

Natural Language Symptom Triage and Asynchronous Clinical Decision Support: AI-Based Solutions for Enhancing Telemedicine Quality and Access

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1. Introduction

On AI-based solutions in telemedicine and practical healthcare application Introduction Today, the evolution of technologies can greatly influence the everyday life of people around the globe. The profound effects of these developments are visible in different sectors, including healthcare. A few decades ago, the delivery and availability of proper healthcare were restricted by geographical boundaries and patient access to facilities. However, this situation has changed dramatically. One of the key areas of healthcare impacted by the widespread use of technology is telemedicine. In particular, connecting everyone with effective healthcare delivery has become the need of the hour. However, robust design with the integration of artificial intelligence (AI)-based approaches can transform telemedicine from a simple doctor consultation to patient engagement. At the time of writing, technology has successfully and naturally assimilated into healthcare and has become ubiquitous. In this perspective, AI-based models, especially machine learning techniques, can adapt themselves for telemedicine practices and have shown extensive potential for different healthcare applications, such as enhancement in diagnostics, effective patient monitoring in real-time, and making treatment plans. A significant future direction of AI intervention could pave the way for increasing the scope of remote diagnosis, patient monitoring, and patient engagement, making health facilities available to potentially everyone. This can definitely improve patient engagement and patient outcomes by enabling them to manage their health proactively. Thus, this study emphasizes the identification of AI's effectiveness in enhancing diagnostic efficiency, patient monitoring, patient engagement, and lifestyle; however, more research is warranted to investigate its long-term utility directly.

1.1. Background and Significance

Telemedicine has a history spanning five decades, but the rapid growth of technology in the twenty-first century has made telemedical services as powerfully critical to healthcare consumers and payors as they are controversial among healthcare providers. As technology progresses and becomes more omnipresent in the modern world, trends have emerged showing telemedicine becoming more focused on outpatient care. More uniquely, around the world, in many cases, lengthy hospital stays are becoming obsolete in favor of infrequent outpatient check-ups; herein lies the potential for chronic conditions to be addressed. In combination with treatment for long-term conditions, telemedicine can also be utilized for primary care consultations. This holds particular promise when it comes to healthcare consumer satisfaction. Patients today are finding it increasingly difficult to schedule appointments that fit into their daily lives, and telemedicine makes it easier than ever to receive the care they need in a manner to which they are more suited. The delivery of healthcare has undergone major transformations with the onset of remote management of patients with chronic illnesses. In the United States, up to 88 million people suffer from more than one chronic disease, making care of elderly populations as complicated as it is widespread. This prevalence shows an increased necessity for healthcare delivery systems to adapt and evolve.

Chronic disease management, communications, and accurate remote diagnostics are now major components of a successful future for telemedicine. As telemedicine becomes more significant in the practice of modern medicine, AI can be employed in a variety of capacities to make patient care more robust, efficient, and accurate. When sick individuals are engaged in healthcare ecosystems, lifestyle and clinic relationships integration will develop patient-focused therapeutic solutions. One consequence of this is a demand for information systems for continuous and shared monitoring. Remote operations must predict deterioration and assess the efficiency of therapies, fitting in with the vision of presymptomatic diagnosis, to allow for precursors of disease to be tracked. In newly diagnosed chronic conditions, AI could be utilized in decision support systems that aid in identifying start points for therapy by analyzing patient data, allowing for a smooth interfacing between healthcare consumers and care providers. Online, deep learning network methods have proven to be extremely effective as an option to increase analytical outcomes. Deep learning has been argued to have massive potential in the detection, segmentation, classification, and prediction aspects of

automated pathology examination. Patient care remains continuous and uninterrupted as the global population ages, and AI-based telemedicine will help drive this shift by improving accessibility to remote care clinics, telemedicine diagnosis quality, faster treatment responses, and resulting in more patient satisfaction. The proliferation of chronic diseases presents an increasingly high cost for society, both in terms of quality of life for patients and from a financial standpoint. Health technology is constantly advancing, and AI and ML have begun to play significant roles in telemedicine as they strive to surpass humans in terms of big-data processing, self-teaching, and decision-making capabilities. Medical personnel rely on extensive patient data to help them make medically literate diagnoses and decisions, and AI and ML can help generate the increasingly complex algorithms needed to sort through and make sense of this data to provide timely smart diagnostics and other robust disease-related information. Correct information is critical to improving patient outcomes, many of whom seek treatment online.

1.2. Research Objectives

The key objectives of this project are as follows. The first objective is to provide our viewpoint on the problems with our current telemedicine practices in the context of remote diagnosis, monitoring, and the need for greater patient engagement. We aim to propose well-defined machine learning problems within each context where AI can make valuable contributions. The second key objective is to suggest AI-based solutions that can help enhance our telemedicine practices, which are equipped to offer innovative solutions to these problems. We pitch our work within the context of AI-augmented telemedicine, which is a platform that enhances the capabilities of our healthcare workers, extending the initiatives beyond 'mere' disaster recovery to achieve deeper impacts on healthcare delivery.

By narrowing the focus to ML-based problems within remote diagnosis, monitoring, and patient engagement, we ensure that our AI-augmented telemedicine practice is complemented with perceivable, qualitative, and quantitative theoretical and tangible results. A positive solution to each problem contributes to the ML/telemedicine community by proposing innovative solutions, and the health community by expanding healthcare delivery opportunities. Patient applications discuss a telemedicine service with significant potential community impacts to improve patient health. Overall, by

successfully establishing the AI-telemedicine opportunities, we will move a step closer to a comprehensive and computational framework for 'intelligent' telemedicine solutions. If done right, our project has the potential to be instrumental in transforming and extending healthcare delivery opportunities.

2. Telemedicine and its Evolution

Telemedicine has been a significant development in contemporary healthcare. Definitions and scope can vary according to different settings and duration. In short, telemedicine can be defined as a subset of e-health that involves direct delivery of care to the patient and includes the telecommunications hardware and software necessary for gathering and other necessary data. Telemedicine systems can be temporarily or permanently located, wired or wireless, and can include audio as well as video data. Communication standards are designed to facilitate the movement of data from one location to another and are independent of platform or application so that data can be shared and examined universally.

Telemedicine has evolved in line with the evolution of technology. Pivotal milestones and other points of interest in telemedicine development include the initiation of telephonic consultations by general practitioners, the first research on interaction in asynchronous telemedicine, and the first tele-urological operation. The telemedicine tool chest has evolved to include electronic stethoscopes, simulated hands for feeling for lymph glands, vision scopes, otoscopes, video dermatoscopes, and imaging devices useful for teledermatology. The need for technological infrastructure and regulatory frameworks has also contributed to telemedicine remaining much in the realms of local, regional, and national projects or small research endeavors. The development of common standards for data communication and adequacy of governance and regulation have been identified as the most problematic technical and regulatory issues, respectively. Telemedicine has been adopted as corporate policy in general and mental health care in some health care organizations. Research indicates an upward trajectory in telehealth systems, estimated due to both patient and consumer demand and the challenges created for the health system by the combined impacts of an aging population, the increasing incidence of chronic disease, and the emerging recognition of shortfalls in health worker availability and distribution.

2.1. Definition and Scope

Telemedicine can encompass a variety of medical services, including conducting remote patient consultations, monitoring patients remotely, and sending reminders and specific instructions to patients between visits. Telemedicine is the provision of medical services, or the conduction of part of the patient-doctor interaction, from a distance in such a way that quality and continuity of care, as well as confidentiality and security of the data exchanged, are assured, together with adequate information to the patient as to the manner and the context in which the tele-assistance is dispensed. Telemedicine refers to remote clinical services provided by means of information and communication technologies.

There is broad agreement about this general scope; however, the volume of telemedicine is difficult to state, and such services are likely to change due to future clinical applications, technical capacity, and regulatory frameworks in the coming years. There are numerous indications of its applications in a broad range of medical specialties as a tool for delivering varying types of medical care, including monitoring, counseling, and follow-up. Most types of modern telemedicine begin with the use of a common communication technology, which is used from a distance to enable health care intervention, diagnosis, consultation, treatment, and therapy. Thus, it is the integration of health care into telecommunications technologies that enables telemedicine. The majority of applications have been driven by the perceived need to serve populations with little or no access to medical care. Telemedicine projects and programs have been implemented and used in industrialized and developing countries.

2.2. Historical Development

Telemedicine is the use of telecommunication and information technology to provide clinical care from a distance. It has been seen that all forms of remote care, inclusive of phone orders or emails with providers and telemental health therapy, have the potential to be more time efficient, reduce costs, and increase the availability of mental health care. The development of telemedicine was historically influenced by the development of telecommunication and electronic mediums; over the years, this included the use of email, electronic health records, store-and-forward systems, the telephone system, videoconferencing, radio, camera, computer, monitor, sensors, and other peripherals, big data, internet protocol, internet services, web, intranet, and extranet. Starting with

brief visionaries from the 1960s, through to the initial experimentation with telemedicine in the 1970s to early 1980s, then on to the implementation of the first video consultation networks from the mid- to late 1980s. Technological milestones, especially the invention of the telephone, allowed the transition from mail-order systems to real-time telemedicine platforms. The digitization of telecommunication led to the rapid expansion of networks to help the spread of teledermatology and other subspecialties. The growing adoption of information technology, especially development in internet capability and cloud storage, has assisted in the maturation of telemedicine platforms, facilitating modern solo healthcare practitioners, multinational corporations, and telemedicine companies to communicate with patients in real time. In terms of policy, the first conferences on telemedicine guidelines in 1955 led to the creation of a program funded by the United Nations. Subsequent regulations in the US in the 1990s played a large role in allowing the spread of modern telemedicine. As of 2021, the rapid rate of adoption of telemedicine in the United States for general and specialized outpatient and emergency care during the COVID-19 pandemic has helped further melt away residual legal barriers to widespread adoption of virtual care.

3. Machine Learning in Healthcare

As a subfield of artificial intelligence, machine learning (ML) involves the development of algorithms that enable computer systems to effectively learn and improve from experience. In cases where computerized systems are exposed to new data, ML enables them to learn, grow, and evolve autonomously. In healthcare, ML has been employed across multiple settings. Several ML techniques are used by researchers and developers to generate findings and understand phenomena, supported by data, in the science of medicine. The different ML techniques for healthcare applications involve supervised learning, unsupervised learning, and semi-supervised, active, and reinforcement learning, respectively. Supervised learning involves training models when the target values are given. In unsupervised learning, the model learns to identify clusters or patterns usually for data sets where the outcome isn't clear or for pattern recognition. Moreover, unsupervised learning techniques, especially clustering techniques, identify subgroups or patterns in various activities, such as fractionated monitoring of disease cohorts, which can be used for telemedicine. Semi-supervised and active learning will further grow in healthcare with the sheer availability of large electronic medical records to carry out pattern recognition.

The salient feature of applying ML in healthcare is to be able to forecast and stratify patient health outcomes that are based on large datasets. In clinical care, machine learning has numerous and distinctive advantages. Undoubtedly, when working with enormous datasets, it is complicated to categorize trends or patterns manually. By extensively working with data, machine learning can greatly expedite the decision-making process for healthcare professionals and augment the diagnostic capability and treatment decisions through evidence-based guidelines. In clinical care, machine learning can provide a logical and automated means of helping the individual healthcare provider, combining patient data inputs available from EMRs with evidence-based guidelines, and developing a personalized treatment plan specific to the individual patient. Additionally, machine learning can be used to create a model for predictive analytics, known as a risk stratification or patient profiling model. The real-world application where a workable and effective machine learning model can be used to examine large datasets and identify trends or groupings is in telemedicine research. In predictive analysis or risk stratification, the ability to generate accurate patient classifications is critical for clinicians. In telemedicine, machine learning can be used to build models to indicate which features or combinations of comorbid conditions, demographics, and healthcare use patterns render patients vulnerable to hospital readmission or poorer health outcomes. In this use case, the focus is not on reporting state-of-the-art algorithm performance improvement; instead, the relevant models employed may be simple, human-understandable models, as clinicians may seek clear algorithm results.

3.1. Overview of Machine Learning

Given its extensive scope, we begin this section by providing an overview of the foundational principles, methodologies, and fundamental concepts of AI-based machine learning that will aid the reader's analysis in understanding telemedicine systems. We will then examine machine learning applications in medicine, particularly within the scope of enhancing telemedicine systems. As a subset of AI that utilizes statistical models to autonomously learn how to perform specific tasks, machine learning is an algorithm-based approach that enables a computer to find, understand, and act upon patterns in data, in order to inform or automate decision-making processes. This is often carried out by way of a particular type of model or a set of models, which are trained with dedicated datasets to handle specific machine learning tasks.

The principles of machine learning present considerable potential in the processing, interpretation, and management of complex multimodal medical data for the improvement of medical diagnostics and patient care. Within the many varied applications of artificial intelligence, machine learning remains fundamentally distinct from AGI approaches in its focus and functionality. AGI or 'human-like' artificial intelligence is concerned with creating systems capable of independent subjectivity and self-awareness. By contrast, the current interest in machine learning focuses mainly on the development of AI systems capable of assisting with particular tasks, in what is known as ANI. While narrow AI holds the capability to enhance human-based task performance significantly, its application is limited to the specific training in which the AI is 'embedded.' In practice, the development, training, validation, and application of machine learning models pose an array of complex challenges, which include gathering representative training data, optimizing model hyperparameters, validating model functionality, and avoiding weaknesses such as overfitting.

3.2. Applications in Healthcare

Machine learning is making tremendous progress in recent years, mainly driven by advances in deep learning. Emerging applications of machine learning in the healthcare domain signal improved patient care, innovations in treatment, and enhanced patient outcomes. Machine learning algorithms use historical patient records to predict a particular health condition in the future. Such predictions can be performed for diverse healthcare use cases, including disease prediction, risk consultancy, patient diagnosis, prognosis, and treatment. After analyzing patient symptoms and case history, machine learning can notify healthcare professionals of potential risks and suggest whether the patient should visit the nearest healthcare center or not.

In terms of diagnostics, machine learning has the potential to make quick analytic decisions based on its learning from previous radiological images or pathological examination reports. Diagnosis can be made with fewer or equal human-level errors using a machine learning-based solution with reduced time. Additionally, machine learning algorithms can help in medical drug recommendation—based on the previous case report, the system can recommend the best medicine and diagnose the disease accurately. Besides, healthcare management is laborious and prone to error when performed manually. In its simplest applications, machine learning can help to automate

various administrative tasks such as scheduling patient visits and hospital bed management as per priority, capacity, and timings, in addition to automating the use of complex analytic systems. Such systems are responsible for operating and managing complex decision-making associated with the daily workflow of the hospital. An ongoing research trend is patient-centered systems represented by technology that improves person/patient-centered care and patient support technologies, as well as those that improve community health programs. Machine learning algorithms are able to support and even replace, to an extent, everyday manual healthcare management in hospitals or healthcare institutions. These technologies should have some degree of accountability, ethical consideration, and ultimately be explained and understandable.

4. AI-Based Solutions in Telemedicine

There is still significant untapped potential in applying AI-based solutions to telemedicine. The ways tech can be transformed through AI are multiple, and among them, machine learning tools hold a special place. These solutions may be applied in particular to enhance the quality of other telemedicine services: those of remote diagnosis, continuous remote monitoring, and patient engagement.

What makes these services particularly relevant? Telemedicine basically involves delivering health-related services and information remotely. All remote interventions may be divided into those that focus on treatment, pharmacological or otherwise, and those providing medical counseling to support these treatments or make therapeutic decisions. Among the latter, direct medical counseling telemedicine services can be quite substantially disabled by restrictions introduced as a result of the current pandemic, particularly by physical distancing. This category includes tele-diagnosis and remote imaging resolution, whose exclusive benefits are limited to content received in the form of personalized expert opinion of excellent diagnostic quality. Remote continuous monitoring offers a relatively high-tech approach to adjusting medical and non-medical treatments, but it can also contribute to remote preventive decision-making. Improving the performance of predictive analytics, which provide a different type of fully automated assessment aimed at facilitating preventive or early intervention decision-making, can be considered in both men's fields of application.

4.1. Remote Diagnosis

AI can assist telemedicine practitioners with remote diagnosis, and vice versa. Machine learning algorithms can be trained using existing data and optimize classification methods for earlier diagnosis of various diseases. These algorithms have been trained to analyze retina images and properly diagnose diabetic retinopathy, classify five different human skin conditions, perform pneumonia detection using X-ray metrics, and track potential respiratory problems using stethoscope recordings. Clinicians can use these decision support tools to reduce resource usage and prioritize patients who need immediate intervention. For instance, the accuracy of pneumonia diagnostics can be improved using the X-ray AI algorithms, which have an accuracy rate between 0.66 and 1.0 for several models in classifying X-ray images collected from pediatric centers. There have been challenges in successfully integrating AI diagnoses in clinical workflows due to availability, data quality, and linguistic barriers.

In addition to diagnosing diseases earlier and reducing misdiagnoses, AI-based remote diagnosis can be used to modify individual patient monitoring techniques over time. Patient attributes are interpreted by machine learning techniques in combination with wearables such as ECG, blood pressure, or pulse oximeters. For instance, past data is used to generate machine learning models of patient health, which indicate early signs of decline in ECGs, with a reconstruction MSE of 8.35% and a classification rate of 91.9% for normal patients. Another decision support system was implemented for providing remote patient assessments using patient data, real-time physiological signals, and physician assessments. These models are used on-site by patients and physicians to guide future patient care. A virtual study, which includes a waiting room simulation and walkthrough, is used to monitor patient activities, review the diagnostics, and improve patient compliance and overall health. Ethical gaps in providing AI decision support are addressed, emphasizing the need for patient consent and transparency in the AI decision-making process. Overall, AI diagnoses can help efficiently guide patient treatment and improve outcomes.

4.2. Remote Monitoring

In a telemedicine environment, AI can be employed to integrate the functionalities of wearable devices and mobile applications to monitor physical activity, heart rate and rhythm, blood pressure, liver stiffness measurements, blood glucose levels, and sleep

quality, among others. This real-time tracking of health metrics helps in the generation of patient schedules and subsequent alerts for medication reminders and side-effect tracking. The patient's performance with respect to the accepted values for these diagnostic and health parameters is continuously fed into an AI model that predicts a health score for the patient. These predictions are currently used for the remote management of chronic diseases, where timely intervention has proven to reduce emergency department visits and patient costs. An AI-based system can predict deterioration in these endpoints in advance, and an alert can be sent for critical issues to a clinician's dashboard system. These monitoring systems can offer the ability to directly transfer the information to the electronic health records of patients.

The adherence to wearable remote monitoring devices can be increased by integrating effective machine learning algorithms in real-time to quantify human movements from wearable sensors. This wearable mobile system with machine learning algorithms demonstrated more than 75% agreement with the standard system using a wireless pressure sensor and was accurate for quantifying the dynamic and static plantar pressures. AI technology can further be utilized to develop and integrate digital application interfaces for monitoring, imaging, transmission, and storage by clinicians to the electronic health records. Such an alignment allows for the retrieval of data from the devices. Engaging the patients and monitoring and measuring their outcomes and side effects through questionnaires daily has demonstrated real-world feasibility and effectiveness. Using this method of clinical patient integration will create added clinical value as the patients are continually and digitally monitored. The security management aspects of using such devices have been published already, focusing on data and network security, and device interoperability issues addressed.

4.3. Patient Engagement

In telemedicine, patient engagement plays a key role, positively influencing the perception of patients toward the technology. The main benefit related to AI applications enabling patient engagement is the personalization of the patient experience. In this aspect, AI-driven solutions provide unique recommendations and support based on the current patient state and preferences. Chatbots and virtual health assistants employ natural language understanding to learn what kind of information patients are looking for, in order to provide it in the most accurate and respectful

manner. Timely information in chatbot releases alleviates patient-care burden from call centers. With chatbots, patients get to see a doctor's assessment, follow up with information to aid physician decision-making, schedule an appointment, and/or access additional materials and resources that can provide further understanding of what is going on with their behavior.

AI also plays an essential role in monitoring patient behavior and treatment adherence. These systems can collect and analyze data related to patients, deduce patient knowledge gaps, and guide a plan of action to close those gaps. The output of these systems can provide instructions in real time to help guide meaningful conversations between the patient and their provider. The interpretation of patient adherence data can be communicated back to patients and used during care coordination. As a consequence, patients are educated with relevant information on their disease, the pressing need for treatment adherence beyond the drug itself, and the unseen consequences of stopping treatment. The range of knowledge expands from disease states, how to maintain and improve their health, treatment options, support programs, and where to seek out a provider, also delivering the ability to empower the patient so that they can make alternative decisions about their care. The use of such knowledge is poised to create an active collaboration between the patient and provider and could potentially showcase evidence of such behavior in a study. Regardless of the definition, these solutions provide information in a manner that fits into a patient's lifestyle rather than burdening them. A challenge remains in patient trust for such solutions. To address patients' fears, it is crucial to communicate how the solution prioritizes user privacy and data security, and represents an unprecedented leap forward in patient-physician collaboration rather than an attempt by the industry to intrude on the relationship between the patient and healthcare provider. In this manner, the industry can overcome mistrust and communicate that the evolution of engagement programs is based on consultation with patients and aligned with their needs.

5. Challenges and Ethical Considerations

However, the integration of AI tools into telemedicine raises several ethical considerations and challenges. One of the foremost concerns is the ownership, safety, privacy, and security of large medical data. Patients' trust in telemedicine services and involvement with AI tools are utterly dependent on the success of these matters.

Another ethical dilemma is the reasonableness and fairness of the commitment of these AI technologies in healthcare practice. AI tools are based on big data analytics, meaning that during the process of decision-making, these mechanisms might be influenced by statistics and historical data.

Another important challenge is the conferment of a clear rationale for why the AI has taken a specific decision. This is more evident in instance-based medicine where the decisions are sustained by the individual properties of the patient. The design of AI, including machine learning and particularly deep learning techniques, may result in undue preferential treatment or discrimination against specific groups, mainly vulnerable ones at higher risk of illness who are of great interest in telemonitoring. Consequently, a global dialogue between stakeholders should reinforce a crucial advancement of common answers. At the moment, pertinent agencies and associations have taken up the challenge and have produced a few fundamental ethical guidelines on AI. However, implementing these guidelines must be primarily achieved by machine learning algorithm developers. In this regard, the changes in the methodologies applied to build these AI tools have already begun to be operationalized in the case of machine learning algorithms. This sets out the significance of compliance with the General Data Protection Regulation when storing and assessing hardly anonymized healthcare data, a basic necessity for any further assessment of the security and usefulness of these algorithms. The tricky issue of liability for these AI-based decisions should malfunction is also under scrutiny. The case of medical diagnosis and medical treatments subsequent to a doctor's reliance on a decision taken by a healthcare instrument has to be cautiously scrutinized. The AI developer could be legally liable for the AI malperformance, but whether or not the healthcare provider could also be legally accountable looks more difficult. Possibly, the clarity concerning the use of these technologies could be a fundamental response. The public sentiment regarding any given technology is of huge importance, and genuine agreement between all stakeholders can only result from negotiations. This suggests an ongoing global dialogue.

5.1. Data Privacy and Security

Data privacy and security. Protecting patient data is an important aspect of telemedicine. Sensory telehealth systems often collect images, audio, videos, and other data. Some of this data can be used to identify the patient. There are well-documented

risks associated with a breach of sensitive patient data, including discrimination, financial loss, harassment, embarrassment, and loss of trust in healthcare. When images and videos are shared for telemedicine diagnosis, patient data may be transmitted to the cloud in encrypted form and then stored on secure servers with access limited to the appropriate care team. Technological measures to reduce the risks of a breach may include access controls and stronger data protections. In general, users of telehealth should be informed of what types of information are being collected and agree to sharing their data.

Patients should have full control regarding the transmission and storage of their personal data. Technological solutions can protect patient data from a third party or cloud storage and decryption rather than transmission of sensitive patient data. In addition, access controls should be implemented to ensure that only the appropriate care providers have access to the interpreted data that is stored. AI tools may be capable of discerning a great deal of sensitive health information related to the patient using the transmitted images and data. However, it is difficult to ensure that the system diagnosing the patient's condition using sensitive information is adequately protecting the information and may reveal sensitive information in the process of diagnosis. Patient consent is a consideration when it comes to sharing telemedicine images and videos for AI diagnosis purposes. For directly transmitted health information, consent can be individual. When sharing the data for AI analysis to improve the system or diagnostics, data may no longer be secure or encrypted, especially when the images or videos have been anonymized. Identifying or re-identifying subjects is nontrivial without advanced encryption and anonymization. Patient consent may also be needed to ensure that the patient is comfortable with the data and the potential loss of security. Maintaining data integrity with AI systems is a concern, given the susceptibility of AI systems to various attacks. As a result, the data is altered. Regulatory and ethical practices aim to balance the need for vetting new uses of data with broad access to data for biomedical research.

5.2. Bias and Fairness in AI Algorithms

Another critical issue concerning the development and application of AI algorithms within telemedicine refers to bias and fairness. When training data are biased, either intentionally or unintentionally, it can lead to unfavorable and unfair treatment outcomes, affecting marginalized populations more. This is a crucial issue because such

unfair treatments are delivered to patients by AI algorithms, with many advantages of machine learning being questioned and doubted if biased cases happen. Concealing such issues can reduce the trust of patients and be an obstacle to preventing and treating healthcare equity. Therefore, it is essential to continually evaluate, audit, and improve the AI system to generate fair and well-disposed outcomes. The improvement of transparency, interpretability, and accountability of AI algorithms should all be suggested to the AI research community to promote fair and just healthcare delivery. In the continuously developing field of AI fairness, several strategies have been suggested to reduce biases. They include employing multiple data sources that are diverse and representative, performing frequent audits and checks of the algorithm outcomes and fairness, designing a multi-stakeholder team that includes not just a development team but also a multidisciplinary group with people from different backgrounds and expertise in law, ethics, and the social sciences. The latter is most relevant in the healthcare context where practitioners and end-users can provide feedback on the fair development of AI tools. Importantly, machine learning engineers should discuss with ethicists, anthropologists, sociologists, social scientists, and more in order to create a fair AI trained on fair and diverse data for equal treatment of patients. How to decrease these biases through either AI-based or alternative critically important approaches needs to be extensively and properly addressed. It is essential to consider the ethical and legal aspects that focus on the role of patients in telemedicine and the accountability of decisions made in delivering remote healthcare.

6. Conclusion

The incorporation of advanced, machine learning-based technologies into telemedicine services has the potential to have a significant impact on remote diagnosis, remote monitoring, and patient engagement and support. Throughout this paper, we have discussed the many factors and considerations that need to be taken into account in order to leverage the full potential of such solutions. Both systems that learn using massive data sets and systems that are specifically trained on datasets reflecting the populations that they are subsequently utilized with have a role to play in the future of AI in telemedicine. At the same time, researchers and solution developers need to be aware of the challenges of data separation and the potential impact of collecting and leveraging large datasets in ways that could be deemed ethically or morally wrong.

Leveraging the capabilities of AI to remove disparities in healthcare systems and based patient care has the potential to improve patient outcomes overall and significantly reduce the time until diagnosis for many who would otherwise be engaged in waiting periods to simply see a healthcare professional. Further, the ability of AI solutions to operate effectively and to work with multiple patients at once could see reductions in the load of human healthcare professionals, particularly those working in first contact environments such as emergency departments. We call for further research to be undertaken in this area and suggest a multidisciplinary collaboration that includes technology developers, users of services, academics, professionals, people with a lived experience of mental health conditions, and their carers be convened. With safety and effectiveness of such potential AI solutions as the primary aim of such collaborations, working in partnership to ensure that there are clear pathways for the responsible development and implementation of AI solutions into telemedicine.