dHealth 2024
D. Hayn et al. (Eds.)

doi:10.3233/SHTI240042

The Evolution of Telehealth in Heart Failure Management: The Role of Large Language Models and HerzMobil as a Potential Use Case

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Abstract. The burgeoning domain of telehealth has witnessed substantial transformation through the advent of advanced technologies such as Large Language Models (LLMs). This study examines the integration of LLMs in heart failure management, with a focus on HerzMobil as a pioneering telehealth program. The technical underpinnings of LLMs, their current applications in the medical field, and their potential to enhance telehealth services, have been explored. The paper highlights the benefits of LLMs in patient interaction, clinical documentation, and decision-making processes. Through the HerzMobil case study, improvements in patient self-management and reductions in hospital readmission rates have been observed, showcasing the successful application of telehealth in chronic disease management. The paper also delves into the challenges and ethical considerations of LLM integration, such as data privacy, potential biases, and regulatory compliance, underscoring the need for a balanced approach that prioritizes patient safety and ethical standards.

Keywords. Telehealth, Natural Language Processing, Large Language Models

1. Introduction

The rapid evolution of telehealth, especially in the context of heart failure management, marks a significant stride in modern healthcare. The COVID-19 pandemic's push for remote care has notably advanced heart failure management, with LLMs enhancing patient education and understanding of their condition through continuous monitoring. [1] This paper focuses on the integration of advanced technologies like Large Language Models (LLMs) into heart failure telehealth, using HerzMobil [2] as a potential use case. It explores how tools like OpenAI's "Generative Pre-trained Transformer" (GPT) series and Alphabet's "Pathway Language Model 2" (PaLM2), known for their ability to emulate human-like text, can redefine patient-provider interactions specifically in heart failure care. This paper discusses how LLMs could transform heart failure telehealth, considering the promise of improved care against issues of privacy, bias, and compliance.

It examines LLMs' applications, their benefits for patient outcomes, and the unique challenges within heart failure management.[3]

2. Methods

This study was conducted through a comprehensive literature review, focusing on the recent advancements and applications of LLMs in telehealth, particularly for heart failure management. The analysis also included a detailed examination of the HerzMobil program as a case study to explore the practical implications of these technologies in a real-world setting. The report provides insights into the technical capabilities of LLMs, their practical use in the HerzMobil program, and the broader implications for the healthcare sector.

3. Results

3.1. LLM Technical Background & Current Applications

LLMs, such as GPT-3 and GPT-4, represent a significant leap in the field of artificial intelligence, particularly in natural language processing (NLP). At their core, LLMs are trained using a technique known as unsupervised learning, where they are fed vast amounts of text data. This training enables them to predict and generate text sequences, making them highly adept at understanding and generating human-like text. [4]

In the healthcare sector, LLM's are increasingly being leveraged for various medical applications. LLMs assist in synthesizing and analyzing vast amounts of medical literature, aiding researchers in keeping up with the latest studies and findings. Furthermore, LLMs offer considerable benefits to patients by dedicating time and patience to deliver adequate information, thereby empowering them to make more informed decisions regarding their healthcare. [5] "The growing mountain of required medical paperwork, formfilling, reporting, claims, orders, and so on creates so much friction, error and burnout. GPT-4 gives us hope that some of this can be reduced … [6]."

3.2. Telehealth & Virtual Care

Telehealth's role has significantly evolved, transitioning from a solution for remote areas to offering a broad spectrum of services, including virtual consultations and remote patient monitoring. This evolution accelerated with the COVID-19 pandemic, leading to widespread adoption in healthcare. The pandemic, with its lockdowns and distancing measures, along with relaxed regulations and technological progress, transformed telehealth into a key component of healthcare delivery. [1] Today, telehealth is valued for enhancing healthcare access, improving care quality, increasing patient satisfaction, and offering cost-effective solutions for chronic conditions and regular care needs. [5]

While telehealth has shown significant growth, it faces several challenges that must be overcome to maximize its effectiveness. The digital divide poses a significant barrier, as not all patients have equal access to the required technology and internet connectivity. This gap can lead to disparities in how patients engage with and adhere to their heart failure treatment plans via telehealth. Furthermore, ensuring a high standard of care through accurate diagnosis and effective communication in a virtual setting is crucial [7]. Managing the large volume of data can benefit from AI support, with LLMs playing a distinct role in processing patient-provider interactions. For instance, LLMs can transcribe medical consultations via speech-to-text capabilities and then apply NLP to analyze the transcriptions, extracting valuable insights and aiding in the follow-up care process. Additionally, maintaining patient privacy and complying with stringent regulations such as the Health Insurance Portability and Accountability Act (HIPAA) [8] and the General Data Protection Regulation (GDPR) [9] introduces significant complexity.

3.3. Integration of LLMs in Heart Failure Telehealth

The use of LLMs in telehealth has the potential to greatly improve patient interaction. They enhance patient triage by efficiently analyzing symptom descriptions to prioritize care based on severity. They also elevate symptom checking by identifying possible conditions and asking follow-up questions for a thorough assessment. [10] Additionally, LLMs are useful in providing easily understandable health information, answering patient queries about diseases, treatments, and preventative measures, which is especially beneficial in telehealth where direct access to healthcare providers might be limited. [3]

To integrate LLMs into everyday clinical practice effectively, it is essential to focus on user-friendly interfaces that accommodate the diverse needs of patients, including those less tech-savvy or with varying levels of health literacy. Implementing voice recognition and natural language understanding capabilities can further enhance interaction, allowing patients to express their concerns in natural language and receive personalized, conversational responses.

LLMs streamline clinical documentation by automating the processing and summarization of medical records and clinical notes. This reduces the time healthcare professionals spend on documentation and minimizes human error. LLMs efficiently extract key information, such as prescription details and medical history, from these documents. When integrated with electronic health record systems, they provide healthcare providers quick access to essential patient information [11]. This facilitates more informed decision-making and enhances patient care. For the successful implementation of LLMs in clinical decision-making, it is crucial to ensure the models are trained on diverse and extensive datasets to accurately reflect the varied patient population they serve. This training helps in identifying patterns and insights from large datasets, contributing to the development of personalized treatment plans. Continuous monitoring and updating of these models are necessary to maintain their accuracy and relevance in the rapidly evolving medical field. This promising approach may enhance patient satisfaction and encourage adherence to treatments, although documented successes in this specific application are still emerging.

3.4. Potential Use Case: HerzMobil Program

The HerzMobil program is an innovative telehealth initiative designed for the management of heart failure patients. Its primary objective is to enhance patient care post-hospital discharge, reduce the frequency of hospital readmissions, and improve overall patient quality of life. The program employs a comprehensive approach, combining regular monitoring through mobile technology with guidance from healthcare professionals. Patients are provided with devices to monitor vital parameters like heart rate and blood pressure, and the data is regularly reviewed by a team of healthcare providers, ensuring timely interventions and adjustments to treatment plans as necessary. [12] HerzMobil has shown notable successes, particularly in improving patient self-management and reducing hospital readmission as well as mortality rates [13]. The program's ability to provide real-time monitoring and feedback has been instrumental in these achievements. However, the scalability of the program and integration into broader healthcare systems presents logistical and financial challenges that need to be addressed for wider implementation. [2] [12]

Integrating Large Language Models into programs like HerzMobil could significantly enhance their effectiveness but require a nuanced understanding of the technical framework and potential challenges. LLMs could be used to analyze patient data more deeply, identifying subtle trends or warning signs that might not be immediately obvious, such as increased interaction with the system, questions asked by patients, or speech pattern analysis. [14] They could also assist in providing personalized health advice and answering patient queries in real-time, improving patient engagement and adherence to treatment plans. Moreover, LLMs could automate parts of the data analysis and reporting process, increasing the efficiency of healthcare providers and allowing them to focus more on direct patient care. The integration of LLMs into HerzMobil has the potential to make the program more responsive, personalized, and scalable, ultimately leading to better outcomes for heart failure patients by interacting in the patient's native language. Addressing the integration challenges involves examining the interoperability between LLMs and existing healthcare IT infrastructures, data privacy and security issues, and the adaptability of these models to the specific needs of HerzMobil's patient demographic. Solutions such as developing secure data pipelines, ensuring compliance with healthcare regulations, and customizing LLMs to address the linguistic and cultural diversity of patients will be critical. An in-depth analysis of how LLM integration could specifically benefit the HerzMobil program is essential. This could include improving real-time patient monitoring, enhancing personalized care through advanced data analysis, and automating routine administrative tasks to allow healthcare professionals to focus more on patient care.

3.5. Ethical Considerations and Challenges

In the integration of LLMs into telehealth, data privacy emerges as a paramount concern. The healthcare sector deals with sensitive personal information, and the incorporation of LLMs, which require extensive data for training and functioning, poses significant privacy and security risks. There is a critical need to ensure that patient data used in these models is anonymized and secure from breaches. [15] Furthermore, the transmission of data to locations with substantial LLM operations, particularly the United States, raises specific concerns under data protection regulations like GDPR, necessitating stringent measures to mitigate potential risks.

Another significant challenge is the potential for bias and the critical need for accuracy in medical recommendations, as well as the rapid evolution of models, which contrasts with the lengthy process of scientific evaluation. LLMs are trained on existing datasets, which may contain inherent biases, leading to skewed or unfair outcomes in patient care. For example, the model's effectiveness can be significantly limited by language barriers, as training data often lacks diversity in patient demographics and language. While the recommendations might be accurate in English, the amount of data in other languages may be insufficient, potentially placing non-native speakers at a disadvantage due to a poorer quality of data for training purposes. [6]

The regulatory landscape for LLMs in healthcare presents its own set of challenges. The rapid pace of AI development often outstrips the speed at which regulations can be formulated and implemented. Current healthcare regulations may not adequately cover the nuances of AI and LLMs, leading to a grey area in terms of compliance and liability.[16]Collaboration between AI developers, healthcare professionals, legal experts, and regulatory bodies is essential to develop a framework that balances innovation with patient safety and ethical considerations. [15]

Since the common heart failure collective is over 60 years old and frailty of the patients increases with age, interaction with the LLMs by typing on displays or keyboards could be cumbersome. Input by voice control or dictation could overcome the limitation of typing, but presents challenges on its own with errors caused by stuttering or rephrasing of questions. These limitations may cause frustration on the patient's side and limit the usage of LLMs. Furthermore, reading of answers provided by LLMs on small screens such as mobile phones may be tedious, but bigger screens like tablet or desktop computers may be less available for socioeconomic reasons. [17]

4. Discussion

This paper has examined the evolving landscape of telehealth in heart failure management, with a specific focus on the integration of LLMs and the practical application within the HerzMobil program. The study reveals significant advancements and potential benefits brought by LLMs in enhancing patient care, particularly in terms of patient interaction, clinical documentation, and decision-making. The implementation of LLMs in telehealth has shown promise in improving patient-provider communication, making symptom assessment more accurate, and facilitating personalized healthcare. The HerzMobil program exemplifies the successful application of telehealth in managing heart failure, demonstrating improvements in patient self-management and reduced hospital readmission rates. However, the scalability of the program and integration into broader healthcare systems presents logistical and financial challenges that need to be addressed for wider implementation. [12] The potential integration of LLMs in programs like HerzMobil could further enhance these telehealth initiatives. LLMs' ability to process and analyze large volumes of data can lead to more personalized and efficient patient care. However, this integration is not without challenges. Data privacy concerns, potential biases in AI models, and regulatory hurdles present significant obstacles that need careful consideration.

In conclusion, the integration of LLMs in heart failure telehealth represents a significant advancement in healthcare technology. While challenges exist, the potential benefits in improving patient outcomes and healthcare efficiency are considerable. As we move forward, the initiation of the first experiments on a locally installed LLM in collaboration with clinical partners is a pivotal step. These initial experiments are primarily focused on ensuring the safety of patient inquiries. This marks the beginning of a new era in telehealth, where the emphasis is on safely integrating advanced technologies like LLMs into patient care.

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