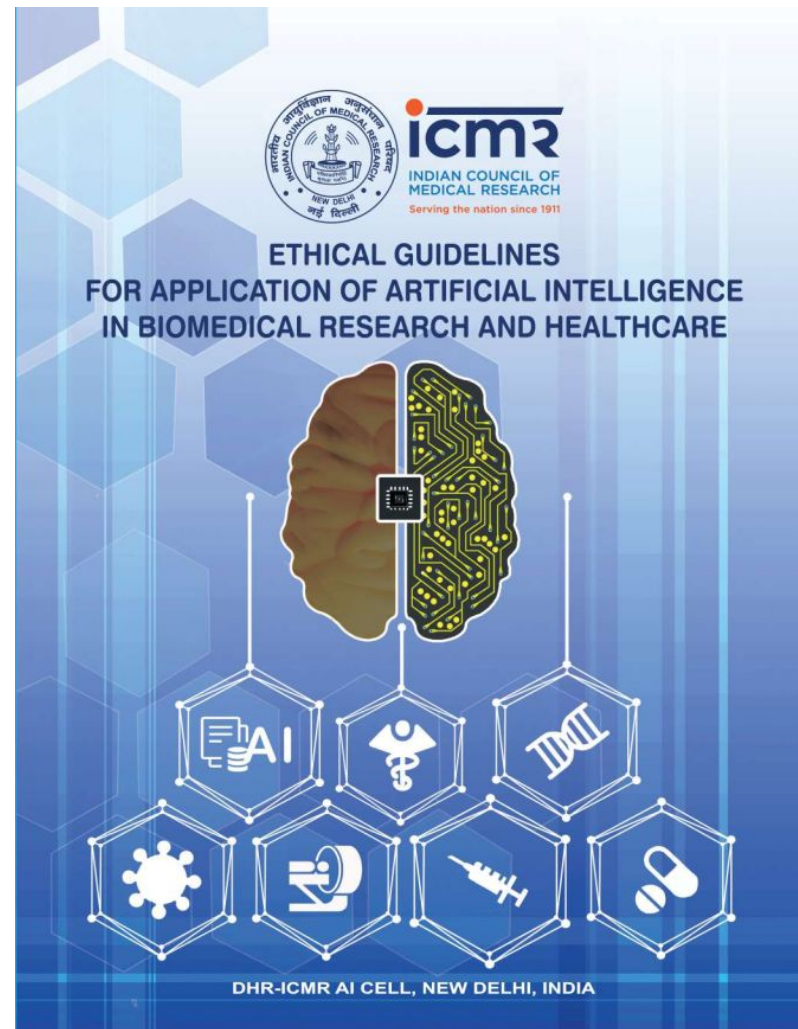
Company	Purpose	Website
AiCure (New York City) Patient-oriented	Uses video, audio, and behavioral data to better understand the connection between patients, disease and treatment.	https://aicure.com
Aidence (Amsterdam, The Netherlands) Clinician-oriented	AI for radiologists: improving diagnostics for the treatment of lung cancer	https://www.aidence.com
Aiva Health (Los Angeles) Administrative and Operational-oriented	The first voice-powered care assistant: connects patients with the correct physician for communication.	https://aivahealth.com
Babylon Health (London) Administrative and Operational-oriented	Uses NLP and AI to create internationally accessible and affordable health system for all.	https://www.babylonhealth.com
Bot MD (Singapore) Clinician-oriented	Bot assistant: answers clinical questions, transcribes dictated case notes and automatically organizes images and files.	https://www.botmd.io/en/
Suki (San Francisco) Clinician-oriented	Voice enabled digital assistant for physicians	https://www.suki.ai
Insitro (San Francisco) Patient-oriented	Uses advanced machine learning with computational genomics to reduce the time and cost associated with drug discovery for patients.	http://insitro.com/

Source: Basu K, Sinha R, Ong A, Basu T. Artificial Intelligence: How is It Changing Medical Sciences and Its Future? Indian J Dermatol. 2020 Sep-Oct;65(5):365-370.

Status in India

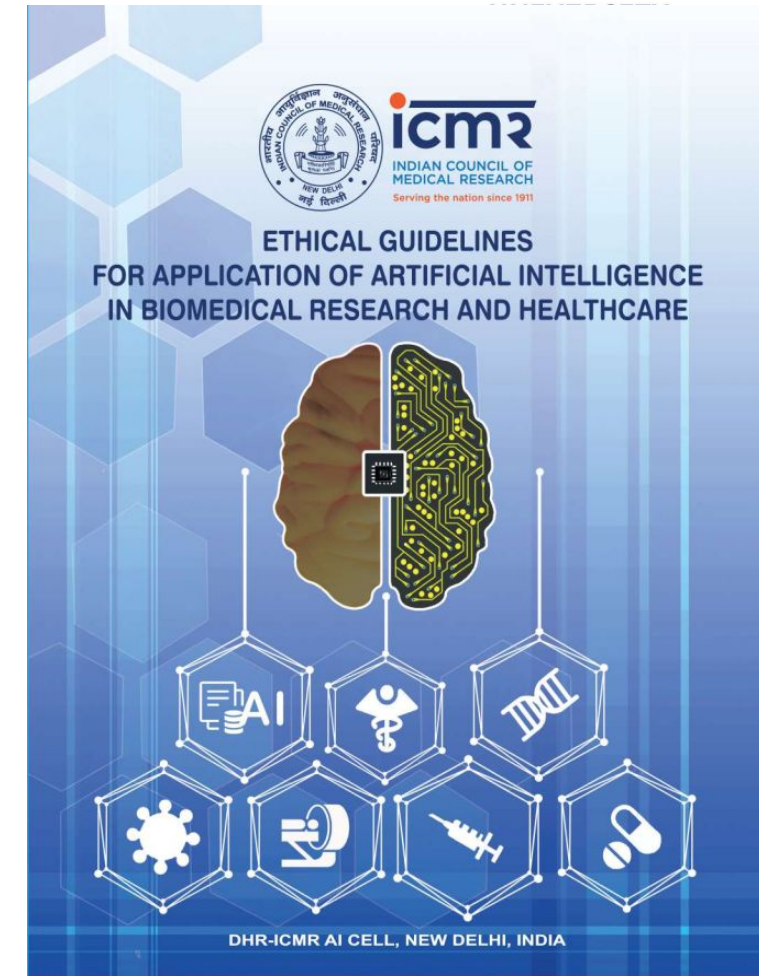
Scope

These guidelines apply to AI based tools created for all biomedical and health research and applications involving human participants and/or their biological data. Considering the far-reaching implications of AI-based technologies in healthcare, these guidelines are applicable to health professionals, technology developers, researchers, entrepreneurs, hospitals, research institutions, organization(s), and laypersons who want to utilize health data for biomedical research and healthcare delivery using AI technology and techniques.



Status in India - Application of AI in Healthcare

- The induction of AI into healthcare has the potential to be the solution for significant challenges faced in the field of healthcare like diagnosis and screening, therapeutics, preventive treatments, clinical decision making, public health surveillance, complex data analysis, and predicting disease outcomes.
- **Diagnostics and Screening:** AI technologies provides an edge in diagnosing diseases. AI provides the hope to tackle the diagnosis and screening burden on the healthcare system.

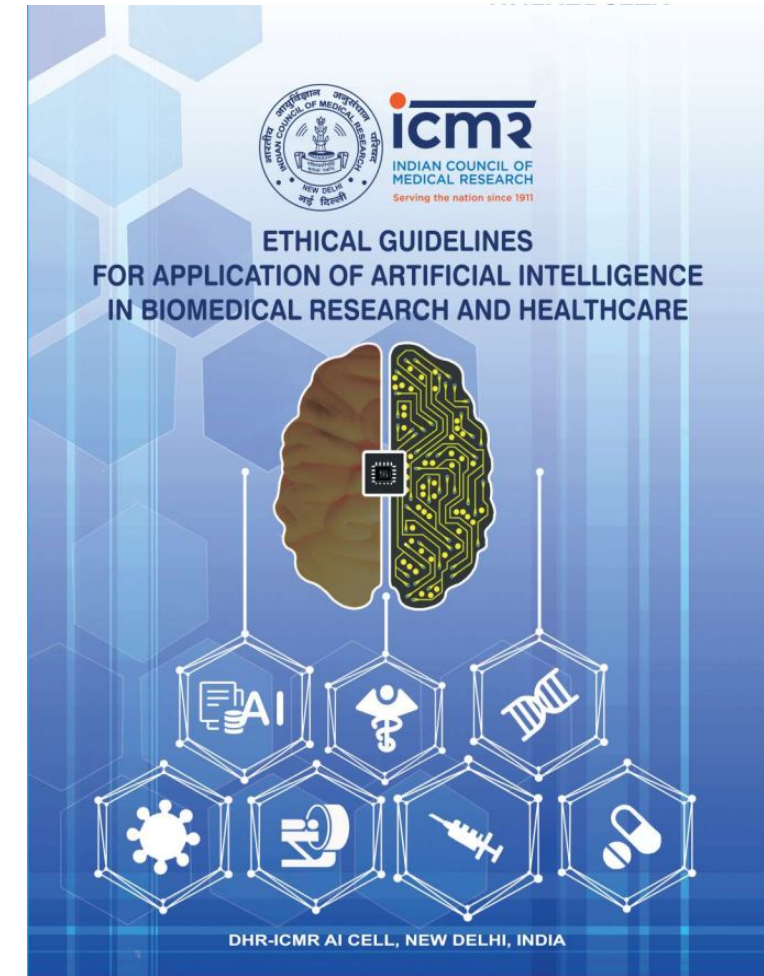


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Status in India - Application of AI in Healthcare

- **Therapeutics, Drug Discovery and Development:** AI technology such as Machine learning (ML) is being used in the field of drug discovery and epitope identification for vaccine development and has the potential to accelerate the process and make it more cost effective.
- Genetic based analysis and personalized drugs to target specific health conditions using AI technology can guide treatment plans.

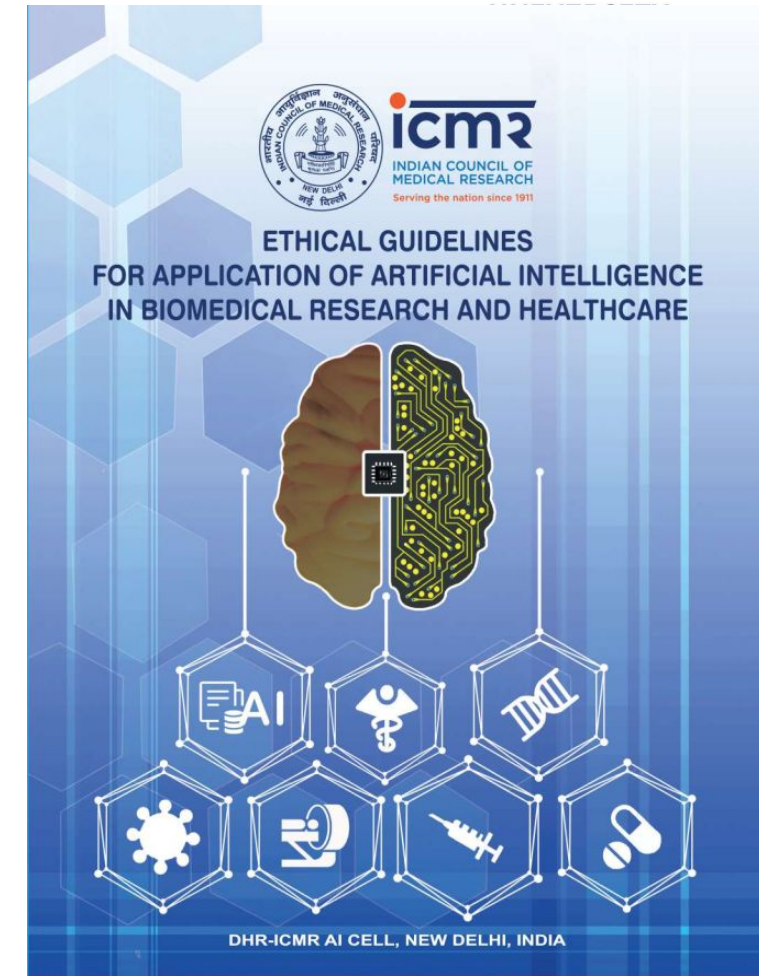


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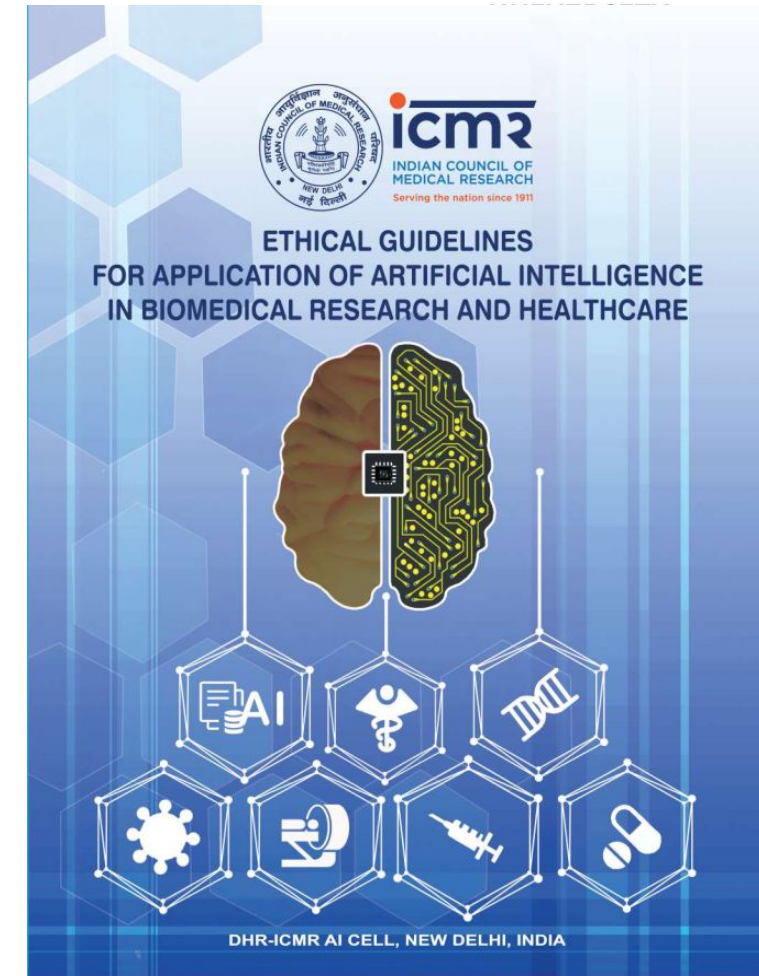
Status in India - Application of AI in Healthcare

- **Behavioral and Mental Healthcare:** Medical AI model provides significant possibilities in behavioural and mental health treatment.
- Medical AI may improve psychology and psychiatric procedures in a variety of ways, including assisting patients in receiving a diagnosis, actively managing their symptoms between in-person consults, predicting and preventing probable flare-ups, and more.



Status in India - Application of AI in Healthcare

- **Health Management Systems using AI:** AI has the potential of improving and optimizing operational functions in a healthcare setup or healthcare organization.
- Healthcare management involves scheduling, admission, Electronic Medical Records (EMR), accounting, billing, claim settling that involves repetitive task and high level of scrutiny.
- By leveraging AI powered tools and automated processes, the productivity could be enhanced, operational and clinical workflows could be improved and operating costs for healthcare practices could be reduced.
- Robotic process automation (RPA) is capable of advanced financial accounting, medical billing and claims. NLP can automate clinical documentation thus reducing the turnaround time.

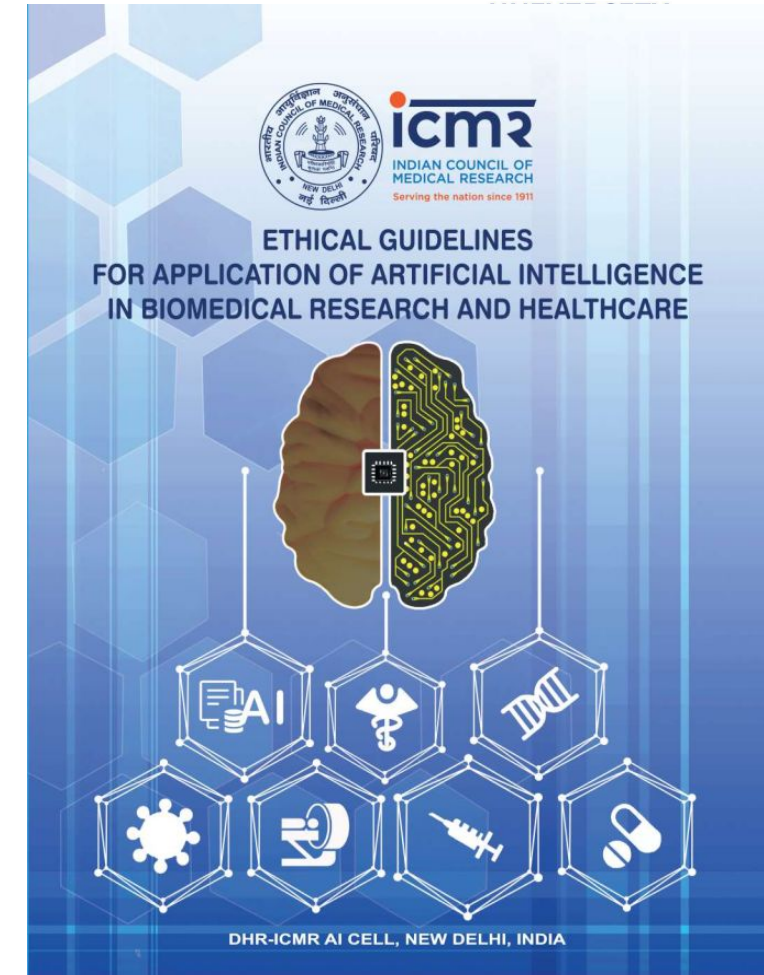


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Status in India - Ethical principles in AI for Health



AI Healthcare tools (Example/s)

- **Merative**, formerly known as IBM Watson Health, can help medical professionals make better decisions, automate daily tasks and empower them to do their most productive work. It is a platform that uses AI in the cloud to store, manage, and analyze medical data in real-time. With the help of this technology, doctors can access patient records more quickly and accurately diagnose patients with a significantly higher level of accuracy.
- **Viz.ai**: With the help of AI, Viz.AI is able to replace outdated, conventional care practices with the use of one convenient platform. This cloud-based patient record management system allows healthcare professionals and patients alike to access and share information more quickly and effectively. When care teams are connected earlier in the workflow with real-time analytics and insights, faster treatment decisions can be made, which leads to better outcomes for the patient.

AI Healthcare tools (Example/s)

- **Enlitic** is a healthcare intelligence platform that uses AI to improve the accuracy of health data. Its solutions include Enlitic Curie™, an AI-powered platform designed to enhance patient care through precision diagnosis and clinical decision support. This system can help identify early signs of health conditions, improve treatment decisions, and provide a more accurate view of a patient's overall health.
- **Regard** provide the finest care possible with Regard-a comprehensive intelligent platform that automates tedious clinical tasks, allowing providers more time for their patients. Unlike manual methods of analyzing and synthesizing patient data, this system provides near-instantaneous insights into complete patient pictures without missing any critical information.

AI Healthcare tools (Example/s)

Diagnostic Tools

- **Aidoc:** An AI-powered radiology platform that analyzes medical images to detect abnormalities in real-time.
- **Zebra Medical Vision:** Provides AI solutions for analyzing medical imaging data to identify various conditions, including cardiovascular diseases and cancers.
- **PathAI:** Uses deep learning to improve the accuracy of pathology diagnostics by analyzing tissue samples.

Clinical Decision Support

- **IBM Watson Health:** Offers AI-driven insights to assist healthcare providers in clinical decision-making and patient management.
- **Epic Systems:** Integrates AI algorithms into electronic health records (EHRs) to provide clinical decision support and predictive analytics.

AI Healthcare tools (Example/s)

Virtual Health Assistants

- **Babylon Health:** An AI-driven health app that provides symptom checking and virtual consultations with healthcare professionals.
- **Ada Health:** A chatbot that helps users understand their symptoms and provides personalized health information.

Drug Discovery and Development

- **Insilico Medicine:** Uses AI to accelerate drug discovery by predicting drug efficacy and identifying potential candidates.
- **Atomwise:** Leverages deep learning to identify new drugs and predict their interactions based on molecular data.

Patient Monitoring and Management

- **Biofourmis:** Provides AI-powered solutions for remote patient monitoring and personalized health management, particularly for chronic diseases.
- **Sensei:** Uses AI to monitor patient vitals and health metrics in real time, providing alerts and insights to healthcare providers.

AI Healthcare tools (Example/s)

Population Health and Predictive Analytics

- **Health Catalyst:** Utilizes AI and data analytics to improve healthcare outcomes through predictive modeling and population health management.
- **Qventus:** An AI platform that optimizes hospital operations by predicting patient flow and automating decision-making processes.

Research and Development

- **DeepMind Health:** Focuses on AI research to improve healthcare, particularly in areas like eye disease diagnostics and patient management.
- **Mayo Clinic's AI Platform:** A suite of AI tools designed to enhance research, diagnostics, and patient care.

AI Healthcare tools (Example/s)

Imaging and Radiology

- **Lunit:** Develops AI solutions for analyzing medical images, particularly in oncology and chest radiography.
- **RadNet:** An AI-driven platform for radiology that provides insights and automates workflows.

Personalized Medicine

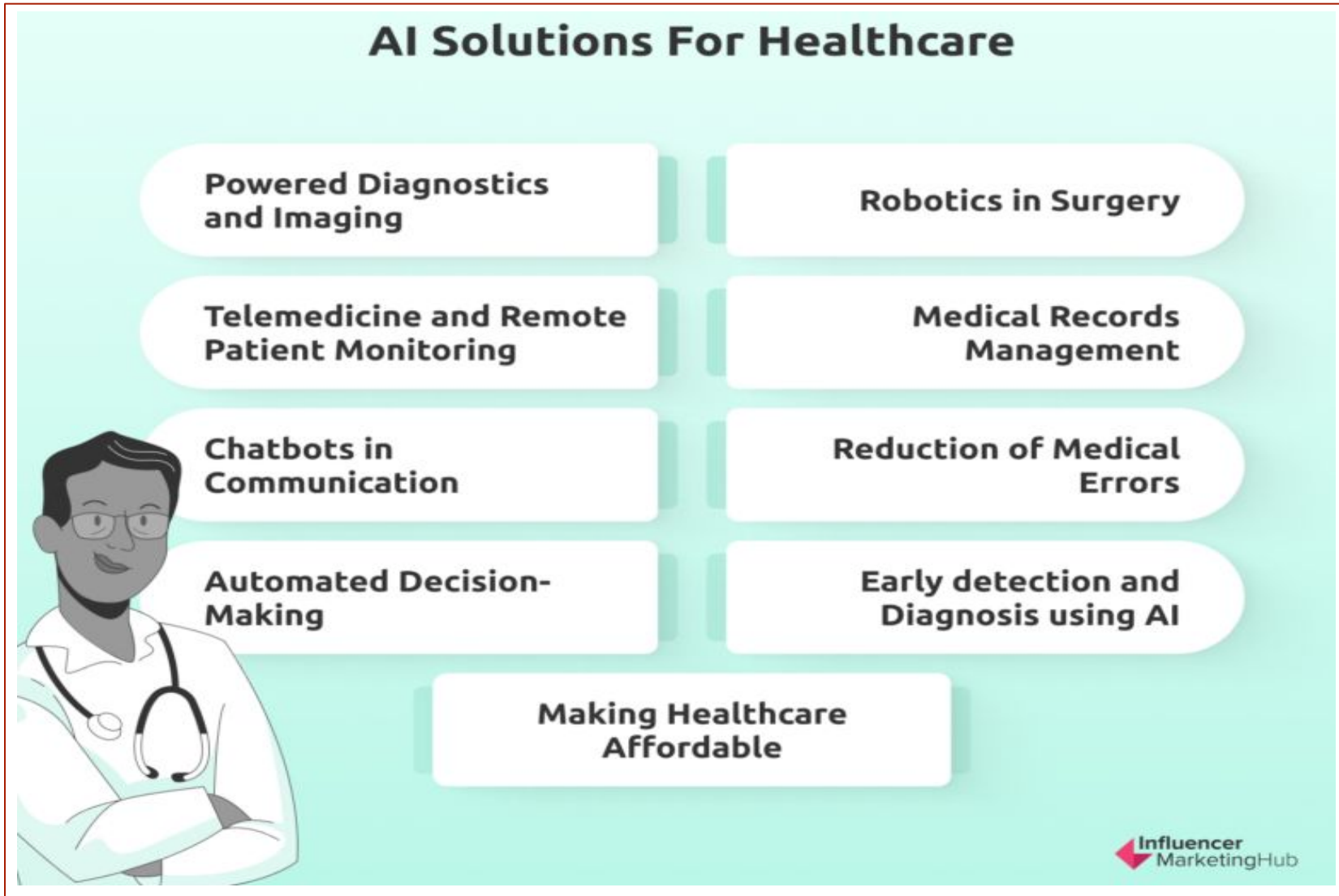
- **Tempus:** Combines clinical and molecular data to provide personalized treatment options for cancer patients through AI analysis.

General Health Platforms

- **CureMetrix:** An AI tool focused on mammography analysis, improving breast cancer detection rates.
- **WellDoc:** An AI-based platform that provides real-time support for managing chronic conditions like diabetes.

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Quick watch:
<https://www.youtube.com/watch?v=H0etieBDxeY>



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