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Review Article

Artificial intelligence for smart patient care: transforming future of nursing practice

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ABSTRACT

Artificial intelligence (AI) in today's era has been described as "the new electricity" as it continually transforms today's world by affecting our way of living in many different spheres. Extensive government programs in most countries and enhanced technology investments thereof are set to rapidly advance AI. Consequently, healthcare teams will be majorly affected by intelligent tools and systems to be launched into healthcare and patient homecare settings. AI represents a variety of functions under an umbrella of terms like machine learning (ML), deep learning, computer vision, natural language processing (NLP) and automated speech recognition (ASR) technologies. Each of these when used individually or in combination has the potential to add intelligence to applications. Understanding of AI in medical field is crucial for nurses. Utilization of AI in nursing will accelerate innovation and fasten up decision making for them thus saving their time and improving patient outcome plus satisfaction with nursing care provided. Of utmost importance while partnering with AI is the requirement for AI to be safe and effective. A major concern for AI practitioners in the current scenario is managing bias. To realize the full potential of AI, stakeholders (AI developers and users) need to be confident about two aspects: (1) reliability and validity of the datasets used and (2) transparency of AI based system. Issues encompassing AI are novel yet complex, and there is still much to be learnt about it. Nursing experience, knowledge, and skills will transit into new ways of thinking and processing information. This will give new roles to nurses-like information integrators, data managers, informatics specialists, health coaches and above all deliverers of compassionate caring-not replaced by AI technologies yet supported by them.

Keywords: AI, Nursing, Informatics, Nursing process, Healthcare

INTRODUCTION

Technology is now a part and parcel of everyday life. AI in today's era is often described as "the new electricity" as it continually transforms our world by affecting our way of living in many different spheres. In healthcare too, it is not surprising that AI is making a significant headway. Research predicts that global AI healthcare spending will increase tremendously in near future[1]. The growth of AI in health market is projected to be-from USD 6.9 billion in 2021 to USD 67.4 billion by the year 2027 (a compounded annual growth rate CAGR of 46.2% from 2021 to 2027)! Key factors fuelling this boom in the market include increasing number of partnerships and collaborations amongst various players in healthcare domain, influx of large and complex data pertaining to healthcare, a continuous need to reduce healthcare costs, constantly improving computing power and declining hardware costs and an ever-increasing need for improvised healthcare services (due to shortage of healthcare manpower and surging patients' load). In today's scenario, AI based technology is expected to be very promising in various sectors of healthcare; providing new opportunities for all stakeholders-health care workers, health institutions and policy makers.[2] With extensive government programs and enhanced technology investments to advance AI, healthcare teams will be significantly affected by intelligent tools and

systems to be launched into healthcare and patient homecare settings.

WHAT IS AI

John McCarthy, recognized as the father of AI for his outstanding contributions in the field of computer science and AI, coined this term AI in 1956. He defined it as "the science and engineering of making intelligent machines, especially intelligent computer programs."[4]

In other words, AI is defined as "the theory and development of computer systems (which are) able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages."[5]

One premier policy thinks tank of the Indian government (NITI Aayog) has identified five sectors-healthcare, agriculture, education, smart cities infrastructure and transportation- to focus its efforts towards the implementation of AI. It defines AI simply as "the branch of computer science concerned with making computers behave like humans". In that sense, AI refers to the ability of machines to perform cognitive tasks like thinking, perceiving, learning, problem solving and decision making.[6]

SIGNIFICANT COMPONENTS OF AI IN HEALTH CARE SECTOR

AI represents a variety of functions under an umbrella of terms like ML, deep learning, computer vision, NLP and ASR technologies (Figure 1). Each of these when used individually or in combination has the potential to add intelligence to applications.[7]

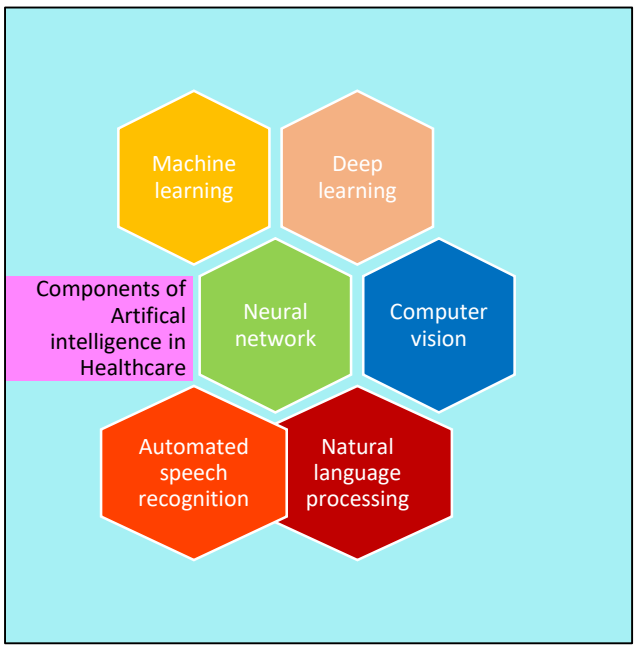

Figure 1: Common applications of AI into health care.

Commonly applied form of AI in healthcare is predictive analytics and ML. ML uses methodologies like mathematical algorithms to process data in the form of information, to ultimately imitate human decision making.[8] Predictive analytics is a mathematical operation that analyses raw data already collected from multiple sources, to predict future course of events; helping in decision making.[9] For instance, advanced analytics can be used to predict the likelihood that a patient may suffer from any disease like stroke, CAD, heart attack or kidney failure. ML analyses previous health related data like blood pressure readings and lab values, and considers a patient's gender, race, family history, socioeconomic status and other risk factors along with the latest data available from clinical trial. This information can then be utilised by nurses to create personalised understanding and then an individualized nursing care plan can be charted.[7,10]

Computer vision (visual recognition) is an area of AI that enables computers and systems to obtain meaningful information from visual inputs like digital images or videos and recommendations are made based on the visual information. If AI enables computers to think, computer vision enables them to see, observe and understand.[11,12]

Deep Learning is the most complex form of ML, also known as neural network models consisting of multiple variables or features that can predict outcomes. There may be numerous hidden features in these models, which are uncovered while processing; using today's advanced graphic processing units/cloud architectures. A commonly used application pertaining to deep learning in radiology is the detection of potentially cancerous lesions in radiological images.[13]

Another AI program is NLP coupled with ASR, which helps computers to better understand, analyze and process human (unstructured) languages; to move smart machines closer to a human-level understanding of language.[7] NLP, includes functions such as speech recognition, text analysis, translation and other language processing functions.[13]

In healthcare sector, the predominant applications of NLP involve the creation, understanding and categorisation of clinical documents and published research. This system can analyse patient's unstructured clinical notes, organise it to prepare reports (e.g., a radiology examination), transcribe patient verbatims and conduct conversational AI.[7,9,13]

RELEVANCE OF AI IN NURSING

Understanding of AI in medical field is crucial for nurses. Utilization of technology like AI in nursing will accelerate innovation, fasten up decision making for them which will save their time and also improve patient outcome as well as satisfaction with nursing care. AI is

the solution for the current day situation of massive and complex data available; fast processing of such data enables positive changes in the delivery of patient care.[10,14] Each of the emerging AI technologies has in store a tremendous opportunity to improve care.[12]

NURSES' DATA COLLECTION AND AI

Nurses are the group of healthcare professionals who are in direct contact with patients for most of their in-hospital time; while doing documentation the nurses collect and generate very important data for health systems. This collected data can be eventually processed using AI tools. Hence, nurses must understand the relationship between the data they collect and its congruity to AI applications. The processed data can provide insight to nurses about their work-as to how this documentation could be used for purposes beyond immediate clinical decision making, administrative reporting and a legal record.[14,15]

Initially, there is bound to be a lot of uncertainty existing at various levels for AI-based clinical decision support; a clear direction in such situations requires clinician expertise and interpretation.[16] At the stage of final decision making about how to follow an AI-based recommendation, nurses act as the last line of evaluation for the appropriateness of a proposed intervention.[17] In the current scenario, in majority of the nursing educational programmes (both entry-level nursing education or continuing education of professional nurses) there is lack of adequate expertise about teaching health informatics and AI technologies to nurses, since it is a novel application and is continually evolving.[18]

CAN AI CAN CHANGE NURSING CARE?

In the last two decades, nurses have effectively learned the handling of large amount of data that results from the introduction of clinical informatics system, electronic records and other advanced technologies. Their practices have accordingly adapted to factor-in this voluminous data. Computer processing systems are now able to interrogate these clinical data and deduce answers to questions that have not yet been asked/considered. These systems have the ability to predict future outcomes of a patient, based on the current trends generated from this patient's data. Herein lies an opportunity for nurses to augment their existing clinical expertise and improve judgement skills- by quickly processing through multiple information sources-to make future recommendations, forecast outcome and assist in decision making. Nurses must welcome and adopt this new technological advance as they will be working closely (as collaborators and commanders of AI systems) with this non-humanoid new member of the patient care team.[19]

AI ENHANCES CRITICAL THINKING

Critical thinking is applied by nurses in solving problems related to patients and in decision-making; these are combined with creativity to enhance the end effect. It is an essential ingredient for making the nursing intervention safe, efficient and skillful.[20]

Critical thinking is a flexible and fluid process, guiding the nurses to learn to think and anticipate what is going to happen next and what intervention would be effective, by asking questions like "What, Why, When and How" before applying any intervention.

Programmed machine-guided prediction (AI) is a good strategy in this direction, since it can help expedite actionable decisions. Also, AI assistants can help nurses to reflect upon and analyse their personal thoughts, opinions and reasoning process using information synthesis done by processing the huge amount of data.[9] AI programming has enhanced the efforts for mere searching for results to providing smart suggestions and recommendations.[21]

AI when used with critical thinking and personal experience strengthens the decision-making process and helps to guide nurses to generate new knowledge, look beyond horizons, and to confront traditional way of thinking. This fluid process of reasoning and deduction - with a healthy mix of nursing knowledge, experience and judgment-is augmented significantly by AI, all through the decision-making process.[22]

AI APPLIED TO NURSING PROCESS

AI, together with critical thinking and human judgment, can guide all phases of nursing process by heightening speed and accuracy of evaluation, anticipation, synthesis and knowledge generation (Figure 2).

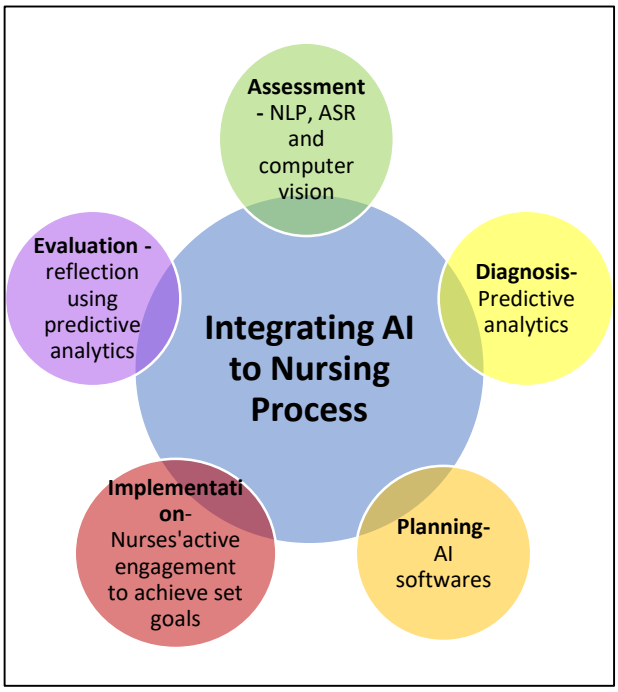

Figure 2: AI in nursing process.

The assessment phase of the nursing process comprises of assembling data, verifying it and subsequently communicating to healthcare team members and patients. NLP, ASR and computer vision can aid these steps by feeding data using hands-free techniques-and by automatic extraction of relevant patient data (from clinical notes, patient history and other fields of the EHR) to determine a patient's condition. Predictive analytics can aid in diagnosis stage by synthesizing the chain of data to define the disease state of a patient; thus, helping a nurse to provide individualised care using personal information from EHR. Planning is the stage where nurses set care priorities and define patients' need-oriented goals using AI software's to overcome biases and dilemma. Intervention is when the nurses engage themselves in actions necessary to achieve the set goals and outcomes timely.[23] All of these stages of nursing process are made more accurate and are expedited by predictive analytics, ML and deep learning. By using data available from multiple sources like the EHR, claims, and integrating with geographic, demographic and socioeconomic variables like gender, ethnicity, family history, past history and other risk factors, ML and deep learning can provide actionable recommendations specific to an individual patient. Evaluation is the final step that enables/helps nurses to reflect upon the predicted outcomes using 'predicted analytics'; and this can refine priorities to ensure individualised and best possible care for each patient throughout the care continuum.[7,9,10,23]

ETHICAL CONCERNS

Of utmost importance while partnering with AI is that it should be safe and effective. A major concern of AI practitioners in current scenario is managing bias. To realize the potential of AI, stakeholders like AI developers and users, need to be confident about two aspects: (1) the reliability and validity of the datasets used and (2) transparency of an AI based system. If computer algorithms are fed with biased information, they are bound to give biased results. For this reason, the data should be trained (labelled) adequately for AI to perform better. In addition, algorithms should be verified periodically to incorporate latest advances and generate accurate results over time. Another issue of concern is data sharing-to make AI based systems conspicuously confident, huge amount of data is required and thus more data sharing and networking is essential.[24-26]

The caveat here is the issue of data privacy. Patient education about use of AI technology in healthcare can help to overcome this concern. The best way to convince people is by generating greater awareness about AI technology and related developments in patient care. Many peoples' idea of AI is abstract at best, and at worst is a conception of a malevolent supercomputer. In reality, AI manifests a smarter software prepared by humans operating in the background, assisting human practitioners with more accurate insights.[26,27]

Patients will give consent to use of their data if they fully understand the scenario that, by allowing the AI developers to 'use' their data, healthcare will move forward merging with new AI and other technological developments, thus improving the overall outcomes for themselves as well as other patients. Also, those seeking to use patient data should reciprocate/convey to the 'subject' patients that their contribution is adding value to their own health and to that of other patients as well, in terms of better care.[27,28]

Once the ethical and legal challenges are addressed, it will unveil the tremendous potential that AI has for improving our healthcare system while simultaneously protecting rights of patients as well as clinical workers.[26]

NURSES ARE VITAL TO INTEGRATION OF AI IN HEALTH CARE

As an increasing number of modern hospitals utilise AI and ML to deliver care to their patients, nurses have become major stakeholders in actually applying AI to patient care. AI has to be well integrated with the clinical workflow and nurses play very crucial role in this integration.[29] The gap between the IT team developing AI software and nurses working in clinical fields should be addressed well to meaningfully streamline clinical workflow.[29,30]

Nursing staff need to identify the inefficiencies they deal with, and how AI and ML would be helpful in overcoming them, thereby allowing nurses to spend more time with their patients. All clinical workforce especially nurses need to be well integrated into the development or selection of these AI-based apps as they are the ones who will be handling it while providing care to the patients.[7,29]

CONCLUSION

The issues encompassing AI are novel and complex, and there is still much to be learnt about them. Healthcare organizations need to harness the power of AI to deliver its value to providers as well as patients. Equipped with the knowledge of how it can contribute to patient care and outcomes, nurses should embrace the utilization of AI in healthcare settings.

As AI still continues to evolve and mature, nurses need to participate in the ongoing open confrontation related to its development and use in healthcare. Nurses can act as key to help organizations implement and adapt to AI technological transformations in healthcare; which will ultimately shape the future of patient care.

Much of current nursing relies upon clinical trials, studies, set-protocols and time-tested methods. However, AI utilizes algorithms or predictive models that can assess data about patient populations and break it down to provide more accurate and personalized solutions for delivery of care. Since healthcare is always saturated with

data, AI with its unique ability to process large amount of data at very fast speeds is naturally fit to be integrated into the nursing practice. AI can enrich the current nursing practice by supplementing their experiences and aiding them to make sound clinical judgements.

As new AI technologies takeover some of the tasks performed by nurses today, making workflow easier for them, it is adding additional roles to nurses and changing how they spend time delivering better patient care. AI technology is supplementing nursing practice; not replacing it. The need for nurses will always remain. Nursing experience, knowledge, and skills will transit into new ways of thinking and processing information. This will give new roles to nurses-like information integrators, data managers, informatics specialists, health coaches and above all, emissaries of compassionate caring. In coming times, increased use of AI will not threaten/substitute nurses' roles; rather it will confer them augmented efficiency.

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