

Digitizing HIV care in Uganda: Patient and provider perspectives on the AmFine patient portal

Ritah Kiconco^{1,2} , Raymond Atwine³ , Francis Kamuganga⁴ , Michael Kanyesigye⁵, Dickens Owamaani⁵, Naomi Sanyu⁶, Wilson Tumuhimbise⁴ , Winnie Muyindike⁷, Angella Musiimenta⁴  and James J. Cimino⁸

Abstract

Background: In resource-limited settings like Uganda, managing HIV care through conventional paper-based systems poses challenges such as inefficiencies in clinical workflows and limited patient engagement. The *AmFine* patient portal and mobile application was developed to digitize the paper-based “blue card” system and enhance patient-provider communication.

Objective: To explore the lived experiences of patients and healthcare providers in using the *AmFine* patient portal and mobile application at the immune suppressive syndrome (ISS) Clinic of Mbarara Regional Referral Hospital, focusing on usability, motivation for use, challenges and suggestions for improvement.

Methods: We conducted face-to-face in-depth interviews with 25 participants (21 patients and 4 healthcare providers) at the ISS Clinic of Mbarara Regional Referral Hospital between April 2023 and May 2023. Interviews were audio-recorded, transcribed verbatim, and analyzed using codebook thematic analysis guided by Braun and Clarke’s approach. Coding was conducted in NVivo 12, and themes were developed inductively to explore participant experiences, perceived usability, and challenges of the *AmFine* patient portal and mobile application.

Results: The *AmFine* patient portal and mobile application was positively perceived as enhancing communication and convenience. Patients appreciated the ability to send messages to providers without traveling to the clinic, fostering privacy and reducing stigma. Providers valued streamlined patient management and communication. Challenges included limited technological literacy among some patients, intermittent internet connectivity, and data costs. Suggestions for improvement included enhancing offline functionality, diversifying language options, and providing more detailed training sessions.

Conclusions: The *AmFine* patient portal and mobile application demonstrated potential to improve HIV care delivery and patient engagement in a resource-limited setting. Addressing identified challenges can optimize system usability and adoption.

Keywords

mHealth, patient portal, HIV care, qualitative study, Uganda, digital health, patient engagement, mobile application

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¹Department of Medical Laboratory Science, Faculty of Medicine, Mbarara University of Science and Technology, Mbarara, Uganda

²Department of Biochemistry, School of Health Sciences, Soroti University, Soroti, Uganda

³Department of Pathology, Faculty of Medicine, Mbarara University of Science and Technology, Mbarara, Uganda

⁴Department of Information Technology, Faculty of Computing and Informatics, Mbarara University of Science and Technology, Mbarara, Uganda

⁵Immune Suppressive Syndrome clinic, Mbarara National Referral Hospital, Mbarara, Uganda

⁶Global health collaborative, Mbarara University of Science and Technology, Mbarara, Uganda

⁷Department of Internal Medicine, Faculty of Medicine, Mbarara University of Science and Technology, Mbarara, Uganda

⁸Department of Biomedical Informatics and Data Science, Heersink School of Medicine, University of Alabama at Birmingham, Birmingham, AL, USA

Corresponding author:

Ritah Kiconco, Department of Medical Laboratory Science, Faculty of Medicine, Mbarara University of Science and Technology, P.O. Box 1410, Mbarara City, Uganda.

Email: rkiconco@must.ac.ug



Introduction

The widespread cell phone ownership and mobile network coverage in Uganda provide a promising platform for the implementation of patient-centered mobile health (mHealth) technologies for delivery of HIV/AIDS services.¹ mHealth technologies hold great potential to improve the quality of life among people living with HIV/AIDS in Uganda.² Adequate patient-centered delivery of HIV/AIDS services has the ability to empower the patients to communicate effectively with their health care providers, build strong HIV/AIDS self-management strategies, allow for responsiveness to patients' preferences and fulfillment of their current or evolving health care needs.^{3,4}

However, in Uganda, the use of mHealth technologies at a patient-level remains inadequate as many of the existing mHealth technologies are mainly used for data collection by health workers in the community to feed into the existing electronic health record systems at the health facility.⁵ The modest prevailing patient-centered mHealth technologies provide insufficient options, mainly SMS reminders and phone calls to fully engage the patients in their healthcare. Patient-centered engagements go beyond just writing a text message or making a clinic appointment reminder phone call.⁶ Additionally, there is a lack of mHealth technologies or portals that enable instant patient-provider interactions and patients' access to simple health education resources in developing countries.^{7,8}

In resource-limited settings such as Uganda, HIV clinics face significant challenges in managing patient information efficiently. Paper-based clinical forms, like the health information systems (HMIS) HIV care/ antiretroviral therapy (ART) card also referred to as the "blue card," due to its distinctive color, are commonly used to capture crucial patient data. The blue card is structured to capture a wide range of information, including the patient's demographic details, HIV status, ART history, and any prior exposure to preventive treatments such as post-exposure prophylaxis (PEP) or prevention of mother-to-child transmission (PMTCT). Additionally, it includes sections for documenting the health status of the patient's family members, such as spouses, children, and sexual partners, with fields to record their HIV status, early infant diagnosis (EID) numbers, and any relevant medical conditions like diabetes, hypertension, or hepatitis B. One of the key features of the blue card is its ability to track periodic screenings and test results, such as for hepatitis B, hepatitis C, and random blood sugar levels, ensuring that patients receive timely interventions for comorbid conditions. It also records the initiation and completion dates of TB Preventive Therapy (TPT), which is crucial for HIV patients who are at higher risk of tuberculosis. A copy of the blue card is a supplemental file 1.

The paper-based systems often present difficulties such as lack of standardization across physicians and healthcare facilities, poor searchability and loss of information.⁹ These

limitations can lead to inefficiencies in patient management, especially in high-volume clinics.

We have developed the AmFine Patient Portal and Mobile Application to address these challenges by digitizing the "blue card" paper system and increasing patient engagement through a corresponding mobile application. This portal transforms the manual processes involved in recording, accessing, and managing clinical data into a streamlined, electronic format. The digitized blue card retains all the vital information needed for clinical encounters while enhancing access, accuracy, and coordination of care.

The AmFine platform enables healthcare providers to register clients, record new clinical encounters, and communicate directly with patients through an integrated messaging system. The system supports real-time data entry and retrieval, ensuring that healthcare professionals can make timely, data-driven decisions. Additionally, it offers a user-friendly interface that facilitates training and adaptation by clinic staff with minimal technical expertise.

A key feature of the AmFine system is its mobile application, designed specifically for patient engagement. The mobile app, which is linked to the patient portal, empowers patients to take an active role in their care by allowing them to access key health information. Patients can view their upcoming appointment dates, ensuring better adherence to clinic schedules. The application also enables secure messaging with clinical care providers, facilitating timely communication for follow-up questions, treatment adjustments, and general inquiries. This direct line of communication enhances the continuity of care between clinic visits.

Moreover, the mobile application features a learning resources library, providing patients with educational materials related to HIV care and management. These resources can help patients better understand their condition, treatment options, and lifestyle modifications that support positive health outcomes. By integrating this library into the mobile app, patients are given a readily accessible tool to enhance their knowledge and self-management skills.

In this study, we describe the architecture and functionalities of the AmFine patient portal and mobile app, emphasizing their role in improving HIV care through enhanced clinical data management and patient engagement. We also assessed the portal's early feasibility, acceptability, and potential for integration into routine HIV care, while also documenting the challenges encountered during the digitization process and the strategies employed to support successful adoption among patients and clinic staff.

Materials and methods

Study design

This qualitative pilot study followed the consolidated criteria for reporting qualitative research (COREQ)¹⁰ checklist

as shown in supplemental file 2. The usability, effectiveness, and implementation challenges of the AmFine patient portal within a high-volume HIV clinic was explored.

Study setting and needs assessment

The study was conducted between March and June 2023 at the immune suppressive syndrome (ISS) Clinic of Mbarara Regional Referral Hospital in Southwestern Uganda, East Africa. Prior to the design and development of the AmFine patient portal, we held informal one-on-one consultations with both clinic staff and patients to explore their digital literacy levels, healthcare information needs, and expectations for system usability. This formative needs assessment played a critical role in shaping the portal's core functionalities. User-friendliness was a central design consideration for the AmFine platform. The mobile interface was tested with patients during the pre-study phase and iteratively modified to enhance accessibility; featuring simplified navigation, large touch-friendly icons, and minimal text to accommodate varying levels of digital literacy. Based on participant input, the platform was designed with a simplified user interface, use of plain and easily comprehensible English, and the inclusion of visual learning materials to support diverse learning preferences. These consultations also highlighted significant disparities in digital access, which informed the development of features such as a low-data usage mode and a step-by-step onboarding process to facilitate system adoption.

Participant recruitment

Participants were purposively selected to reflect diverse experiences with the portal. The sample included adult HIV patients receiving care at the study site who owned and could operate a smartphone, as well as healthcare providers strategically involved in patient triage using the facility's blue card system. A total of 25 participants (21 patients and four providers) were recruited. This sample size was informed by the goal of reaching data sufficiency while also balancing the need for rich data with the logistical constraints of a pilot study. There were no dropouts of study participants after recruitment. Participants were approached face-to-face at the ISS clinic by the interviewer and after explaining the purpose of the study requested them for their informed written consent before full participation. The interviewer maintained a neutral stance and had no preexisting relationships with the study participants prior to the data collection.

System architecture overview

The AmFine Patient Portal and Mobile Application was designed as a comprehensive platform that supports the digitization of HIV clinical data, specifically the paper-

based "blue card." The system architecture comprises two main components: a web-based portal for healthcare providers and a mobile application for patients. Both components are integrated with a secure cloud-based server for data storage and management. We designed the digital tool with interoperability in mind. The backend Application Programming Interface (API) is modular and supports future integration with the Uganda Ministry of Health's e-health ecosystem and OpenMRS frameworks already piloted at several HIV clinics in the country. This will ensure that patients' records on the AmFine portal can eventually sync with other departmental systems to avoid data silos and support coordinated patient care in the future adoption use of the portal.

Healthcare provider portal

This portal enables healthcare providers to manage patient records, register new patients, update clinical data, and communicate with patients through a secure messaging system. The portal is optimized for low-resource settings, ensuring functionality even in areas with intermittent internet connectivity. It also includes an administrative interface for managing user permissions, library resources, and system configurations. A user guide manual is provided as a supplemental file 3.

Mobile application

The AmFine patient-facing mobile application allows patients to view upcoming appointments, communicate with healthcare providers, and access educational materials on HIV care. The mobile application was developed with jet pack compose and is at the moment compatible with only Android devices, ensuring accessibility for the majority of our study population. Instructions for the application installation via use of an Android Package Kit file are in supplemental file 4.

System development, deployment and scalability

The system was developed using a combination of modern web and mobile technologies and deployed on the Linode Platform for its reliability and ease of use. With a wider dataset, we will ensure a sustainable scalability plan to be put into play such as migrating the deployment to Amazon Web Services (AWS), migrating the front end to flutter so as to support a wider range of smart phones and migrating the API away from the back-end for reliability.

Frontend and backend

A Python-based Django framework was used for the server-side development, and My Structured Query Language was chosen for the relational database due to its scalability and

reliability especially with small datasets. Content is shown to users with easy to navigate Hypertext Markup Language version 5-based components.

Security protocols

In compliance with Uganda's Data Protection and Privacy Act (2019),¹¹ all user data on the AmFine patient portal was protected through end-to-end encryption during transmission Hypertext Transfer Protocol Secure/Secure Sockets Layer and encryption at rest on a secure server. In the study, healthcare providers accessed the system using multi-factor authentication, while patient access was safeguarded with secure login credentials. These measures were implemented to ensure that only authorized users could access specific data. Additionally, all user activity; including data submissions and messaging by participants was logged by the system. These logs were periodically reviewed by the study investigators, in their role as system administrators, to monitor portal and mobile application usage.

Data collection

The data collection tools used in this study were developed by the authors, drawing on instruments previously applied in similar research to ensure relevance and contextual appropriateness. The acceptability and feasibility of the AmFine patient portal were explored using a combination of brief Likert-scale survey questions and qualitative interviews conducted after one month of portal use. The survey assessed user perceptions across domains such as perceived usefulness, ease of use, social norms, and facilitating conditions. While some survey items were informed by constructs commonly found in usability frameworks, including the System Usability Scale (SUS), we did not generate a composite SUS score due to the brief exposure period and small sample size.

The rationale for combining surveys and interviews was to allow for data triangulation. Surveys captured structured participant characteristics and basic system use patterns, while interviews offered deeper insights into lived experiences, motivation, and contextual barriers. Together, these approaches provided a richer understanding of the portal's early-stage acceptability and implementation. While the structured survey data were valuable for descriptive purposes, they were not analyzed inferentially or presented as standalone findings, but rather used to contextualize the qualitative themes.

Qualitatively, the AmFine patient portal was assessed using constructs from the Unified Theory of Acceptance and Use of Technology (UTAUT) model¹² (Figure 1). Interview questions were mapped to core UTAUT domains including performance expectancy, effort expectancy, social influence, facilitating conditions, behavioral intention to use, and actual use. In-depth, semi-structured interviews

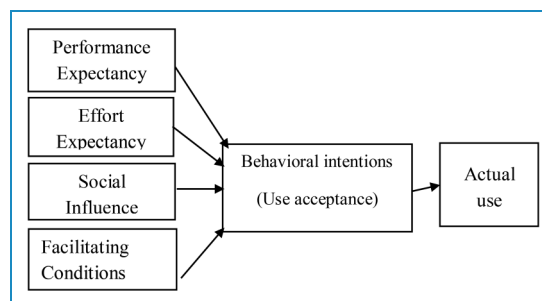


Figure 1. UTAUT model for technology acceptability.

were carried out by a trained female public health researcher and a co-author of this work, at the end of the one-month portal use period to explore participants' experiences, motivations, and perceptions, with special emphasis on understanding how the portal affected engagement with HIV care. Only the interviewer and the participant were present in the interview session and there were no repeat interviews conducted.

Interviews were conducted in person by trained qualitative researchers from the Mbarara University Global Health Collaborative between April and May 2023. All interviews were held in private spaces at the ISS clinic, conducted in either Runyankole or English language depending on the participant's preference, and were audio recorded and transcribed verbatim with consent from the participants. Runyankole transcripts were translated into English prior to analysis. The transcripts were not returned to participants for comment or correction. The interview guide and survey tool used are presented in supplemental file 5. We further captured information on mobile phone ownership, type of phone, and prior use of social media platforms, which helped contextualize participants' readiness for digital health engagement. The questionnaires used were adapted from established tools, including the Technology Adoption Propensity.¹³ Although not all components were validated, the instrument was informally pilot-tested among five ISS clinic patients, and revised for clarity and cultural relevance. Field notes were made during and after interviews to capture context. The interviews lasted between 30–60 minutes.

Data analysis

Descriptive statistics of participants were analyzed using IBM SPSS Statistics Version 28.0.0.0 (IBM Corp., Armonk, NY, USA). These included frequencies and percentages that were used to summarize participant characteristics. Qualitative data were analyzed using a codebook thematic analysis, guided by a post-positivist epistemological stance appropriate for structured health systems research. The six-phase framework involving familiarizing with the data, generating initial codes, generating themes,

Table 1. Participants' characteristics (N = 25).

Variable	Frequency (n)
Patients (n = 21)	
Sex	
Male	8
Female	13
Age	
18–34	12
≥35	9
Providers (n = 4)	
Sex	
Male	2
Female	2
Age	
18–34	3
≥ 35	1

reviewing themes, defining and naming themes, and writing up the findings described by Braun and Clarke¹⁴ was used. Transcripts were first read for familiarization, and initial codes were generated inductively based on semantic patterns in the data. Coding was conducted in NVivo 12, and a preliminary codebook was developed collaboratively by the research team through iterative discussions. The coding framework is appended as supplemental file 6. Coding disagreements were resolved through consensus. Themes were refined by grouping related codes, and data sufficiency was determined when no new themes or codes emerged from the final transcripts, a method elaborated by Guest et al.¹⁵ This codebook analytic approach explained by Ayre and McCaffery et al.¹⁶ enabled a comprehensive understanding of participant experiences with the AmFine portal, particularly in identifying barriers, facilitators, and contextual factors influencing system adoption and acceptability.

Results

Participants. As shown in Table 1, clinic staff (n = 4) and patients (n = 21) were recruited to use the system over a 2 months' period. Staff were trained to use the provider

portal, while patients were introduced to the mobile application and encouraged to engage with its features.

Participants generally viewed the portal as a useful tool for communication, learning, and accessing medical information. However, issues like delayed responses, technical challenges, and the need for clearer communication pathways were noted as areas for improvement.

Findings from the codebook thematic analysis

The following three topic/broad codes referred to as (theme) reflect the core findings identified through the coding process.

Theme 1: feelings/experiences and motivations for using the app. Participants generally expressed positive feelings about the app, emphasizing its usefulness in enhancing communication with healthcare providers. Participants shared overwhelmingly positive experiences with the AmFine app, citing its convenience, improved communication with providers, and ease of use over time. Both patients and healthcare providers were motivated by the platform's ability to save time, offer privacy, support continuous learning, and enable skill development. Many viewed the patient portal as an innovative, empowering tool that complemented familiar platforms like WhatsApp and encouraged greater engagement with HIV care. Both patients and providers had distinct motivations for using the tool as shown in Table 2.

Theme 2: challenges and concerns using the portal. Despite the AmFine digital tool's perceived benefits, users encountered several barriers. These included fears around stigma and data privacy, inconsistent internet connectivity, high data costs, technical glitches, and the complexity of content presented in English. Other challenges included limited device compatibility, busy provider schedules, delayed message responses, and ambiguity in communication. Participants also highlighted difficulties with application navigation, preference for video content over text, and unequal access linked to digital literacy and infrastructure.

Participants highlighted several challenges and concerns with the AmFine application as shown in Table 3.

Theme 3: suggested areas for improvement and future use of the portal. Participants proposed a range of improvements to increase the app's utility and inclusivity. These included adding real-time notifications, incorporating local languages, enabling audio messaging, and improving provider responsiveness. Emotional reactions to content highlighted the need for sensitive messaging. Participants also emphasized the importance of peer influence, ongoing access to the platform, and tailoring content to user needs. There was strong interest in continued use, with many expressing

Table 2. Motivations for using the app.

Code	Quotes	Observation
Time efficiency and convenience	<i>"It saves time... not spoiling your day."</i> [45 years old female patient.] <i>"Instead of putting transport, coming, sitting there, so this app is so nice to us."</i> [36 years old female patient.]	Participants acknowledged that the application would help them cut down on expenditures related to attending physical sessions at the clinic.
Ease of use	<i>"At the start, it challenged us a lot, but after it worked well, it became so easy."</i> [43 years old female patient.]	Initially challenging for some, the application became easier to navigate with familiarity.
Enhanced access to care	<i>"I sent a message to a doctor... he said I should come to the clinic first thing in the morning."</i> [29 years old male patient]	Participants appreciated the convenience of contacting doctors directly through the app, eliminating the need for physical visits.
Privacy and discretion	<i>"It ensures privacy... what I have discussed with the doctor will stay between me and the doctor."</i> [27 years old female patient.] <i>"It will favor those who have gone to school...but if it can be translated and cater for those without smartphones, the better."</i> [32 years old male patient.] <i>"I don't think they would take it badly because... there is nothing they are exposing."</i> [36 years old female patient.]	Some participants expressed their satisfaction with the "safe space" the application provides for them as they interact with the healthcare providers. Concerns about privacy, literacy, and the digital divide were evident. Participants noted that the application might disproportionately benefit literate individuals with smartphones, potentially excluding others
Innovative and Encouraging features	<i>"It's just like using WhatsApp."</i> [27 years old female patient.]	Participants described the application as comparable to other familiar platforms like WhatsApp, making it user-friendly.
Desire for information	<i>"I may want to check on the messages to see what new thing has been posted so that I don't miss out."</i> [42 years old male patient.]	Because of the learning materials provided, some participants regularly checked the application to see any updated information.
Skill development and innovation	<i>"I would want to surely be able to have it as part of a skill... this time using the internet and technology."</i> [33 years old male provider.]	A provider gave feedback on how they want to continue with using the technology for the purpose of skills development.
Professional motivation	<i>"It has eased communication."</i> [39 years old female provider.] <i>"I was part of the study... to see if the clients were sending messages and if they would like it."</i> [29 years old female provider.] <i>"If only you could have us on that app even if the study ends, as long as we continue having communication."</i> [39 years old female provider.] <i>"Yes, now the world is digital...it would be nice for our patients to embrace the technology."</i> [33 years old male provider]	Besides eased communication, a provider mentioned how they agreed to use the application to check on how the messaging aspect would work out between the provider and the patient. There was a strong desire for the app's continued availability beyond the study, with participants expressing optimism about its potential to integrate into routine healthcare
Positive experiences with educational content	<i>"I learnt how HIV started and how Lutaaya was infected... he encouraged people to take their medicine."</i> [45 years old female patient.] <i>"They are too educative, especially for someone who has just started taking the HIV medicine."</i> [36 years old female patient.]	Participants highlighted the value of the HIV-related learning materials available on the portal, including videos and articles.

(continued)

Table 2. Continued.

Code	Quotes	Observation
Motivation to learn	<i>"The motivation is that learning is never-ending... there is something that is updated."</i> [42 years old male patient.]	Participants were motivated by the continuous learning opportunities provided.
Perceived utility and relevance	<i>"If only it could open, it could help us a lot...I could text the doctor and tell him that it's my day, but I can't come to the clinic because I am busy."</i> [38 years old female patient.]	There was general agreement that the application held significant potential to enhance communication and improve healthcare experiences. Some individuals recognized its convenience and ability to reduce physical visits to the clinic

hope that the application could be integrated into routine HIV care delivery.

Participants highlighted several areas to enhance the app's utility as shown in Table 4.

Discussion

The findings reveal that the AmFine patient portal and mobile application provide a significant opportunity to address communication and operational challenges in HIV care at Mbarara regional referral hospital in south western Uganda. Patients valued the privacy, accessibility, and time efficiency of the platform, which aligns with the goal of patient-centered mHealth interventions. These findings are consistent with other similar studies such as a study that was conducted by Madanian et al. which found that an integrated online patient system was beneficial for chronically ill patients managing their health data across different healthcare systems.¹⁷

Another study by Househ et al. reported that patient portals facilitated improved communication with healthcare providers and increased patients' ability to manage their health.¹⁸ This finding is consistent with the accessibility and time efficiency benefits mentioned in our research study. Moreover, another study found that patient portals have the potential to enhance the doctor-patient relationship, improve health status awareness, and increase adherence to therapy.¹⁹

However, challenges such as technical barriers, limited digital literacy, and infrastructure constraints underscore the need for adaptive solutions. A case study from Uganda by Meyer et al. identified similar barriers to patient portal adoption, including technical issues, lack of digital literacy, and inadequate infrastructure. The study emphasized the need for user-friendly interfaces and targeted education programs to overcome these challenges.²⁰ Additionally, another study found that mHealth projects in Africa often fail due to social and economic issues rather than technology alone, highlighting the importance of addressing infrastructure and literacy constraints in

developing regions.⁷ Moreover, a WHO study showed that Infrastructure limitations, particularly in developing countries, pose significant challenges to mHealth implementation.²¹

Time efficiency and convenience were commonly noted benefits. Participants reported that the portal saved them time and reduced transportation costs by minimizing the need for physical visits to the clinic. These findings are consistent with prior research showing that digital health platforms can reduce patient burden and improve clinic efficiency in low-resource settings.^{22,23} The portal's asynchronous communication function allowed patients to receive timely guidance without disrupting their daily routines; a feature known to improve appointment adherence and self-management.²⁴

Regarding ease of use, initial difficulties in navigating the mobile application were reported, particularly among those less familiar with mobile technology. However, most users indicated that with continued use, the system became intuitive. This aligns with the Technology Acceptance Model (TAM) and UTAUT, which emphasize that perceived ease of use increases with exposure and familiarity.²⁵ The comparison of the AmFine mobile application to WhatsApp; an already widely adopted platform in Uganda, further underscores the importance of building on familiar digital behaviors to promote usability.

Enhanced access to care was another salient outcome. Participants valued the ability to contact their healthcare providers directly and receive prompt responses, suggesting that the portal supported more responsive and continuous care. Similar benefits have been observed in studies evaluating patient portals in HIV care across sub-Saharan Africa,²² where mHealth interventions improved patient-to-provider communication and reduced clinical burden.

Participants also reported a strong appreciation for the privacy and discretion the portal afforded. This aligns with literature highlighting that digital platforms can offer a "safe space" for people living with HIV, helping to reduce stigma and support confidential communication.^{23,26} However, some participants raised valid concerns about

Table 3. Challenges and concerns using the app.

Code	Quotes	Observation
Fear of stigma and loss of confidentiality	<i>"Maybe they would think this person is sick of HIV... I wouldn't allow them to touch my phone."</i> [29 years old male patient.] <i>"Some people give their phones to their family; so that may affect their privacy."</i> [36 years old female patient.]	Some participants mentioned that access of a third party to their phone would potentially expose their data. While some have ability to keep them away from their phone, others don't.
Connectivity, data constraints/usage and network issues	<i>"You may be home sick and want to log in but don't have data."</i> [27 years old female patient.] <i>"It's not easy; we used to get Wi-Fi during weekdays, but it doesn't reach where we sit."</i> [39 years old female provider.] <i>"There are days when the internet is completely slow or down, so I don't really manage."</i> [32 years old male patient.] <i>"The data goes like in big bundles, especially when you are watching the YouTube stuff."</i> [36 years old female patient.]	Poor internet connections and insufficient data emerged as barriers to application usage. Inconsistency with internet connection and band width were evident limitations. Participants mentioned high data costs associated with application usage, particularly for learning materials with a redirecting link to YouTube videos.
Technical issues	<i>"It has failed to login, but if it logs in, it will be easier to send messages to my doctor."</i> 32 years old female patient. <i>"Am fine didn't open. When I reply to a message, it doesn't go."</i> [38 years old female patient.] <i>"I could delete it, uninstall it like five times, and it still refused to work."</i> [34 years old male patient.]	A few participants reported significant technical difficulties with the tool, including login issues and failure of the application to function as intended.
Complexity of learning materials	<i>"No, English is just too deep, it is more medical for the layperson."</i> [36 years old female patient.] <i>"The challenge is the clips are in English, so if they could be translated, it would be fine."</i> [42 years old male patient.]	The language and format of the learning materials posed challenges, particularly for laypersons. Comments highlighted the inaccessibility of medical jargon and lack of local language translations.
Accessibility challenges and device limitations	<i>"The app only works for people who have Android phones, and not on computers"</i> [26 years old male patient.] <i>"If it would work on a phone instead of just a PC, it would be okay for me."</i> [33 years old male provider]	Providers interface was only accessible on desktop but they expressed desire to have access on mobile phone as well and the reverse was true for the patients.
Scheduling conflicts	<i>"Sometimes you feel busy; the more work you have, the less likely you are to reply to messages."</i> [33 years old male provider]	Busy schedules limited the ability of providers to engage with the portal consistently.
Delayed responses	<i>"When I send someone a message, I expect a quick response; if they don't respond, the problem isn't solved."</i> [43 years old female patient.] <i>"With prompt replies, even within two hours, it would be easier for someone who is sick."</i> [27 years old female patient.] <i>"I assume doctors know how to use computers and phones... if you see it, you know you have to do what you signed up for."</i> [47 years old female patient.]	Participants emphasized the need for timely feedback from healthcare providers, as delays diminished the app's reliability. Delays in message responses were highlighted as a challenge, with a participant expressing frustration. Suggestions for improvement included integrating alert tones to ensure timely responses.

(continued)

Table 3. Continued.

Code	Quotes	Observation
Limitations of remote care	<i>"As a clinician, you may not satisfy someone's needs; you might need to see someone physically."</i> [33 years old male provider]	Participants expressed that some healthcare needs require physical examinations, which the application cannot accommodate.
Power and device use	<i>"I would check the app in the morning before the phone battery runs out."</i> [32 years old male patient.]	Users in rural areas faced power shortages, limiting their ability to use the application consistently.
Ambiguity in messaging interactions	<i>"I don't know if it's the computers that reply to me, or is it the doctor."</i> [29 years old male patient.]	Some users were unsure whether replies came from a doctor or an automated system, indicating a need for clearer communication channels.
Document submission and access Challenges in submission	<i>"You try to submit, but all the information you have put is not captured, so you have to repeat."</i> [39 years old female provider.]	While some found document submission straightforward with a stable network, others faced challenges like data not being captured properly.
Seamless access to patient records	<i>"Literally, you log in, go to that patient and see everything... the way everything is on the MOH patient blue card is on the system, which is good."</i> [33 years old male provider]	Providers appreciated the ability to access detailed patient records through the portal.
Barriers to utilization	<i>"I have not used the app yet because it has refused to work."</i> [50 years old female patient]	Challenges in navigating app, with some participants noting technical issues or lack of time to explore the resources.
Preferred learning formats	<i>"What I see I remember... I would prefer the audio or video than reading."</i> [45 years old female patient.]	Videos were preferred over written materials for their accessibility and engagement. A participant explained,
Mixed reactions to accessibility and usability	<i>"The issue is that I have never got the app... they told us they would call us back, but I didn't get it."</i> [34 years old male patient.] <i>"It was easy for me... I was one of the first three people that downloaded and installed the app."</i> [29 years old male patient.]	Participants frequently noted challenges in accessing and using the app. Some expressed frustration with technical difficulties such as installation issues and connectivity problems, while others appreciated its user-friendly design and integration with existing healthcare processes.

digital exclusion due to literacy barriers and lack of access to smartphones, echoing findings from other mHealth evaluations in low-income settings.^{27–29} These disparities underscore the need for inclusive design features such as local language support and low-data usage modes to ensure equitable access.

Providers and patients also expressed motivation to continue using the digital platform beyond the study period. This reflects growing recognition of the role digital tools play in strengthening provider-to-patient relationships and sustaining long-term engagement in HIV care.³⁰ The integration of educational content was another appreciated feature. Participants reported learning more about HIV treatment, history, and medication adherence, supporting evidence that patient portals can be effective platforms for health education and empowerment.^{19,31}

Moreover, providers highlighted how the platform contributed to their own professional development, citing the portal as a means to improve communication, digital literacy, and patient monitoring. These findings are supported by prior work suggesting that healthcare workers in resource-limited settings are increasingly open to adopting digital tools, particularly when aligned with workflow and training needs.^{21,32,33}

One prominent concern was fear of stigma and loss of confidentiality, particularly when participants shared their phones with family members or when notifications could reveal sensitive health information. These concerns mirror findings from other mHealth studies in HIV care, where perceived risks to confidentiality and fear of unintended disclosure have been cited as major barriers to engagement.^{34,35} Ensuring secure access controls and giving

Table 4. Suggested areas for improvement and future use.

Code	Quotes	Observation
Notifications	<i>"They should make notifications pop up...just like WhatsApp."</i> [27 years old female patient.]	Participants wanted notifications in case of any activity on the application such as a new upload in the learning materials or message received.
Language options	<i>"Translate to a simple language like Runyankole or Luganda."</i> [36 years old female patient.]	To tackle the English language issue, some participants suggested translation of the application features and content to local dialects for eased comprehension.
Interactive features	<i>"It would be better if there was a place for sending an audio message or a place for putting a profile photo."</i> [45 years old female patient.]	Participants wanted a personal touch to the mobile application.
Provider responsiveness	<i>"Maybe an automatic alert to notify the provider of a message."</i> [33 years old male provider]	Providers wanted notifications in case of any activity on the patient portal such as receiving a message from the patient.
Perceived impact and future use	<i>"We can be the pioneers to give others the zeal to use it."</i> [39 years old female provider.] <i>"Talking to the doctors...if the app is there specifically to talk to our patients, I think they will not get tired of us."</i> [39 years old female provider.] <i>"It is better because...you can text the doctor anywhere you are, and the doctor can give you quick feedback."</i> [27 years old female patient.]	Participants envisioned continued use of the app, particularly as a pioneering tool
Emotional responses to content	<i>"Some would get really sad...the videos of the 1980s when HIV was really bad."</i> [45 years old female patient.] <i>"The videos and the doctors are encouraging; if you have stopped taking drugs, you can start again."</i> [36 years old female patient.]	Certain features, such as the app's videos, elicited strong emotional reactions, ranging from motivation to distress. Participants emphasized the importance of tailoring content to avoid negative emotional impacts.
Social and peer influences	<i>"I told another friend maybe if you have any problem, you can use that app to communicate...but she didn't take it seriously."</i> [27 years old female patient.] <i>"I told a friend about this app. She said she also wants to use it because she feels she is missing out."</i> [27 years old female patient.]	Participants highlighted the role of social perceptions in influencing adoption. While some individuals expressed interest based on others' positive experiences, others noted hesitancy or indifference among peers
Desire for continued and future use	<i>"If only you could have us on that app even if the study ends, as long as we continue having communication."</i> [43 years old female patient.] <i>"Yes, now the world is digital...it would be nice for we who are HIV+ to move with the technology."</i> [29 years old male patient]	There was a strong desire for the app's continued availability beyond the study, with participants expressing optimism about its potential to integrate into routine healthcare

users the ability to manage notifications discreetly are critical components of equitable and stigma-sensitive design.

Connectivity and data constraints were also frequently reported. Participants described difficulties accessing the portal due to lack of mobile data, slow or unreliable internet, and high data consumption associated with multimedia learning materials. These issues are emblematic of the digital divide in low- and middle-income countries (LMICs), where infrastructure and affordability significantly affect

technology adoption.^{36,37} High data costs, particularly for accessing educational YouTube content, disproportionately affect low-income users, reinforcing inequalities in access to digital health interventions.

Closely related were technical issues, including mobile application crashes, failed logins, and problems with message transmission or document submission. As noted in prior research, technical unreliability undermines trust in digital tools and contributes to discontinuation of use.^{38,39} Additionally,

device limitations such as incompatibility with non-Android systems or lack of mobile access for providers restricted usage, suggesting the need for broader cross-platform functionality to promote inclusivity across user types.

Language and literacy barriers further exacerbated inequities. Participants reported that medical jargon and English-only content made educational materials difficult to understand. This reflects a well-documented challenge in mHealth interventions where health content is not localized or simplified, thereby excluding individuals with low literacy or limited proficiency in the language of delivery.⁴⁰ Calls for audio and translated content echo WHO recommendations for inclusive content development tailored to end-user needs.²⁹

Several structural and logistical factors also limited equitable participation. Busy provider schedules led to delayed responses, which some patients interpreted as neglect. Timeliness in provider–patient communication is central to maintaining trust in mHealth systems, particularly among patients managing chronic conditions.²² Ambiguity about who was responding to messages; whether a doctor or an automated system; further illustrates the importance of transparent and personalized communication protocols in digital platforms.⁴¹

Power shortages, especially in rural areas, also affected portal use. Participants noted that they would engage with the mobile application early in the day before their phone battery died. This highlights the need to design systems that are not only data-efficient but also energy-conscious, recognizing power access as a structural determinant of digital health equity.^{42,43}

Despite these barriers, some participants recognized the value of remote access to care, especially for triaging health issues that did not require physical examination. Others, however, underscored the limitations of remote care, emphasizing that certain clinical concerns require face-to-face consultations—an observation supported by literature cautioning against overreliance on telemedicine in contexts with limited diagnostic infrastructure.⁴⁴

Mixed experiences with the mobile application accessibility and usability reinforce the need for participatory and iterative design approaches. While some users reported seamless onboarding and user-friendly interfaces, others were never able to install or access the app. This discrepancy underscores that “access” is not a binary outcome, but rather a function of multiple intersecting factors; technical literacy, infrastructure, support systems, and personal context.⁴⁵

A strong desire for notification features, similar to those used in platforms like WhatsApp, was expressed by both patients and providers. Participants suggested that push notifications should alert users of new messages or updates to learning materials. This aligns with findings from earlier mHealth studies, which show that timely and proactive system notifications can significantly improve

engagement, adherence to treatment plans, and communication in chronic care settings.^{46–48} From a digital equity perspective, these features are not just convenient; they help mitigate information gaps in contexts where patients may only intermittently access the internet or power their devices.

Language accessibility emerged as a critical equity issue. Participants noted that English-only content was a barrier, recommending translation into local languages like Runyankole or Luganda. Language is a well-documented determinant of digital inclusion. Prior research confirms that local language support in mHealth tools enhances usability, comprehension, and trust, particularly for users with lower health or digital literacy.^{49,50} Localizing content also affirms users’ cultural identity, thereby increasing uptake and sustained use of digital interventions in multilingual populations.

Several participants expressed interest in interactive and personalized features, such as sending audio messages or adding profile photos. These requests reflect a desire to humanize digital interactions and mirror familiar platforms. This is supported by the literature on health technology usability, which shows that personalization; such as profile customization and multimedia communication—can enhance perceived relevance and emotional connection to the system.^{38,51} Providers, in particular, wanted real-time alerts when patients sent messages, indicating the need for backend functionality that ensures timely responsiveness without adding to workload or causing alert fatigue.

The portal’s emotional impact, especially from historical HIV videos, elicited mixed reactions. Some participants found the content motivational, while others found it distressing. Emotional design is an emerging concern in digital health, particularly in HIV care, where content must balance realism with psychological safety. Studies have shown that while evocative content can motivate behavioral change, poorly tailored messaging may alienate or overwhelm users.^{26,34} This suggests that content curation must consider not only informational clarity but also emotional appropriateness, possibly with content warnings or opt-in choices.

Social and peer influences also played a key role in portal engagement. Some participants shared the news about the mobile application with friends who became interested, while others noted indifference from peers. These findings echo Rogers’ Diffusion of Innovations theory, which posits that peer endorsement accelerates adoption, particularly in tight-knit communities or stigma-sensitive contexts like HIV care.⁵² Leveraging “digital champions” or early adopters as ambassadors may help build trust and normalize portal use in wider patient networks.

Importantly, both patients and providers expressed a strong desire for continued access to the portal beyond the study period. Participants envisioned the portal becoming a permanent part of care, citing the convenience of remote

communication and the evolving nature of digital healthcare. This readiness for long-term use parallels findings from implementation studies in other LMICs, where pilot-phase engagement often predicts long-term viability, especially when systems are seen as filling real gaps in care.^{36,44} However, sustained use depends on addressing systemic inequities such as device compatibility, reliable power and internet access, and ongoing technical support.

Participant feedback on the AmFine patient portal emphasized the importance of user-centered design features such as real-time notifications, language translation, interactive components, and emotional sensitivity in educational content. These preferences and concerns reflect broader principles in digital health design and adoption, particularly in resource-constrained and culturally diverse settings.

Our findings reveal several equity concerns relevant to digital health interventions in low-resource settings. Participants highlighted barriers related to language (e.g., English-only interfaces), access to smartphones and electricity, and internet connectivity; factors consistent with the broader discourse on digital health equity.^{7,18} These limitations underscore the importance of inclusive design, including multilingual support, offline access, and user training. Addressing the digital divide will be essential for equitable scale-up of mHealth tools like AmFine Portal.

To improve accessibility, ongoing updates will include local language translations such as Runyankole and Luganda, voice-guided features, and audio versions of learning materials. Suggestions from participants regarding support for visually impaired users, such as font adjustment and text-to-speech functionality, are under consideration for future development.

Key indicators relevant for evaluating the potential impact of the AmFine portal can be inferred from established digital health research, including clinic visit adherence, turnaround time for message responses, and the frequency of patient-to-provider interactions; factors commonly cited in studies assessing digital tool efficiency and user engagement.¹⁹ In this study, qualitative outcomes such as patient satisfaction and perceived usefulness were assessed, consistent with literature emphasizing the importance of user perceptions in technology adoption and sustained use.²⁵ While this pilot study did not formally analyze system usage metrics, observational insights from the system logs helped interpret the qualitative findings. For example, participants who described the mobile application as “just like using WhatsApp” or praised its role in easing communication were often those who actively used the messaging feature. Similarly, individuals who appreciated saving transport costs and avoiding long wait times were typically among those who valued the app’s convenience for managing clinic visits remotely. These patterns informed our understanding of acceptability and the portal’s feasibility in a real-world HIV clinic setting. A more extensive follow-up study will be planned to assess the portal’s

long-term effectiveness and integration into routine HIV care.

One possible next step is to develop a roadmap, in collaboration with the hospital’s IT department, to explore transitioning hosting to AWS and decoupling the backend API to support broader scalability. Integration with the hospital’s digital infrastructure could also be considered, which may enable institutional support for routine maintenance, version control, and system updates. Additionally, phased expansion of the platform to other departments and regional HIV clinics may be pursued, contingent on resource availability and technical capacity development.

As a limitation, this study was conducted at a single HIV clinic, which may limit the transferability of findings to other settings. While codebook thematic analysis supports structured comparisons and broader insights, the results remain context-specific and should be interpreted with caution when considering application to other regions or populations. Given the small pilot sample size ($N=25$), robust quantitative analysis was not conducted, as the data were intended primarily to support and contextualize the qualitative findings. Although parts of the questionnaire were based on validated tools, the full instrument was not validated formally and this remains a limitation of the study.

Conclusion

The AmFine platform demonstrates the potential to enhance patient-provider interactions and streamline HIV care in resource-limited settings. While the pilot study highlighted valuable insights, addressing identified challenges is crucial for widespread adoption and long-term sustainability. Further research is needed to evaluate the platform’s impact on clinical outcomes and its scalability across diverse healthcare settings.

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ORCID iDs

Ritah Kiconco  <https://orcid.org/0000-0003-0194-2828>

Raymond Atwine  <https://orcid.org/0000-0001-7888-7818>

Francis Kamuganga  <https://orcid.org/0009-0007-9480-4286>

Wilson Tumuhimbise  <https://orcid.org/0000-0003-1895-9255>

Angella Musiimenta  <https://orcid.org/0000-0003-1983-696X>

Ethical statements

This study was conducted with full adherence to ethical guidelines for research involving human participants. Ethical approval was sought and obtained from the Mbarara University of Science and Technology Research Ethics Committee (MUST REC) study number MUST-2023-898 and the Uganda National Council for Science and Technology study number HS3151ES. Informed written consent was obtained from all participants before their involvement in the study, ensuring that they fully understood the purpose of the research, their role in it, and their rights as participants.

Participants were healthcare providers and patients interacting with a patient portal and a mHealth application. Their participation was voluntary, and they were informed that they could withdraw from the study at any time without any consequences. All data collected were anonymized to protect the identity and confidentiality of the participants. The study also complied with relevant data protection regulations to safeguard sensitive health information, ensuring the privacy and security of the participants' data. No harm or risk was anticipated in the study. However, participants were informed of the minimal risks, such as the possibility of accidental data exposure. Mitigating measures, including secure data storage and restricted access, were implemented to address such concerns. Throughout the research process, the dignity and autonomy of participants were respected, and every effort was made to ensure that their well-being was prioritized.

Contributorship

Ritah Kiconco contributed to conceptualization, methodology, data collection, formal analysis, and writing—original draft.

Raymond Atwine contributed to data collection, validation, project administration, and writing—review and editing.

Francis Kamuganga contributed to software development, system architecture design, data curation, and writing—review and editing.

Michael Kanyesigye contributed to data analysis, visualization, and writing—review and editing.

Dickens Owamaani contributed to investigation, methodology, and writing—review and editing.

Naomi Sanyu contributed to clinical validation, data interpretation, and writing—review and editing.

Wilson Tumuhimbise contributed to supervision, system implementation, technical validation, and writing—review and editing.

Winnie Muyindike contributed to supervision, clinical expertise, validation, and writing—review and editing.

Angella Musiimenta contributed to supervision, conceptualization, funding acquisition, and writing—review and editing.

James J. Cimino contributed to conceptualization, supervision, and writing—review and editing.

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Guarantors

Angella Musiimenta and Wilson Tumuhimbise serve as the guarantors of this study. They foresaw the study processes, including the study design, data collection, analysis, and the accuracy of the reported results. They affirm that all aspects of the research adhere to ethical and scientific standards and that the conclusions drawn are a true reflection of the study findings.

Supplemental Material

Supplemental material for this article is available online.

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