Dissertation Report

To Analyze Application of Artificial Intelligence in Indian Healthcare industry

Submitted

By

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TO WHOMSOEVER IT MAY CONCERN

This is certify that Prannay Deep Singh student of Post Graduate Diploma in Hospital and Health Management (PGDHM) from International Institute of Health Management Research (IIHMR), New Delhi has undergone dissertation training from March 2020 to May 2020 and worked from home.

The candidate has successfully carried out the study designated to him during pandemic time, his approach to the study has been sincere, scientific and analytical.

The dissertation report is in fulfillment of the course requirements.

I wish him all the success in all his future endeavors.

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CERTIFICATE OF APPROVAL

The following dissertation titled a study review "To Analyze Application of Artificial Intelligence in Indian Healthcare industry" is hereby approved as a certified study in management carried out and presented in the manner satisfactorily to warrant its acceptance as a prerequisite for the award of Post **Graduate Diploma in Health and Hospital Management** for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein but approve for dissertation purpose only and it is submitted.

For evaluation please:-

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Certificate by Scholar

This is to certify that the dissertation titled a study review "**To Analyze Application of Artificial Intelligence in Indian Healthcare industry**" submitted by Prannay Deep Singh enrolment No PG/18/047 under the supervision of Dr Manish Priyadarshi for award of Postgraduate Diploma in Hospital and Health Management of the institute carried out during the period from March 2020 to May 2020 embodied my original work and has not formed for the basis of award of any degree, diploma associated fellowship, titled neither in this nor any other Institute or similar institute of higher learning as per best of my knowledge.

Signature with Date

FEEDBACK FORM

Name of the Student: Prannay Deep Singh

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Signature of the Officer-in-Charge/ Organisation Mentor (Dissertation)

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TABLE OF CONTENTS

Acronyms/ Abbreviations

Short Form	Full Form
AI	Artificial Intelligence
GDP	Gross Domestic Product
SWOT	Strength Weakness Opportunity Threat
WHO	World Health Organization
NITI	National Institution for Transforming India
CT	Computed Tomography
PET	Positron Emission Tomography
MRI	Magnetic Resonance Imaging

Introduction

I. Background

Healthcare sector plays an important role in impacting the economy of a country. It is one of the major determinants of happiness and wellbeing of the people. It affects parameters such as Gross Domestic Product (GDP) and Human Capital Index. Health impacts economic process in a no. of ways. for instance, it reduces production losses thanks to employee unhealthiness, it will increase the productivity of adult as a result of higher nutrition, it lowers absence rates & improves learning among college kids. Health additionally permits for the employment of natural resources that won't to be entirely or part inaccessible thanks to sicknesses. Finally, it permits the various use of financial resources which may usually be destined for the treatment of health problem.

But a major challenge that healthcare industry suffers is last mile delivery of the services in a seamless way. In developing nations like India where there is scarcity of right infrastructure, and large number of potential beneficiaries the problem becomes graver. There are additional challenges like digital illiteracy, population diversity and challenges specific to geography of an area.

Technology can play an important role in solving existing problems. Artificial Intelligence can be applied in healthcare to improve the quality of services and results of precision medicine. Two important metrices of success in an AI system are – robustness and performance. India has resources like population diversity, vast volumes of unstructured medical data and abundance of human talent that can be utilized together to create solutions that can stand the test of robustness and performance.

In India, AI has the potential to play a significant role in creating care additional accessible & creating early designation systems accessible. By delivering efficiencies & reducing price, AI will play a significant role in increasing accessibility of crucial treatment. during a immense country like Republic of India, AI provides chance for economical illness pursuit & management notably for quick spreading diseases.

One vertical within the Indian care sector wherever AI will play a large role is tele-medicine, that is remote designation & treatment of patients through telecommunication & data technology. Tele-medicine is associate degree economical resolution to bridge the urban-rural divide & reach the remotest components of the country through high-speed net property. As of 2016, the tele-medicine market stood at USD fifteen million & is foretold to rise at a CAGR of 2 hundredth throughout FY 2016-20 to achieve USD thirty-two million by 2020.

India can see net users rise by concerning forty per cent & no. of smartphones to double by 2023. With the inflated penetration of smartphones, specialized diagnostic solutions will be provided through mobile phones for the convenience of doctors and patients. AI isn't attending to replace doctors however are a perfect middle layer to bridge the demand and provide gap between patients & doctors.

II. LITRATURE REVIEW

1.”King Jr (2018) discusses the impact of AI on the field of radiology. Radiology has witnessed tremendous strides with the advent of ultrasound, CT, PET & MRI scanning technologies. He believes that the next breakthrough will come as a courtesy of AI utilizing the imaging data that is already available from imaging technologies such as ultrasound, CT, PET & MRI. According to him, AI in radiology probably appear in stages with the initial stage already making an

appearance. In the first stage, AI systems perform automatic segmentation of various structures within CT & MR images. This will help to isolate and to identify pathologic lesions for analysis and this will yield significant time savings for radiologists."

2. "Bertalan Meskó, also known as The Medical Futurist, has called AI the The Stethoscope of the 21st Century. As per him, just as it took time for the medical community to accept the stethoscope, so it will take for the medical community time to accept AI as a full-fledged tool for healthcare. Even so, he predicts that AI will take its rightful place in healthcare with cognitive computers helping physicians in taking clinical decisions. To make it a reality, he recommends that physicians should learn how AI works in healthcare, companies such as IBM should increase awareness in the general public about the advantages and risks of using AI in medicine, and healthcare institutions should measure the effectiveness of the AI-based system."

3. "Zaidi (2018) highlights application areas of AI in healthcare that look to be very promising. One of these areas is cognitive assisted robotics. It is considered minimally invasive whereby large incisions are replaced with a series of quarter-inch incisions and utilize miniaturized surgical instruments. Furthermore, surgeons integrate the data from patient pre-op medical records with real-time operating metrics to improve surgical outcomes. A case in point is the da Vinci Surgical System which is a surgical system with robotic limbs that provides a high-definition, magnified, 3-D view of the surgical site. This facilitates complex surgery using a minimally invasive approach and is controlled by a surgeon from a console. On its administrative side, Gohil discusses AI applications that automate non-patient care activities such as writing chart notes, prescribing medications, ordering tests. Such AI-based systems that depend on

machine learning help healthcare providers to cut documentation time & to improve reporting quality."

4. "Houssami et al. (2017) discuss the promise and current reality of AI in carcinoma (BC) detection. While mammography screening for BC can confer a mortality benefit through early BC detection, it can also miss cancer that is present or can result in false-positives. To try and improve results mammography screenings have mostly focused on additional imaging within the sort of double rather than single-reading and more frequent screens. The additional imaging increases resource expenditures. As per him, AI can assist mammography screenings to become more efficient by advanced learning using large complex datasets, and by performing tasks such as image interpretation. He concludes that while AI is very promising for BC screenings, to translate this promise into reality, it requires very large data-sets of imaging examinations that are associated with clinical factors to coach AI models."

5. "Liew (2018) discusses the necessity for the safe implementation of AI systems in radiology, where radiologists are mandatory as component human authorities. This is referred to as 'radiologist-in-the- loop'. In this, radiologists would be needed to lead multi-disciplinary meetings, make judgment calls & verify reports. As per him, machine learning in the form of image processing, computer vision, and natural language processing are the key AI technologies which would augment radiology in the future. The expectation is, this would lead to a lowering of the overall cost of imaging to the patient by increasing the productivity of radiologists through automation of time-consuming & low cognitive value tasks."

III. Objective

1. **To find potential usage of AI in healthcare facilities**
2. **To evaluate the challenges in using AI in existing healthcare facilities**
3. **To assess the Government initiatives in promoting AI in healthcare**
4. **SWOT analysis of AI in healthcare**

IV. Methodology

This dissertation study includes findings from various articles and research papers that have been published online as result of already conducted research on the matter. The research is highly secondary in nature as there is no access to required resources for conducting a primary research. This research has tried to explore state of AI in healthcare in India. It has tried to establish the ways in which AI can be used to bridge the gaps in current healthcare system. Data will be collected on multitude of topics like – potential use cases of AI, benefits of using AI in certain areas, challenges of implementing AI, role of government and private sector in implementing AI in healthcare. This research has also tried to through light on future of AI in healthcare. The research has drawn upon news items, company websites, academic articles, industry reports, interviews, and roundtable inputs to identify different AI solutions being used in each sub-segment of the healthcare industry in India. Findings will be published at the end of research and all the references are clearly mentioned.

SWOT analysis will be done as a part of this research and suggestions will be given as per the analysis results.

RESEARCH DESIGN

Secondary research was conducted by combining multiple secondary data sets. This research was be conducted by using qualitative data. Past data was used to inform the current research. External sources of data were used to extract the data required for the current research.

Data Extraction

Data sources were located and thoroughly read to get further information. Collected data was assessed on the below parameters – usefulness, reliability, validity of data collection methods and consistency among data collected from different sources. Information gaps were identified and filled by following methods –

1. Collecting more information by finding more sources
2. Use of proxies to replace missing data

Inclusion Criteria : Inclusion criteria for report were defined as follows: (1) a comprehensive description of an AI functionality, (2) an evaluation of the efficiency and outcomes of the AI functionality in healthcare, and (3) potential benefits of the AI functionality in at least one health care system (4) challenges and risks in implementing AI in healthcare in India (5) SWOT analysis of AI in healthcare

Exclusion Criteria: Exclusion criteria for report were defined as follows: (1) the title did not covered a topic related to AI in healthcare, (2) neither the title nor the abstract contained a description of an AI application in health care or (3) the title, abstract, or full text did not elaborate on any of the outcome of AI in health care applications in any of the health care system.

V. Outcome

Outcome gives us a conclusive data on below listed items –

1. Issues/ Inefficiencies in existing healthcare system

a. **Scarcity of qualified healthcare professionals** like doctors, nurses, technicians and lack of quality infrastructure. As per WHO numbers there are 0.76 doctors and 2.09 nurses per 1000 people as compared to World Health Organization Recommendation of 1 doctor and 2.5 nurses per 1000 population respectively.

b. **Non-uniform access to healthcare facilities across the country** with conspicuous disparity between rural and urban areas. Physical access to preventive and curative health services is a major challenge in most of the areas.

c. **Concentration of good private facilities in Tier 1 and Tier 2 cities** causes mental trauma and financial stress to patients as they have travel considerable distance and live far away from their home. There is an extra burden to bear travel cost and accommodation expenses apart from the treatment cost.

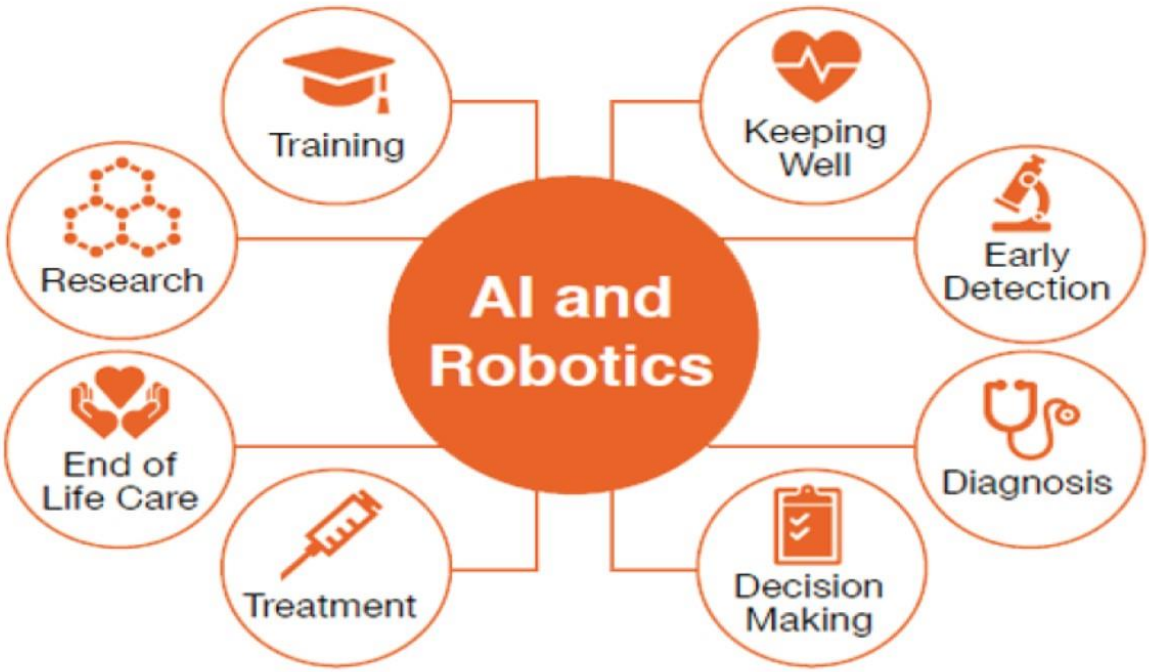
d. **Affordability of quality healthcare facilities** remains a major problem in the country. Significant portion of hospital costs are in both rural (47%) and urban (31%) areas are financed by sale of assets and loans.

e. **Lack of awareness about health issues in most of the population**. This is mainly due to low educational levels, poor functional literacy and less priority to health in the existing population.

f. **Inadequate investment in healthcare by the government**. In India, the Govt. Contribution to health sector constitutes only 1.3 per cent of GDP which is very less. This is one of the major reasons for low health standards in the country.

g. **Medical Research in the country is not focused on drugs and vaccines** for tropical diseases. More funds need to be allocated to boost medical research in this direction.

2. Areas which can be improved by implementing AI



This figure shows areas where AI can be used immediately and extensively. AI solutions can supplement the scarce human personnel and other facilities. AI can be used to overcome the accessibility barriers, can cater to large parts of the country through early detection and diagnostic decision making and treatment.

a. Medical records and data management

Collection and analysis of important data like medical records and patient history can be done using digital automation and AI. Robots can gather, store and trace data to provide quicker and reliable access.

b. Handling repetitive tasks

Mundane tasks can be done more efficiently by robots than humans. Such tasks include analyzing CT Scans, X-Rays, Data Entry and Test Reports. Areas where amount of data to be analyzed is huge like Radiology and Cardiology can be benefited from AI. Human expertise can be utilized in complicated cases in these areas where it is needed.

c. Digital Consultation

Apps can provide medical consultation based on patient's history and common medical knowledge. Patient medical history should be stored in a common database which can be accessed by such apps. Patients can share their personal details and report their symptoms in the app which will then fetch their history from database and suggest a solution accordingly.

d. Medication Management

Apps can be created to monitor intake of medication by the patients. Mobile phone 's webcam can be integrated with AI to check if patients are taking medication as prescribed and monitor their progress. It can be beneficial for patients with serious illnesses but no guardian to take care, participants of clinical trials and patients who tend to or have not followed doctors' instructions in the past. Smart devices can be critical for monitoring patients in ICU and elsewhere.

e. Drug Creation

Most pharmaceutical drugs are developed by undergoing multiple clinical trials which take decades and cost billion of dollars. In case of outbreaks AI can be used to scan the existing and redesign them to create new drugs as a treatment for the disease. The time and cost to create a new drug can be substantially reduced by using AI as compared to traditional methods of developing a new drug.

f. Precision Medicine

Precision medicines can be developed by studying genetics and genomics to find linkage between diseases and DNA information. AI can be leveraged for doing body scans and predicting health issues people might face based on their genetics.

g. Healthcare System Analysis

AI can be used to scrutinize patients' data and treatment provided to point out issues in treatment, workflow inefficiencies and avoid unnecessary hospitalizations. It can also provide better solutions to save time, increase accuracy and reduce costs

h. Cancer screening and treatment

AI can be very promising in large scale interventions for treating Cancer. Every year around 1 million new incidences of cancer come into picture in India. AI can be used for early detection and management to establish a correct cancer treatment regimen across the country. This can be done by creating a repository of annotated and curated pathology images. Also, by analyzing these pathology images at pixel level using AI, better assessment on future progress of cancer can be done. For example – If a cancer is going to progress rapidly or slowly will change how patient will be treated based on an algorithm rather than clinical staging.

i. Expanding access to medical care in rural areas

AI can be used to bridge the gap due to shortage of skilled personnel in healthcare by taking over some of the diagnostic duties allocated to humans. For example – AI imaging tools can be used to screen chest X-Rays for sign of tuberculosis with the same accuracy as humans. This capability can be provided to low resource areas through an app reducing the requirement of trained medical diagnostic at the site.

j. Containing risk of viral and bacterial outbreaks

Electronic health record data can help in identifying infection patterns & highlight patients at risk before they even begin to show symptoms. Leveraging machine learning & AI tools to drive these analytics can enhance its accuracy & create faster, more accurate alerts for no. of healthcare providers.

3. Government initiatives in promoting AI in healthcare

National Institution for Transforming India (NITI) Aayog is spearheading a national programm on AI a focusing on research. NITI Aayog is trying to augment the productivity of existing radiologists and pathologists through AI image recognition in its pilot projects. It is also working on early diagnosis and detection of Cardiac risk and Diabetic Retinopathy based on AI models. Such models can be utilized in long run to help patients by proving proactive medication in early stages as compared to reactive treatment in later stages. This will improve the chance of survival and reduce the cost of treatment.

According to the latest National Health Profile 2018, India is among the countries with the least public health spending. The Indian government plans to measure up to its promise of health

assurance to all or any Indians with a health spending of just Rs. 3 per person per day that counts for 1.02 percent of the GDP. Indian government plans to spend on below applications of healthcare –

- Robot Assisted surgery
- Automated Image Diagnosis
- Dosage Error Reduction
- Drug Testing Simulations
- Virtual Nursing Assistants
- Clinical Trial Participation

Ministry of Health and Family Welfare has established National eHealth Authority to take care of development of integrated health information system in India. Integrated Health Information System will be developed along with application of telemedicine and mobile health by collaborating with various stakeholders. Its primary objectives included the formulation of the "National eHealth Policy and Strategy" for coordinated eHealth adoption, setting up of state health records repositories and health information exchanges (HIEs) to facilitate interoperability, laying down of data management, privacy and security policies, guidelines and health records of patients.

Government of India is working towards establishing various Centers of Excellence for AI around nine focus centers. Healthcare is one of those sectors where AI is projected to drive innovation and assist in resolving social issues.

Four Committees have been formed to create policy framework and develop ecosystem of AI in India.

Committee on:

- Platforms & data for AI
- Leveraging AI in order to identify National Missions in various Key Sectors
- Mapping Technological capabilities, Skilling, Re-skilling, R&D and Key policy enablers.
- Cybersecurity, Legal, Safety & Ethical issues

4. Challenges in AI Application

a. **Regulatory Issues** – Outdated regulatory norms are obstructing the acceptance of AI in healthcare. Regulations that are applicable for software as a medical device is applied on AI based software too. Most regulatory approvals are based on repeatability, but AI system evolves with repeatability. By the time an AI algorithm is granted a regulatory approval it may evolve and become a different algorithm altogether.

b. **Black box nature of AI** – Blackbox nature of AI poses the problem of explicability. Some of the AI tools are uninterpretable which makes it difficult for regulatory agencies to examine them. These systems pose great safety concerns which need to be addressed before their acceptance.

c. Managing data and protecting privacy

One of the biggest challenges that health industry faces is storing health data in a lean and balanced way, retrieving it efficiently for benefits of the patients and data users. Another challenge is to mine this data for use in AI algorithm without

violating the privacy and preventing any misuse. New technologies are making it easier for people to track their health through health monitoring apps, smart watches etc. But they are also giving access to their private information with not may rules in place. There should be proper rules around collection and usage of such type of data.

d. Controlling Unemployment

AI wave can uproot jobs on a large scale. Many workers employed in clerical, customer service, sales and other mundane jobs can be affected by advancements in AI. Specially in growing economies like India where there is a lack of skilled resources, these people will not be able to upkeep with the demands of new kind of job that will be generated and will be left jobless.

e. Training issues

It has been established that initial training and technical and guiding support is necessary for accurate use of AI devices in healthcare. It is more required for old workers with low computer literacy. There should be proper guidelines in place to deal in the situations when there is a conflict between recommendations provided by the system and health workers. Currently, there is lack of professional support when workers feel uncertainty towards AI systems. Regular system upgrades should be done to increase the usage of AI devices as it will increase confidence of users.

f. Retrospective studies vs. Perspective studies

Most of the studies use historical data to train and test AI algorithms which cannot help to realize true utility of AI systems. Performance of AI systems may worsen when it is run on the real-world data as compared to training data.

g. Metrics do not reflect clinical applicability

Metrices that capture desirable properties of model do not include one important parameter i.e. how model results will be helpful in improving the patient care.

h. Injuries and errors

If any AI systems gives a wrong recommendation like prescribing a wrong drug or predicting a radiological scan inaccurately then it may lead to fatal injuries. Of course injuries occur due to error in medical system in present date also but AI injuries can be more fatal. First, patients may react differently to injuries caused due to system than human and it will be difficult to find the solution in such cases. Secondly, AI systems may have a cascading effect, breakdown of one system might lead to failure in other systems as well affecting large number of patients.

5. SWOT Analysis of AI in healthcare

Global Healthcare Artificial Intelligence is predicted to grow at 51.9% CAGR from 2018-2023 due to increase in the adoption rate of AI solutions among healthcare providers. AI is considered as the next frontier of healthcare innovation. Potential utility of AI spans across healthcare verticals. AI can play an important role in dealing with some of the major issues posed by the existing healthcare facilities.

Strengths –

1. Government is taking an initiative in promoting AI in healthcare along with the private players. NITI Aayog is overlooking an initiative on AI focusing on research. NITI Aayog is trying to augment the productivity of existing radiologists and pathologists through AI image recognition in its pilot projects. It is also working on early diagnosis and detection of Cardiac risk and Diabetic Retinopathy based on AI models.

2. Adoption rate of AI will increase due to growing number if AI healthcare apps coupled with rising demand for medical research. These healthcare apps can collect vast amount of patients' s data and then manage it systematically for analysis. This data can be used for healthcare system analysis to point out issues in treatment, workflow inefficiencies and avoid unnecessary hospitalizations. It can also be used to provide digital consultation based on patients' history. It can also be used to predict risks of developing certain diseases in future based on toady's condition.

3. Technological companies like IBM are investing in development of AI for research and healthcare. AI is being used for diagnosis, prognosis and therapy can further stimulate the growth of AI

4. AI in healthcare promotes effectiveness and efficiency which will trigger its adoption in the coming years.

Weaknesses –

1. Absence of skilled and trained human personnel who can use AI systems to augment their work as they might not be able to take advantage of the decisions taken by the AI systems. Proper training needs to be provided as there might be an old generation of health workers where adoption rate of new technology is very low.

2. There will be a fear among the healthcare workers that AI might take away their jobs, so it might further delay adoption of AI solutions by them. Proper training should be conducted, and these workers should be enabled to coexist with AI systems. Their myths around AI should be busted well in advance before implementing any AI system.

3. High costs associated with implementation of AI in healthcare or any area may act as major barrier for healthcare service providers to adopt it. High cost will also lead to inequitable access to these AI services. Government intervention will be required in such cases. Government should encourage private players to adopt AI by rewarding them. Also, they should keep prices of health services in control.

4. Stringent guidelines regulating AI can also act as a barrier to the adoption.

Opportunities –

1. AI in healthcare can be used to expand access of healthcare services in rural areas where physical access to preventive and curative health services is a major challenge. AI can be used for digital consultation based on patients records in these areas where there is no doctor present at the site.

2. AI can be utilized in handling mundane tasks where human expertise is not required. Such tasks include analyzing CT Scans, X-Rays, Data Entry and Test Reports. In areas like Radiology and Cardiology where there is huge data to be analyzed can be benefited from using AI.

3. AI can be used in medication management to observe if patients are taking medication as prescribed and monitor their progress.

4. AI can be leveraged in drug creation in a faster manner than the usual clinical trials approach. In case of outbreaks AI can be used to scan the existing and redesign them to create new drugs as a treatment for the disease.

5. AI can be very useful in large scale interventions for cancer screening and treatment. AI can be used for early detection and management to establish a correct cancer treatment regimen across the country.

6. By mode of application robot assisted surgery is one of the most promising areas where AI can be leveraged. It offers flexibility and high precision even while performing complex procedures.

Threats –

1. Loss of jobs will happen if people are not skilled enough to work with AI systems, they are not able understand AI algorithms and take decisions based on those. AI systems might eliminate the need of human intervention altogether in some of the areas. In such cases, new jobs should be generated where humans can coexist with AI systems, but existing health workers are not adaptable enough to deal with this change

2. Humans can lose control over the systems that they developed. In that case systems will take matters in their own hands and might take decisions that can be catastrophic for the mankind.

3. One of the most obvious threats is what happens when AI system is wrong. It might lead to fatalities. If an AI system recommends the wrong drug to a patient or diagnoses an illness incorrectly or fails to notice a tumor on a radiological scan then it can lead to serious fatalities. Also, patient might react very differently to these errors as compared to the human errors.

VI. Conclusion

1. AI can revolutionize the healthcare industry in India. Opportunities and benefits of AI seems promising and can change the face of the healthcare sector.

2. Government should invest more in healthcare and consider AI as an investment rather than an expense. It should increase the public expenditure to reduce the out of pocket expense especially for poor people which pushes them further in the poverty line.

3. Government and private sector should work in collaboration focusing on AI research to explore efficient ways of utilizing AI to improve the existing processes and address the shortcomings in the healthcare system. It should also bring in measures to control the cost of AI facilities in healthcare.

4. AI should be used to collect, store, maintain and analyze patients' data system. It should be then used for digital consultation, predicting future risks, monitoring day to day health of the patients.

5. AI should be leveraged to provide good health services to rural areas which currently suffer due to shortage of health care facilities and health workers.

6. AI should be used in CT Scans, X-Rays, Data Entry and Test Reports. Robot assisted surgery is another application area for AI. AI should be used in large scale interventions for cancer screening and treatment. It should be leveraged for drug creation.

7. Government should bring in right regulations for AI. It should also take steps in training the healthcare workers to make them skilled in AI.

VII. Discussion

There is great scope and new avenues for exploration of AI in healthcare.

1. AI will lead to a breakthrough in Precision health. AI will have access to multiple data sources which will help to expose disease patterns and help with care and treatment. In future, healthcare systems will be able to predict when someone is at risk pf developing a chronic disease

2. There will be networked hospitals and connected networks. Hospitals will be able to function in hub and spoke manner where the central hospital can treat critically ill patients and look after the complex procedures and normal cases can be treated through smaller retail clinics. AI will remove bottlenecks from the system and improve the patient hospital allocation process.

3. AI will lead to better patient and staff experiences by reducing the waiting times, streamlining the workflow and eliminate the administrative workload.

4. Virtual Health Assistants will be able to provide personalized experience to patients wherein they will get answers to their health issues.

5. Robots will not be involved in surgeries but will also be taking care of various tasks like examining patients, treating patients in rural areas through telepresence, disinfecting hospitals, automating labs.

6. 3D printing might help doctors in replicating patient specific organs. It will also help in creating surgical devices and medical equipment by printing them.

The advancements will redefine healthcare for both physicians and patients. It will reduce the overall cost of medical services for the patients. The future looks promising as AI has already started penetrating in healthcare. Though, there are lot of challenges which may slowdown the pace with which AI changes the face of the industry, but it still has significant benefits that cannot be ignored.

VIII. Recommendation

1. As of now government contribution to healthcare is just 1.3 per cent of GDP ranking 187th among 194 countries. India's total healthcare spending is 3.6% of GDP (out of pocket and public) is way lesser than other countries. Government should start investing more in healthcare especially in technology and AI.

2. India should consider investment in AI as an investment rather than cost. According to CDC estimates, there is $10 return on every $1 spent on children vaccines. On the similar lines if India invest in AI it will boost the economy in long term. It will reduce the out of pocket expenses on healthcare especially in rural areas. These expenses are a major trigger of pushing people into poverty. In 2011 and 2012 – 55 million Indians fell into poverty because of healthcare spending. It will boost human capital's productivity. It will improve poor public health which is 12th major hurdle in ease of doing business in India.

3. Private sector should also step up and start investing more in technologies like AI and Machine learning and focus more on AI research. AI should be leveraged for prognosis, diagnosis and therapy. AI should be augmented with the existing healthcare facilities.

4. Application of AI should be developed in healthcare around delivery of health services, detection of diseases, drug discovery and management of chronic diseases.

5. AI should be leveraged to overcome the shortage of health personnel in the country and promote an equitable access of health services to all the areas. This can be done by improving productivity through automation of complicated tasks. It can be used of digital consultation in areas where no physical doctors are present. It can also be used for medication management to observe if patients are taking medication as prescribed and monitor their progress.

6. AI should be leveraged in handling mundane tasks where human expertise is not required. Such tasks include analyzing CT Scans, X-Rays, Data Entry and Test Reports.

In areas like Radiology and Cardiology where there is huge data to be analyzed can be benefited from using AI.

7. Government and private healthcare providers should also resolve training issues. It has been established that initial training and technical and guiding support is necessary for accurate use of AI devices in healthcare. It is more required for old workers with low computer literacy. Currently, there is lack of professional support when workers feel uncertainty towards AI systems. Regular system upgrades should be done to increase the usage of AI devices as it will increase confidence of users.
8. AI should be used in drug creation in a faster manner than the usual clinical trials approach. In case of outbreaks AI can be used to scan the existing and redesign them to create new drugs as a treatment for the disease.
9. By mode of application robot assisted surgery is one of the most promising areas where AI should be leveraged. It offers flexibility and high precision even while performing complex procedures.
10. AI can be leveraged for early detection and management to establish a correct cancer treatment regimen across the country. This can be done by creating a repository of annotated and curated pathology images. Also, by analyzing these pathology images at pixel level using AI, better assessment on future progress of cancer can be done.
11. Government should resolve regulatory issues around AI before it is used in large scale in the healthcare. There should be regulatory principles to ensure that privacy of the patients is not violated by using the data collected through apps. A robust system should be developed to manage and analyze this data. Also, there should be regulations in place to use, run, update and monitor AI algorithms and take decisions based on them.

IX. Limitations

1. Study is highly secondary in nature and mostly based on assumptions and there is a lack of any proof of application.

2. All the estimated benefits are based on assumptions or taken from similar experiments in developed countries like US. But the conditions in developing countries like India are very different.

3. There is no reference data to compare and estimate the benefits or limitations of AI in healthcare in the country.

4. No examples of success stories where AI has been utilized in any healthcare facility.

5. Lack of success stories from another sector. If AI would have been used successfully in any sector, then it could have been benchmarked and AI could have been successfully implemented on the similar lines.

6. Financial aspect/estimated growth rate/Cost reduction not covered. Important factor to consider for a developing country.

7. It is not possible to setup a research and run AI algorithms and then evaluate its performance to estimate the potential benefits. There are very few experts in AI so conducting a primary research to collect data is also not a feasible solution.

8. Study is highly dependent on the experiments conducted by the experts and their findings.

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