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APPLICATIONS OF ARTIFICIAL INTELLIGENCE TOWARDS SUSTAINABLE HEALTH CARE SYSTEM: THE NEXT GENERATION IN PATIENT CARE: AI-POWERED HOSPITAL BEDS

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ABSTRACT

Artificial intelligence (AI) plays a very important and critical role in achieving sustainability which is a current major global problem. We aim to use AI as a tool for more efficient use of practices and processes. Our goal is to keep natural resources and reduce the energy consumption associated with human activities.

All countries are seeking for implementation of AI technologies and applications that accelerate the achievement of sustainable development (SD) goals. One of the most important sectors in which AI implementation can achieve a paradigm shift in services and practices is the health care sector. The repeated pandemics that the world faced in the last decades including Severe Acute Respiratory Syndrome Corona Virus Infection (SARS- CoV-1), Influenza A H1N1 2009, Middle East Respiratory Syndrome (MERS), CoV Infection and Ebola Virus Pandemic represented a great motive to develop immediate and effective solutions. One of these promising solutions is AI integration in health sector.

Infact despite representing a revolution, AI needs to be carefully and correctly applied and also needs to be clearly understood to can achieve benefits from its technologies. AI implementation can help us save several elements including cost, time and even personnel. In the same time to be applied, AI faces a lot of challenges that should be handled in a right way to make it effective and efficient in achieving SD goals.

Many challenges have arisen in healthcare systems in the last years appeared clear after corona pandemic including cost, patient access, availability of resources, increased need for individualized patient care, medical staff shortage and the over worked staff. Through implementation of new AI powered technologies these challenges can be overcome.

AI applications in this sector can enhance decision making leading to much more precise diagnosis and management of diseases and also prediction and prevention of acute episodes of illness. In addition, AI can be used to improve the medical imaging and can have a hand in hospital management, infrastructure and operations. Overall the integration of AI in health care system can revolutionize the way the medical care is delivered to patients and enable SD goals

Our review is presenting a new era where implementation of AI in health sector can transform health care through enhancing patient monitoring and improving health service quality and patient safety. Besides, it will help in facing shortage in health care workers and overworked staff which is a great challenge and one of the most important indictors of SD goals.

INTRODUCTION

Artificial Intelligence Definition

There is no agreement on one definition for Artificial Intelligence. One of the most commonly used definitions of artificial intelligence is a computer science that acts to mimic human behavior for a better performance aiming for replicating human intelligence, increasing productivity with much more efficient resources use (1, 2). Another definition of AI is any technology performing at least one of the following capabilities: perception, prediction and logical reasoning(3). The Organization for Economic Co-operation and Development (OECD),2019 defines AI as any system that can make prediction, give recommendations or take decisions that can influence our environment(4) and carry out behaviors such as learning, and sensing (2).

Such technology can have impact on almost every field in our life(1). It can be involved in health care systems, business, defense, art, finance, marketing, education, agriculture, engineering, industry, transportation, and aerospace(1, 5). In financial field, AI technologies can be used in chatbots and algorithmic trading(6). In transportation field, AI used in many forms. It can be used to make reservations, make autonomous cars and some car companies use AI as virtual assistants to help their customers(6). AI also can be used in agriculture where robots and sensors are used to monitor crops(6). AI can be very helpful in detecting cyber-attacks more early and quickly so we can protect important information and data from being hacked or misused(6).

According to the European Union, Sustainable Development is defined as development that meets the needs of the present generations without compromising the ability of future generations to meet their own needs(7). Sustainable Development has 17 goals and 169 targets agreed in the 2030 agenda (3). Objectives of SD address the global challenges

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including environmental degradation , peace , inequality, climate change, poverty and justice(8). Three pillars of SD are economy, society and environment and AI can positively affect the goals within each pillar(3).

AI can help in achieving societal outcomes of SD through providing food, health and water to individuals(3). It contributes to sustainability in three main aspects organizational, technical and processing aspects. Organizational aspect is concerned with integration and implementation of AI while technical aspects include setting algorithms that can detect challenges and directing systems towards Sustainable Development. The processing aspect is concerned with the transformation happens within institutions as a result of implementation of AI (9). When organizations actively work and take in consideration infrastructure development and continuous improvement while directing AI towards sustainability, it is expected to achieve economic, environmental and social positive impact(9).

The health sector faced and still facing many obstacles as a result of increased morbidity, information demand, limited budget and demographics change (10, 11).

Recently AI has been widely used in health services to support clinicians decisions and qualify patient care (12). In the next years, it is expected that AI technologies will be responsible for more activities that are performed by clinicians and health care givers (13). Health care providers will still have a role in health care delivery but to lesser extent where they are expected to fill the gaps when AI cannot be used (13, 14).

Various applications of AI in health sector have been studied particularly in the most emerging areas AI-led drug discovery, patient care and clinical trials(15). In drug discovery , AI can automate target identification and help in drug repurposing (15-17). AI-powered diagnostic tools can improve the quality of patient care as well as safety(18). In addition the new technologies applied in the inventory management process and hospitals infrastructure can reduce the cost burden(18). AI can be used to predict the length of hospital stay of patients helping more efficient use of resources(19). Clinical trials based on AI can give more accurate and valid outcomes consuming very large database and smaller sample size (15, 20, 21).

AI APPLICATIONS IN HEALTH SECTOR

We Mentioned before that implementation of AI in health sector represent a revolution because these technologies can deal with much more data and have the ability to provide efficient and rapid solutions for many problems than do traditional ways (12).

AI devices in health care lies within two main categories Machine Learning and Natural Language Processing. ML procedures analyze structured data including imaging and electrophysiological data while NLP procedures can extract information from unstructured data like progress notes and convert them to structured data that can be analyzed by ML procedures (22).

The involvement of AI in health sector is not recent. It started early in 1970 where a physician called William B Schwartz was interested in using computing science in medicine(23). Then trials are made to apply AI in medicine till 1990 where clinical research used techniques like Machine Learning in making clinical decision.

Several AI technologies have been implemented in health care sector starting from routine patient care to clinical trials and drug discovery.

AI can be used to develop tools that can keep medical infrastructure. Predictive models can be used to predict treatment and prognosis. AI techniques can promote treatment individualization and so patient centered care rather than depending on treatment algorithms. AI can enhance diagnosis and monitoring accuracy (24).

Great efforts are done to develop electronic health records (HER) (25, 26). Health records are reports containing patient information including diagnosis, demographics, vital signs, lab results, consultation reports, progress notes, medications and all patient related information. Recently, we are seeking to digitalize health records and apply methodologies to develop EHR.

In pharmacovigilance science we collect and record adverse events of medications. We can use certain AI algorithms for data mining so as to predict adverse events of drugs and also drug drug interactions (26).

In clinical trials new technologies have been implicated in design, data mining, enhancing the power of the trials and reducing the required sample size(27).

AI in health care is expected to transform heath care delivery process in a way that meets the international standards meaning safe, high quality, patient centered, efficient, effective and in a timely manner(28).

AI can perform the usual tasks like data entry and review lab and imaging results by certain techniques and hence free time for medical staff to perform direct patient care and interventions that cannot be done by using AI(28).

Developed countries already can benefit from implementation of AI in their health care systems. One study found that by 2026 there will be annual saving of $150 billion in health costs in USA(29).

In resource poor countries, it is expected that AI integration in health services will be also transformative. In poor countries, AI can help clinicians in diagnosing and treating diseases as in high income countries. AI also can be used to predict illnesses. Researchers from Brazil have developed models to predict birth asphyxia in developing countries. These cases require immediate intervention after delivery. The application was found to be 95% specific and 77% sensitive in predicting cases of birth asphyxia (29).

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In surveillance of transmissible diseases and situations of epidemics , AI has had a role in predicting and slowing spread of diseases as dengue fever through the use of ML all over the world including settings with poor resources(29).

SMART HOSPITAL BEDS

We are seeking to introduce AI in designing hospital beds. We are expecting that smart hospital beds can revolutionize patient care, save a lot of time for clinicians, decrease work load and decrease required number of staff per patient.
So many factors make us think in integrating AI in hospital bed design.

Among these factors: Overworked medical staff, global shortage in clinicians and nurses and the increase in the number of elderly people in population who need continuous care and sometimes require long term care facilities.

The United Nation of Sustainable Development goals together with the World Health Organization WHO health workforce 2030 strategy clarified the role of Human Resources for Health (HRH) in achieving priorities of 2030 agenda.

Density and distribution of health workers are indicators of SD goals. The 2030 agenda has outlined the need for improving and increasing the health workforce by 2030 (30).

In 2022 the US -based commonwealth fund published the international survey of primary health care physicians. This report found that 93 % of German primary care physicians reported a workload increase and 91 % of United Kingdom primary care physicians also reported a workload increase(31).

Given these previous facts together with the fact that Patients need for continuous monitoring especially if critically ill, so we need a tool that can help in overcoming the workforce shortage and work overload.

AI can be used to perform a lot of patient services and monitoring instead of medical staff. This can result in saving time for clinicians, decreasing work load, blocking the gap between demand and supply and ensure the precision and validity of the obtained data.

By introducing AI in hospital bed design, hospital bed will not be only just a place for patient, but it will be a tool for enhancing patient care delivery and safety.

FEATURES OF SMART HOSPITAL BEDS

Adaptive Beds

Bed sores are one of the most dangerous complications that critically ill patients may exhibit in ICU or even in long term care facilities. Bed sores require using antibiotics and may need surgical debridement in late stages and if not treated patient may develop septic shock which is accompanied by increased morbidity and mortality.

The idea is to integrate AI in bed design so as to be capable of automatic adjustment of its shape and firmness according to patient preference and status. Pressure sensors can be integrated in the design to monitor patient position continuously reducing bed sores and pressure ulcers and enhancing patient comfort. Beds also can be voice activated where patients and care givers can control bed functions using voice commands which is suitable for patients with restricted mobility.

Smart Monitoring Beds

Patients need continuous monitoring of vital signs including heart rate, blood pressure, pulse, respiratory rate and body temperature. A bed with built-in AI technologies can track these vital signs periodically without the need for external devices.

The bed also can be provided with sensors or alert system to early detect signs of deterioration. AI also can be integrated to link beds with EHR to easily collect all patient related data and perform analysis using certain models to predict any health crisis.

Rehabilitation and Physical Therapy Beds

Critically ill patients are immobile and always need physical therapy and rehabilitation programs. This can be achieved automatically through AI. AI powered-robotic arms can be integrated in bed design and assist in patient movements and perform regular exercise according to specified schedule and provide clinicians with feedback continuously.

Mobility System Assisted Beds

AI systems can be used to help patients transitioning between different positions. They can aid patient to sit, stand and even move to a wheelchair. Beds also can be provided with lifting mechanisms that can reduce health workers strain.

Beds with Safety features

In 2002, the number of deaths due to fall was estimated to be 391.000 death making fall the second cause of death following traffic accidents (32). The hospital bed can be provided with AI driven anti-fall mechanisms such as sensors that automatically lower the bed when the patient is trying to get up or give alert to care givers when there is a fall risk.

AI and Isolation Beds

Patients may require isolation in certain situations as those with infectious diseases and multi drug resistant organisms. In such cases we need isolation for health care givers protection and protection of surrounding patients. Strict isolation precautions may be needed mainly for the goal of patient protection as in cases of organ transplantation and bone marrow transplantation. Hospital beds may be equipped with AI technologies that support isolation precautions via monitoring of environmental factors including humidity, aeration, temperature and hygiene.

High efficiency Air filters and sterilization system can be integrated in bed design to ensure high quality of air in patient zone.
AI can also be used to make isolation beds remotely controlled to reduce contact and infection risk and protect care givers.

Challenges

All these mentioned features are of great importance and if applied in real life there will be a great shift in health care sector

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worldwide. The challenge that we may face is mainly the cost. This cost may be due to direct integration of AI technologies which requires certain experts in addition to the cost required to train health care providers on how to use these technologies and how to interpret the obtained data.

We think it worth to perform more cost benefit analysis in further research to know exactly which of the mentioned features is cost effective when applied in real life although we also think that whatever was the cost the resultant impact will be great enough to cover this cost especially with increased number of critically ill patients and decreasing number of workforce together with limited resources and limited health budget that all the world has faced after corona virus.

We may think about the cost saved when we prevent for example: bed sores, birth asphyxia or transmissible disease (as COVID, open pulmonary tuberculosis or meningitis) including cost of treatment, interventions, consultations, and supplies.

CONCLUSION

Integrating AI in designing hospital beds will be an advancement in health care sector. It will offer not only a place to stay but also it will transform all health services. In other words, it will convert a solid equipment to a piece of art that can talk providing staff with high quality medical data, performing tasks instead of medical staff and protecting not only patients but also staff.
This great investment will greatly improve patient outcomes utilizing less personnel and saving both time and cost.

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