Research Article Available online www.ijsrr.org ISSN: 2279–0543

International Journal of Scientific Research and Reviews

Role of Artificial Intelligence in Hospitals: How it has changed the Healthcare system

Dhoundiyal Neha[1], Yadav Neha[2], Sharma Prerna[3], Savaria Mukesh[4*]& Singh Neha[5]

Master's in Hospital Management at Delhi Pharmaceutical Sciences and Research University, New Delhi[1], Senior Process Associate, TCS, Virar Homoeopathic Medical College, Virar, Maharashtra[2], Master's in Public Health at DPSRU, New Delhi[3], Assistant Research Officer, THE INCLEN TRUST INTERNATIONAL[4,*], Research scholar at DPSRU, New Delhi, India[5]

ABSTRACT

Due to the increasing complexity of medical procedures Artificial intelligence is gaining popularity in healthcare. This paper provides an overview about the use of AI in hospitals as in IPD, ICU, Data support, Patient management and logistics, etc. After assessing inclusion and exclusion criteria out of initially indentified 78 articles, a referential and cross-referential analysis of 59 articles was done for final synthesis; statistical reports are taken from Mckinsey, Accenture and Statistca. Reports from Niti Ayog on Current scenario of AI in India, initiative of government, future Objective and Aim were considered. Insights of wearable, sensors, neural technique, accelerometer, fuzzy logic and other aspect of AI are discussed in detail. Successful working model of AI-PPP in Indian hospitals like MINE, NIRMAI, DRISHTI are highlighted. Result reveals an exponential growth of AI in hospital's ecosystem however identifies the gap in requirement for future researches, issues in technology acceptance, data security and lack of legal framework.

KEYWORDS: Artificial intelligence, Patient management, Data support, Data Security

Corresponding Author:

Dr. Mukesh Savaria

Assistant Research Officer (ARO)

THE INCLEN TRUST INTERNATIONAL,

F-1/5, Okhla Industrial area Phase-1, New Delhi-110020

Mukesh.savaria11@gmail.com

Mob. No. - +919560187300

1. INTRODUCTION

Healthcare service industry especially hospitals are facing unprecedented pressure in recent times due to changing demographics of the population, expanding administrative burden, need of more skilled workforce, rapidly changing pattern of morbidity along with increasing demand and expectations of the individuals. All these pressure points can be easily dealt with by the introduction of artificial intelligence in the hospital system. Artificial intelligence along with it forms like machine learning is being increasingly used in the healthcare industry due to its potential to transform the management, care, and satisfaction of patient in the hospital set up. Artificial intelligence not only have the capability of easing out the patient aspect within hospital set up but also helps in various other domain like administrative process, inventory management, internal patient department, and intensive care units.

Various studies have been done then and now have repeatedly suggested the precise performance of artificial intelligence-powered technology in various health care branches whether diagnostic or administrator.

In 2016 the artificial industry has the largest share of investment when compared to any other sector in the global economy[1]. Artificial intelligent aims to mimic human cognitive functions. AI provides a positive shift in hospital management due to its analytical technique. Artificial intelligence is used in fields like detection and diagnosis of disease, predicting the treatment and its outcome and decision-making[2].

2. TYPES OF AI USED IN HOSPITALS-

2.1. Machine learning

This can be explained as the statistical process of assessing data to learn, train and interpret a specific model with the help of this data, commonest forms of artificial intelligence that is used in hospitals[13]. Among healthcare industry, the most common use of machine learning is predictive technology which is most famous due to its precision[14].

2.2. Neural system network

A complex technological technique machine learning which was released in 1960[15]. It has been used to predict the disease prevalence and pattern within patients. This is done by analyzing input-output based on patient details like weight and history.

2.3. Deep learning

This is yet another famous form of machine learning which is being rapidly used in different fields of healthcare. This is specifically being used in recent years for disease diagnostic says through

radiological aid like cancer lesion[16]. Technology aided deep learning can find the smallest of information through data imaging detection which can be skipped by a human eye specially in case of rare cancers[17]. This is known as computer-aided detection or CAD.

2.4. Natural language processing

This technology is based on sensing, understanding and analyzing human languages. There are two basic approaches through which natural language processing helps the healthcare industry that is semantic and statistical within the hospital ecosystem Natural language processing can be used in creating, understanding and classifying the tons of clinical data received on daily basis[13].

2.5. Robots

An artificial intelligence-powered robot has been in the US since 2000. They have the capability of assisting surgeons by improving ability for precise, low invasive incisions and better stitch wound management in surgeries[18]. They are capable of performing tasks like delivering supplies, managing inventory and maintenance support in hospitals as mentioned in

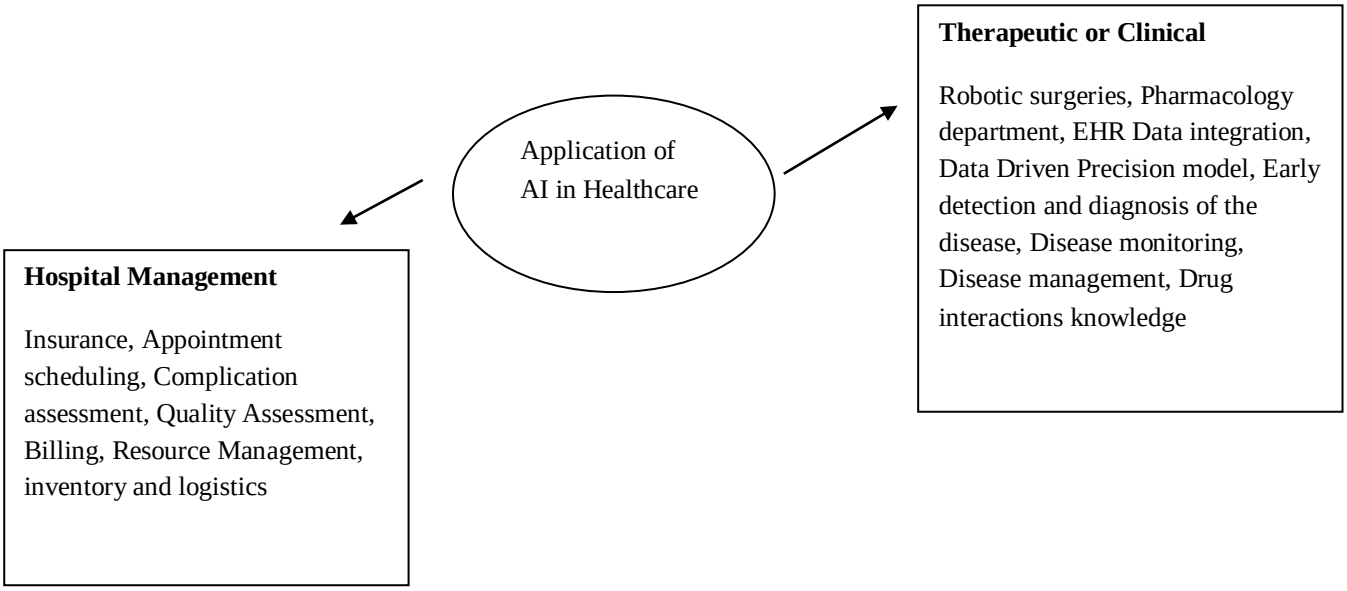


Figure 1: Use of AI in health sector

3. USE OF AI IN HOSPITALS

AI is used for mostly the three usual tasks involved in clinical practices of the hospital that are the diagnosis, prognosis, and therapy[39]. Generally, the medical diagnosis cycle in any disease may include observation and examination, patient data, formulating a diagnosis. If we can compare the medical diagnostic cycle to the concept of an intelligent agent system, the physician is the intelligent agent, the patient data is the input and the diagnosis is the output. The practical application of this systematic approach can be seen in Clinical Decision Support Systems (CDSS)[39]. It is helpful in assessment of individual cases on basis of data[59].

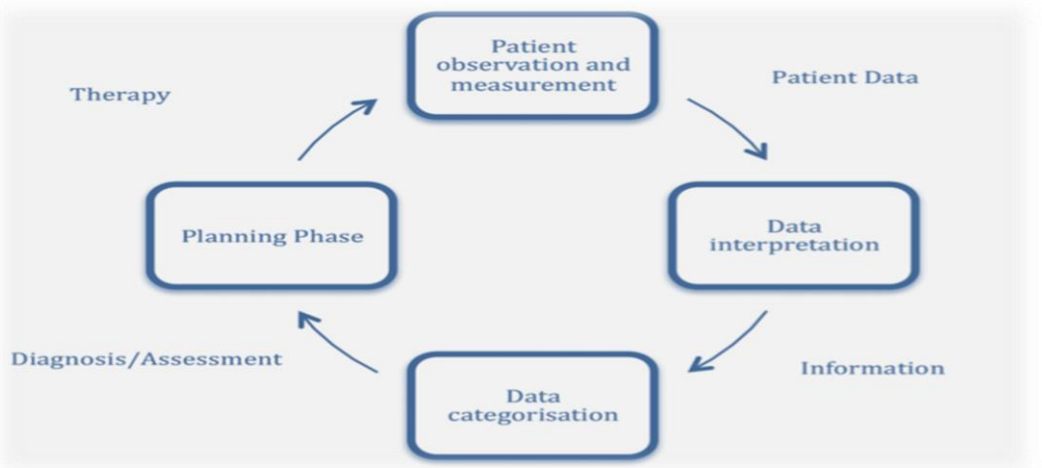
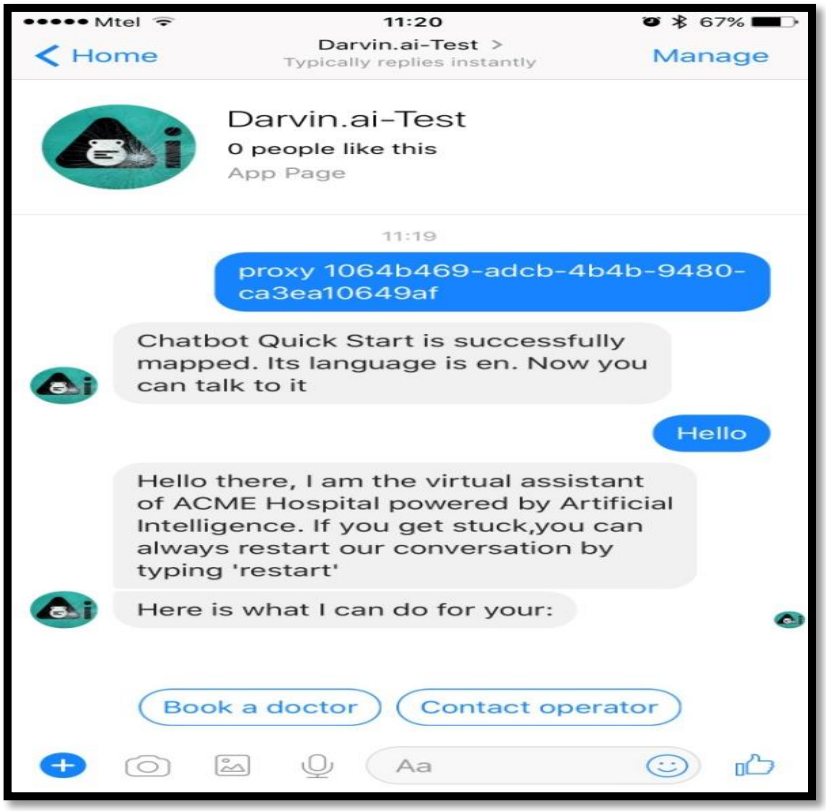


Figure 2: Patient management cycle model in artificial intelligence



Screenshot – I - from an automated chat bot app that uses natural language processing to answer questions by patients to answer related to their hospital. The chat bot uses natural language processing to classify intents and respond appropriately. He is also able to recognize from a previous question.

Source: https://docs.nativechat.com/docs/1.0/getting-started/tutorial-book-a-doctor.html

3.1 Administration support

In recent years there has been an immense increase in the utilization of artificial intelligence and power technology in the field of health care[3]. The delivery system of the healthcare industry especially hospitals has become complex due to the maximum stretch capability and capacity of hospitals specifically in developing nations[3]. Artificial intelligence tools have been used in past and demonstrate the power to enhance the functioning of hospitals by reducing the administrative burden through augmented critical data analysis which further aims at reducing the non-clinical overload over the physician[4].

AI techniques can help hospitals in the following method-

a. The machine learning algorithm can be used for clinic appointment scheduling as well as patient privatization this reduces the wastage of time and enhances the efficiency of services[5].
b. Natural language processing, (NLP) works on voice capture and Transcription can be used to compile the notes for the Electronic medical record (EMR) hence clinicians can get more time for the patient-related process[6].
c. Various healthcare organizations also using AI-powered chat boxes for interactions with their patient in the field of telemedicine and mental health. This can be done through NLP based applications that are useful for refilling previously instructed prescriptions[13]. However, the use of chat bots is in very invasion stage and in and so the patient has expressed concern about security concern and poor usability[19].
d. Machine learning and AI technology can be used for matching data across various platforms and sources which is, in turn, helps in payment and claims settlement. This reduces the burden over the hospital due to the endless long claim settlement process. It also helps in analyzing the coding process which is the most common cause of incorrect claim information. It also helps in auditing through the potential use of data mining and data matching.
e. The integration of big data helps in providing opportunities in simplifying healthcare information which is beneficial for patients, regulatory bodies and hospitals[21].
f. In view of Figure 2., It can be said that artificial intelligence helps in simplifying the hospital system of working be it front lines like reception or appointment scheduling or blackened working like supply chains.

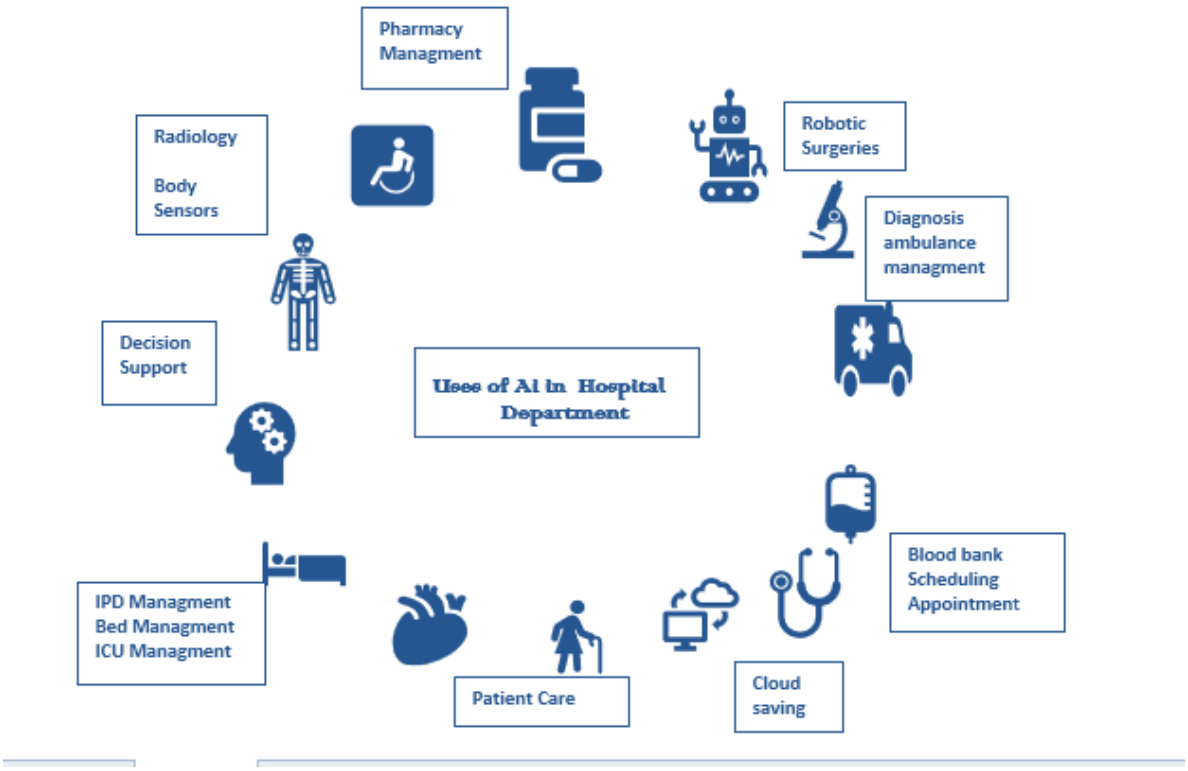


Figure 3: How use of AI is simplifies various day to day aspect of Hospital system of working

3.2 Patient management

a. Artificial intelligence program which has been linked with the servers of hospital or self-capable of analyzing already recorded data of patient which can intern use for answering the queries of a patient. This reduces the waiting time over the counters. This also very well reduces the load over the emergency department[7].

b. Machine learning and AI programs which are synchronized with electronic medical records from detect patient information through their biometrics and recommend early-stage clinical guidelines[8]. This helps in better patient management even in cases of shortage of skilled manpower.

c. AI programs can be used in administering drugs through fuzzy logic. Fuzzy logic is the logic that is based on several values procured from past experiences[8]. It is the science of reasoning, thinking which is further translated into a matter of degree. In fuzzy logic the output can be depicted as "IF" and the outcome in the form of "THEN" as mentioned in Table 1[23]. For example, fuzzy logic can be used to administer vasodilator to post-operative patients.

Table 1: Typical Fuzzy Logic Information

IF	Change in bowel habit	OR	Rectal Bleeding
THEN	Consult Doctor		

3.3 Better IPD bed regulation

Artificial intelligence can be used to manage the flow of patients by predicting the patient flow within the hospital system. This can be done through various uses of technologies like cloud integration, chatbots, and web-based software[9, 10]. This is done through an intelligent patient flow management system (IFPM).

Better resource management and IPD ward utilization allow the optimal flow of patient and designated surgery planning which promises higher revenues and patient satisfaction. The integration of big data helps in providing an opportunity for both patients and the Hospital[11]. This can be associated with the use of a potentially enhanced clinical workflow system in hospitals.

BOX: 1

Potential Enhanced Clinical Workflow with Artificial Intelligence (AI) Interventions[24]

In a traditional system of treating the patients, the decision for treatment protocol is based on multiple factors like clinical sign and symptoms presentations, histo-pathological reports, radiological reports, blood reports, etc. The clinical outcome is decided after a long period. In comparison to this, AI-based interventions have the potential to augment the clinical workflow to uplift the decision-making power at different stages of care. This can be further improved with the help of Continuous feedback as well as optimization from various outcomes.

3.4 In ICU settings

AI in critical care units is being used to reduce the burden on the nurses and duty doctors. This is done by optimizing workload settings. These allow clinicians and nurses to spend more time on patients rather than doing technical and paperwork. AI allows penetration of human decisions with the aid of machine learning. This puts forwards a cost-effective and highly efficient machinery system[12]. Following are the tools which are being used-

a. Variables like light sensors, head position reading, facial expression capturing are assessed with the help of video monitoring, sound sensors, and accelerometer. These technologies are converting conventional intensive care unit into an ICU information system[12] as mentioned in Figure 3(a) [12]. In figure 4(a) we can see how a video screen can be seen for the scrutiny of the patient status on one hand and the other hand light sensor sound sensor and accelerometers are linked with physiological signs and symptoms which are in turn trained to work on their

own. This allows better time as well as resources management where nurses do not have to keep a visit or check again and again and utilize the same amount of time for other crucial activities.

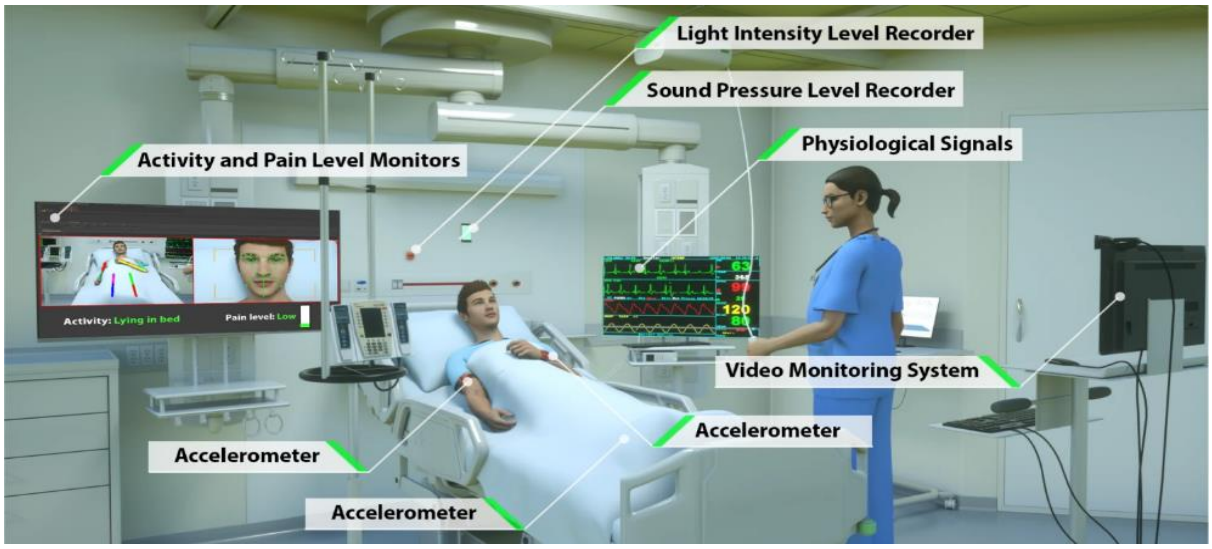


Figure 4 (a): ICU information system powered by AI: use of sensor, accelerometer and monitoring through the video are the key components of the setting. An automated technological supported ICU setting

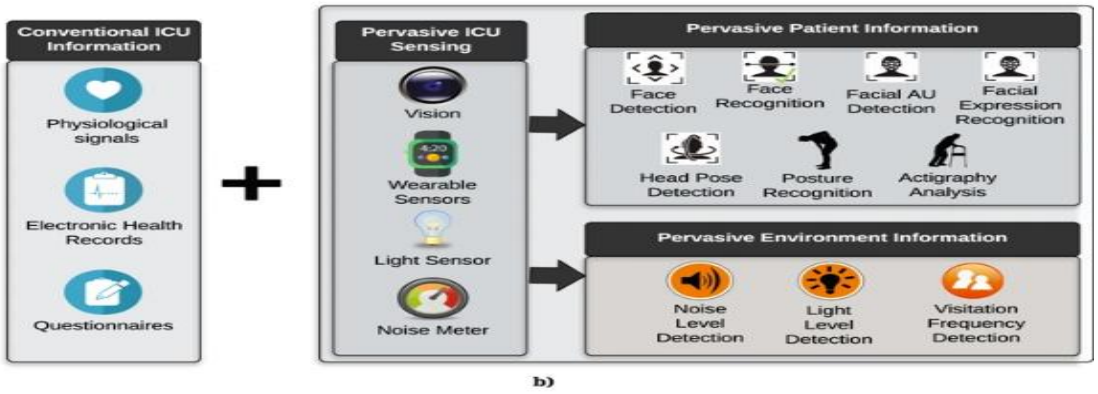


Figure 4 (b): shows how conventional ICU information are combined with AI pervasive ICU sensing

b. Intelligent ICU used for autonomous patient monitoring using pervasive sensing and machine learning[12] Fig 4(b) shows how conventional ICU information like physiological signals, electronic health records are combined with AI pervasive ICU sensing like wearable sensors, light sensors, etc. for better patient management[12].

3.5 Inventory management and supply chain:

The use of technology can increase the efficacy of supply chains significantly. This holds well, especially for perishable items[20], One such example is the utilization of RFID (radio frequency identification device) [21]. AI through RFID can control the circulation of counterfeit drugs that further influence the pricing decision of materials like drugs and instruments or types of equipment[22].

The use of AI can be used for analyzing expiry dates through tagging of medicines allowing early detection of expiry dates, stock management, etc. It also increases the permeability of information flow between the parties in the supply chain of the hospital like investors, stakeholders, manufacturers, wholesalers, and suppliers.

3.6 Controlling hospital acquired infection-

Hospital-acquired infection is one of the commonest complications as well as challenges in front of the hospital industry. The computerized patient records in hospitals can allow automated identification to find out the early sign of hospital-acquired infection. This can be done with the help of fuzzy logic at the ICU settings done in accordance to the European Surveillance System HELICS this is currently being in operation at the Vienna General Hospital. It is helpful in controlling infection from catheterization[30].

4. MATERIALS AND METHODS USED

A detailed literature review was carried, which includes searching and evaluating the cyberspace platforms like Research Gate, PubMed and Google Scholar for articles related to the topic. Articles focusing on the performance of Artificial Intelligence in hospitals since 2000 have been considered. Global and national articles published presenting the role of AI in public and private domains were studies for the eligibility and appropriateness of the topic. Multiple aspects of Total 59 articles have been considered, out of which 37 comprises of implementation model of AI in hospital (IPD, Administration, Patient flow management system) while the rest of the 09 articles were on the challenges of AI,4 article reports the future and current scenario of AI. 4 studies deal with the therapeutic aspect of AI in Cancer, Dermatology, Vascular neurology and strokes. 5 studies focus on the standardized strategy model of India in AI. Articles have been studied for the deep understanding of AI in hospitals globally as well in the Indian context.

6. DISCUSSION

The techniques implementation of AI across hospital with current, future out-coming and actual challenges are overviewed. Analysis reveals successful AI models currently in use as Fussy logic mentioned by Ramesh A et al.[8], Baldwin K.[6]; smart ICU System by Davoudi A et al.,[12], De Bruin J et al.,[30]; patient Management by Jiang F et al.,[2], Jones S[10] et al., H T. IOS Press Ebooks[9], Neill D et al.,[58]; Resource planning as described by Yousefi M et al.,[7],Huang J et al.,[5]; Supply Chain found in Daverport T et al.,[18], Utermohlen K et al.,[19], Hossein P et al.,[20], Deniz B et al.,[22] and Data integration by Ribeiro M et al.,[25], Gambhir S et al.,[3], Yousefi M et al.,[7], Ribeiro M et al.,[25], Joshi R et al.,[46]. Explicit contribution of AI in cancer detection as mentioned in Farookh R et al.,[16],Snyder C et

al .,[4] Hosny A et al.,[24], Alanna V et al.,[17], Esteva A et al.,[26] is observed, however acceptance among doctors, more strict regulations, data privacy, system efficiency are the key determinant of the future success and huge challenge as supported by various studies of Char D[28] et al., Kelly C et al.,[29], Hosny A et al.,[24], Coiera E et al.,[40], Giuliano et al.,[49].

Initiative of Indian healthcare sector came out to be appreciable but require higher degree of commitment as Indian healthcare system is unstructured and complex.

7. CONCLUSION

Literature analysis revealed despite being a significant key to the appropriate revolution in healthcare AI still lacks a widespread adoption in hospitals. There are multiple aspects of AI implementations that need to be addressed. Cost and lack of the structure came forward as the biggest challenge of AI whereas no stringent law for data privacy and leakage is major concern. Although there is huge complimenting ability of AI to health workers if implemented with sheer will but need of further researches cannot be denied specially in Indian healthcare system.

8. REFERENCES

1. Shah P, Kendall F, Khozin S, Goosen R, Hu J, Laramie J et al. Artificial intelligence and machine learning in clinical development: a translational perspective. npj Digital Medicine. 2019; 2(1).
2. Jiang F, Jiang Y, Zhi H, Dong Y, Li H, Ma S et al. Artificial intelligence in healthcare: past, present and future. Stroke and Vascular Neurology. 2017;2(4):230-243.
3. Gambhir S, Malik S, Kumar Y et al. Role of Soft Computing Approaches in HealthCare Domain: A Mini Review. Journal of Medical Systems. 2016;40(12).
4. Snyder C, Wu A, Miller R, Jensen R, Bantug E, Wolff A et al. The Role of Informatics in Promoting Patient-Centered Care.The Cancer Journal. 2011;17(4):211-218.
5. Huang J, Jennings N, Fox J et al. Agent-based approach to health care management. Applied Artificial Intelligence. 2002;9(4):401-420.
6. Baldwin K. Evaluating Healthcare Quality Using Natural Language Processing. Journal For Healthcare Quality. 2008;30(4):24-29.
7. Yousefi M, Yousefi M, Ferreira R, Kim J, Fogliatto F et al. Chaotic genetic algorithm and Adaboost ensemble metamodeling approach for optimum resource planning in emergency departments. Artificial Intelligence in Medicine. 2018;84:23-33.
8. Ramesh A, Kambhampati C, Monson J et al, Drew P. Artificial intelligence in medicine. Annals of The Royal College of Surgeons of England. 2004;86(5):334-338.

9. H T. IOS Press Ebooks - Intelligent Patient Flow Management System at a Primary Healthcare Center – The Effect on Service Use and Costs [Internet]. Ebooks.iospress.nl. 2020 [cited 26 April 2020]. Available from: http://ebooks.iospress.nl/publication/50490
10. Jones S, Thomas A, Evans R, Welch S, Haug P, Snow G et al. Forecasting Daily Patient Volumes in the Emergency Department. Academic Emergency Medicine. 2008;15(2):159-170.
11. [Internet]. 2020 [cited 26 April 2020]. Available from: https://www.researchgate.net/publication/335600087_DeepHealth_Deep_Learning_for_Health_Informatics
12. Davoudi A, Malhotra K, Shickel B, Siegel S, Williams S, Ruppert M et al. Intelligent ICU for Autonomous Patient Monitoring Using Pervasive Sensing and Deep Learning. Scientific Reports. 2019;9(1).
13. Davenport T, Kalakota R. The potential for artificial intelligence in healthcare.Future Healthcare Journal. 2019;6(2):94-98.
14. Artificial intelligence (AI) | Deloitte Insights [Internet]. Deloitte United States. 2020 [cited 26 April 2020].
15. Gordo M. (PDF) Introduction to neural networks in healthcare [Internet]. ResearchGate. 2020 [cited27 April 2020].Available from: https://www.researchgate.net/publication/228820949_Introduction_to_neural_networks_in_healthcare
16. Ladhak F, Nazi A et al. Using Deep learning to enhance cancer diagnosis and classification: A Conference on machine learning. The 30th International Conference on Machine Learning (ICML2013), [cited 16 April 2020];67-82.
17. 17 Vial A, Stirling D, Field M, Ros M, Ritz C, Carolan M et al. The role of deep learning and radiomic feature extraction in cancer-specific predictive modelling: a review. Translational Cancer Research. 2018;7(3):803-816.. Available from: https://scholars.uow.edu.au/display/publication128772
18. Daverport T, Glaser J. Just-in-Time Delivery Comes to Knowledge Management [Internet]. Harvard Business Review. 2020 [cited 27 April 2020]. Available from: https://hbr.org/2002/07/just-in-time-delivery-comes-to-knowledge-management
19. Utermohlen K. 4 Robotic Process Automation (RPA) Applications in the Healthcare Industry. [Internet]. 2018[cited 16 April 2020]; Available from: https://medium.com/@karl.utermohlen/4-robotic-process-automation-rpa-applications-in-the-healthcare-industry-4d449b24b613

20. Hossein P, Mingzouh J, Mohammad R. Healthcare inventory and supply chain management: a literature review [Internet]. Reserach Gate. 2011 [cited 27 April 2020]. Available from: https://www.researchgate.net/publication/283732340_Healthcare_inventory_and_supply_chain_management_a_literature_review
21. He J, Baxter S, Xu J, Xu J, Zhou X, Zhang K et al. The practical implementation of artificial intelligence technologies in medicine. Nature Medicine. 2019;25(1):30-36.
22. Deniz B, Karaesmen I, Scheller et al.-Wolf A. Managing Perishables with Substitution: Inventory Issuance and Replenishment Heuristics. Manufacturing & Service Operations Management. 2010;12(2):319-329.
23. Ramesh A, Kambhampati C, Monson J, Drew P et al. Artificial intelligence in medicine. Annals of The Royal College of Surgeons of England. 2004;86(5):334-338. https://www.researchgate.net/publication/8379547_Artificial_intelligence_in_medicine
24. Bi W, Hosny A, Schabath M, Giger M, Birkbak N, Mehrtash A et al. Artificial intelligence in cancer imaging: Clinical challenges and applications. CA: A Cancer Journal for Clinicians. 2019.
25. Ribeiro M, Singh S, Guestrin C. et al. Why Should I Trust You?". Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining - KDD '16 [Internet]. 2016 [cited 5 April 2020];:1135-1144. Available from: https://dl.acm.org/doi/abs/10.1145/2939672.2939778
26. Esteva A, Kuprel B, Novoa R, Ko J, Swetter S, Blau H et al. Dermatologist-level classification of skin cancer with deep neural networks. Nature. 2017;542(7639):115-118.
27. Zech J, Badgeley M, Liu M, Costa A, Titano J, Oermann E et al. Variable generalization performance of a deep learning model to detect pneumonia in chest radiographs: A cross-sectional study. PLOS Medicine.2018;15(11):e1002683. https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1002683 https://www.ncbi.nlm.nih.gov/pubmed/30399157
28. Char D, Shah N, Magnus D et al. Implementing Machine Learning in Health Care — Addressing Ethical Challenges. New England Journal of Medicine. 2018;378(11):981-983.DOI: 10.1056/nejmp1714229
29. Kelly C, Karthikesalingam A, Suleyman M, Corrado G, King D et al. Key challenges for delivering clinical impact with artificial intelligence. BMC Medicine. 2019;17(1).DOI: 10.1186/s12916-019-1426-2
30. De Bruin J, Adlassnig K, Blacky A, Mandl H, Fehre K, Koller W et al. Effectiveness of an automated surveillance system for intensive care unit-acquired infections [Internet]. 2009

[cited 6 April 2020]. Available from: :https://www.researchgate.net/publication/26803735_Artificial-intelligence-based_hospital-acquired_infection_control/ [Accessed 10 April 2020] DOI: 10.3233/978-1-60750-050-6-103

31. Accelerating Indian economic growth with AI Accenture.com. 2007. [online] Available at: https://www.accenture.com/t20171220t030619z__w__/in-en/_acnmedia/pdf-68/accenture-rewire-for-growth-pov-19-12-final.pdf/ [Accessed 10 April 2020].
32. Internet & Society, C., Shah, N., Abraham, S. and Wright, G et al. 2012. Open Government Data Study: India. *SSRN Electronic Journal*, DOI: 10.2139/ssrn.2071605
33. Manipalhospitals.com. 2018. *Manipalhospitals*. [online] Available at: https://www.manipalhospitals.com/blog/upgrading-cancer-care-with-ibm-watson// [Accessed 16 April 2020].
34. Simonte, T., 2018. Google's Eye Doctor Ready To Work In India. [Blog] *Wired.com*, Available at: https://www.wired.com/2017/06/googles-ai-eye-doctor-gets-ready-go-work-india// [Accessed 15 April 2020].
35. Kaul, A. and Singh, A., 2018. *National Strategy For Artificial Intelligence*. [online] Niti.gov.in. Available at: https://niti.gov.in/writereaddata/files/document_publication/NationalStrategy-for-AI-Discussion-Paper.pdf/ [Accessed 17 April 2020].
36. How artificial intelligence can deliver real value to companies [Internet]. McKinsey & Company. 2016 [cited 17 April 2020]. Available from: https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/how-artificial-intelligence-can-deliver-real-value-to-companies/
37. Sullivan F. From $600 M to $6 Billion, Artificial Intelligence Systems Poised for Dramatic Market Expansion in Healthcare [Internet]. Frost & Sullivan. 2016 [cited 27 April 2020]. Available from: https://ww2.frost.com/news/press-releases/600-m-6-billion-artificial-intelligence-systems-poised-dramatic-market-expansion-healthcare/
38. Farrugia A, Al-Jumeily D, Al-Jumaily M, Hussain A et al. Lamb D. Medical diagnosis: Are artificial intelligence systems able to diagnose the underlying causes of specific head- aches?, International Conference on Developments in e-Systems Engineering (DeSE); 2013.
39. MacLean C, Littenberg B, Gagnon M et al. Diabetes Decision Support: Initial Experience With the Vermont Diabetes Information System. American Journal of Public Health. 2006;96(4):593-595.
40. Coiera E. The Price of Artificial Intelligence.Yearbook of Medical Informatics. 2019;28(01):014-015.DOI: 10.1055/s-0039-1677892

41. Du Rant H, You J. Humans need not apply. Science Journal of New Zealand. 2014;346(6206):190-191.DOI: 10.1126/science.346.6206.190
42. Annals of the Royal College of Surgeons - Google Scholar Citations [Internet]. Scholar.google.com. 2020 [cited 9 April 2020].Available from: http://scholar.google.com/citations?user=bepJ4YIAAAAJ&hl=en/
43. The Top 7 Digital Healthcare Trends in 2019 | AT&T Business [Internet]. Business.att.com. 2020 [cited 10 April 2020]. Available from: https://www.business.att.com/learn/research-reports/the-top-7-digital-healthcare-trends-in-2019.html
44. Kulkarni P, Mulay P. Evolve systems using incremental clustering approach. Evolving Systems. 2012;4(2):71-85.DOI: 10.1007/s12530-012-9068-z
45. Pwc.in.2020. [online] Available at: <https://www.pwc.in/assets/pdfs/publications/2018/reimagining-the-possible-in-the-indian-healthcare-ecosystem-with-emerging-technologies.pdf> [Accessed 10 April 2020].
46. Joshi R, Mulay P. Closeness Factor Based Clustering Algorithm (CFBA) and Allied Implementations—Proposed IoMT Perspective [Internet]. A Handbook of Internet of Things in Biomedical and Cyber Physical System (pp.191-215). 2008 [cited 10 April 2020]. Available from: https://www.researchgate.net/publication/334599388_Closeness_Factor_Based_Clustering_Algorithm_CFBA_and_Allied_Implementations-Proposed_IoMT_Perspective/ DOI:10.1007/978-3-030-23983-1_8_8.
47. Gordon R, Perlman M. The hospital of the future: How digital technology can change hospitals globally [Internet]. Deloitte. 2017 [cited 10 April 2020]. Available from: https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/us-lshc-hospital-of-the-future.pdf.
48. Annual Report | NITI Aayog [Internet]. Niti.gov.in. 2017 [cited 12 April 2020]. Available from: https://niti.gov.in/annual-reports.
49. Giuliano J, Staff B, Staff B, Pardo-Bunte M, Pardo-Bunte M, Reedy J et al. IBM Watson Flops For Cancer Treatment: Why Did AI Fail? [Internet]. Better Buys. 2017 [cited 12 April 2020]. Available from: https://www.betterbuys.com/bi/ibm-watson-for-cancer-treatment
50. Technology – Niramai [Internet]. Niramai.com. 2018 [cited 10 April 2020]. Available from: https://www.niramai.com/technology.
51. Home - ten3T Healthcare - Wearable, medical grade, continuous vitals monitoring health devices.[Internet].ten3T Healthcare - Wearable, medical grade, continuous vitals monitoring health devices. 2018 [cited 10 April 2020]. Available from: http://www.ten3thealth.com/

52. Drouin J, Hediger V. Health care costs: A market-based view", The McKinsey Quarterly [Internet]. Mckinsey.com. 2008 [cited 10 April 2020]. Available from: https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/healthcare%20systems%20and%20services/pdfs/healthcare-costs-a-market-based-view.ashx
53. D'Monte L. How Philips is using AI to transform healthcare [Internet]. Livemint. 2016 [cited 10 April 2020]. Available from: http://www.livemint.com/Science/yxgekz1jJJ3smvvRLwmaAL/How-Philips-is-using-AI-totransform-healthcare.html
54. India M. Government of Telangana adopts Microsoft Cloud and becomes the first state to use Artificial Intelligence for eye care screening for children - Microsoft News Center India [Internet]. Microsoft News Center India. 2018 [cited 10 April 2020]. Available from: https://news.microsoft.com/en-in/government-telangana-adopts-microsoft-cloud-becomes-first-state-use-artificial-intelligence-eye-care-screening-children/
55. National eHealth Authority (NeHA) | National Health Portal of India [Internet]. Nhp.gov.in. 2018 [cited 15 April 2020]. Available from: https://www.nhp.gov.in/national_eHealth_authority_neha_mtl
56. Report of Task Force on Artificial Intelligence | Department for Promotion of Industry and Internal Trade | MoCI | GoI [Internet]. Dipp.gov.in. 2018 [cited 15 April 2020]. Available from: https://dipp.gov.in/whats-new/report-task-force-artificial-intelligence
57. Office Memorandum - Constitution of a Committee of Experts to deliberate on a data protection framework of India | Ministry of Electronics and Information Technology, Government of India [Internet]. Meity.gov.in. 2018 [cited 15 April 2020]. Available from: https://meity.gov.in/content/office-memorandum-constitution-committee-experts-deliberate-data-protection-framework-india
58. Neill D. Using Artificial Intelligence to Improve Hospital Inpatient Care. IEEE Intelligent Systems.2013;28(2):92-95.DOI:10.1109/mis.2013.51
59. Sachitanand R. Here's why Indian companies are betting big on AI [Internet]. The Economic Times. 2019 [cited 12 April 2020]. Available from: https://www.google.co.in/amp/s/m.economictimes.com/tech/internet/heres-why-indian-companies-are-betting-big-on-ai/amp_articleshow/67919349.cms.