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# Medication Management Companion (MMC) for a Rural Kenyan Community

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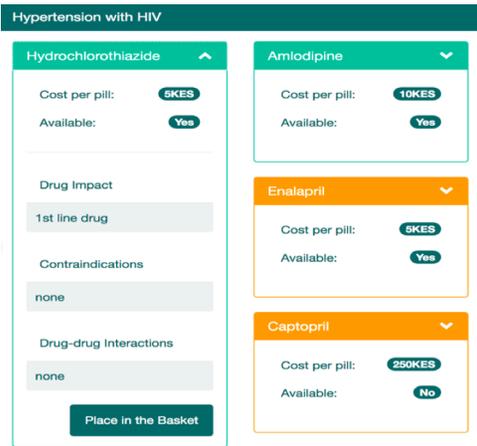
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**Abstract**

Cardiovascular diseases in patients living with HIV is increasingly taking its toll on communities in rural parts of Western Kenya. Telemedicine offers an avenue for addressing the management of Non Communicable Diseases (NCDs) in these regions. In this paper, we describe the design of the Medication Management Companion (MMC), an integrated desktop and mobile application designed to better support the efficacy, safety, and personalization in the prescribing of medication and management of hypertensive patients living with HIV. By adopting principles of community practices around HIV and hypertension management, we seek to understand how medication technologies should be designed and used. Our design explores how practices such as understanding the economic challenges of patients and building trust between patients and medical practitioners within a community can bring new opportunities in the design of sustainable technology that supports management of these conditions.

**Author Keywords**

ICTD; Hypertension; HIV; Telemedicine; Healthcare; mobile devices; Medication Management Companion; MMC; NCD



**Figure 1:** Drug Comparison Window Listing both HIV and Hypertension Medication.

**Introduction**

Developing countries are known to have a high prevalence of hypertension, a chronic condition that is aggravated by resource constraints and lack of patient history, leading to poor patient care and management [1,3,4]. Challenges around healthcare provisioning, such as access to cost effective healthcare delivery and providing clinical services and support for clinical education programs in rural settings also slow the effectiveness of intervention measures [2]. Remote diagnosis and treatment of patients using telecommunications technology offers promise in healthcare delivery for such settings. Telemedicine has focussed on addressing adaptability not only from a clinical and technological perspective, but also through understanding of a rural Kenyan community. However, telemedicine faces implementation challenges in regions with poor infrastructure, digital illiteracy, poverty, and lack of access to expensive medication [1,2].

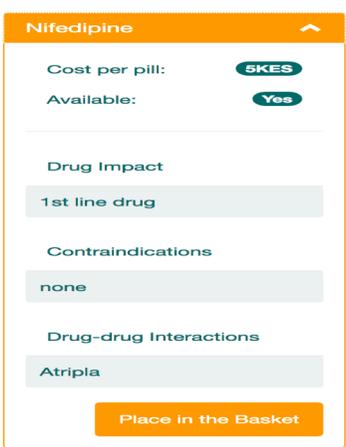
Our research focuses on the use of technology in the management of chronic health conditions in settings that are characterized by poverty and subsistence lifestyles. We conducted contextual user interviews to understand how the routines and activities of medical practitioners and their hypertensive patients who were also living with HIV in a rural Kenyan setting, could inform the design of sustainable technology. Results showed that trust between patients and clinical health workers (CHWs) led to open interaction around management of HIV. Economic empowerment initiatives for patient support groups and pervasive low end smart phones [7] also provided patients and health practitioners with an opportunity to explore the use of technology in managing patient conditions.

The results informed the design of an online web and mobile based system called the Medication Management Companion (MMC). The MMC provides informed prescription recommendations based on a patient’s condition, medical history, and an informed prescription generated on the basis of a patient’s preference.

**Related Work**

Communities in developing countries have supported information and technology projects that focus on rural telemedicine, monitoring of infectious disease epidemics and assistive technology [4]. ICT has also been used to disseminate information in conducting malaria prevention campaigns, in promoting safe sanitation practices, and even in creating awareness during epidemics such as the Ebola outbreak [3]. Within this space, research has explored the impact of technology interventions on the management and treatment of patients with HIV. In addition, we see communities living in Western Kenya record high HIV prevalence rates in addition to the documented risks of hypertension. In addition, research on designing sustainable technology that supports stakeholders in the management of these health conditions is still at its infancy.

However, leveraging technology and patient medical history in management of chronic health conditions shows promise. For example, an evaluation of a mobile based remote medication adherence measurement system in elderly patients who were at risk of developing NCDs revealed that mobile adherence management was feasible and well received with people who had increased cardiovascular risk [2]. A review of four applications: Medication



**Figure 2:** Drug Details Window

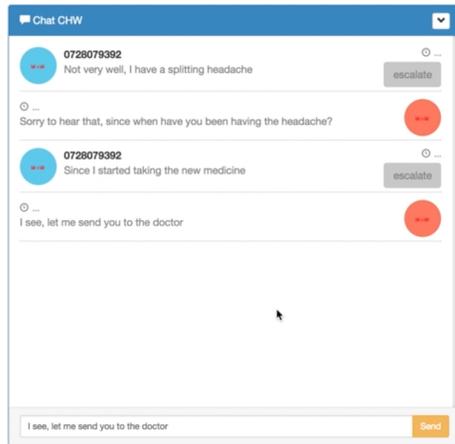


Figure 3: Patient, CHW Chat Window

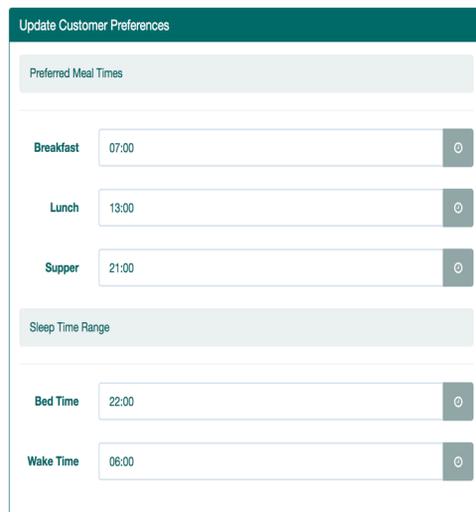


Figure 4: Customer Preferences Window

Adherence, Health Worker Communication, Health Education, and Emergency and Disaster Response was conducted by [1]. Results highlight successful attempts in the use of mobile powered technologies to dispense medication in South Africa and Uganda [1], use of video accompanied by text for TB management, and SMS to manage HIV cases in Kenya. However, Nkqubela et al. highlights challenges that hinder effective support of telemedicine initiatives using ICTs in South Africa [6]. Their study shows that health facilities had inadequate telemedicine services available. Computer illiteracy of healthcare staff and infrastructure challenges such as Internet availability also affected ICT use in these centres [1,5,7]. We are interested in how routine community activities such as trust between patients and health practitioners, and collective economic empowerment initiatives for patients inform the MMC design (see Figure 1) [1,5,7].

### Prototype Design

The MMC is an integrated desktop and mobile application designed to improve the efficacy, safety, and personalization of medication prescription for hypertensive patients living with HIV. It provides the clinician with an interface that lists patients currently registered in the clinic with medical history accessed by clicking on an individual name. We used Ministry of Health (MOH) guidelines, patient’s medical history, and triage information into drools rules. The MMC analyzes patient Adverse Drug Reaction (ADR) information, encoded in Ministry of Health (MOH) guidelines, along with triage data based on a rules engine, to suggest medication for prescription by the clinician (see Figure 1). The prescription information becomes accessible to the pharmacist and forms part of the patient’s record. The MMC pharmacist interface allows the pharmacist to

review the patient’s prescription as soon as it is generated. The prescription provides dosage information and suggestions of medication ingestion times that align with a patient’s routine and preference. When a possible drug interaction, contraindication or allergy is identified, the MMC provides a chat window for the pharmacist and clinician to promptly address the issue (see Figure 2).

The mobile Healthy Conversation module provides Community Health Workers (CHWs) with a chat interface and by extension, provides clinicians and pharmacists with the opportunity to address adherence and ADR monitoring related discussions. The patients send texts using mobile phones to interact with the CHW via the direct Conversation module (see Figure 3). The CHWs also use another separate dedicated MMC communication channel to interact with the patient’s clinician or pharmacist. With regards to the platforms used, the clinicians and pharmacists use the desktop version of the MMC, the CHWs use the mobile version while the patients use the low-end smart phone version.

### Usage Scenarios

We foresee the MMC being used in the following scenarios:

1. **Patient monitoring:** We expect the MMC’s Healthy Conversations module to support the Public Health Department of the local clinic in gathering patient data from conversations around awareness of chronic diseases such as hypertension and HIV. The CHWs also act as intermediaries should any patient face challenges interpreting information delivered to their mobile phones via the Healthy Conversation Module. The chat

module thus provides the patient with an opportunity to manage their health condition remotely without need to visit the health facility whenever they need to communicate with health practitioners.

**2. Drug regimen optimization:** Our contextual field study results illustrated how trust between CHWs and patients led to open conversations around adherence and economic challenges. We expect the MMC to build on such practices of trust to provide the CHWs with an opportunity to interact with the system on behalf of illiterate patients while exploring ways to address cases of polypharmacy [1]. The more informed ability to address polypharmacy via the MMC leads to optimizing the pill burden of patients. This is done by suggestions of the best possible combination of medication alternatives and recommended periods when medication should be taken based on a patient's unique situation. The recommendation is guided by patients preferred meal times, subsistence farm work periods and ideal sleep times (see Figure 4). The recommendations are delivered to patients' mobile phones with a notification also forwarded to their designated CHW's MMC mobile device.

**3. Patient safety and personalization:** The integration of drug information sources, encoded guidelines from MOH, patient's economic ability, clinical inventory and patient triage data will support the clinician in recommending safe and affordable medication tailored to a specific patient. Access and workflow control is implemented to ensure access to the MMC chat interface is only open to authorized entities via a specific communication channel.

## Conclusion and Discussion

This paper outlines the design space and application of MMC in the management of hypertension for patients living with HIV in a rural facility. In the future we intend to explore ways in which patient information stored in the MMC database could be shared with other health institutions, with prior consent from the patient, to improve the management of chronic illnesses across various health institutions. We thank Lwala Community Alliance for collaborating with us in this study.

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