



Electronic Antiretroviral Therapy Adherence Monitors and Associated Interventions Improve Adolescent–Caregiver Relationships and Self-Efficacy Among Adolescents and Young Adults with HIV in Uganda

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Abstract

Many adolescents and young adults with HIV (AYWH) struggle with antiretroviral therapy (ART) adherence and experience poorer outcomes than adults. Relevant factors include forgetfulness and poor self-efficacy related to their evolving neurobiology. We qualitatively explored experiences of AYWH–caregivers dyads using real-time ART adherence monitors and associated reminder functions in the home setting. As part of an implementation science-oriented study, AYWH used the Wisepill adherence monitor for 3 months. AYWH could also opt for short message service (SMS) self-reminders, a self-selected social supporter for delayed or missed doses, or an alarm reminder. We conducted in-depth interviews with randomly selected AYWH–caregiver dyads regarding their experience using the monitor. Qualitative data were analyzed using inductive content analysis. We completed 15 AYWH–caregiver dyad interviews. Of the AYWH, 67% were female, mean age was 16 years, 56% lived with their biological mother, and 86% were virologically suppressed. AYWH and their caregivers generally found the adherence monitors acceptable, though some had privacy concerns. AYWH felt the monitors helped them take charge of their medication, largely through the real-time alarm and SMS reminders; this took the burden of adherence reminders away from the caregivers, improving strained AYWH–caregiver relationships. Two adolescents reported rebound poor adherence after monitor withdrawal. ART adherence monitors and associated tools were largely acceptable to AYWH and their caregivers in home settings. The intervention helped improve AYWH self-efficacy and alleviated burden from some AYWH–caregiver relationships. Rebound poor adherence suggests the need for on-going support and/or other means to achieve intrinsic mechanisms for sustained adherence. Clinical Trial Registration number: NCT03825952.

Keywords: adolescents, HIV, adherence, mHealth, Africa

Introduction

WITH THE ROLL OUT OF combination antiretroviral therapy (cART), many children born with HIV are surviving into adolescence and adulthood. cART improves survival

tremendously; however, to obtain maximum benefit of cART, adherence is paramount. Adherence not only improves survival, but also prevents onward transmission of HIV.¹

Despite the known benefits of cART adherence, 30–70% of adolescents and young adults with HIV (AYWH) still face

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challenges with consistent pill taking.^{2,3} Because of poor adherence, AYWH experience poorer clinical outcomes than other groups with HIV. In 2019, mortality among AYWH increased by 50% and AIDS-related deaths were the second leading cause of deaths among young people aged 15–24 years.⁴ Moreover, the virological nonsuppression resulting from low adherence is a major driver of the HIV epidemic.

Many adherence challenges among AYWH are distinct from those faced by adults and are related to their developmental stage, which is a period of physical, emotional, and social change. Neurodevelopmental issues are common among AYWH and include greater self-regulatory challenges and forgetfulness.⁵ The incidence of mental health disorders such as depression and anxiety is often high in this population.⁶ This neurodevelopmental process is associated with risky decisions and behavior in adolescence prioritizing short-term reward over long-term health priorities.^{5,7}

To overcome these barriers to adherence, caregivers of AYWH serve an important role from diagnosis throughout adolescence until the AYWH are transitioned to self-care/adult care.⁸ Caregivers play a role of counseling and promote reminders that strengthen cART adherence among AYWH. This relationship is usually easier to navigate during early to middle childhood;⁹ however, as adolescents grow, they begin seeking autonomy and semi-independence. This need for independence may strain the caregiver–AYWH relationship and may have a negative effect on adherence.

Caregivers may also be preoccupied with other duties, including providing for their families and, as the adolescent grows, may pay less attention to the AYWH's HIV care, assuming they have taken on this responsibility. Moreover, repeated reminders from the caregiver may evoke feelings of guilt from vertical transmission among caregivers who are biological mothers and further strain the AYWH–caregiver relationship.

Real-time electronic adherence monitors provide an objective record of adherence that can be used for counseling purposes and/or combined with text message reminders and notifications to support ART adherence. These technologies have been used extensively with adult populations and have been shown to improve adherence.^{10,11} Our group recently reported overall positive experiences with their use among adults in routine care, including perceptions of improved adherence, clinic experiences, and clinician–client relationships.¹² The literature on electronic adherence monitors and associated interventions among adolescents, however, is limited^{13–15} and does not reflect their use in routine care, particularly in sub-Saharan Africa.

We conducted a mixed methods implementation study to assess the use of a real-time electronic monitor and other associated interventions to improve adherence to ART among AYWH in routine clinical practice. This analysis explores how the monitor and associated reminder functions may affect the experiences of AYWH and their relationships with their caregivers around adherence.

Methods

Study design and setting

The data underlying the study were collected as part of a larger study, the Optimizing Adherence through Implementation Science (OASIS) study—a mixed methods pilot

study that sought to understand the implementation of a real-time adherence monitor (evriMED, Wisepill technologies, South Africa) and associated interventions in multiple clinical settings.¹² This analysis reflects experiences in a large pediatric care clinic, the Immune Syndrome Suppression (ISS) clinic in semirural southwestern Uganda.

The ISS clinic provides comprehensive HIV care to >15,000 adults and children with HIV and has experience carrying out research studies. The evriMED electronic adherence monitor is a relatively low-cost smart pill box that transmits real-time device opening data to a central server through cellular networks; these data can then be viewed digitally as adherence graphs. Optional associated interventions included data-informed adherence counseling, short message service (SMS) texts, and/or real-time alarm reminder. The SMS reminders were one or two way and were sent either to the participant or to his/her social supporter who, in most cases, was also the caregiver.

The SMS reminders were sent at a scheduled time or in response to a missed dose—typically 30 min after a missed dose. The alarms were triggered if the monitor was not opened within 30 min of the set dosing time. The OASIS study enrolled a convenience sample of 25 AYWH and their caregivers, with approximately half <15 years and half >15 years old to understand differing developmental stages and circumstances. AYWH and their caregivers were followed up for at least 3 months during implementation of the study.

After follow-up, we conducted qualitative interviews with AYWH–caregiver dyads and health care workers (HCWs) postdeployment of the adherence monitors. Interviews were conducted between June 2022 and August 2022. AYWH–caregiver dyads were randomly selected within the two age categories (i.e., <15 vs. ≥15 years). Interviews were conducted in a quiet private setting using the native language of participants, Runyakole and English or a mixture of both languages. Two bilingual clinic staff (J.B.T., R.B.), both male, conducted all the interviews. Interviews were conducted until thematic saturation was attained.

Both clinic staff were hired specifically for the OASIS study and had experience and training in conducting qualitative interviews. All focus groups were digitally recorded with permission from participants and then translated verbatim into English for data analysis.

Interview administration

The interview guide was guided by the Consolidated Framework for Implementation Research (CFIR); the CFIR helps to explain factors that may influence adoption of an intervention (i.e., those related to the actual intervention, the individual, the inner and outer environment, and the process of implementing the intervention). Within these domains, the interview guide included questions about likes and dislikes of the adherence monitor, suggested improvement of the device, experience using the monitor at home, concerns about privacy/stigma, and how the monitor affected clinic care.

As noted in the “Study design and setting” section, this study was part of the OASIS study, which involved two prior iterations of the same procedures among adults in similar settings within southwestern Uganda. The interview guide was used successfully in both contexts and adapted for use with adolescents and their caregivers (Supplementary Appendix S1).

Data analysis

Authors J.A. and J.E.H. analyzed the transcripts using an inductive content analysis approach¹⁶ to explore the experience of AYWH, their caregivers, and the interactions between them. After reading the first four interviews, they identified relevant content and then formulated codes based on this content and assembled a codebook. J.A. then used the codebook to code all qualitative data, which were entered into qualitative analysis software (Dedoose). J.A. and J.E.H. then developed categories by characterizing core concepts, developing labels to represent the concepts, writing operational definitions, and selecting illustrative quotes as evidence from the interviews. Themes were reviewed with the qualitative research assistants to ensure accurate reflection of the participant-stated perspectives.

Data collection and analysis followed the COnsolidated criteria for REporting Qualitative research (COREQ) guidelines.¹⁷

Ethical review

All participants provided written informed consent or assent. All study procedures were approved by the Mbarara University of Science and Technology institutional review board (IRB), the Mass General Brigham IRB, and the Uganda National Council for Science and Technology. The study was registered with (ClinicTrials.gov).

Results

Participant characteristics

Of the 15 AYWH enrolled in the qualitative study, over two-thirds (67%) were female, mean age was 16 years (range, 12–19 years), and majority (88%) perinatally infected, 86% were virologically suppressed (i.e., had a viral load of <40 copies/mL), and 56% lived with a biological mother as the caregiver. Participant cART regimen was a lamivudine/tenofovir backbone with either dolutegravir or ritonavir-boosted lopinavir or atazanavir. One AYWH lived with the father as the caregiver and the rest lived with either a grandmother or other biological relative. Of the AYWH, 52% lived in an urban area, whereas the rest lived in a rural area.

Five HCWs were interviewed, of whom four were female, and the average age was 36 years. Two of the HCWs were clinicians, two were nurses, and one was an adherence counselor, all provide care to adolescents with HIV in the ISS clinic.

Qualitative interview overview

In general, the AYWH and their caregivers liked the adherence monitors, although some had concerns of privacy with the loud alarms. AYWH reported that the monitors helped them take charge of their medication through the real-time alarm and SMS reminder functions. The burden of adherence reminders was removed from the caregivers, thus improving some strained AYWH–caregiver relationships. Two adolescents reported rebound poor adherence after monitor withdrawal.

Monitor likes, dislikes, and stigma

Monitor likes centered around the fact that the monitor provides safe storage for pill boxes and provides prompt reminders for medication dosing time.

“I also like its portability and it stored my medicine very well. Also it quickly reminds me time to swallow my medicine.” (female AYWH)

“I liked it because it reminded him to swallow medicine wherever he would be and in case he would not open he would be knowing that am going to receive the SMS then I get to know that he has not swallowed medicine” (caregiver of AYWH)

Some AYWH felt that the alarm was stigmatizing and recommended modifying this add-on intervention as captured in the quotes below:

Monitor dislikes and stigma

“When I left home and went to work where I am currently living, it became bad and hard for me to have a evriMED. Where I am working and currently living, I was always scared and worried that my boss and other children/people I am living with would see it because none of them know that I am HIV positive or on ART” (female AYWH, 17 years)

If the monitor is kept well without the alarm and only getting the SMS on your phone, it is very fine. The alarm can only affect privacy if it rings and someone else or a visitor is at home (male AYWH, 16 years).

The monitors relieved caregivers of the burden of reminding AYWH about medication and improved dyadic relationships

Many of the caregivers reported that the adherence monitor and the associated interventions provided reminders to the AYWH under their care about dosing time, and as such, the caregiver did not need to constantly remind the AYWH when it was time for taking their medication.

“So I was not worried that she would forget to take her drugs or have the burden of having to remind her to take her drugs whenever it was time. It played an important role of reminding her all the time.” (female caregiver)

“The time before we used to remind her that its time but when she got the monitor she knew that it was going to remind her so which means even if I was not around she knew what to do already because she has the reminder at home, so the monitor was of benefit to me.” (female caregiver)

Improved ART self-efficacy with using the monitors

The adherence monitor and the associated interventions empowered the AYWH to take charge of the medication and encouraged some level of independence with ART adherence. Some of the stated mechanisms through which this was achieved were overcoming forgetfulness, which is a common barrier to adherence among AYWH, and desired accountability.

“They had even put me on second line of drugs because my viral load was not suppressing. But when I started using that box (evriMED), my viral load got suppressed. It helped me and forced me to take my drugs very well because I knew the doctors and counselors would know if I didn't take my drugs well and on time.” (Female AYWH, 15 years)

“In addition, it became part of her instinct in that before even the alarm rang. She would feel it in her life and she would find the alarm ringing as she went to take her drugs. It helped us that way and she took her drugs very well, her health and energy came back as you can see her.” (caregiver of AYWH)

Improved counselor–AYWH relationship with adherence monitoring

AYWH with poor prior adherence had strained relationships with the clinic counselors. With introduction of the monitors, their ART adherence improved and so did their relationships with clinic ART adherence counselors.

“I would lie to them/deceive them (counselors) that I take my drugs well but now, you can’t lie because of the monitor data. It also makes easier for the health workers to do counseling based on evidence of the monitor data. And to me, I can no longer take my drugs poorly and lie to the health workers that I am adhering well.” (male AYWH, 16 years)

“I reached there they saw the results and were all happy they bought me a cake and encouraged me to continue swallowing that way.” (female AYWH, 17 years)

All the HCWs interviewed thought the evriMED monitor was helpful in improving AYWH adherence and self-efficacy/ART treatment independence.

“The children become independent on their own and it motivates them to take without the command of their caretakers” (male HCW)

HCWs did not think the monitors would cause a delay in service provision of the clinic and mentioned that the adherence graphs would be a helpful feature for targeted adherence counseling.

“But for this person for whom we have data from the monitor we shall already be informed that this person is not taking their drugs well and there is no reason for that person to sit at the triage to wait for all that health education, they should go straight to the counsellor, make an adherence plan and the to be seen by the clinician and it will improve the flow in that sense.” (Female HCW)

However, some HCWs expressed concern over privacy issues, especially about the size of the monitor. The thoughts of the HCWs are captured in the quote below:

“I know like most people who have not disclosed, there is a way they can hide their drugs, but now this monitor is big in size” (Female HCW)

Rebound poor adherence after evriMED withdrawal

Notably, two AYWH who had joined the study with detectable viral load at baseline became suppressed during the study period and later had rebound viraemia after withdrawal of the evriMED. One of these AYWH explained that she had developed a dependency on the monitor for adherence reminders and after the monitor withdrawal, she found it hard to remember to swallow her ARVs in time, as shown in the quote below:

“It affected me because the virus increased, I think it’s because of missing time. I mean that sometimes I could forget to swallow the medicine at the right time because there was no reminder to guide about the time.” (Female AYWH, 16 years)

Below is a conversation with the above AYWH
Question: Why do you think a person should use it (monitor) forever.

Response: Because when the person has already been used to it and you take it he/she gets disorganized.

Question: Do you have any example of the person who was disorganized after taking the monitor (evriMED) away?

Response: “Yes, it happened to me because I started swallowing medicine late because of lacking reminder. When I reached at the clinic they told me that my viral load had increased.”

Because the SMS messages were helping me to know whether he has taken his drugs or not. It had helped my child to take his drugs and also helping me not to get worried that he has not taken his drugs when I am not at home.” (female caregiver)

Discussion

This qualitative study explored the impact of a real-time adherence monitor and associated reminder functions on the experiences of AYWH and their caregivers around medication adherence. Most AYWH and their caregivers found the adherence monitors acceptable. Concerns were mostly around privacy and stigma associated especially with the alarm function. The monitors helped AYWH take charge of their medication through the associated real-time alarm and SMS reminder functions, taking the burden of adherence reminders from the caregivers. ALWH reported improved adherence and reduced strain on the AYWH–caregiver relationships.

Previous studies have shown that AYWH often like interventions that involve the use of wireless technology to address adherence; some of the interventions studied have included one- and two-way SMS texts, telephone call reminders, WhatsApp messaging,^{18–21} and other forms of wireless communication. Over 80% of AYWH in low- and middle-income countries have access to mHealth-based interventions throughout the continuum of HIV care.^{22–24} AYWH typically find mHealth interventions novel, fun, and something within their control.²⁵

The evriMED monitor and associated functions provide a wireless technology-based approach to cART adherence for AYWH and primarily works through reminding AYWH about dosing in real-time through either SMS or alarm, therefore, addressing the issue of forgetfulness. They additionally provided an avenue for targeted adherence counseling as clinic counselors were able to view the adherence graphs associated with smart pillbox opening.

Adolescents in this study had variable degrees of independence to adhere to their own medication. Especially among the younger AWYH, caregivers often play the role of addressing forgetfulness by providing daily cART reminders to AYWH. However, as AYWH grow, they prefer to be in charge of their medication and move toward independence. This step is necessary to transition to self-medication and important for successful transition to adult care.^{26,27} Although some caregivers encourage AYWH to transition to self-management, others struggle to allow AYWH take charge of their medication and cite fear that AYWH are not old enough to remember their dosing time.⁹

As a result, some caregivers may resort to negative methods such as physical and emotional punishment to try and force AYWH to adhere to medication, which may not be effective. Other caregivers may all together avoid engaging in conversations around HIV or cART due to fear of having to disclose their own status and how transmission may have occurred.²⁸ The evriMED monitor was perceived as a personal reminder by AYWH, replacing the daily persistent reminders and associated threats from caregivers and thus

giving AYWH some semi-independence while still supporting them in taking their medication.

These reminders may be helpful throughout the turbulent adolescence years as cognitive skills begin to exponentially improve and the ability to understand the complex relationships²⁹ that quite often surround HIV acquisition and management growth. This support is necessary for achieving ART medication independence and minimizing gaps in adherence. Long-acting cART dosing options for AYWH that do not require daily reminders are becoming more readily available,³⁰ which will ease this burden; however, support will still be needed for maintaining care engagement.

Limitations of this study include the short duration of follow-up, thus not enabling observation of sustained effects of the adherence monitors. In addition, the adherence monitors are based on opening of the smart box, which may not necessarily equate to dosing; therefore, the real-time adherence data may not be a true representation of actual adherence.

This study describes the reported experiences of participants; future research is needed to quantitatively determine the impact of the adherence monitors and associated interventions on adherence and adolescent-caregiver relationships in routine clinical care.

Strengths of the analysis include the in-depth exploration of multiple perspectives and real-life experience with the technology. We also conducted the interviews until thematic saturation was attained.

In this pilot study, adherence monitors were largely acceptable by AYWH and their caregivers. Participants reported that the monitors helped improve AYWH cART self-efficacy and the overall AYWH-caregiver relationship. We propose larger studies to further explore the role adherence monitors may play in improving AYWH adherence.

Authors' Contributions

J.E.H. and S.A. conceived of the study. R.B., J.B.T., and E.T. collected data for the study. D.N. and W.M. supported study implementation and oversight. L.E.G. provided program management. J.A. and J.E.H. conducted the qualitative analysis. J.A. wrote the first draft of the article; all authors edited and approved the final article.

Author Disclosure Statement

J.E.H. has been a consultant for Merck. The other authors declare no conflict of interest and that the research was conducted in the absence of any commercial or financial relationships that may be a source of potential conflict of interest.

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Supplementary Material

Supplementary Appendix S1

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