Harnessing Artificial Intelligence to Improve Digital Health Coaching

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Abstract

At mDoc, a digital health social enterprise headquartered in Nigeria, we are dedicated to helping people build the self-efficacy and agency needed for adopting healthier lifestyle changes. Our high-tech, high-touch approach is designed to optimize end-to-end care for those living with or at risk of chronic conditions. During the Covid-19 pandemic, demand for our services rose significantly, leading us to develop Kem, a rules-based chatbot, which we recently evolved thanks to the rapid evolution of Large Language Models. In this paper, we share some promising results and lessons learned from our early experiments and highlight persistent challenges to scaling the approach.

Introduction

Africa is currently grappling with an alarming increase in premature and preventable deaths due to Non-Communicable Diseases (NCDs). Cardiovascular diseases (such as hypertension), cancer, chronic respiratory diseases, and diabetes are the culprits behind 82% of these deaths. These diseases disproportionately affect women and are often accompanied by mental health conditions such as depression and anxiety. The majority of NCD complications and deaths can be averted with an integrated care approach that emphasizes patient awareness and robust support systems. In Nigeria, a staggering 20% of the population aged 30-70 succumb prematurely to NCDs, primarily due to inadequate access to care and insufficient guidance on self-care, coupled with a widespread lack of expertise in comprehensive, evidence-based chronic disease management among healthcare providers.

At mDoc, a digital health social enterprise headquartered in Nigeria, we are dedicated to helping people build the self-efficacy and agency needed to adopt healthier lifestyle changes. Our high-tech, high-touch approach is designed to optimize end-to-end care for those living with or at risk of chronic conditions. By harnessing behavioral science, quality improvement methodologies, and technology, we provide an integrated care solution that addresses chronic health needs. Our approach is anchored in four pillars:

- **Omni-Channel Digital Platform**: The CompleteHealth™ platform connects individuals with virtual coach-led self-care teams, fostering the co-creation of health goals and nudging them toward the adoption of lifestyle modifications and healthier behaviors.

- **Accessible In-Person Support**: Our 'nudge hubs' (also considered to be health kiosks) provide hands-on self-management support in various community settings. Here, members learn digital platform usage and participate in workshops focused on exercise, nutrition, and financial literacy.

- **Healthcare Navigation**: A comprehensive geocoded directory of services enables us to guide members to appropriate emergent, urgent, and preventative care.

- **Provider Capability Enhancement**: We offer tele-education programs to train healthcare workers in delivering person-centered, efficient, and evidence-based care.

The Genesis of Kem - mDoc's Self-Care Coaching Chatbot

The advent of COVID-19 brought an overwhelming volume of inquiries from our members, leading us to develop Kem, a rules-based chatbot, using Google's Dialog Flow. Named 'Kem' – meaning 'my own' in Igbo and 'Pamper me' in Yoruba – it initially focused on hypertension-related questions. Kem 1.0 was crafted by a multidisciplinary team of machine learning experts and clinicians to replicate the natural dialogue of member-coach interactions, aiming to empower users in managing their hypertension and bridging the gap with healthcare providers. With user testing and later, after full deployment, we observed that users exhibited a strong willingness to engage in reading and learning more about their health condition through the use of the chatbot.

Their curiosity extended to the depth of the chatbot's knowledge base, as they showed a keen interest in exploring the extensive library of responses to various hypertension-related inquiries. Interestingly, users expressed excitement regarding the rich and comprehensive set of answers available in the frequently asked questions (FAQs), despite initial concerns expressed by the clinical and design teams about the potential lengthiness of these responses. Moreover, it was notable that as the complexity of the technology increased, with the integration of advanced artificial intelligence (AI), users found it more appealing, better received, and easier to use compared to simpler, more familiar technology solutions. This suggests a positive inclination toward embracing AI-driven healthcare interactions for enhanced engagement and information acquisition.

Broadening Kem's Horizon

While Kem initially focused on hypertension, our vision was to expand its capabilities. A critical milestone in this journey was receiving a grant from the Hub for Artificial and Sexual Health Network out of IDI in Uganda, which enabled us to integrate information on sexually transmitted infections – a significant area of inquiry among our members. The advent of Large Language Models (LLMs) presented an opportunity to further enhance Kem. We started exploring how to integrate LLMs to safely and accurately enable us to provide more comprehensive evidence-based contextualized self-care support. Through support from the Bill and Melinda Gates Foundation Grand Challenges, we received funding and technical support to help us conduct an observational study. This study evaluates the efficacy of integrating ChatGPT-3.5 into Kem across three areas that will improve self-care coaching for women of reproductive age, an unconventional approach to maternal and neonatal care. Our focus was to assess Kem's enhanced response accuracy and empathy in handling diverse inquiries from women, including its improved ability to triage based on reproductive stages and risk factors. Additionally, we also examined how effectively human health coaches use ChatGPT-3.5 to address questions beyond Kem's scope. Our vision is that women in Nigeria will directly benefit from the LLM-enhanced platform's personalized care. Consequently, we evolved Kem into version 2.0, integrating LLMs to vastly improve its ability to address a broader spectrum of inquiries, catering to our diverse member base of over 100,000, predominantly women of reproductive age.

Impact and Evolution to Kem 2.0

The upgrade to Kem 2.0 marked a transformative improvement in our service delivery. User feedback during our iterative series of testing indicated a notable increase in satisfaction with Kem's expanded capabilities. Our internal metrics demonstrated that Kem 2.0 was more effective in managing a variety of chronic diseases, indicating a significant leap in our mission to provide comprehensive digital support for chronic disease management. The observational study focused on safety, accuracy, contextual relevance, and empathy in Kem's responses. This study has been crucial in ensuring that the advanced capabilities of Kem 2.0 align with our commitment to providing empathetic, accurate, and safe healthcare support. To achieve these objectives, each development cycle of Kem is carefully evaluated by clinical experts. These professionals assess both training data as well as Kem's performance across key parameters: accuracy, empathy, safety, contextualization, and equity. Their quantitative and qualitative analyses are pivotal in steering subsequent enhancements of Kem in these specific areas. In response to their feedback, we have experimented with various base LLMs such as GPT-3.5-turbo, GPT-4, GPT-4-turbo, and Claude-2. This exploration has been coupled with the refinement of prompting strategies and the enhancement of Kem's instructional layer, making it more conversational, empathetic, and equitable in its interactions.
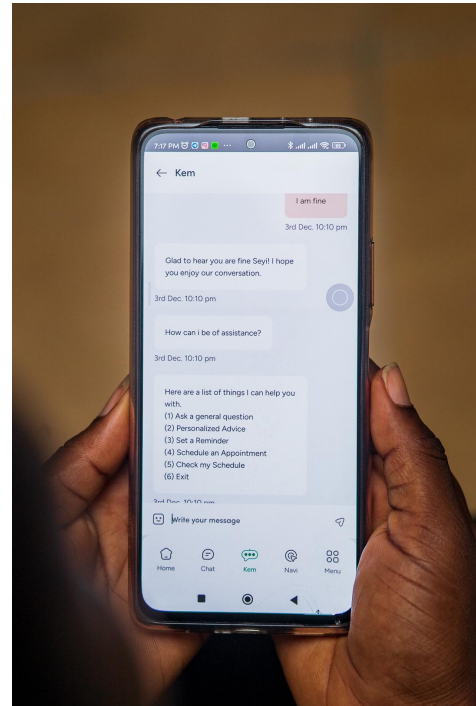
For accuracy, we have programmed Kem to prioritize responses that align with reliable sources, including the World Health Organization (WHO), the American College of Obstetricians and Gynecologists (ACOG), the International Federation of Gynecology and Obstetrics (FIGO), the American Academy of Pediatrics (AAP), and many others. In situations where safety is critical, Kem is designed to urge users to consult mDoc's health coaches and professionals. Additionally, it directs users to the NaviHealth™ platform for locating and accessing nearby healthcare facilities, thereby ensuring a comprehensive and safe healthcare experience.

We are still conducting iterative cycles of testing with the women we serve. We have tested Kem 2.0 with over 300 women to date in urban and peri-urban Lagos and Nigeria, and we have learned a lot. Some of our lessons have underscored that the infrastructural and connectivity challenges that have impacted the scalability of digital health in many instances will also have a similar impact on the spread of AI if we do not address these barriers. Also, we have learned that while integrating with local languages may help address some literacy concerns, voice-integrated options are key to addressing the literacy barriers we have encountered in the women we serve. We have been fortunate in that we have digitized data sets that reflect similar conversations and questions of our members, so we are working to build high-quality data sets that can be further

used to fine-tune Kem. We have also learned that to scale AI effectively, especially the use of LLMs in healthcare, we need to invest in AI literacy and capacity building.

The evolution from Kem 1.0 to Kem 2.0 reflects our unwavering commitment to innovative healthcare solutions. It highlights the significant role of AI in enhancing chronic disease management and sets the stage for future advancements in digital health. As we move forward, our focus remains on leveraging cutting-edge technology to improve health outcomes for individuals facing chronic diseases, ensuring that our solutions are not only technologically advanced but also empathetic and safe for our members across Africa, regardless of who they are or where they live.