International Journal of Research and Review Techniques (IJRRT), ISSN: 3006-1075
Volume 2, Issue 1, January-March, 2023, Available online at: https://ijrrt.com

Improving Healthcare Accessibility with AI-Enabled Telemedicine Solutions

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ABSTRACT

The use of technological devices to provide hospital information and services far away, without needing patients and healthcare practitioners to be in close physical contact, is known as telemedicine. The COVID-19 pandemic has expedited the rapid expansion of telemedicine on a global scale. The potential for enhancement and growth in telemedicine's ability to handle a range of healthcare demands, including monitoring of patients, care IT, intelligent diagnosis, and help, is there when AI is integrated with the technology. Even though using AI in telemedicine has significant advantages, there are drawbacks that may be avoided with medical guidance. Given the wide adoption of AI in other industries, research in the medical field has begun to use AI's advantages in processing and interpreting data in telehealth. Due to the challenges that come with telemedicine's implementation, it is essential that its capabilities and procedures be improved so that they may be adapted to deal with specific problems. This article highlights the significance of physician-guided distribution, adherence to current clinical standards, and adequate training and education for health care providers as it explores the benefits and disadvantages of AI-based telemedicine in a variety of medical areas.

Keywords: Artificial Intelligence (AI), Healthcare Providers, Telemedicine, Coronavirus Disease 2019, Data Processing, Physical Proximity, Medical Domains, Information Technology (IT).

INTRODUCTION

The advent of Artificial Intelligence (AI) has led to a significant growth in the doctor-patient interaction in the contemporary world. The main problems with healthcare availability in both rural and urban settings are its high cost and its difficult accessibility. In addition, a growing issue is the quantity of therapy providers and their incapacity to keep up with the rapid advancements in technology [1]. AI is thus the ideal course of action to address the increasing spread of illness and to be able for offering a more timely and affordable solution [1, 2].

The laborious process of developing new drugs and producing medications, which formerly needed enormous amounts of money and human involvement, may now be completed with a single click [2, 3]. Everything from finding an approach to putting it into practice is now under AI supervision. Therefore, when machines and new technologies are used, effectiveness as well as efficiency are heavily addressed [3, 4].

AI proved to be somewhat of a godsend during the COVID-19 epidemic, combining accumulating medical laboratory data with history of patient's analysis. A thorough examination of the post-COVID-19 symptoms aided in the advancement of vaccine development [4, 5]. As a result, AI is a comprehensive strategy for both therapeutic and preventative actions [6].

Without a question, artificial intelligence (AI) has completely transformed healthcare and is still doing so, but there are also significant drawbacks, mostly related to privacy and ethical issues. The absence of reliable data is the first issue [6, 7]. The malfunction of the algorithm is the second issue. Patient security is based on safe keeping of data and the eradication of information breaches [7, 8].

There is a growing need to develop e-health systems, such as telemedicine, e-visits, e-consultations, Mobile Health (m-health), Electronic Health Record (EHR) systems, and Remote Patient Monitoring (RPM) [9]. These systems are used in therapy, diagnosis, prediction, and ongoing monitoring. As a result, they lower the cost of healthcare and let patients go about their regular lives with constant monitoring of their bodily functions [10].

Furthermore, these tools let doctors follow up with patients at any time, and not just while they're in the hospital. Patient Monitoring (PM) systems assist patients live more independently and improve their quality of life by educating them about their symptoms and available therapies. On the opposite hand, PM system are useful in hospitals because they enable them to prioritise crucial patient care by, [11], for instance, ranking patients according to their conditions [12].

The number individuals using medical care has been greatly impacted by the growing usage of smart mobile devices. Between 2013 and 2018, the percentage of patients employing mobile devices surged from 35,000 to 7 million [12, 13]. RPMs thus have a big effect on patients across several areas. According to a study conducted by the authors on the impact of RPM systems on patients with spinal cord injuries (SCI), PM systems have a significant and promising role in the management or avoidance of complications for SCI patients, and treatment planning may want to take this into account. Others, including offering an RPM literature review [14, 15].

The value of RPM was emphasised in the conclusion, since it enabled doctors to monitor multiple clients at once. The authors of provide an exhaustive examination for RPM, focusing on the function of PMs in various illnesses. Some prefer to focus on the most current PM application created [15, 16].

The process of performing medical consultations, examinations, and procedures remotely as well as promoting interprofessional collaboration in the healthcare sector is known as telemedicine [16, 17]. The idea that telemedicine is an "open and continually growing science" that incorporates new technical advancements to adapt to the shifting health needs and community contexts is often emphasised [17, 18].

Over the last ten years, there has been an increase in research on dependable and efficient protocols for the medical domain as well as investigations on the use of wireless technology for sensors, especially in relation to home monitoring and electronic patient records. Data have always been essential to the healthcare sector's ability to make excellent decisions and provide high-quality patient care [17, 18].

Large volumes of data are being produced from a variety of sources, including health care equipment, insurance, sciences of life, and medical research, as a result of the introduction of electronic systems in the healthcare industry. The wealth of data offers a fantastic chance to change healthcare by offering insightful information to help with decision-making, enhance patient care, react to emergencies quickly, and save more lives.

By using sophisticated analytics, learning algorithms, and neural network approaches, stakeholders may extract valuable and actionable insights from the data, enabling this change. Apart from scrutinising past data, these methodologies enable predictive analytics in projecting future results and prescriptive analytics in ascertaining the optimal course of action given the circumstances. Healthcare stakeholders can improve resource utilisation, enhance processes and goods or services, and lower operational and financial costs by using data.

Artificial Intelligence (AI) has being used more and more in telemedicine and healthcare in recent years. Using computer-generated dialogue to help patients and healthcare practitioners communicate is one area of development. Many advantages may be obtained from this technology, including the ability to conduct therapeutic sessions remotely and the automation of basic medical duties. Automated conversational interactions have a wide variety of possible applications, from basic message delivery to more intricate interactions [19].

Basic auditory or visual signals could be enough for basic activities like setting reminders or verifying appointments.

Rule-based systems, which create replies to user inputs using pre-defined tree of choices or expert systems, may handle these kinds of interactions.

But more sophisticated AI is needed for more intricate interactions. These might include virtual assistants that can answer queries, provide medical advice, or even carry out simple diagnostic tasks. For instance, virtual assistants might help those with cognitive impairments or provide senior patients avatar-based care. AI models must be able to comprehend the context of the discussion and adjust to the demands of the individual using them in order to enable these kinds of interactions.

The prospect for AI-assisted artificially intelligent assistants in the healthcare industry is substantial. They may lessen the strain on overburdened healthcare systems by offering medical practitioners an affordable and scalable patient care alternative. Additionally, the use of AI may enhance patient outcomes by offering individualised, on-demand guidance and assistance. We may anticipate seeing more and more healthcare apps use AI as technology develops to enhance patient care and results [20].

The Importance of Telemedicine

The World Health Organisation defines telemedicine as the use of technology for communications and information to provide healthcare services where a patient's distance is a significant consideration. In order to advance the health of people and communities, the definition includes a number of activities, including diagnosing, treating, avoiding, and

curing illnesses and injuries as well as conducting research and offering continuing instruction for medical professionals.
Telemedicine may be done via a variety of modalities, including store-and-forward message systems or live video consultations; it is a way of healthcare, not a technology. Other terms, like digital health and mobile health, have been utilised to provide a broader and more thorough view of people's health care in the age of information and communication. Although terms like telemedicine, telehealth, and telemedicine are often utilised interchangeably, they carry distinguish technical and regulatory definitions [20, 21].

While telehealth is a more general term that encompasses all healthcare services delivered through technology, such as distant monitoring, education of patients, and medical record management, online healthcare refers specifically to the provisioning of health care services and conversations through remote technologies like videoconferencing.

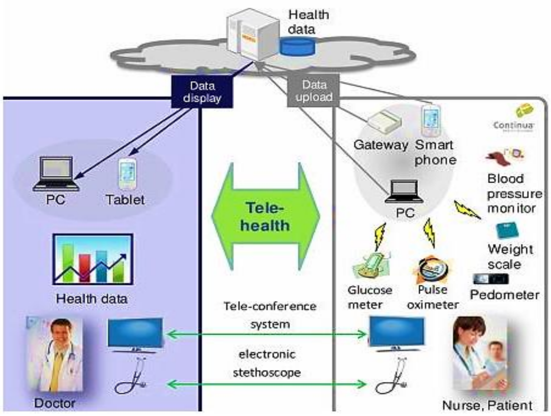

Fig. 1 Architecture for Telemedicine [21]

The base machine/doctor's unit is placed at the location where the patient's transmissions and pictures are monitored and relayed, while the telemedicine unit is placed at the patient's location in each case. The patient's bio signals and other types of data are automatically sent to the base unit via the telemedicine equipment.

The physician's station is made up of many easily navigable software modules that may send and receive data to and from the telecommunications device, as well as save vital information in an on-site database. The system provides several applications, which may vary somewhat based on the kind and specifications of the present healthcare service.

AI in telemedicine: Problems and Integration

Artificial Intelligence has the ability to increase telemedicine's efficiency and safety while also strengthening the skills of medical practitioners. AI is expected to address the problem of preventable medical mistakes and improve workflow efficiency, which are prevalent in the delivery of healthcare at the moment [22]. However, owing to a number of issues, such as safety concerns, legal restrictions, and budgetary difficulties, its adoption into routine practice has been restricted.

Possible difficulties in deploying AI-enabled telemedicine in environments with limited resource

In environments with limited resources, implementing AI-enabled telemedicine may present a variety of difficulties. A few of the major obstacles are as follows:

- **Inability to access technologies:** The absence of technological access is one of the primary problems in environments with low resources. Advanced infrastructure and technology, including as PCs, mobile devices, and high-speed Internet, are needed for AI-enabled telemedicine [22, 23]. It might be challenging to establish and maintain telemedicine services in places where these funds are limited.
- **Insufficient human resources:** The scarcity of healthcare providers in locations with inadequate resources is another difficulty. The systems for AI-enabled telemedicine must be developed, run, and maintained by qualified experts. It might be challenging to locate and educate people with the required abilities in places where there is already a lack of healthcare professionals.
- **Cultural and linguistic divides:** One of the biggest obstacles to telemedicine implementation in situations with low resources is communication problems. It might be difficult to locate healthcare providers who are multilingual and culturally aware among the many varied groups in these places. While AI-enabled processing of natural languages might help remove some of these obstacles, it might not always be the best solution.

- **Concerns about data security and privacy:** Ensuring patient data confidentiality and privacy is another difficulty. AI-powered telemedicine mostly depends on patient data utilisation and interchange. Sensitive information loss and data breaches are possible in places with inadequate infrastructure and resources for data security and privacy.
- **Limited funds available:** AI-enabled telemedicine implementation may be costly, especially in situations with limited funding and resources. The expenses of creating and maintaining the infrastructure and technology in order as well as hiring, training, and compensating employees, may be quite difficult.

TELEMEDICINE AND AI'S SYNERGY IN HEALTHCARE

AI's involvement in the Tele-Intensive Care Unit (ICU)

The transfer of medical data via electronic communications from one hospital's emergency room to another is known as tele-ICU, or telemedicine in intensive care units. Intensivists may remotely track and treat critically sick patients in numerous places at once by using tele-ICU. Studies have shown that this methodology has the potential to enhance clinical results, reduce mortality, and decrease Intensive Care Unit (ICU) stays [23].

ICU patient capacity during the COVID-19 pandemic have fluctuated greatly, varying from 52% to 289% under surge circumstances. In the COVID-19 period, the death rate for these patients, who are the most severely sick in acute care, may reach 41%.

In the US, expenditure on health care makes up around 17% of GDP, with intensive care unit costs making up as much as 4.1% of this total. Developing strategies that improve patient outcomes and maximise the effectiveness of care delivery is essential. Tele-ICU has been used to increase patient safety and decrease death rates [24].

AI has a great deal of promise to improve tele-ICU skills as it can help with scientific decision-making and analyse patient data in real-time. Artificial intelligence (AI) systems may be taught to spot trends in patient data and send out alarms when a patient's status deviates from typical ranges.

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Additionally, it allows medical staff to keep an eye on the severity of a disease from a distance control centre. Both hospitals have established field Intensive Care Units (field ICUs) that will function as major care facilities in Israel in preparation for a spike in ICU admissions. These devices use telemedicine capabilities so that a central control centre may monitor patients remotely [25].

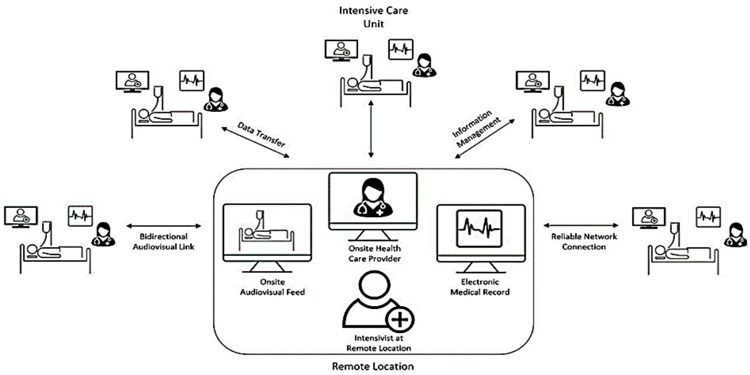

Fig. 2 Displays the CLEW model [25].

Additionally, it is critical to provide explain ability and openness when using AI so that medical professionals can understand the logic behind the computers' recommendations and make well-informed decisions. All things considered, tele-ICU and AI together have the potential to enhance patient outcomes, expand access to critical medical knowledge, and optimise resource allocation and efficiency. However, it is important to use caution while using this technology in an appropriate and responsible way [25, 26].

Concerns about ethics while using AI in tele-ICU

The possibility of depending too much on technology and undervaluing human knowledge and judgement is one ethical issue with using AI in tele-ICUs. It is important to make sure that, rather than completely replacing clinical decision-making, AI is used as a tool to complement and enhance it.

Furthermore, there's an opportunity that the AI algorithms will be skewed, which might result in different treatment for different patient groups. It is essential to include a wide range of specialists in the creation and use of AI algorithms, as well as to routinely assess the algorithms' accuracy, bias, and transparency, in order to allay these worries. In order to guarantee that physicians are making well-informed judgements, it is also critical to train and educate them on the appropriate use and comprehension of AI outputs [27].

AI's involvement in tele cardiology

The use of via telemedicine to diagnose and treat heart-related disorders remotely is known as tele cardiology. It includes the use of technology to move medical records, pictures, and other data regarding heart care from one place to another [27, 28]. This allows for remote diagnosis and consultation, which may be particularly helpful for patients who live in distant or rural areas or who have limited mobility. Since tele cardiology has been shown to save costs and improve the health of patients, many healthcare professionals find it to be a desirable choice.

AI's involvement in tele oncology

The use of telemedicine as a means of getting to cancer treatment and management for patients who live far away or lack access to specialised oncology services is known as tele oncology. Tele oncology is becoming an essential tool for lowering patient burden, extending access to treatment, and boosting the effectiveness of healthcare delivery as a result of the rising incidence of cancer in the globe.

The potential of tele oncology to provide multidisciplinary consults and coordination of treatment between patients, primary care physicians, and oncology experts, regardless of their location, is one of its greatest advantages. This is especially helpful in isolated or remote areas, when resources for cancer treatment are few or unavailable. In addition to saving money and time on travel, tele oncology enables patients and their family to schedule check-ins and subsequent appointments more often [29].

Artificial Intelligence and Tele psychiatry

The technique of offering mental health treatments remotely via phone conversations, video conferences, or messaging apps is known as tele psychiatry. It has been more well-liked as a telemedicine method in recent years, especially in underprivileged communities where access to mental health treatment is limited.

Many benefits come with using tele psychiatry, such as bettering patient and provider flexibility, cutting down on trip expenses and time, and expanding access to psychological care. However, several challenges must continue to be addressed, such as worries about security and privacy, legal restrictions, and the need that providers have proper training and education [30].

Tele stroke and AI's involvement

Stroke is one of the top causes of death and disability worldwide, and it comes at a high financial cost to individuals, families, and medical organisations. Eighty-five percent of attacks occur in low- and middle-income countries, and poor outcomes might result from delays in early detection and treatment.

Tele stroke is a health care provider that links neurologists in distant or underserved locations with individuals suffering from stroke by using telemedicine technology. In places where there is a dearth of neurologists, telemedicine—in particular, tele neurology—has become an appealing option for delivering neurology treatment at a reasonable cost.

Even AI methods, including as machine learning and deep learning, have been integrated into tele stroke systems. These algorithms may be used to automatically analyse and classify radiologic images. It has been shown that these algorithms are capable of precisely identifying the place, severity, or subtypes of strokes, including midline changes.

These automated methods have sometimes also aided in the interventional reperfusion treatment decision-making process.

Tele urology and artificial intelligence

In tele urology, patients get urological treatment from a distance via communication technologies. Digital health applications and tele urology proven to be very beneficial, especially during the COVID-19 epidemic. Artificial intelligence (AI) may assist in the field of urology by analysing medical pictures and identifying irregularities or anomalies that may be suggestive of certain disorders or diseases.

The following list includes a few of the hospitals that provide patients remote urological treatment using AI-based tele urology:

- The State University of the state of California, Los Angeles (UCLA) Healthcare System has launched a tele urology programme driven by artificial intelligence (AI) that offers patients with urological issues virtual consultations. The application analyses medical photos using AI algorithms and gives healthcare professionals diagnostic advice.
- An AI-powered tool called UroScore, created by the University of Southern California (USC) the Institute of Urology, can forecast the risk of prostate cancer based on a number of variables, including age, genetic background, and PSA, or prostate-specific antigen, levels. UroScore is utilised to deliver remote prostate cancer diagnosis and follow-up treatment in combination with tele-urology conferences.
- Predictive Analysis for Kidney damage (PAKI), a machine learning system created by the Cleveland Clinic, can forecast the risk of acute kidney failure in patients having urological processes. When combined with teleology consultations, PAKI allows for remote patient monitoring and, if required early action.

In general, AI-powered teleology has great promise for enhancing patient outcomes and facilitating access to treatment, particularly in regions where access to specialised services is restricted.

CONCLUSION AND FUTURE SCOPE

Whenever used in combination, telemedicine and AI have an opportunity to completely change the way that healthcare is delivered by improving patient access, enhancing the precision of diagnoses, and improving treatment results. But it's crucial to make sure that these advancements are used morally and that thorough investigation and assessment are used to confirm their efficacy and safety. To make the most of AI algorithms, doctors should have a solid grasp of their capabilities and limits without needing to become AI specialists. All things considered, AI has the ability to significantly boost the standard of treatment provided via telemedicine, especially in critical instances like the COVID-19 pandemic.

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