

AMALGAMATION OF ARTIFICIAL INTELLIGENCE (AI) IN EMERGENCY MEDICINE; A PARADIGM APPROACH

Abstract

Advent of AI has revolutionizing potential in total management of patient care. It is a reality today and application of AI interwoven from hospital administration to therapeutic decisions. A new paradigm has emerged and AI is changing the medical landscape in its entirety. The modern AI utilizes the innovations in machine learning and deep learnings which enable it to create and modify its the algorithms continuously based on real time informations. The modern AI tools are capable of learning from the patients data, recognize the patterns and modify them to be more precise and accurate. Thus predict the responses and outcome in hospital stay management. AI has been successfully applied to predicting the flow and footfall of patients into the emergency department. This helps in streamlining patient flow to hospital, monitoring treatment patients in ward and emergency department. Smart management of patients care through AI helps predicting the availability of bed in inpatients in advance which helps in optimizing the available resources. The general dictum is that intelligence is defined by learning from the events around and accurately analyzing and reasoning. It is clearly understood that AI is based on three components of learning enabled algorithms, machine learning and deep learning and upgrading the algorithm accordingly to be more accurate and pertinent tool.

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I. INTRODUCTION

‘Artificial Intelligence’ (AI) is a new term but it was coined in 1956 and is defined as, “the science and engineering of making intelligent machines which is empowered to think and predict outcome of action as human being do”. It is also a useful tool for healthcare administration. Clinical Applications based on Artificial intelligence (AI) is the most important and innovative development in medical sciences which has enormous potential to positively influence the various aspect of diagnosis and treatment across all field of medical practices. Medical tools which are AI-based, now have been commonly used for predicting various factors in emergency medicine such as risk stratification, diagnosis and treatment. AI is a new subset of computer science that simulates human intelligence, including speech recognition, predictive modeling, and problem solving as the human would do. While Machine learning (ML), which is again a subset of AI, is commonly used in medicine. ML has the ability to improve medical algorithms autonomously which is based on the clinical input from the medical records. Newer techniques which increases computing power and processing techniques of vast pool of clinical data such as deep learning and thus improve patient care. Use of Artificial Intelligence has multifactorial in heathcare industries including hospitals, emergency, diagnostics, radiology, laboratories, and research facilities. Healthcare administration and operations, clinical decision support, predictions in healthcare, patient monitoring, and healthcare interventions are various spectrs where this new techniq has promising results. One of the most common AI predictive model is the patient streamlining the triage inflow into emergency department, management of disease. Predicting the outcomes, and in-patient mortality.

Emergency medicine is the new promising field of medicine which harnesses its strength by combining the knowledge of modern medical sciences and pooling the support of other related specialities for mitigating the serious patients reporting to emergency services and are suffering due to poisoning, burns, road accidents and other life threatening ailments and trauma. Emergency Medicine is a medical speciality—which deals with unpredictable patients and emergency physician has knowledge and skills required to prevent, diagnose, and manage urgent aspects of medical problems affecting all age groups. Emergency physician is responsible for initiating resuscitation, stabilization and performing the initial investigations and interventions. Further emergency medicine is divided into subspecialisation such as; disaster medicine, medical toxicology, support of diagnostic radiology, point-of-care ultrasonography, critical care medicine, emergency medical services, hyperbaric medicine, sports medicine, palliative care, or aerospace medicine, pre-hospital and in-hospital emergency medical systems. The difficulty faced by EM physician in variety of complex clinical situation to take precise and accurate judgment about diagnosis and treatment in split second poses challenge to human ability. The AI may assist in these complex situation by its interactive algorithms in ascertaining the course of treatment to be followed for care of the patients.

II. CHALLENGES IN EMERGENCY MEDICINE

The challenges in emergency medicine are manifold and it encompasses to quick diagnosis, management of triage, attended the patient in golden hour, and arranging the expertise and specialist lifesaving services round the clock. The greatest challenge of emergency department is over burden capacity, more and more people are suffering with

chronic diseases with more acute exacerbation. Road traffic accidents, other traumas, and acute illnesses are continually on rising trends which have overburdened the ED. Emergency departments have to treat more complex illnesses within a stipulated time within golden hours, leads to suboptimal healthcare delivery to patients in need. Increased ED referrals from other hospitals due to various reasons have enhanced ED attendance. Many patient related information like their medical background, history and other social factors Emergency medicine physicians often don't have all the information they needed to treat and this causes more time consuming way of treatment. Moreover sometimes patients are alone or their attendant do not have enough medical information. So a proper and detailed electronic prior history is paramount and helpful for easy treatment plan. Ai can play vital role in quick assessment of such vast and complex clinical situations. Also better connectivity with AI with post discharge patients is necessary to navigate a patient to wellness. Over Crowding in the ED is common problem in hospitals across the globe emergency medicine is the one of the specialty with a legal mandate to provide care to every sick patients. This over burden causes following problems with emergency care:

- Patients walking out of the emergency department without being seen.
- Poor Patient or Attendant Satisfaction
- Poor Health care delivery to sick patients
- Excessive waiting times

It may be possible for AI to mitigate the problems faced by patients by calibrated induction and in emergency medicine

III. AI IN PLANNING OF BED OCCUPANCY AND LENGTH OF STAY

Managing the bed occupancy and attending the critical patients reporting to ED has remained under debate from long time. However, the interactive algorithm approach adopted by AI has shown promise in managing the inflow of the patient and manage the be occupancy as well. This facilitates the administrative management, augments the critical care and unnecessary demand and burden on clinician is reduced. It has been shown in several studies that automated and interactive AI can fast track the diagnostic finding in all radiological investigations both in ED and wards with accuracy and precision. AI has been infused with the capability to predict the need of readmission in certain patients for specified durations which helps in advance planning of bed occupancy and also reduces the cost by optimizing the hospital stay. The time management and approach to reduce footfall in ED has remained a challenge as each moment is of critical importance in the emergency lifesaving services. Saving precious moments with intervention of AI guidance would vastly improve the care and experience of the patient in triage and ED. However, the challenge remains in ED to allocate beds to every patient (about 25% of patients from ED) to the specialty services once it has recovered from emergency conditions. The bottle neck is unless a bed opens in the hospital the ED patients can not be shifted hospital beds. AI have shown path breaking promise in resolving many such problems by enhancing the decision making, suggesting about discharge of patients, suggestion to utilize interdepartmental referrals and enhancing the clinical diagnosis capabilities.

IV. AI IN MANAGING THE STAFFING IN ED

ED is a facility which runs 24x7 for 365 days of the year and footfall increase during festivals and holidays. This punishing schedule require scientific management of staffing and care of the staff working in ED otherwise they may face burnout. It is imperative to draw a balance between work –life and deeply engaging and demanding duties in ED. Thus proper scheduling and sensitivities of each staff in essential in management of ED staffing. It has also been observed that staff constraint remains all time in ED as the allocation always fall short of the expected needs and number. Moreover, records of the ED of the services rendered and making available the treatment records for further academic analysis, research and evaluations require proper staff for records management in ED. Convectional ED treatments records are more often than not are incomplete and the real statement of clinician vis-a- vis patients interaction records are not available as the treating physician relies more on the person abilities. AI based electronic records seamlessly help in keeping of the whole process of ED and could become a game changer. An AI interphase for objective recording the clinician and patients interaction will generate most valuable electronic data for research and academic analysis of the patent management and outcome. AI based communication will help in developing algorithms which will later be a guide in translating the management approach in more focused manner and predict the possible outcome of a course of therapy.

ED works in a high risk environment and engaged in life saving endeavour in varied of clinical situation in a unpredictable nature of inflow of patients. The EM physician utilises his cognitive abilities based on previous work experiences and literature in the emergency conditions when a patients reports. The need of hour is to make quick decision and save the moment for patients with support of limited information. This is a very tricky situation in many circumstances. It is imperative to conduct extensive diagnostic test so that nothing is missed and effort of the ED physician is also to be on right side of the law to avoid any litigations later on. Most of the ED physician work in most complex situation where there is lack of facilities. And absence of proper infrastructure to manage the totally unpredictable clinical situation which in next moment may come for treatment. Often the constraints faces are unavailability of necessary equipment's, diagnostic tools and trained manpower, lack of requisite numbers of beds both in emergency as well as in main hospital to refer the needy patients requiring hospital care. It has been established that staff allocation by the conventional methods results in waste of resources resulting in delays in delivery of required health care services. AI has developed a smart system of staff management and need based allocation and distribution of staff. The AI based staff allocations has evolved with continued up gradations by learning the needs and its inbuilt ability of pattern recognitions and allotting the staff where there is need and optimising the limited resources to maximum utility. Thus, AI based systems offers a potential opportunity for ED to quantify the flow metrics and foot fall of patients and accordingly make resource allocation. AI is empowered to recognise the needs and optimized the distribution through algorithm support and computerized assisted decision making. Needless to add that AI may be superior to humans in predictive modelling of the vast data of inflow of patients. It has inbuilt ability to process multiple variables simultaneously across large data sets which keep accumulating in the electronic data sheet of ED patients . The smart record keeping and tracking the progress of patients helps in calculating risk, treatment response in an unbiased manner and predict the mortality .

V. AI EMPOWERS THE CHANGES IN THE EFFICIENCY OF EMERGENCY

ED department as to deal with complex and varied medical cases comprising of various specialties. It is therefore considered that ED is uniquely suited for implementation of AI, as AI has ability to predict and guide the triage and analyses the diverse the factors. ED has very limited information about the patient and it has to take a decision excluding the all other possibilities related to treatment, risk stratifications and balancing the risk Vs benefits. AI helps in ED in resource allocation, triage and choosing the most suitable course of action for the benefit of patients. It is clearly understood that ED faces complex set of issues and it faces number of variable to arrive at a suitable protocol. AI has gained acceptance in medical management due power of its algorithm which provides quick analysis in processing the complex clinical information's. Further the AI keeps itself updated from the data inputted and it has the benefit of deep learning and machine learning and it empowers the system to provide suitable guide in ED. American Medical Association has suggested that since AI plays an suggestive role in clinical areas, it may be renamed as “augmented Intelligence”.

It has been obverse that machine based learning has been successfully applied in reading the ECG. AI based units are able to provide interpretation of ECG precisely and all other possibilities of ailments. This technology has been available for several decades. ECG performed in triage quickly enables the physician automatically in arriving a decision. Thus simple ECG reading of “normal” through AI change the management approach. The use of AI in diagnosis and treatment is well proven in ED and it is also being used in monitoring patients from last few years. The rapid evolutions of tools will lead to contactless sensors and AI will provided most probable diagnosis and treatment protocol to totally revolutionise the practices in ED. AI augmented with machine learning is posed to totally revamp the functioning of ED and unburden the physician in ED. The medical science is expanding continuously which may exceed the capacity and cognitive approach of individual human mind to apprehend all and recall all in complex situations. AI has the ability to serve as the information repository and help physician by resolutely removing the unwarranted and unrealistic information's. Thus a new era is dawning where the focus would shift from information acquisition to knowledge managements. This will help in enhancement of education, interpret and communicate to patients, ascertain quick diagnostic and suggestions for therapeutic protocol based on AI empowered medical information systems. Fig-1 provide a blue print of the various process of AI in the medical practices.

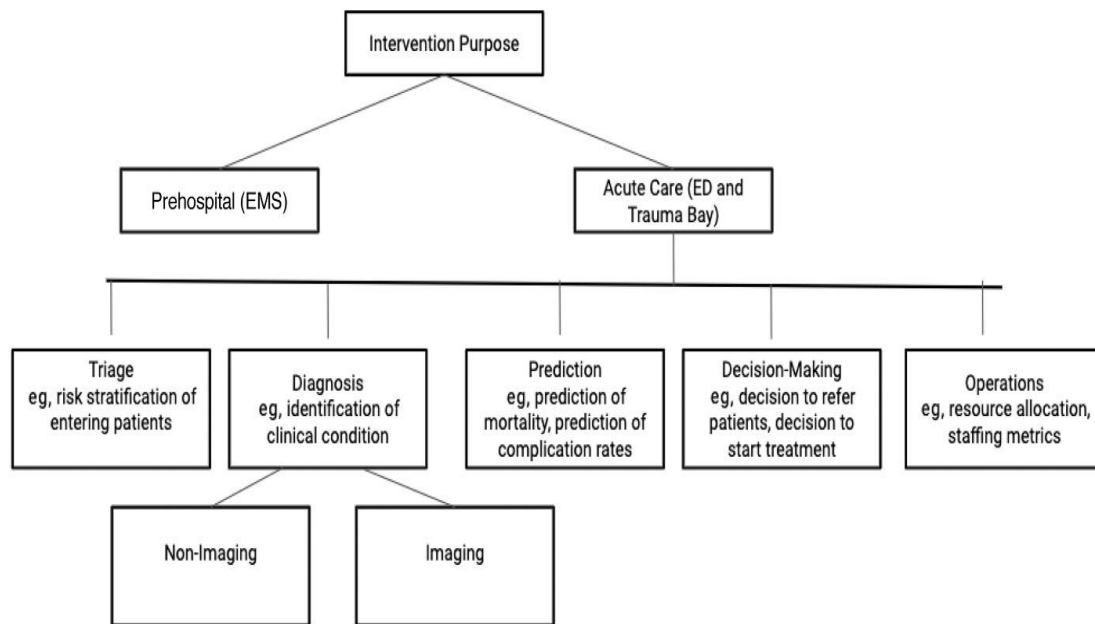


Figure 1: Flow of information and AI

Medical science is poised for a revolution in application of AI and the medical education may shift to AI based protocol and may be benefited through virtual reality (VR) . VR provides a protocol through computed supported simulation of the of the reality of the patients and opportunity to research the various impending diagnostic issues. VR hardware, allows for real-time interaction with the patients and providing an realistic experience about the possibilities of care to be given to patients. AI algorithms will further be empowered to work for data mining from the electronic medical data and come up with ability to provide differentiations and early diagnosis in complicated medical conditions such as neutropenic fever and other viral fevers. This will help in choosing appropriate treatment protocol for benefit of patient. AI also has the ability to recognise early signs of shock requiring immediate stabilization and interventions.

One of the interesting factor of machine learning systems is their ability to review medical record data from millions of patient data and look for common pattern and beneficial working protocol for patients care. This ability can identify significant associations between various patients and emerging patterns that can guide diagnosis and treatment decisions. U.S. Food and Drug Administration and recently approved EM practices using AI and advocated the utility of AI in ED with caution. Some of the protocol approve dare Critical Care Suite (GE Healthcare, Chicago, IL) and Health PNX (Nanox, Neve Ilan, Israel), which assess chest radiographs for pneumothoraxes. The AI based analysis of noncontrast head computed tomography and it's most probable diagnosis provider's great assistance in triage.

VI. CONSIDERATIONS FOR IMPLEMENTING AI

Many researchers in AI based VR and medical data mining suggest that soon AI may be able to outperform the human capability of clinical data analysis and classical statistical data analysis. This suggestion sis based on the premises that AI has the ability to process

multiple variables simultaneously across large pool of data sets and also continuously update its predictive algorithms. Human may not be able to comprehend the complex set of multiple data, analyse its complexity, predict the data set orientations and recognise the unbiased patterns. Whereas, AIs can take advantage of large data sets for stronger pattern recognition, which is particularly highly appreciable and relevant in important medical fields such as radiology and cytopathology. AI can process databases made of hundreds of thousands of radiographs and their reports, resulting in an algorithm that can accurately diagnose new radiographs based on pattern recognition. This makes it an unique proposition to enhance the focus of research on AI in radiology which will help in detection of fractures, early singe of metastasis , and arthritis.

VII. ASSISTANCE OF AI IS EFFECTIVE MANAGEMENT OF TRIAGE

Triage is the apex facility of any ED and is the front line interphase with the public and ED. It is plays pivotal role in identification and initiation of life saving diagnosis, and care. It is designed to provide both to the physician and patient with the coordinates for ensuring that needed care is delivered to the right person, on time without loss of time. In order to deliver accurate and desired intervention the interphase of artificial intelligence (AI) has emerged a powerful tool for emergency room triage. AI empowered with interactive algorithm has evolved over the past few years to play vital role in emergency triage and contributing significantly with reliability. It is designed to support ED physicians to arrive at most probably diagnosis and treatment strategy to handle the increasing load and variety of patients load. AI based on its large pool of data and ever evolving interactive algorithm uses its capabilities in segregating and identifying the patient for different layer of care needed in triage so that physicians can accurately identify and categories the treatment protocol for the patients. The progress in capabilities of AI has been attained by infusing it with large volume of authentic clinical data so that it has the ability to suggest and support the emergency room management in more objective fashion. These employees that before AI module is accepted for implementation in the emergency triage it has to follow rigorous process of testing and modeling to get the best capabilities in practical situation of intriguing triage management. It is clearly understood and practice today that AI has entered into the daily clinical work of the radiology department to provide essential support for the practitioners in managing extraordinary volumes of images and its reporting. Thus AI has helped in redefining the efficiency in radiology reporting and eventual triage management. The AI has become integral part of ED triage management in several hospitals with the help of apps to segregation of patient, referral management, diagnostic information and care to patients through a multispecialty facilities. Early identification of patients in the emergency department using AI tools requiring admission help in optimizing the hospital resources and timely care to patients. In general, the prediction of patient admission to ward from the emergency department was based solely on the triage (demographics, vital signs, chief complaint, nursing notes, and early diagnostics). AI uses various triage-based prediction models which include the Sydney Triage to Admission Risk Tool and the Glasgow Admission Prediction Score for helping in identification of needs of admission. It has been observe that AI empowered tools uses integrated mechanism in addition to historical information which has significantly improved predictive performance significantly in admission management.

VIII. AI IMPLEMENTATION IN REDUCING THE BURDEN ON ICU

AI by using its predictive model of outcome and treatment protocol has immense potential in reducing the burden on the ED and the ICU. Significantly it can be linked in the management of emergency through telemedicine which may be a boon to remote patients. In such situation it can proactively help and predict the outcome of triage for remote patients. It can also help in identification for keeping such patients remote who have lesser risk till alternative space is created in ICU of ED. It can suggest that such patient be kept on remote facility before moving to ED triage or ICU based on different level of urgency, thereby limiting the unnecessary ED influx and reducing the burden on ICU. The confidence generated with the predictive model both in patient in care givers would be a significant addition of popular acceptance of AI. It can be used to manage patient fear as with the assistance of AI they are provided with high-level of insight and support from remote locations. Patients in remote locations can also potentially be ensured faster and more accurate triage with AI technology. This would work wonders and will reduce the pressure on the ED medical professional. This will also help patients needing urgent care to receive it faster, thereby helping the cause of patient and reducing the pressure on the ED. As more data and clinical input is added in AI it may become increasingly be more capable of providing better support in triage in ED. Information harnessed from AI in triage has the potential to minimize risk, improve accuracy, and reduce the burden on the ICU, hence give significant assistance in years to come

IX. LEGAL ISSUES, PRIVACY, CONFIDENTIALITY, AND BIG DATA

Universal acceptance of AI in medical armamentarium need to be based on its ability to stand medico legal scrutiny. Therefore, before advocating wider application of AI it is imperative to ponder that the proposed AI has acceptance and proven track records of acceptance in the arena of medico legal complexities. It is intended that in years to come AI systems would be empowered to generate specific treatment recommendations and there will be options for finally choosing the suggested protocol by the emergency physician (EP) for implementation. The compounding factor in the AI implementation would emerge if the EP lacks a clear understanding of the reasons for accepting the AI supported treatment recommendations; it may create confusion and hence may delay the treatment rather than expediting. Ultimately the ED physician is liable for the harm caused by the treatment protocol and the legal system would held the physician responsible. This may be one of the biggest dilemma in accepting AI supported regimen.

It is therefore felt that from safe medico legal point of view the implementation of AI based practice would demand that physician uses medical AI only as suggestive protocol. Under the existing medical liability regimen it is felt that AI suggestions is used as a confirmatory tool in addition to cognitive ability of the treating physician. It should, thus, be utilised to support the existing decision-making processes and not solely rely and follow on AI to make treatment choices. Unless we have the support of legal frame work for implementation of AI in medicine it may be a recommendatory tool. The pace of development and evolution in the AI based technologies is much faster than the evolution in legal frame work. Moreover the AI sysytems are continuously evolving and apprehending more and more clinical date to be more accurate and realistic with enhanced diagnostic and therapeutic capabilities. It is in fact an on-going process of evolution. Thus the challenge is

AI, is dynamic and continually developing, which certainly outpacing policies, protections, and legal guidance available. In addition to this aspect there are concerns regarding the use of AI and its implications for patient safety considering. It is a nascent and evolutionary technology which is based on limited body of evidence to support its projected outcome. Hence, it is imperative that AI based practices undergo large planned control trails and evaluations based on statistically significant large pool of data so that it acquires universal and clinically acceptable. Till such that it has found sound legal frame work for implementations it may remain more a suggestive technology.

We are legally bound with the dictum of privacy and protection of patient confidentiality. Thus every health care system has fundamental professional responsibility to maintain patient privacy and confidentiality. The advent of AI empowered interactive of electronic data acquisition, collection and transmission about the patient it is apprehended that there may be breach in the privacy of personal health care information. AI's uses machine learning, interactive acquisition of big data for its update and upgrade to be more reliable and accurate which adds further complexity in the challenge of safeguarding patient confidentiality and privacy. One of the drawback of AI is the possibility of a phenomenon of erroneous acceptance of an incorrect automatic interpretation is known as automation bias. The automation is alluring and tempting in making mistakes as it generate overreliance. Overreliance on complex and streamlined clinical processes leads to complacency and reduced vigilance in information seeking, processing and accepting the recommendation generated by AI. A general acceptance is that AI is the integral part of the whole medical system and is here to stay with legal frame work support.

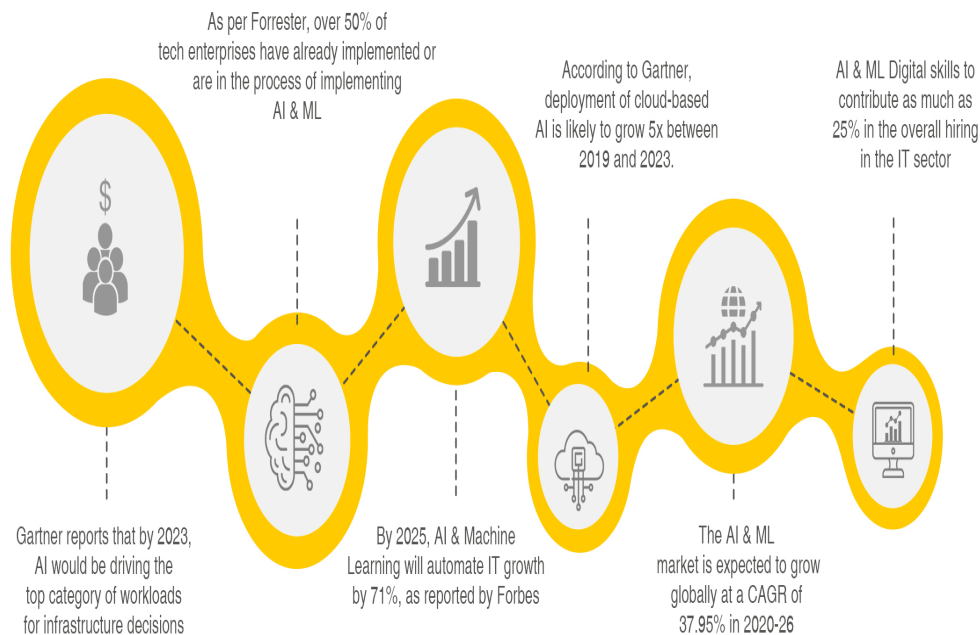


Figure 2: Projected progression in AI and ML in the years ahead.

X. DISCUSSION

AI is the futuristic innovations and most of the radiological and pathological diagnostic information's may be based from the input of AI. AI interventions in general would be a huge helping hand in ED which may guide in optimize resource allocation, analysis and report radiology investigations, computed tomography (CT) imaging, and predict needs of hospital admission based on patterns recognition of similar cases using electronic medical records. Published literature has amply indicated that radiology is more amenable to AI analysis because it is technology-driven, the images have pattern of appearances, and relative large pool of data sets available to build a robust algorithm for predicting the diagnosis. The radiological images present the pattern of appearance of tumor, fracture of lesions; hence AI helps in ED by providing accurate and speedy diagnosis from radiological studies. Several studies sand published literate indicate that AI provides far superior analysis of data and analysis that the conventional statistical based data analysis. One of the studies indicated that AI was superior in predicting the mortality and risk in pneumonia. AI may be superior to humans in predictive the complex clinical variables as it has capability to process multiple variable simultaneously across a large pool of data which is beyond the cognitive ability of human skills. Thus, AI has predictive power and ability to use various data from the treatment patterns and their outcome to suggest the patents outcomes in ED. It can safely be added that AI will have a significant impact in hospital setting managing the triage and wards admissions. There are several studies which have concluded that AI appears superior to clinicians regarding predictive the diagnostic and therapeutic protocol and modeling. But it can safely be added that current level of evidence provided by AI is still has narrow base and uncertain in many situations. There are serious dilemma about medico legal implications and controlled trails of AI vs. human clinical acumen in dealing a clinical case. However, it is the clear that large pool of data and published scientific literature deduces that AI has shown strong promise in improving outcome prediction in the ED. It has also been established that AI showed superiority over human comparators in several areas, especially in analyzing large data sets and rapidly changing variables. In depth analysis and research may be of utmost value in ascertain the utility of AI in ED and its comparison with existing standard of care. Future research may be necessary with a prospective controlled trials in order to determine true superiority, assessing costs of AI, feasibility, enter phasing of AI and integration of AI in ED. The other practical difficulty is preparing an environment both in ED physician and support staff far seamless integration of AI in ED and its adaptability. Some of the suggested recommendations are listed below:

XI. RECOMMENDATIONS

- AI is computer programmed augmented intelligence utilising pattern recognitions and modelling based on data inputs which may help in enhancing the skills and clinical judgement to speciality trained physician.
- Emergency physician (EP) may exercise caution and analyse the AI suggestion based on their clinical skills to interpret the information and recommendations. It is only an assisting tool and not the final approvals.
- Professional clinical bodies and health authorities should work on policy frame to utilize in the use of AI in clinical care, research and training and devolve its own standards and verifications.

- All AI tools and applications should be evaluated through a planned scientific manner as other clinical trials prior to its widespread implementation.
- ED physician should be legally enabled to implement the AI and ML and accept it only the help that conform the professional standards.
- EPs should demand regulations and legislation for protection of patient confidentiality and privacy.
- The ED care should be provided only by the physician and under no condition a non-medical personnel be authorised based on AI enabled tools to start the treatment.
- Every efforts and modalities be in place to protect the privacy and confidentiality of patients and AI generated information should not be abused.

With the advent in AI and its beneficial effects in clinical management it may be imperative to commence the education in AI and it should be the part of curriculum in all specialities and across all the spectrum of the care givers in ED. The AI will expand its scope further hence in-depth study of AI, electronic data records and Machine learning is encouraged to be part of curriculum at all levels. Professional bodies may meanwhile start updates and continuing education on AI for the ED and other specialities. It may be more appropriate if ED physicians with augmentations of computer skills engage in development AI and further updates of algorithms. This will further advance the AI and its implementations in ED. Simulations of AI operated ED will help physicians in integrating it in clinical practices and help them in developing the necessary skills. AI-related research may have to rapidly increase in emergency medicine for an authentic AI for ED. Studies show promising opportunities for AI radiological diagnosis, predictive modelling for patient outcomes and triage management. However, it is still not clear and not yet exclusively proved that AI supported protocols are superior over standard practice. Further interactive and planned research is needed before AI is accepted as a clinical guide and its implementation.

XII. SUMMARY

Advent of AI has revolutionizing potential in total management of patient care. It is a reality today and application of AI interwoven from hospital administration to therapeutic decisions. A new paradigm has emerged and AI is changing the medical landscape in its entirety. The modern AI utilizes the innovations in machine learning and deep learnings which enable it to create and modify its the algorithms continuously based on real time informations. The modern AI tools are capable of learning from the patients data, recognize the patterns and modify them to be more precise and accurate. Thus predict the responses and outcome in hospital stay management. AI has been successfully applied to predicting the flow and footfall of patients into the emergency department. This helps in streamlining patient flow to hospital, monitoring treatment patients in ward and emergency department. Smart management of patients care through AI helps predicting the availability of bed in in-patients in advance which helps in optimizing the available resources. The general dictum is that intelligence is defined by learning from the events around and accurately analyzing and reasoning. It is clearly understood that AI is based on three components of learning enabled algorithms, machine learning and deep learning and upgrading the algorithm accordingly to be more accurate and pertinent tool.

