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Using Real-Time Adherence Feedback to Enhance Communication About Adherence to Antiretroviral Therapy: Patient and Clinician Perspectives

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Abstract

New technologies for real-time adherence monitoring hold the potential to enhance antiretroviral therapy adherence interventions by providing objective information about daily medication-taking behavior. To realize this potential, we need to understand how to integrate real-time adherence feedback into existing best practices to promote antiretroviral therapy adherence at the point of care. Using in-depth interviews with 30 HIV-infected patients and 29 HIV care clinicians, our primary aims were to understand patients' and clinicians' perceptions of anticipated benefits and preferred uses of objective feedback to enhance conversations about adherence and to identify concerns about the impact of objective monitoring on patient–clinician relationships and communication. Both patients and clinicians suggested that identifying patterns of nonadherence with real-time feedback could (a) facilitate collaborative adherence problem-solving, (b) motivate patient adherence, and (c) reinforce the importance of optimal adherence. Some clinicians worried that delivery of real-time feedback could imply mistrust of patient-reported adherence and suggested careful framing of monitoring results. A few patients and clinicians were concerned that negative reactions to monitoring could discourage retention in care and reduce adherence motivation. These results indicate the potential of real-time feedback to enhance existing evidence-based adherence interventions targeting the key adherence precursors of adherence information, motivation, and behavioral skills. Guidance for the delivery of real-time adherence feedback should focus on both optimizing adherence and mitigating negative perceptions of adherence monitoring.

Key words: HIV, adherence, antiretroviral therapy, real-time monitoring, hair

Adherence to antiretroviral therapy (ART) is critical not only to maintaining the health of people living with HIV (PLWH) but also to preventing the spread of HIV. Maintaining lifelong adherence to ART, however, presents a significant challenge for an important minority of PLWH. An estimated 20% of PLWH in the United States receiving ART have not achieved viral suppression (Centers for Disease Control and Prevention, 2017), indicating suboptimal medication adherence. Although many evidence-based strategies for promoting ART adherence exist, their effectiveness is often hampered by poor patient recall of adherence (Simoni et al., 2006), as well as social desirability bias when reporting adherence. Without accurate information about daily adherence behavior, effective adherence counseling is difficult. HIV care clinicians are likely to benefit from additional tools that provide objective adherence information to more effectively counsel their patients about adherence (Golin, Smith, & Reif, 2004; Wilson et al., 2010).

Emerging technologies for adherence monitoring that generate objective data have the potential to promote optimal adherence by providing accurate information on patient medication-taking behavior. There are numerous technologies existing or under development to collect objective adherence information in real time, including electronic adherence monitors, digital medicine systems, and pharmacologic measures. Not only are these measures of

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

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http://dx.doi.org/10.1097/JNC.0000000000000089

adherence more accurate than self-report, but they provide dose-to-dose information about adherence over time that can identify patterns of missed doses associated with risk for viral rebound (Haberer et al., 2015). Electronic adherence monitors, including electronic pill boxes and bottles that record time and date stamps of package openings, have been used in numerous adherence promotion trials (de Bruin et al., 2017; Garrison & Haberer, 2017; Gross et al., 2013; Sabin et al., 2010). Adherence counseling using electronic adherence monitoring results shows promise as an effective strategy to promote medication adherence (Finocchario-Kessler et al., 2012; Reich, 2013). Despite these benefits, electronic adherence monitors do not directly measure ingestion of a medication, which can instead be achieved through the use of sensors and pharmacologic measurement. Ingestible digital medicine sensors, which transmit real-time information of a medication's ingestion via an electrical current based on exposure to stomach acid are in early stages of development (Hafezi et al., 2015). Pharmacologic assessment of adherence through quantification of medication concentrations in hair or blood cells can provide objective longitudinal measures of medication ingestion (Garrison & Haberer, 2017). These pharmacologic methods are objective, can assess adherence retrospectively, and require minimal effort on the part of the patient.

The accuracy, acceptability, and feasibility of these technologies to measure ART adherence has been assessed in multiple clinical studies (Garrison & Haberer, 2017). In contrast, studies on the use of real-time feedback to enhance adherence counseling practices have been largely limited to electronic adherence monitors (de Bruin et al., 2017; Gross et al., 2013; Sabin et al., 2010). There have been few studies to test the use of ingestible digital medicine sensors (Thompson et al., 2017) or longitudinal pharmacologic measures to enhance ART adherence counseling. Although real-time adherence monitoring technologies show promise for promoting adherence (Gandhi et al., 2018; Rosen et al., 2016), more evidence is needed to assess the value of these technologies for improving clinical outcomes (van Heuckelum et al., 2017).

The utility of objective real-time monitoring technologies for promoting ART adherence cannot be judged independently of the communication methods used to deliver the adherence data that they generate. To fully judge their value for promoting adherence and subsequent viral suppression, studies are needed to determine the best use of data from these monitors in the clinical encounter and to identify potential unintended consequences, such as those which may erode patient–clinician trust (Campbell, Eyal, Musiimenta, & Haberer, 2016). As a first step toward this understanding, we sought the opinions of patients living with HIV and HIV care clinicians on the application of real-time feedback to patient–clinician conversations about adherence. Specifically, we aimed to describe patients' and clinicians' perceptions of anticipated benefits and preferred uses of objective feedback to enhance conversations about adherence and identify concerns about the impact of objective monitoring on patient–clinician relationships and communication. With this information, our broader objective was to identify actionable recommendations for the integration of real-time adherence monitoring into routine adherence counseling and interventions and to identify strategies to mitigate potential negative patient reactions to monitoring.

Methods

Study Background and Setting

The present research was conducted within the context of an ongoing study, the Establishing Novel Antiretroviral Imaging for Hair to Elucidate Non-adherence Project. In this study, we aim to develop and test a simple, noninvasive method to longitudinally measure antiretroviral drug concentrations in a small sample of patient hair (R01AI122319; co-PIs: Angela D. M. Kashuba and Elias P. Rosen). The method uses infrared matrix-assisted laser desorption electrospray ionization (IR-MALDESI) technology for mass spectrometry imaging (MSI; Rosen et al., 2016), will require approximately 2 hours from sample collection to results delivery, and provides weeks to months of retrospective adherence information to both clinicians and patients. We will pilot the clinical use of hair IR-MALDESI MSI-based ART adherence feedback to enhance patient–clinician communication about adherence in the University of North Carolina (UNC) Infectious Diseases (ID) Clinic. In preparation for this pilot, we conducted formative interviews with HIV-positive patients and clinicians at the UNC ID Clinic to assess the acceptability, appropriateness, and feasibility of using IR-MALDESI MSI results to provide patients with feedback regarding longitudinal patterns of medication adherence.

Ethical Review

This study was registered (clinicaltrials.gov identifier: NCT03218592) and conducted in accordance with International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH) Good Clinical Practice standards and the Declaration of Helsinki. Study procedures were approved by the University of North Carolina's Biomedical Institutional Review Board (protocol no. 15-2933). All participants provided written informed consent prior to enrollment.

Participant Recruitment and Enrollment

Thirty patients from the UNC ID Clinic were purposively selected to participate in individual in-depth interviews. Patients were eligible if they met the following criteria: HIV positive, age 18 years or older, had been prescribed ART for at least 3 months, had scalp hair of at least 1 cm in length, and had at least one viral load (VL) on record from the past 12 months. VL testing is conducted every 6 months in the study clinic, but more frequently at the initiation of therapy or if there are changes in therapy (approximately every 4–8 weeks). We purposively selected eligible patients in the following three VL strata: (a) all HIV RNA <50 copies/ml, (b) at least one HIV RNA between 50 and 1,000 copies/ml and no HIV RNA >1,000 copies/ml, or (c) at least one HIV RNA >1,000 copies/ml. Because patients may have met the criteria for the second or third stratum at some point over the past 12 months but not at others, we defined these two strata on the basis of having at least one qualifying VL on record. We aimed to recruit an equal number of participants in each of the three strata.

Patients meeting the eligibility criteria and fulfilling the purposive VL recruitment strata were contacted to assess their interest in participating in the study. Eligible patients provided written informed consent. Patients participating in the study included 12 patients in the VL <50 copies/ml stratum, 8 patients in the VL 50–1,000 copies/ml stratum, and 10 patients in the VL >1,000 copies/ml stratum. The ratio of patients recruited in each stratum deviated from the intended equal thirds slightly because the second stratum proved difficult to recruit due to fewer numbers of patients with these specific VL levels. We also aimed to select patients to reflect the gender and racial/ethnic identity of the UNC ID Clinic patient population: approximately two-thirds male and approximately one-half Black/African American, one-third White/Caucasian, and the remainder other racial and ethnic minorities.

Clinicians from UNC ID Clinic were also recruited to participate through email contact. All 29 clinicians in the ID Clinic, including 19 physicians, 3 nurses, 3 physician assistants or nurse practitioners, 1 pharmacist, and 3 social workers participated in the study. Clinicians gave written informed consent prior to the in-depth interview.

Data Collection Procedures

At enrollment, patient participants completed a brief questionnaire to solicit demographic information, time since HIV diagnosis and ART initiation, current ART regimen, source of health insurance, hair length, and hair treatment practices. Preceding the in-depth interview, clinician participants completed a brief questionnaire to report their position in the clinic, basic demographic information, years of HIV care experience, and average clinic hours per week. Individual in-depth interviews were conducted by trained research staff using a semi-structured interview guide. Both patient and clinician participants were asked to discuss preferences for adherence discussions using hair MSI results and perceived benefits and concerns about the test and discussions of the results. Interviews lasted approximately 45–90 minutes. Each interview was digitally recorded and transcribed verbatim to text for analysis.

Data Analysis

In the analysis of the in-depth interview data, we aimed to (a) describe patients' and clinicians' perceptions of the anticipated benefits and preferred uses of MSI-based adherence feedback in patient–clinician communication about adherence to ART and (b) identify concerns about the effects of MSI-based adherence feedback on patient–clinician relationships and communication. We began analysis of the qualitative interviews by reading the transcripts in full until we reached a high level of familiarity with the content (Bernard & Bernard, 2013) and wrote a brief summary for each interview. We developed a codebook based on the interview guide and iteratively piloted this codebook using the first four interviews; each interview was double coded to reconcile code application, and codes and rules for their application were modified as needed. Transcripts were then coded in Atlas.ti version 8.0 using topical codes based on interview guide questions. All transcripts were double coded; two authors independently coded transcripts and met to review areas of discrepancy until complete agreement was achieved on coded text. We summarized content relevant to each code by participant, then across participants (patients and clinicians separately), and took inventory of the principal themes related to each code and observed the variation or richness of each theme (Tolley, Ulin, Mack, Robinson, & Succop, 2016).

Results

Thirty patients and 29 clinicians participated in the in-depth interviews presented here. Twenty-one of the 30 patient participants were male, 17 identified as Black/African American, 10 as White/Caucasian, and 3 as Hispanic/Latino. Sixteen participants had initiated ART 10 or more years prior to the interview, 12 had initiated 1–10 years prior, and the remaining 2 had initiated ART in the past 6–12 months.

Both patients and clinicians expressed many anticipated benefits of the use of objective adherence feedback during

typical adherence conversations. The key perceived benefits of counseling using real-time feedback were grounded in a desire for more accurate and detailed information about medication-taking behavior than patient-reported adherence. Participants identified multiple potential benefits of objective adherence feedback, including facilitation of problem-solving discussions, motivation of future adherence, and reinforcement of the importance of adherence. Concerns about the use of real-time adherence feedback were less commonly reported than positive projections about its use and included worries about harm to the patient–clinician relationship and potential negative reactions to objective adherence monitoring that could discourage retention in care or diminish adherence motivation.

Anticipated Benefits and Preferred Uses of Real-Time Feedback

Real-time monitoring provides accurate adherence information desired by clinicians. Most patients and clinicians highlighted the anticipated benefit of having access to more accurate ART adherence information using a pharmacologic measure. Clinicians reflected that patients may not accurately report their adherence, and many were excited about the possibility of no longer having to rely on patient recall to assess adherence. Although underlining the fact that most patients are honest about their adherence, clinicians suggested that there is a certain subset of patients for whom objective monitoring could encourage greater accuracy in discussing their adherence behavior. They often described this as an issue with social desirability bias.

> *I think for people who struggle with adherence and yet try to make their response socially acceptable by saying, "I missed two doses," when, in fact, they've taken two doses, it would be helpful… they acknowledge having problems, but they underestimate the problem, either because they don't remember, or because they want to have a socially acceptable interaction, and they feel like they don't want to disappoint you...*—ID clinician

Beyond social desirability, this clinician suggests that recall of missed doses can be difficult and patients may tend to underestimate the number of doses missed. Clinicians further explained that in their current practice, a VL received after their consultation with a patient may contradict what the patient reported to them about their level of adherence, forcing them to question the reliability of what patients are telling them.

> *One of the most common things that we run into is, "Oh yeah, I'm taking my meds everything's great." Then we get their labs a week later and they're not. It indicates they're not taking their meds… being able to have that real-time and knowing if they're taking them is really going to help that conversation.*—ID clinician

Clinicians expressed a sense of awkwardness in having to decide whether to take patients at their word or doubt their reported behavior. For them, it would be a relief to have objective information about their patients' adherence. Although patients discussed inaccuracies in their self-reported adherence less frequently than clinicians, some patients suggested that it would be beneficial for clinicians to be able to challenge patients on the basis of real-time monitoring results, serving as a wake-up call for those with suboptimal adherence.

> *If you're not honest, then [the clinician is] like, "Okay, well, let's look at the graph right here. Okay. This is what the graph showed us for the month or over the 6 months or the 3 month." … That would really wake a person up, make them really do right about their medicine.*—Female patient, VL < 50

Objective adherence feedback could facilitate problem-solving. Many patients and clinicians suggested that identifying patterns of nonadherence with the feedback could help patients and clinicians work together to identify strategies to promote adherence. They suggested that identifying days or periods of missed doses based on the feedback could create the opportunity to identify the causes of days or episodes of missed doses and strategize together to avoid the same issues in the future.

> *[If a clinician] says, "Something's going on there. You need to take your medicine. What's going on?" All depends what I'm doing, right? If I'm taking it or not, it's going to show up, right? Like I tell him, I'm taking it, but I don't know what's going on, so he needs to do something. Like, "Okay, are we going to change?"*—Male patient, VL > 1,000

Clinicians also suggested that day-level information on missed doses would allow for more specific, and therefore more beneficial, problem-solving conversations. They suggested it would be important to use dates, life events, and other markers of time to help patients recall what might have been the cause of a given missed dose or series of missed doses.

> *"Well, it looks like a week and a half ago maybe you might've missed some days. Do you remember? Was anything going on?"… instead of saying, "What are your barriers to taking your medication?" They say—especially if you can anchor it to important events in their life, but even days. "You go to work every Monday—was it a weekend trip?" You can really start to see what the rest of their lifestyle—and that's useful outside of just the drug-monitoring conversation.*—ID clinician

Clinicians suggested that real-time feedback could create the opportunity to discuss not only situational or practical barriers to adherence (e.g., schedule disruption, lack of transportation) but also underlying personal barriers, such as lack of HIV status disclosure or social support.

"I see maybe in this part of your recent history that a couple weeks ago it might have been a struggle for you… Can we talk about what's going on? Is there something going on in your life that's making it difficult. Is it a transportation thing? Is it an access thing? Is it your family doesn't know about your status and you don't want them seeing you taking your pills?" It would lead to a whole host of different conversations.—ID clinician

Adherence feedback could motivate both highly adherent and nonadherent patients. Some patients and clinicians suggested that the feedback could provide positive reinforcement to those patients with high adherence, providing encouragement to keep up the good work.

If you get a little happy face pillow or something that indicated good adherence and good practices, good viral load management, or just an ongoing awareness of the fact that you're HIV-positive and you're sticking to your prescribed behaviors… it's right there in your face.—Male patient, VL > 1,000

In addition to positive motivation for highly adherent patients, some clinicians suggested that the real-time feedback could be motivating for nonadherent patients as well. They suggested that comparing the patient's results to the ideal level of adherence could motivate improved adherence by depicting a concrete goal for the patient.

Could be useful to compare patients' levels with ideal levels so they know what to strive for. Although I think it would be amazing to have one of these [feedback reports] to show people that has all the [ideal concentration] lines up above the [observed concentration] and tell them, "This is what we want you to strive for."—ID clinician

Some clinicians pointed out that the real-time feedback could reinforce adherence more quickly than VL or $CD4^+$ count results because of the rapid availability of the results. Echoing clinicians, patients suggested that they could use the feedback to set goals for themselves and then monitor reports to see their progress: "I'm going to say, "Next time you see me, you can draw this line right here, I'm going to be above it. Yeah, it's a goal." (Male patient, VL 50–1,000). A couple of patients also suggested that having the report to take home could serve as a sustained motivator by providing a visual reminder to take their medication and of their own adherence goals and commitment to their health.

I would probably put it on my desk or put it by something that I look at every day. I would want to remember that, "Oh, I didn't take my medicine yesterday. Make sure I take it today. Do better"... I think it would help me take it more seriously if I did have it at home with me, for sure.—Male patient, VL > 1,000

Using real-time adherence feedback to reinforce the importance of adherence. In addition to commenting on the utility of adherence feedback on its own, some clinicians suggested that using the feedback in tandem with VL reports could create a teachable moment to reinforce the importance and impact of adherence to ART on patients' health. They suggested that discussing these results together could help illustrate to patients how ART works to suppress viral replication and, therefore, the importance of taking it as instructed.

I think my goal would be to overlay this [adherence feedback] on their [viral load] lab result and say, "This is what's happening when you're not taking your meds," or, "You've been virologically controlled, but the problem with this is that every time you're down in this danger zone, your virus can replicate and become resistant, and maybe by the time you see me again, you're suppressed, but in the interim, you can be building up resistance."—ID clinician

Even for patients with undetectable VLs, clinicians suggested feedback revealing fluctuating levels of adherence could be used to explain to the patient how this pattern could foster the development of drug resistance. Similarly, a couple of patients suggested that the feedback could help them to understand why each medication they are taking is important. They also suggested that comparing the adherence feedback with VL results could help clarify the impact of taking ART on their health, showing proof of its effect in their own body.

As far as the charts, it could help you know that—cause I believe by the time the medication gets in your hair, it's done got over your whole body… I think it'd be very helpful having the charts to help explain the progression of your viral load as the medicine—as you continue to take the medicine, how much is it truly helping out.—Male patient, VL > 1,000

Potential Concerns About Adherence Counseling Using Real-Time Feedback

Patients shared few personal concerns for the use of real-time feedback in adherence counseling. Most patients expressed that they were not concerned about discussions of the real-time results, with some patients explaining that they had nothing to hide from clinicians. They emphasized the importance of clinicians having as much information as possible to ensure that they deliver the best care and believed that other patients would feel the same way: "If they're serious about their healthcare, I think they would be happy for the doctor to see all this. I want mine to know everything" (Female patient, VL < 50). It should be noted that most patients perceived their own adherence to be very high, and thus may not have been concerned about adherence conversations, expecting no issues to be raised: "I'm cool with it 'cause I know I take my medicine… I know I take medicine every day, so it should go from here all the

way down to the end of my hair" (Female patient, VL > 1,000). Although patients expressed few concerns, clinicians were commonly concerned that real-time monitoring and feedback could lead to perceived mistrust in patient–clinician interactions. These clinician concerns and some echoes in patient narratives are discussed below.

Careful framing of real-time adherence monitoring is needed to preserve trust in the patient–clinician relationship. Some clinicians expressed concern that using hair-based monitoring could indicate a distrust of patient reports of adherence and could be perceived as "going behind their backs." As one clinician put it: "I think there's also the question of are you doubting the veracity of their statement. Are you questioning their reliability?" (ID clinician). Clinicians thought that certain patients could feel singled out and targeted if subjected to monitoring: "For folks who are sensitive about their HIV and aren't doing their best with adherence… could be hard for them if they feel like you're targeting them because you don't believe them" (ID clinician). Some clinicians worried that these potential negative perceptions could serve to alienate patients from them. They emphasized that they work hard to establish a trusting relationship with their patients and would not want to do anything to harm this trust.

I mean, if I were going to my doctor and they were asking me to clip my hair or my nails—I mean, if I didn't see why it was necessary, I think it just injects a problem where there is none, and we work really hard to establish a good therapeutic relationship with our patients, so it wouldn't feel nice to inject that.—ID clinician

Some were specifically worried that having to directly challenge patients' reported levels of medication adherence on the basis of the monitoring results could strain the relationship. However, clinicians also suggested that the monitoring results could be carefully framed to avoid implying mistrust of the patient.

If the results contradict what they've been saying, that it could turn into, "This says you're lying." How do you frame that? They may not be lying. I think that when we ask somebody how things have been going over a 3-month period, the recall—I couldn't tell you what I ate for dinner 2 weeks ago.—ID clinician

Echoing these clinicians, a few patients were worried about the tone that could occur in conversations regarding the monitoring results. They suggested that being accused of lying about their adherence in light of the results could be hurtful.

[If] the doctor be like, "Well, you're lying. You're lying. You're telling a fib"... That would hurt, because you're lying to yourself and you're lying to your doctor. Come on, you can't do that. You're lying to yourself, and you're lying to your doctor. Not only that, you're messing with your life. You don't want to go out like that.—Male patient, VL 50–1,000

As this patient suggests, although hurtful, being challenged on their self-reported adherence could force patients to face potential denial about their own level of adherence. Some patients went even further to say that in the past they have appreciated clinicians challenging them to be honest about their adherence, as it had motivated them to improve. In some cases, patients noted that although being challenged could be positive, delivery of contradictory monitoring results should be framed in the least accusatory manner possible.

I think it might be worthwhile for the doctor to sit down, and say, "We might be able to see things that you're forgetting, or not remembering, but we want you to know that nobody is perfect, and we just want to help you get healthier." Just stress that it's more about helping me get better.—Female patient, VL 50–1,000

Clinicians also suggested careful framing and tone in the delivery of adherence feedback to avoid making the patient feel judged or accused of lying. Some suggested that making the monitoring routine could make patients feel less singled out, comparing it to routine drug testing.

Like anything, it has to be used in a thoughtful way that doesn't alienate you from the patient or the patient from you. I think we just have to—like drug screening—we have to just think about how we do it and how we approach it.—ID clinician

Negative reactions to monitoring results could harm adherence motivation and engagement in care. Beyond potentially difficult conversations with clinicians, two patients stated that they would be upset if their results contradicted their perceived level of adherence, suggesting that the perceived inaccuracy could be confusing for them. A few went further to say that they or others might have a strong emotional reaction to receiving poor results.

I got a whole bunch of friends that don't like to take their medicine. That would be challenging for them because once they see that they're in that red, they're going to get mad, and then, they probably ain't going to take it.—Female patient, VL > 1,000

Similarly, some clinicians were concerned that the patients with the most issues with adherence might avoid future appointments to avoid being "policed" in their adherence: "I'm wondering, also, if it could impact them to avoid their appointments 'cause they know someone's going to be keeping them accountable" (ID clinician).

Discussion

We present for the first time a comprehensive qualitative analysis of patients' and clinicians' perceptions of the use of real-time objective adherence monitoring and feedback for ART adherence counseling. Patients and clinicians identified a number of anticipated benefits and preferred uses of real-time adherence feedback generated by an objective metric (hair MSI results) to promote adherence to ART: facilitating problem-solving in regularly taking medications, motivating future adherence, and creating opportunities to reinforce the importance of optimal adherence by comparing adherence reports to VL results.

These beneficial and preferred applications of the adherence feedback, which emerged during the interviews, closely align with the key constructs of the Information, Motivation, and Behavioral Skills model of HIV/AIDS-related behavior change (Fisher & Fisher, 1992; Fisher, Fisher, Amico, & Harman, 2006). This model was applied to the results post hoc as an organizing framework to highlight the primary implications of the study results for clinical practice. Below, we summarize participant-preferred uses of real-time adherence monitoring results corresponding to the key constructs put forth by the Information, Motivation, and Behavioral Skills model (Figure 1) and discuss ways in which objective adherence feedback could be used to enhance intervention approaches targeting adherence information, adherence motivation, and adherence behavioral skills.

Adherence information shapes adherence behavior both directly and indirectly by cultivating adherence behavioral skills (Fisher et al., 2006). Such information may include basic education on the importance of adherence to ART, proper dosing, side effects, and accurate information about patient adherence. Although patients may already be aware of the importance of high adherence to their ART regimen to achieve and maintain viral suppression, patients and clinicians in our study suggested that being able to compare adherence feedback and VL reports could help reinforce for patients the importance of adherence not only theoretically but in their own bodies. Beyond specific information, providing objective information about patient adherence addresses the issue of recall bias in adherence reporting, an issue that is well documented (Arnsten et al., 2001; Thirumurthy et al., 2012; Wagner & Miller, 2004).

A major component of many ART adherence interventions is adherence education and information. In one text messaging and peer support intervention created by Simoni et al. (2009), participants received educational messages by SMS about side effects management, medication benefits, the importance of adherence, etc. Such text messages could be modified to include patient adherence monitoring results to increase the personal relevance of these messages. For example, information from patient records could be included to enhance educational messages about the importance of adherence, by reminding the patients of their adherence level based on real-time monitoring over the past month, and their most recent VL.

Adherence motivation shapes adherence behavior both directly and through adherence behavioral skills (Fisher et al., 2006). Participants suggested that the real-time adherence feedback could be used to motivate patient adherence in two key ways: (a) by providing positive reinforcement of good adherence, motivating

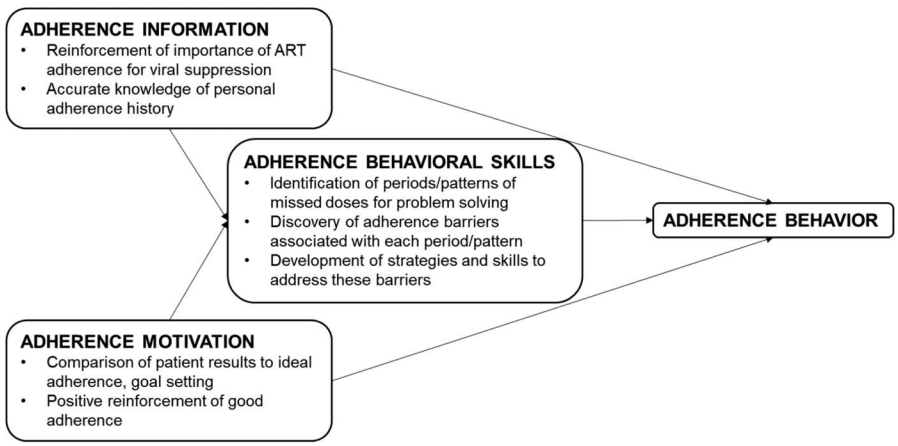

Figure 1. Participant-suggested uses of real-time adherence feedback as they correspond to constructs of the Information-Motivation-Behavioral Skills Model of Adherence to ART. *Note.* ART = antiretroviral therapy.

patients to maintain high adherence; and (b) by providing a concrete comparison of actual adherence to ideal adherence, motivating patients with suboptimal adherence to strive to improve.

Motivational interviewing is a widely used and an effective approach to ART adherence promotion (Golin et al., 2006), which targets patients' motivation and self-efficacy to enact behavioral changes, often through goal setting (Miller & Rollnick, 2013). Real-time adherence results could serve as a concrete measure by which to set goals and verify progress toward those goals in motivational interviewing counseling. For example, patients could set goals for the number of completed doses they would like to increase by for the next visit and validate whether they met this goal with their next visit's monitoring results.

Adherence behavioral skills resulting from effective adherence information and motivation are essential to successful ART adherence (Fisher et al., 2006). Relevant skills include the ability to acquire prescription refills, remember doses, and fit dose timing into one's routines and lifestyle. Participants suggested that real-time feedback could be leveraged to identify periods and patterns of missed doses and corresponding barriers to adherence, allowing development of strategies and skills to address these barriers. Existing evidence-based adherence promotion strategies incorporate patient adherence information into behavioral skill-building processes. For example, the Managed Problem-Solving intervention (Gross et al., 2013) uses electronic monitors to record patient adherence and generate adherence history reports. These reports are used to identify barriers to adherence, identify potential solutions, develop a plan of action, and evaluate and modify the plan over multiple visits. Although Managed Problem-Solving intervention uses electronic pill bottle caps, results from hair MSI-based monitoring and other pharmacologic measures could be similarly used to identify adherence barriers, develop strategies to overcome these barriers, and evaluate the success of these strategies in the future.

In these ways, real-time adherence feedback could be integrated into existing evidence-based interventions for adherence promotion and could enhance the efficacy of these interventions by providing more accurate information about patients' adherence to motivate future adherence and build adherence behavioral skills. The extent to which the addition of real-time adherence feedback increases the efficacy of these interventions should be evaluated.

Monitoring and Addressing Concerns About the Use of Real-Time Adherence Feedback

Although the unintended or undesirable effects of introducing real-time adherence monitoring into routine clinical care cannot be fully known until its use is tested in this context, the concerns expressed by some participants in our study highlight key issues to carefully monitor and address upfront. Given clinician concerns about potential harm to trust in the patient–clinician relationship, we recommend framing real-time adherence monitoring as a complement to patient self-report given the challenge of accurately recalling missed doses. This framing suggests that patients may misremember or overestimate their adherence rather than implying that patients intentionally mislead clinicians. Similar concerns about adherence monitoring and patient–clinician trust have been discussed by others (Campbell et al., 2016), but the effect of objective adherence monitoring on perceived patient–clinician trust has not been formally evaluated to our knowledge. Although a minority opinion among clinicians, the concern that certain patients may disengage from care for fear of being monitored should be taken seriously because of the gravity of such an outcome. In future evaluations of adherence promotion interventions using real-time feedback, it will be important to carefully monitor and document negative reactions and disengagement from care. When using such technologies in practice, clinicians can judge whether their patient would benefit from adherence monitoring and should consider the risk–benefit balance of optimal adherence and engagement in care for each patient.

Limitations

The study results should be interpreted with key limitations in mind. The population of the UNC ID Clinic, a specialized academic clinic, may not represent the perspectives and opinions of patients and clinicians in other clinical contexts. Although we attempted to recruit a diverse set of patients with varied virologic suppression patterns, it is still likely that those patients that we recruited may be those most engaged in care and may not represent the broader clinic population. Patient VLs upon which recruitment was based did not immediately precede the in-depth interview; therefore, the level of adherence that we hoped to infer may have changed by the time of the interview. Although we purposively selected patients with likely suboptimal adherence on the basis of their most recent VL, very few patients acknowledged issues with their own adherence and in

many cases talked about other patients' difficulties with adherence. Although this limits the ability to conclude that these perspectives were grounded in their own anticipated experience with real-time monitoring, it highlights the potential benefit of objective monitoring as patients most in need may have difficulty recalling or understanding the extent of their adherence issues.

Conclusions

Both patients and clinicians saw adherence feedback based on an objective real-time pharmacologic measure as beneficial and potentially motivating for both highly adherent and nonadherent patients. Participants suggested that identifying patterns of nonadherence with the feedback could facilitate problem-solving to promote future adherence, motivate improved adherence, and create a teachable opportunity to reinforce the importance of optimal adherence. The use of real-time adherence feedback should be integrated into best-evidence adherence interventions and rigorously evaluated. Guidance for patient–clinician communication using real-time feedback should focus on both optimizing adherence and mitigating negative perceptions of adherence monitoring to preserve trust and engagement in care.

Disclosures

The authors report no real or perceived vested interests that relate to this article that could be construed as a conflict of interest.

Acknowledgments

This research is supported by funding from the National Institute of Allergy and Infectious Diseases (R01AI122319, PIs: A. D. M. Kashuba and E. P. Rosen, clinicaltrials.gov identifier: NCT03218592; R01AI098472, PI: M. Gandhi). This research was partially supported by a National Research Service Award Post-Doctoral Traineeship from the Agency for Healthcare Research and Quality sponsored by The Cecil G. Sheps Center for Health Services Research, The University of North Carolina at Chapel Hill (T32 HS000032, PI: Holmes). Dr. Golin's salary was partially supported by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (K24HD069204, PI: C. E. Golin). The authors would like to thank the UNC Infectious Diseases Clinic for their support of this study, and the UNC Center for AIDS Research (P30AI50410, PI: Swanstrom) for data analysis support.

Key Considerations

- ❍ Objective adherence monitoring can enhance patient–clinician communication about adherence and lead to identification of periods and patterns of missed doses, development of strategies to improve adherence, and setting measurable goals for future adherence.
- ❍ To avoid patients' perceptions of mistrust, recommendations for adherence monitoring and delivery of monitoring results should frame monitoring as a tool for enhancing collaborative problem-solving.
- ❍ Clinics that use adherence monitoring should carefully track any negative patient reactions and disengagement from care related to the use of monitoring.

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DOI: 10.1097/JNC.0000000000000155