

A computer-based assessment detects regimen misunderstandings and nonadherence for patients on HIV antiretroviral therapy

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Abstract *Accurately assessing nonadherence is a necessary first step toward improving adherence to highly active antiretroviral therapy (HAART). Patient self report is the most practical method for assessing adherence in clinical settings, but may produce unreliable and invalid results unless optimally performed. A computer-assisted, self-administered interview (CASI) may improve the disclosure of medication nonadherence by providing a neutral and seemingly private interview. One hundred and ten patients completed a computer program which assessed their understanding of and adherence to HIV medications and produced a report for their providers. Eleven providers of these patients completed a questionnaire describing their patients' medication regimens and estimating adherence. Patients completed a written exit survey and providers completed an exit interview to assess the acceptability of our CASI-based assessment. More than half of patients (54%) made at least one error in reporting their medication regimen. Providers tended to overestimate their patients' adherence and correctly classified only 24% of nonadherent patients at the 80% adherence level. Computerized HIV medication adherence assessment is feasible and acceptable to patients and providers. Clinical tools that can accurately and efficiently detect important medication errors and nonadherence, and alert providers to these problems, will help ensure the health of HIV-seropositive patients.*

Introduction

Highly active antiretroviral therapy (HAART) for HIV produces dramatic reductions in morbidity and mortality for many individuals who maintain a very high level of adherence to their medications (Centers for Disease Control and Prevention, 1998; Palella, *et al.*, 1998). Between 17 and 33% of HIV-seropositive patients will miss at least one of their medication doses over a one- to three-day period, substantially reducing their ability to benefit from treatment (Chesney, 1997; Chesney *et al.*, 2000; Gallant & Block, 1998; Hecht *et al.*, 1998;

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Kalichman *et al.*, 1999) and missing as few as 5% of prescribed doses is associated with loss of complete viral suppression (Bangsberg *et al.*, 2000; Paterson *et al.*, 2000). Accurately assessing nonadherence in clinical practice is a necessary first step toward improving adherence to HAART.

There is no currently accepted method to assess adherence to HAART in routine clinic settings. Patient self report is the most practical method of assessing adherence, but may produce unreliable and invalid results unless optimally performed. Existing adherence questionnaires fail to detect 20 to 35% of nonadherent individuals (Morisky, 1986; Arnsten *et al.*, 2001). Electronic pill cap monitoring and unannounced home-based pill counts, while valid adherence measures, are not feasible in clinical practice (Bangsberg *et al.*, 2001). Providers' estimates of patients' adherence are inaccurate and, often, no better than chance (Bangsberg *et al.*, 2001; Gilbert *et al.*, 1980; Haubrich *et al.*, 1999; Mushlin & Appel, 1977; Steiner, 1995).

Patients may be hesitant to disclose undesirable behaviour when interviewed face-to-face by their provider or other individuals. Computer-assisted, self-administered interviews (CASI), by providing a neutral and seemingly private interview, have been shown to improve participant disclosure of high-risk sexual encounters and may similarly improve disclosure of medication nonadherence (Gerbert *et al.*, 1999; Kissinger *et al.*, 1999; Webb *et al.*, 1999). CASI assessment also is not personnel intensive and could be administered either in a waiting room or at home via the Internet.

We set out to test the feasibility of CASI adherence assessment in HIV-positive patients on HAART. We compared provider adherence estimates with CASI-based adherence assessment. We also compared patient-reported adherence with concurrent patient viral load to validate the adherence assessment tool.

Methods

Participant recruitment and procedures

Patient and provider participants were recruited from a private practice medical clinic and a county hospital in the San Francisco Bay Area. To recruit private practice providers, we mailed a letter describing the study to 14 physicians who had offices in a local medical centre and were known to provide HIV care. To recruit physicians practising at the county hospital, the director of HIV services at the county hospital distributed a letter of invitation to six physicians. We followed this letter with a telephone call to answer questions and invite the physicians' participation.

Patients of the participating physicians were recruited either by telephone or consecutively from the clinic reception area. English-speaking patients, over 18 years of age, receiving at least two antiretroviral medications and not visually impaired were eligible.

Instruments

Computerized patient adherence assessment. The computerized patient adherence assessment was based upon an instrument developed and tested in previous research (Bangsberg *et al.*, 2000; Chesney *et al.*, 2000), and consisted of three main segments: (1) determining the patient's understanding of their medication regimen, (2) determining the patient's medication adherence over a three-day period, and (3) demographic and background information. The software was written using C++ and Microsoft Access.

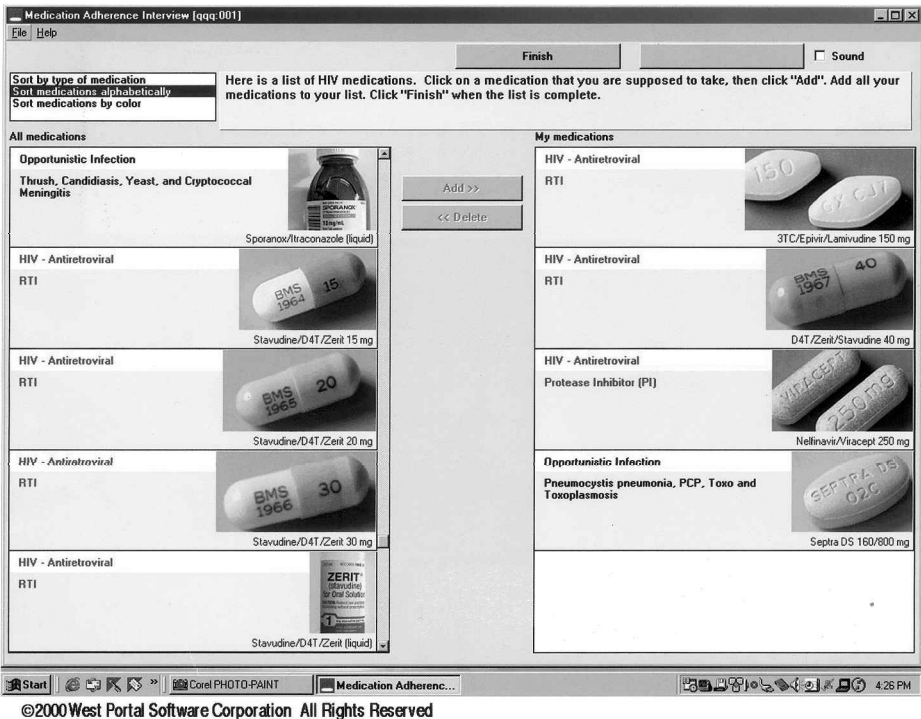


FIG. 1. Screen capture of medication selection C. 2000, West Portal Software Corp, San Francisco, CA; reprinted with permission. www.edermpda.com/HIVadhere

Regimen identification. Patients identified their current medication regimen by selecting all of the HIV medications they were supposed to be currently taking. The program asked patients to identify their medications from digitized images of 47 different HIV antiretroviral and opportunistic infection medications alongside their generic and trade names. Medications could be sorted alphabetically, by colour, or by associated disease (e.g. CMV, Toxoplasmosis). Patients selected a medication by pointing and clicking the mouse on a picture of the medication. Once the medication was selected, it appeared on the computer screen under a heading 'My Medications' (see Figure 1). Patients could add or delete medications from their personal medication list until it was complete. After selecting their medications, the program prompted patients to provide the following information for each selected medication: (1) number of pills per dose, (2) number of doses per day, and (3) associated dietary requirements. Patients indicated their responses by selecting options from drop-down lists. Once this information was collected, the program presented the patient with a summary of their medication regimen, and asked them to review the summary and correct any errors. For patients with cognitive or dexterity impairment, a research assistant was available to assist completion of the assessment by having the patients verbally indicate their answers to the research assistant who operated the computer mouse.

Adherence assessment. The second segment assessed patients' adherence over a three-day period (yesterday, day before yesterday, two days ago). For each assessment day, patients were presented with a 24-hour calendar and were prompted with the day of the week and date. To cue participants' memory and structure their responses, patients were asked to indicate the time they woke up, went to sleep and ate meals. Icons reflecting each activity

were selected on the appropriate time of day. Patients then selected the time of each dose for each medication. If patients indicated having missed a dose of one of their medications, the program prompted them to indicate why they had missed it by selecting one or more reasons from a list of 15 options derived from studies on antiretroviral adherence (Chesney, 1997; Haubrich *et al.*, 1999; Samet *et al.*, 1992). These procedures were repeated to measure dose ingestion for each of the last three days.

Demographic and health information. Demographic information (sex, age, education level, race/ethnicity) and recent CD4 and current self reported viral load count were collected at the end of the adherence assessment.

Patient exit survey

Patients were asked to rate the following on a four-point scale: (1) how easy it was to complete the computerized assessment, (2) how much they enjoyed completing the assessment, (3) how much completing the assessment made them think more about how they take their medications, (4) their willingness to complete a similar assessment in the future, (5) how important it was for their physician to see their assessment answers, (6) how well they felt the assessment reflects how they take their medicine, and (7) their comfort in using a computer.

Provider adherence estimate

Providers were surveyed to identify each patient's prescribed medication regimen and the number of estimated missed doses over the past three days. Providers were asked to record the name of each HIV medication prescribed, medication strength in milligrams, number of pills per dose, number of doses per day, number of doses prescribed over past three days and the estimated number of total missed doses over the past three days.

Patient adherence report

A patient adherence report was generated which summarized the patient's understanding of and adherence to their medication regimen. The report combined data from the computerized patient adherence assessment and the provider's report of the patient's prescribed regimen. The first section of the report highlighted mismatches or discrepancies between the patient and provider reports of the patient's medication regimen. The second section summarized the patient's report of their adherence over the past three days, and presented percentages for adherence to each medication and adherence across all medications as well as the reasons patients indicate for having missed doses.

Provider exit interview

We developed a semi-structured interview guide to conduct face-to-face interviews with providers about their reactions to the patient adherence report and computerized adherence assessments. Audio tapes of the provider interviews were transcribed and coded.

Data analysis

Relevant quantitative data were imported into a Microsoft access database and were analyzed using SAS. We calculated regimen mismatches by comparing patient and provider reports of regimens. Only those medications which the patient and provider agreed the patient was taking were included in calculating mismatches in medication strength, pills/dose, doses/day and dietary instructions. For dietary instruction mismatches, only those instances in which the provider indicated specific dietary instructions (e.g. 'take on an empty stomach', 'take with food') and the patient did not indicate these same instructions were considered mismatches; cases in which the provider indicated 'no dietary instructions' but the patient thought there was an instruction were not considered as mismatches. Our participating providers suggested that these patients may have misinterpreted the dietary question and reported dietary instructions that were optional (e.g. take with food only if you have side effects) rather than required. For this reason we decided not to count this type of discrepancy as a mismatch.

We compared the rates with which providers overestimated patient adherence (i.e. estimated as adherent patients reporting < 80% adherence) and underestimated adherence (i.e. estimated as nonadherent patients reporting \geq 80% adherence) using McNemar's test. To determine if providers significantly varied in their ability to detect patient nonadherence, we compared providers' correct and incorrect estimates of patient nonadherence using a chi-square test.

To analyze the qualitative exit interview data, one of the investigators (AB) reviewed each interview transcript to identify prominent themes and constructed a template of open codes. The transcripts were coded and specific themes identified in accordance with standard qualitative convention (Strauss & Corbin, 1990).

Adherence calculations

Daily adherence to each antiretroviral (ARV) medication was calculated using the formula: [(number of doses taken—number of doses prescribed)/(number of doses prescribed)] * 100. If patients reported taking more than their prescribed number of doses of a medication, their achieved adherence to that medication was considered to be 100%. Under the formal definition of adherence (taking medicine exactly as prescribed), patients who report taking more than their prescribed doses would be considered as nonadherent. However, this type of nonadherence does not have the same implications for the key HIV therapy health outcomes (sub-optimal viral suppression and the possibility of selecting for resistant virus) as nonadherence due to taking fewer than the prescribed doses. Patients who report overdosing should achieve similar viral load counts as those who report 100% adherence. For this reason, we decided to classify patients who reported overdosing as 100% adherent. Adherence was dichotomized at either the 80% or 90% levels for analyses.

Patient self-reported viral load

We created a dichotomous variable for patients' self-reported viral load—undetectable (< 500) and detectable (\geq 500). The association between viral load and self-reported adherence was assessed with odds ratios.

Table 1. *Patient characteristics (N = 110)*

Characteristic	% (n)
Sex	
Male	96 (106)
Age (mean)	46 years
Race/ethnicity	
Caucasian	76% (85)
African-American	13% (14)
Hispanic	5% (5)
Other	7% (8)
Education	
Less than high school	5% (5)
High school diploma	10% (11)
Some college	31% (34)
College degree	54% (60)
CD4 Count	
0–100	14% (15)
101–200	18% (20)
201–300	15% (16)
301–500	27% (30)
501–750	17% (19)
> 750	9% (10)
Viral load	
< 500	60% (66)
500–5,000	12% (13)
5,001–10,000	12% (13)
10,001–50,000	10% (11)
50,001–100,000	2% (2)
> 100,000	5% (5)

Results

Participants

Eleven providers (ten physicians and one nurse practitioner) and 114 patients participated in the study. Data collected from four patients were not included because they did not meet the study eligibility criteria (three patients were not prescribed ARV medications and one was significantly visually impaired), resulting in a final sample size of 110 patients.

Providers were predominantly male (64%) and Caucasian (82%), with an average age of 48 years. The majority (73%) worked in a solo or group private practice; 27% worked in a county hospital. Providers managed an average of 150 HIV-seropositive patients, comprising 39% of their patient panel. Forty-five per cent of providers were ‘very’ confident of their ability to accurately estimate their patients’ medication adherence, 36% were ‘somewhat’ confident and 18% were ‘a little’ confident.

The characteristics of the patient participants are presented in Table 1. Ninety patient participants received their medical care in private practice offices; 20 patients received medical care at a San Francisco Bay Area county hospital. Six exit surveys were not completed due to language barriers.

Operation of the computer assessment

Ninety-one percent of patients were able to complete the computer assessment after brief instruction by the research assistant. Ten patients (seven county hospital and three private

Table 2. *Types of medication errors*

Type of medication error	% (n)
Any medication error	54 (59)
Incorrectly identifying number of pills per dose	25 (28)
Incorrectly identifying dietary instructions	19 (21)
Incorrectly identifying number of doses per day	18 (20)
Incorrectly identifying medication strength	17 (19)
Identifying ARV medication not prescribed	14 (15)
Failing to identify prescribed ARV medication	14 (15)

practice) were unable to effectively operate the computer mouse, due to apparent low literacy or cognitive impairment. The research assistant observed all patients as they completed the assessment. The research assistant suspected that a response error had occurred when patients' verbalizations describing their medication regimen did not match their inputted answers. A few patients mistakenly reversed their responses to questions about the number of pills per dose and number of doses per day. Several patients also failed to indicate all meals they had eaten when completing the daily calendar. When a response error was suspected, the research assistant questioned the participant, who either confirmed or edited their response.

Patient medication regimens

Patients were prescribed an average of three ARV medications (range = 1–6). Of these, 55% were also receiving a medication to treat or prevent one or more opportunistic infections. Of those receiving an opportunistic infection medication, the median number of medications was one (range = 1–6). Sixty-six percent of patients were on a protease inhibitor based regimen. Twenty-six percent were on a non-nucleoside reverse transcriptase inhibitor (NNRTI) based regimen and 24% were on a combined PI-NNRTI regimen. Seven percent of patients were on a regimen containing only nucleoside analogues. Patients were taking an average of seven doses and 13.6 pills per day.

Identification of medication errors

The computerized assessment detected several inconsistencies between patients' and providers' reports of HIV medication regimens. More than half of patients (54%) made at least one type of medication error. Table 2 summarizes the frequency of medication errors, including incorrectly identifying the number of pills per dose, the dietary instructions, the number of doses per day or the strength of one or more prescribed ARV medications. Other errors included identifying one or more ARV medications that was not part of the prescribed regimen (14%) and failing to identify at least one of the prescribed ARV medications (14%).

Patient adherence

Table 3 summarizes patients' computer assessment reports of adherence to ARV medications. Five of the 72 patients reporting 100% adherence had taken more pills than were

Table 3. *Self-reported adherence to ARV medications*

Patient adherence	% (n)
Adherence over past 3 days	
100%	66 (72)
90–100%	5 (6)
80–89%	12 (13)
< 80%	17 (19)
Last missed a medication dose	
Never	16 (17)
Within past week	41 (45)
2–4 weeks ago	16 (18)
More than 1 month ago	27 (30)

prescribed for one or more of their medications. Seventeen percent of patients reported taking less than 80% of their prescribed ARV medications over the past three days; 10% of patients had missed taking all of their ARV medications on at least one out of the past three days. The most common reasons patients cited for missing doses were: ‘simply forgetting’ (44%), ‘feeling good’ (32%), being away from home (24%), being busy with other things (22%), running out of or losing medications (17%), feeling that the drug was ‘toxic to your system’ (17%) and sleeping through a dose (15%). Only one patient reported missing a dose because he was ‘drunk or high on drugs.’

Comparison of provider estimate and patient report of adherence

Table 4 compares provider estimates and patient reports of adherence to ARV medications using the 80% and 90% definitions of adherence. The sensitivity for providers detecting nonadherence was only 24% at the 80% level. Of the patients for whom the physicians made the wrong prediction, 16 patients reporting <80% adherence were predicted to be adherent and one patient reporting \geq 80% adherence was predicted to be nonadherent by their provider. These two types of discrepancies occurred at significantly different rates ($p < 0.001$, McNemar’s test). Providers did not significantly vary in their accuracy in estimating patient nonadherence ($p = 0.18$), ranging from one to four errors each. Overall, providers’ estimates of adherence were accurate in 84% of cases ($p < 0.001$, McNemar’s test).

Table 4. *Provider estimate and patient report of adherence to ARV medications*

Provider estimate	Patient report (n)			
	80%		90%	
	Nonadherent	Adherent	Nonadherent	Adherent
Nonadherent	5	1	8	6
Adherent	16	88	25	71

McNemar’s test (80% level) = 13.23, $p < 0.001$.

McNemar’s test (90% level) = 11.64, $p < 0.001$.

Table 5. Relationship between self-reported viral load and adherence at 80%

Group	Detectable/N (%)	Odds ratio	95% CI
Patient \geq 80%*	31/89 (34)	1.0	
Patient < 80%	13/21 (62)	3.0	1.1–8.1
Provider \geq 80%*	40/104 (38)	1.0	
Provider < 80%	4/6 (67)	3.2	0.6–18.3
Patient < 80%*	13/21 (62)	1.0	
Provider < 80%	4/6 (67)	0.9	0.2–3.9
Provider \geq 80%*	40/104 (38)	1.0	
Patient < 80%	13/21 (62)	2.6	1.0–6.8
Patient \geq 80%*	31/89 (34)	1.0	
Provider < 80%	4/6 (67)	3.7	0.6–21.6
Patient \geq 80%*	31/89 (34)	1.0	
Provider \geq 80%	40/104 (38)	0.8	0.5–1.5

*Reference category for computing odds ratio.

Validation of patient self report

Table 5 compares patient report of the most recent viral load and patient reported adherence and provider adherence estimate at the 80% level. Patients who reported <80% adherence were more likely to have a detectable viral load than patients reporting \geq 80% adherence (OR = 3.0, 95% confidence 1.1–8.1). Similarly, patients whom providers estimated were <80% adherent were more likely to have a detectable viral load compared with patients whom providers estimated were \geq 80% adherent (OR = 3.2, 95% confidence 0.6–18.3).

Patients' reactions to the computerized assessment

Most patients reported that the computerized assessment was easy to complete: 77% found the assessment 'very' easy, 21% found it 'somewhat' easy and only 2% found it 'somewhat' or 'very' difficult to complete. Ninety percent of patients stated that they enjoyed completing the assessment (45% enjoyed it 'a lot' and 45% 'somewhat'). Most patients felt that assessment was relevant to their health care and accurately reflected how they take their medicines. Sixty-two percent of the sample reported that completing the assessment prompted them to think more about how they take their medications. Seventy-three percent of patients felt that it was 'very' important and 21% felt it was 'somewhat' important for their doctor to see the results of their assessment. Most patients stated that the computerized assessment accurately reflected how they took their medications, with 82% stating that it reflected this 'very well' and 15% stating that it reflected this 'somewhat' well. Almost all patients indicated that they would 'definitely' (77%) or 'probably' (21%) agree to complete a similar computerized medication assessment. Most patients (75%) reported that they were 'very' comfortable using computers, 19% were 'somewhat' comfortable, 4% were 'a little' comfortable and 2% were 'not at all' comfortable.

Providers were surprised by information revealed in the patient adherence reports:

Now, here's another good thing. He says here ... he's taking Sustiva, which I had him on. And he also said he's taking Nevirapine, which I didn't have him on ... Now, I don't understand that. Obviously, that brings up a problem ... Probably he was on one and it was discontinued and he never stopped [taking] it.

This actually helps ... I can't figure out why his liver is shot. Now I say, 'Ah, ha! He's taking six pills instead of two pills of the drug that's worst on the liver.' ... So this is a good example of where this actually helps.

Look at this ... he's missed all of his medications. He's on a drug holiday that I didn't know about.

Providers believed that patients are more likely to disclose nonadherence to the computer:

Why are people more honest with the computer than they are with the doctor? If I ask him if he misses any doses, he says, 'Oh, no.' Then I look at this [the report], and he's only taking [his medication] 1/3 of the time ... he's supposed to be on Norvir and he's missed every single dose ... yet, you ask him and [he says] everything's fine.

People can tell anything to the computer without feeling any judgement or attitude back. I can imagine people feeling comfortable to 'fess up' [to the computer] where they wouldn't necessarily to their clinician who has expectations of them ... the interaction is with the machine and I think that could make people more open.

Providers lack the time to conduct thorough medication assessments:

I don't sit down and ask them about every single drug in this detail. Basically, I say, 'Are you taking your medications?' 'Have you missed any doses?' But I don't go and ask them, 'how many Sustiva have you missed? How many Nevirapine have you missed?' So this helps.

I usually ask what they are taking and most of the time how many times a day. But I don't always ask everybody what medications are you taking, how many times a day, how many pills.

Providers believe that computerized patient assessments can save them time and provide valuable information:

I would put this [adherence report] in the chart and give a copy to the patient so they would have a reference. I think that would probably cut down on some of our phone calls.

When I change a cocktail in somebody, I typically will write the prescription and then write all this stuff [dosing instructions] and it takes eight minutes just to do that. This could be very helpful to develop a program and push a button. That is how I like things.

It seems the more patients can do on their own and then have communicated to us, the better.

FIG. 2. *Provider exit interview themes.*

Providers' reactions to the patient adherence report and the use of computerized assessments in practice

Figure 2 presents direct quotations from providers exemplifying the four major themes which emerged from the interviews: (1) providers were often surprised by the information revealed in the patient adherence reports, (2) providers believed that patients are more likely to disclose nonadherence to the computer than to the provider, (3) providers do not have enough time to conduct thorough adherence assessments in their practices, and (4) providers believe that incorporating computerized patient medication assessment into their practice would help them be more efficient and effective.

Discussion

This study indicates that computerized HIV medication adherence assessment is feasible and acceptable to patients and providers in both private practice and county hospital settings. The

assessment detected a substantial number of potentially critical patient misunderstandings of regimens and nonadherence. Over half of the patients who completed the assessment made at least one error in describing their ARV medication regimen, with 14% failing to name at least one of their medications and 14% identifying a medication not currently prescribed. These results are similar to a recent study finding that 22% of all HIV-positive patients and 14% of those reporting good adherence failed to accurately identify one or more of their antiretroviral medications in a visual recognition test (Parienti *et al.*, 2001). The regimen misunderstandings detected by our CASI were not otherwise apparent to the providers and may have been missed without adherence assessment. Correcting misunderstanding or misinterpretation of medication regimens is a concrete, achievable and necessary step to improving adherence.

Computerized adherence assessment detected sub-optimal adherence in a substantial proportion of individuals. Thirty per cent of patients reported taking less than 90% of their antiretroviral medications over a three-day period. This proportion of nonadherent patients is comparable to the proportions identified in recent studies of HIV-seropositive individuals (Chesney *et al.*, 2000; Haubrich *et al.*, 1999; Hecht *et al.*, 1998; Kalichman *et al.*, 1999; Paterson *et al.*, 2000). Though our computerized adherence assessment detected a substantial proportion of patients with sub-optimal adherence and other research suggests that computerized interview methods may increase the disclosure of socially undesirable behaviour, we are unable to determine whether our CASI-based assessment detected more or less nonadherence than other methods such as self-administered questionnaires or face-to-face interviews.

Comparison of provider estimates and patient reports of adherence revealed that providers overestimated their patients' adherence, correctly identifying only 24% of nonadherent patients. Thus, poor adherence was likely unrecognized in many patients. While our study found that providers dramatically underestimated nonadherence, their predictions were not entirely made at random. This is in contrast to a body of research indicating that providers' estimates of adherence to non-HIV medications are no better than chance (Caron & Roth, 1968; Charney *et al.*, 1967; Gilbert *et al.*, 1980; Mushlin & Appel, 1977; Steiner, 1995). With respect to HIV research, two studies have found no significant relationship between provider estimate and either patient self report (Haubrich *et al.*, 1999) or electronic medication monitoring (Paterson *et al.*, 2000). One study that treated adherence as a continuous variable found an imprecise, but not strictly random, association between provider estimate and unannounced pill count (Bangsberg *et al.*, 2001). Though to different degrees, all of these studies find that providers' estimates of adherence are imprecise and that they greatly underestimate nonadherence. Failure to identify nonadherence in routine clinical care is an important obstacle to maximizing successful antiretroviral therapy. Structured computer-based adherence interviews may improve provider recognition of poor adherence.

The computer assessment may be better able to detect patient nonadherence for several reasons. First, providers indicated that they lack the time to conduct detailed adherence assessments on all of their patients. The computer assessment asks all patients a standard series of questions about all of their medications, ensuring that detailed information about patients' medication-taking behaviours are captured. Second, previous research (Gerbert *et al.*, 1999; Kissinger *et al.*, 1999; Webb *et al.*, 1999) and the findings of this study suggest that patients may be more open to disclosing nonadherence to a computer than to their provider. The interaction with the computer may be experienced as more 'neutral' or 'private' than interaction with the provider, thus encouraging greater disclosure of behaviours sensitive to negative judgement.

Several limitations of the study should be noted. The main goal of this project was to determine the acceptability and feasibility of a rapidly developed prototype computer adherence assessment. The prototype was designed to be self administered, but did require the presence of a research assistant to occasionally verbally clarify instructions and, rarely, physically assist the patient in operating the computer. The study results should be interpreted in light of the possibility that patients' disclosures of nonadherence were impacted by the presence of the research assistant. In addition, the study results were based on a convenience sample, and may not generalize to the population of HIV providers and patients. Other research has supported the utility and acceptability of audio-CASI for assessing sexual risk behaviours in substance abusing populations (Des Jarlais *et al.*, 1999; Metzger *et al.*, 2000). We are further simplifying our assessment to ensure that most HIV-positive patients, including those with active substance abuse, can accurately complete the assessment without assistance.

No objective measures were used to corroborate patients' reports of their understanding of their regimen and adherence. Some patients may have incorrectly followed the assessment instructions, resulting in the false detection of medication errors and nonadherence. Others may have under-reported nonadherence during the self assessment. Patients who reported nonadherence on the computer assessment were considerably more likely to have a detectable viral load compared with patients reporting adherence. While this provides some support for the validity of the computer-based assessments, it is limited by the ability of patients to accurately report their viral load.

Despite these limitations, the study findings suggest that our computerized assessment could be an important, accessible and inexpensive tool to assess patient adherence to antiretroviral therapy. The data collected by our computerized medication adherence assessment could be readily compared with current prescription information, pharmacy refill data and recent laboratory tests. Clinical tools which can accurately and efficiently detect important medication errors and nonadherence, and alert providers to these problems, will help to ensure the health of HIV-seropositive patients.

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