Improving the Self-Report of HIV Antiretroviral Medication Adherence: Is the Glass Half Full or Half Empty?

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Self-reports are the most widely used method for measuring antiretroviral adherence. The association between self-reports and viral loads has been repeatedly demonstrated, but this association does not address how well self-reports measure actual medication-taking behaviors. Understanding adherence self-reports requires studying the science of memory and the reporting of behaviors. In the first section of this review, we discuss research in cognitive psychology that pertains to adherence self-reports, focusing primarily on studies that examine cognitive processes respondents use to answer survey questions. In the second section, we review recent articles examining the relationship between self-reports and objective measures of adherence, highlighting the strength of associations and key methodologic issues. We conclude with key questions for future research and methodologic recommendations.

Introduction

Researchers use several methods for estimating patients' medication adherence [1–3]. These include subjective self-report measures and objective measures including pharmacy records, pill counts, electronic drug monitoring technologies that use computer chips to record pill bottle openings, and biological sampling to measure drugs or metabolites in plasma, urine, or breath. In clinical care, as well as in many research settings, collecting objective measures of adherence is neither feasible nor affordable. It is thus critical to optimize the quality of self-reports of antiretroviral (ARV) adherence.

In this article, we discuss two important issues related to the optimization of self-report. The first is the staggering variety of self-report questions (or survey "items") reported in the literature. This lack of standardization reflects our limited knowledge about basic methodologic issues such as what time frames, questions, and answer choices (or "response tasks") work best [4•].

The second is that clinicians and researchers lack consensus about how to assess the validity of adherence self-reports. Numerous studies over the past 15 years have shown a significant correlation between self-reports of ARV adherence and viral load. These findings notwithstanding, few would disagree that a patient's clinical response is an indirect adherence measure [1]. Viral suppression is the goal of ARV therapy, but excellent adherence is only the first step in a cascade of events that is required for such suppression to occur. Subsequent events include appropriate absorption, favorable pharmacokinetics and pharmacodynamics, viral susceptibility, and host immune status [5–7]. This logic implies that validity testing of self-reports should utilize objective measures of the actual behavior rather than downstream physiologic events.

Our first objective is to expand our understanding of survey questions by reviewing research in cognitive psychology from the past 25 years that pertains to the self-report of ARV adherence. Second, to better understand the validity of commonly used measures we review recent articles that examine the relationship between self-reports of ARV adherence and objective adherence measures. We conclude with key research questions and methodologic recommendations.

Summary of Relevant Cognitive Psychology Research

The behavior of medication-taking has several features that should inform the survey methods used to measure it—these include regularity (pill-taking is generally once or twice daily), similarity (taking pills is generally the same from day to day), and low salience (there is generally nothing memorable about taking any particular dose). What does prior

research teach us about how to ask people about medication-taking? Despite extensive literature on reporting the frequency of autobiographic events [8–10], only a handful of articles directly address the specific measurement challenges posed by reporting behaviors that are regular, similar, and of low salience, such as medication-taking.

Recall versus estimation

Frequency questions about specific behaviors are critical to marketing (eg, how often people shop at a certain store). Blair and Burton [11] studied the relationship of the cognitive processes used to recall events that occur at different natural frequencies. Specifically, they sought to determine when respondents use "episode enumeration" (ie, recalling and counting specific episodes), and when they use a rate-based process (ie, estimation). The authors asked randomly selected adults how often they engaged in six common behaviors: purchasing gasoline, purchasing clothing, making a long distance telephone call, attending a movie, viewing a favorite weekly television show, and dining at a restaurant. They used different recall periods, from 2 weeks to 6 months, and asked participants after each response, "How did you choose that answer?" They found that when participants reported more than five episodes in the period of interest, only 15% used episode enumeration, and that no one used it when there were 10 or more episodes. In other words, for the behaviors they studied, virtually everyone used some kind of estimation process when there were five or more events. In addition, longer recall periods were associated with less use of episode enumeration.

In another study, Burton and Blair [12] examined response accuracy among college business majors to questions about the number of B grades they received and the number of courses taken outside the College of Business at a large university. They verified subjects' responses by reviewing official transcripts. The response accuracy for these tasks was, in their words, "distressingly low." The correlation between responses and the actual numbers from the transcripts was 0.50 for the number of B grades and 0.41 for the number of courses outside the College of Business. For these tasks, response "errors" occurred in both directions; that is, some produced overreports and some underreports.

Menon [13] studied how the concepts of regularity and similarity of the behavior affect the cognitive processes used to judge frequency, and the accuracy of those judgments. She studied undergraduate business students and asked them about 12 behaviors arrayed on a spectrum of regularity (regular to irregular) and similarity (similar to dissimilar), including behaviors such as brushing teeth, washing hair, going out in the evening, having dinner, drinking from a public fountain, eating at a fast food restaurant, making unplanned stops to talk to friends, and snacking. She found that participants were more likely to use estimation methods, not episode enumeration, for regular as compared with irregular behaviors, and for similar as opposed to dissimilar behaviors.

A final instructive example is the dietary recall work of Smith et al. [14]. They asked community volunteers to complete food diaries for 2- and 4-week periods, and then to recall what they ate 0, 2, 4, and 6 weeks after the food diary period ended. Not surprisingly, the recalled number of food items decreased monotonically with increasing recall period. Further, the accuracy of participants' recall was poor: of the items recorded in the diaries, only an average (across the time periods) of 38% were recalled, and of the items that were recalled, an average of 34% had not been recorded in the diaries. They concluded that reports of dietary intake tend to rely on generic memories; that is, people tend to report their typical diets rather than recall specific foods.

Pill-taking is arguably even more regular and similar than eating, presumably making accurate recall even more challenging. These studies of a wide range of behaviors with some similarity to ARV adherence suggest that patients do not, and cannot, recall and enumerate specific pill-taking events. Instead, they answer adherence questions by estimating. This work also shows that these estimates (or educated guesses) are often inaccurate. If estimation is the cognitive process patients use when responding to adherence questions, a key question for adherence researchers may be, "What can we do to get better estimates?"

Overreporting bias

There is an additional problem for medication adherence researchers—not only are responses often inaccurate, they are generally biased upward [1,3,15,16]. But researchers debate what cognitive processes explain this overreporting. Belli [16] proposes two: intentional deception and misremembering. The former is a conscious process that occurs when there is some perceived negative consequence to admitting nonadherence. The latter is more complex and uses what psychologists call "source monitoring" [17,18]. Source monitoring is "using a set of processes to make attributions about the origins of memories, knowledge, and beliefs" [17]. Source monitoring assumes that it is not always possible to separate intention from action; that is, that there are different sources of a memory, which can be conflated. The argument goes as follows: if patients decide to take medication, intend to be adherent, and remember that when they wake up on a particular day they should take their medication before breakfast, but then forget to take it, they may misremember their intention as the actual act of taking the dose, and report it as such.

To tease apart these two cognitive processes, Belli [16] examined rates of overreporting in studies that compared self-reports of adherence with objective adherence measures (Table 1). He included two types of self-report (retrospective and concurrent using diaries) and two types of objective measures (summary and continuous). Summary measures are assessments done at the end of the observation period by means of a pill count, whereas

Table 1. Review of adherence validation studies

Study	Adherence criterion	Underreport, %	Overreport, %
Panel A: Retrospective self-reports and summary measures			
Park and Lipman [35]	100%	1.7	38.5
Gordis et al. [36]	75%	0	31.1
Haynes et al. [37]	80%	2.4	19.5
Gilbert et al. [38]	80%	5.7	24.0
Inui et al. [39]	75%	4.6	27.8
Stewart [40]	100%	16.3	9.2
Waterhouse et al. [41]	80%	0	16.7
Panel B: Retrospective self-reports and continuous measures			
Unaware of continuous monitoring			
Rand et al. [42]	85%	0.0	58.1
Waterhouse et al. [41]	80%	0.0	75.0
Aware of continuous monitoring			
Burney et al. [43]	80%	8.3	30.6
Panel C: Diary self-reports and continuous measures			
Unaware of continuous monitoring			
Spector et al. [44]	80%	0.0	63.2
Yeung et al. [45]	80%	0.0	40.0
Aware of continuous monitoring			
Yeung et al. [45]	80%	0.0	20.0

(*Adapted from* Belli [16]; with permission.)

continuous measures are assessments done throughout the observation period (eg, electronic drug monitoring). He further distinguished continuous monitoring done with and without the participant's awareness.

First, Belli [16] compared summary measures (panel A) with continuous measures (panels B and C) in which participants were unaware of the monitoring. The "overreport" rates in panel A were approximately half those in panels B and C. He suggests that the lower rates of overreporting observed with summary measures could be explained by patients engaging in intentional deception (ie, pill dumping). Intentional deception increases the "adherence criterion" but does not affect self-report, which makes the self-report more closely approximate the "objective" measure.

Next, in panels B and C, Belli [16] compared those unaware and aware of the continuous monitoring and found that the rate of overreporting was lower in the group that was aware of the monitoring. His explanation is that those who are aware of the monitoring do not inflate their self-reports because they understand that their actual behavior has been observed. He concludes that the overreporting seen among those who know they are being observed is misremembering and suggests that this misremembering can be understood using a source monitoring framework. Belli [16] does not compare the groups statistically; rather, his goal is to use a semiquantitative approach to justify separating overreporting into two components.

Review of Recent Literature

Previous research

In their 2006 review, Simoni et al. [19•] found that self-reported ARV adherence was significantly correlated with viral load in 84% of comparisons. Nieuwkerk and Oort [20] pooled data from 65 studies and 15,351 patients and found that the pooled odds ratio of having a detectable viral load was 2.31 (95% CI = 1.99–2.68) for nonadherent patients, compared with adherent patients. Among the studies in both reviews there was tremendous heterogeneity in specific self-report questions, analytic decisions (eg, the cutpoint for dichotomizing adherence data), and recall periods.

Simoni et al. [19•] further explored the construct validity of self-reports by reviewing 19 articles published between 1996 and 2004 that compared self-reports with objective adherence measures. The most common self-report item was a single open-ended question querying the number of doses missed over a defined period of time, and the most common objective adherence measure was electronic drug monitoring. Of the nine studies that reported correlations between self-reports and electronic drug monitoring, eight reported coefficients between 0.30 and 0.55. Because the correlations between self-report and viral load that Simoni et al. [19•] reported were in the 0.3 to 0.6 range, one would have expected stronger correlations between two adherence measures. To better

understand the strength of association between self-report and objective adherence measures, we reviewed similar articles published since 2004.

Search strategy

We searched MEDLINE for papers published in English between January 2004 and December 2009. Articles about HIV were identified using medical subject heading (MeSH) terms "HIV infections," "acquired immunodeficiency syndrome," and "highly active antiretroviral therapy." To identify adherence articles, we used the MeSH term "medication adherence" and searched for "adherence" as a text word. We combined results of the two searches to compile abstracts on ARV adherence. We also searched reference lists and used the Web of Science database to identify articles that cited papers reviewed by Simoni et al. [19•].

Article selection process

A total of 654 abstracts were read independently by two authors (KMB and AEC). Of these, we included 44 abstracts that mentioned self- or patient-report and at least one other adherence measure (ie, another self-report measure or an objective measure). All 44 articles were read by the same two authors. Most articles were excluded because they did not directly compare adherence rates derived from multiple measures, but instead reported parallel analyses for each measure in which adherence was the predictor and a clinical indicator (eg, viral load) was the outcome. We also excluded articles in which the self-report data were not collected by survey (eg, calendar or diary) or were combined with other constructs, such as reasons for nonadherence.

Of the 44 articles, 10 met criteria for inclusion [4•,21–26,27•,28,29]. We extracted specific self-report questions and response options, objective adherence measures, recall periods, central tendencies for adherence, and statistical measures of association. Five authors were contacted for additional information.

Results

The 10 studies are described in Table 2. Studies were conducted primarily in community-based settings in the United States (n = 7), Europe (n = 2, Spain and Belgium), Canada (n = 1), China (n = 1), and Africa (n = 1, Uganda and Zimbabwe).

Self-report items were heterogeneous in terms of response options and recall periods. Many studies included questions that focused on the number of missed doses during a defined time period using either a single open-ended question or multiple questions based on the Adult AIDS Clinical Trials Group questionnaire [4•,21,22,25,26,27•,28]. Some studies asked frequency questions, such as how often respondents either had perfect adherence or missed a dose (eg, "most of the time") [4•,27•,28,29], and others asked respondents to report the proportion of medications taken as prescribed (eg, 60%) [4•,28]. The remaining studies assessed missed doses using a dichotomous yes/no question [23], calculated composite scores derived from multiple survey questions [4•,24], or assessed respondents' overall ability to adhere [4•].

Objective measures included electronic drug monitoring (n = 6) [4•,21,22,25,28], pill count (n = 4) [21,23–25], pharmacy records (n = 2) [24,29], and a composite measure combining electronic drug monitoring and pill count (n = 1) [26]. Three studies included more than one objective measure [21,24,25].

Comparisons between self-report and objective adherence measures

Most studies derived continuous adherence data from one or more questions about the number of doses taken or missed over a defined period of time. Of the seven studies that reported mean rates of self-reported adherence, two also reported medians. Overall, mean self-reported adherence rates were 10% to 15% lower than medians.

Self-reports were weakly associated with objectively measured adherence. Four of the six studies that reported correlations between self-reported and objectively measured adherence reported coefficients of less than 0.25. Three studies included graphic representations of the raw data [25,26,28]. Among the three studies that dichotomized self-report and objectively measured adherence, sensitivity of self-report ranged from 24% to 57%, specificity ranged from 66% to 97%, and the one reported kappa statistic was less than 0.15 [23].

Methodologic issues

Important methodologic considerations may have affected associations between self-reported and objectively measured adherence rates. First, comparisons were often made over different recall periods (eg, self reports of the past 3–4 days compared with 4 weeks of electronic monitoring) [23,26]. Only four of the nine studies that compared self-reported and objectively measured adherence used the same recall period [4•,22,27•,29]. In addition, self-reported adherence rates often reflected adherence to an entire ARV regimen, whereas electronic pill bottle caps were often placed on a single medication. Lastly, several studies did not fully describe the adherence survey question or response options, making it difficult to compare results across studies.

Conclusions

A paper of this length cannot hope to be comprehensive. Instead, we have highlighted several specific methodologic problems faced by HIV clinicians and adherence researchers. The first section of the paper, we hope, made one main point. We reviewed relevant literature from nonmedical fields that examines how people remember and report regular, similar, mundane, daily events, such as medication taking. It seems clear from this literature that respondents do not and cannot recall specific events

Table 2. Studies comparing self-report rates of ARV adherence with objectively measured rates

Study (year), sample size	Self-report item and recall period	Response options	Self-reported adherence rates	Objective adherence measure and time period	Objectively measured adherence rates	Measure of association
Fletcher et al. [21] (2005), *n* = 266	"How many pills did you skip taking yesterday?", "…2 days ago?", "...3 days ago?", "...4 days ago?"; **recall period: n/r***	Continuous numeric responses†	Mean (SD): 82 (32); median (IQR): 100 (75–100)	Continuous EDM rate; **time period: 16 weeks**	Mean (SD): 72 (29); median (IQR): 82 (50–98)	Pearson's *r* = -0.24; Spearman's rho = 0.20
Halkitis et al. [22] (2005), *n* = 300	"How many full doses have you missed taking?"; **recall period: 2 weeks**	Continuous numeric responses†	Mean (SD): 95 (9)	Continuous EDM rate; **time period: 2 weeks**	Mean (SD): 90 (18)	*r* = 0.32
Holzemer et al. [24] (2006)‡, *n* = 240	Morisky: 4 yes/no questions summed to obtain score ranging from 0–4§; **recall period: n/a**	Dichotomous score of 4 = adherent	26% adherent	Dichotomous PC cutpoint 95%; **time period: 1 month**	29% adherent‡	Phi correlation = 0.24
				Dichotomous PR¶ < cutpoint 95%; **time period: 6 months**	40% adherent‡	Phi correlation = 0.16
Kerr et al. [29] (2008), *n* = 88	"How often did you take your medications as prescribed?"; **recall period: 6 months**	5 levels from "always" to "never"; dichotomous "always" or "usually" = adherent	92% adherent	Continuous PR rates; dichotomous cut point 75%; **time period: 6 months**	48% adherent	Continuous: *r* = -0.06; dichotomous: odds ratio = 1.66 (95% CI = 0.35–7.90)
Liu et al. [26] (2006), *n* = 305	"How many times did you miss a dose?"; **recall period: combined 3 and 7 days**	Dichotomous cutpoints 90% and 95%	Mean: 96	Composite adherence score**; dichotomous cutpoints 90% and 95%; **time period: 4 weeks**	Mean: 81	90% cutpoint: sensitivity = 24%, specificity = 94%; 95% cutpoint: sensitivity = 31%, specificity = 93%

*2 or 4 days (personal communication with author).
†Standard formula for converting numeric responses to adherence rate: [(number of pills prescribed - number of pills missed) / number of pills prescribed] × 100.
‡Baseline values reported.
§Morisky scale questions: 1) Do you ever forget to take your medications?; 2) Are you careless at times about taking your medications?; 3) When you feel better, do you sometimes stop taking your medicine?; 4) Sometimes, if you feel worse when you take your medicine, do you stop taking it?
¶Prior to baseline.
**Composite adherence score uses a hierarchic algorithm to combine adherence data from electronic drug monitoring and pill count.
††Significantly greater than EDM rate.
‡‡Not significantly different from EDM rate.
§§Data from 3-month time point.
¶¶EDM time period of 50 days is 3 months minus first 40 days of the monitoring period.
ARV—antiretroviral; EDM—electronic drug monitoring; IQR—interquartile range; n/a—not applicable; n/r—not reported; PC—pill count; PR—pharmacist refill; SD—standard deviation.

Table 2. Studies comparing self-report rates of ARV adherence with objectively measured rates *(Continued)*

Study (year), sample size	Self-report item and recall period	Response options	Self-reported adherence rates	Objective adherence measure and time period	Objectively measured adherence rates	Measure of association
Lu et al. [4•] (2007), *n* = 156	"How many pills did you skip taking yesterday?", "…2 days ago?", "…3 days ago?"; **recall period: 3 days**	Continuous numeric responses†	Mean (SD): 89.7 (25.3); median: 100	Continuous EDM; **time period: 3 days**	3-day EDM mean (SD): 72.4 (32.4); median: 83.3	$r = 0.50$††
	"How many doses did you miss?"; **recall period: 7 days**	Continuous numeric responses	Mean (SD): 84.9 (26.4); median: 100	Continuous EDM; **time period: 7 days**	7-day EDM mean (SD): 70.6 (32.5); median: 85.7	$r = 0.49$††
	Frequency: "Did you take all your medications?"; **recall period: 30 days**	6 levels: "none of the time" to "all of the time"	Mean (SD): 81.5 (24); median: 80	Continuous EDM; **time period: 30 days**	Same as above	$r = 0.51$††
	Percent: "What percent of the time were you able to take all your medications exactly as your doctor prescribed them?"; **recall period: 30 days**	11 levels from 0%–100%	Mean (SD): 82.2 (21.5); median: 90	Continuous EDM; **time period: 30 days**	30-day EDM mean (SD): 69.8 (30.9); median: 83.3	$r = 0.45$††
	Rating: "Rate your ability to take all your medications as prescribed"; **recall period: 30 days**	6 levels: "very poor" to "excellent"	Mean (SD): 72.7 (25.9); median: 80	Continuous EDM; **time period: 30 days**	Same as above	$r = 0.48$‡‡
	Average of frequency, percent, and rating items; **recall period: 30 days**	n/a	Mean (SD): 78.8 (21); median: 83.3	Continuous EDM; **time period: 30 days**	Same as above	$r = 0.55$††
Munoz-Moreno et al. [25] (2007), *n* = 464	"How many doses did you miss?"; **recall period: 7 days and 1 month**	Continuous numeric responses†; dichotomous cutpoint 95%	7-days mean (SD): 98 (8); 1 month mean (SD): 9 (12)	Continuous EDM < 95% vs ≥ 95%; **time period: 1 month**	7 days mean (SD): 89.7 (21.8); 1 month mean (SD): 91.8 (16.7)	75% agreement by Bland and Altman method

*2 or 4 days (personal communication with author).
†Standard formula for converting numeric responses to adherence rate: [(number of pills prescribed - number of pills missed) / number of pills prescribed] × 100.
‡Baseline values reported.
§Morisky scale questions: 1) Do you ever forget to take your medications?; 2) Are you careless at times about taking your medications?; 3) When you feel better, do you sometimes stop taking your medicine?; 4) Sometimes, if you feel worse when you take your medicine, do you stop taking it?
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¶¶EDM time period of 50 days is 3 months minus first 40 days of the monitoring period.
ARV—antiretroviral; EDM—electronic drug monitoring; IQR—interquartile range; n/a—not applicable; n/r—not reported; PC—pill count; PR—pharmacist refill; SD—standard deviation.

Table 2. Studies comparing self-report rates of ARV adherence with objectively measured rates *(Continued)*

Study (year), sample size	Self-report item and recall period	Response options	Self-reported adherence rates	Objective adherence measure and time period	Objectively measured adherence rates	Measure of association
Muyingo et al. [23] (2008), *n* = 2957	"Did you miss any dose?"; **recall period: 4 days**	No = adherent	48% adherent	PC < 100% vs 100%; **time period: 1 month**	n/r	kappa < 0.15
		No = adherent	28% adherent			kappa = 0.44; sensitivity = 40%; specificity = 97%
Pearson et al. [27•] (2007)[§§], *n* = 136	"How many times did you take your medication yesterday?", "…2 days ago?", "…3 days ago?"; **recall period: 3 days**	Continuous numeric responses[†]	Mean (SD): 80 (34)	Continuous EDM; **time period: 3 days**	Mean (SD): 54 (40)	*r* = 0.41
	"How often did you miss a dose of your medication?"; **recall period: 28 days**	6 levels from "every day" to "not once" (ordinal scale)	n/a	Continuous EDM; **time period: 28 days**	Mean (SD): 54 (40)	*r* = 0.30
Deschamps et al. [28] (2008), *n* = 133	Overall doses taken; **recall period: 1 month**	11 levels from 0%–100%; dichotomous cutpoint 100%	98	EDM; **time period: 50 days**[¶¶]	91% adherent	Sensitivity = 57%; specificity = 66%
	"How often did you miss a dose of your HIV medication?"; **recall period: 1 month**	6 levels: "never" to "every day"; "never" = adherent	79% adherent	EDM; **time period: 50 days**	Same as above	Sensitivity = 38%; specificity = 80%
	"During the past 30 days, how many times did you not take any of these pills?"; **recall period: 1 month**	Continuous numeric responses[†]; dichotomous cutpoint 100%	99	EDM; **time period: 50 days**	Same as above	Sensitivity = 33%; specificity = 92%

*2 or 4 days (personal communication with author).
[†]Standard formula for converting numeric responses to adherence rate: [(number of pills prescribed - number of pills missed) / number of pills prescribed] × 100.
[‡]Baseline values reported.
[§]Morisky scale questions: 1) Do you ever forget to take your medications?; 2) Are you careless at times about taking your medications?; 3) When you feel better, do you sometimes stop taking your medicine?; 4) Sometimes, if you feel worse when you take your medicine, do you stop taking it?
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of this type—they construct an estimate. This implies that it is futile, in general, to ask patients to enumerate adherence-related events such as doses taken or missed. We hope this will motivate adherence researchers to think critically about adherence questions and collaborate with psychologists who are experts in rigorous methods used to study memory and recall.

In the second part of the article, we reviewed recent literature that compares self-reports of ARV adherence with objective measures. We did this in part to update the comprehensive earlier review of the subject by Simoni et al. [19•], but also to highlight problems that we have yet to solve.

Key questions

We believe that the following specific questions are basic to adherence research and should be priorities:

1. *What is the optimal time frame for self-report questions?* Although some studies will have hypotheses that necessitate a focus on specific time frames, most researchers, and arguably most clinicians, are interested in "current" or "recent" adherence. On one hand, we may sacrifice accuracy with longer recall periods. However, because few have asked about adherence behavior for more than the prior month (a relatively short period), this argument may be speculative. On the other hand, focus on a longer time frame such as a month may be more representative of current or recent adherence than a shorter interval, such as 3 to 4 days. Lu et al. [4•] compared 3-day, 7-day, and 1-month self-reports with electronic monitoring, and found that the 1-month self-reports were more accurate than the 3- or 7-day reports. Based on current data, we would recommend a 1-month recall period.
2. *What behavior should we ask respondents to report?* For example, should we ask about doses missed or doses taken? Asking respondents to report missed doses might work in a patient who is intentionally nonadherent, such as someone who decides to take a drug "holiday." It also might work if a patient uses a pillbox and notes doses not taken. However, for those who are unintentionally nonadherent, such as someone who tends to forget evening or weekend doses, asking them to remember something that they forgot to do may not be cognitively reasonable [30]. In this setting, asking about missed doses may increase the risk that they will report an intention instead of an action [16]. This issue can be empirically studied using the methods employed by psychologists interested in memory and recall.
3. *What response task leads to the most accurate answers?* If patients are making educated guesses when they respond to survey items about medication adherence, do some response tasks produce more accurate estimates than others? Lu et al. [4•] evaluated three response tasks by comparing each with electronic drug monitoring for the same 1-month period. The three response tasks were 1) how often patients were able to take their medications as prescribed (with six responses from "all of the time" to "none of the time"); 2) the percent of the time that respondents were able to take medications as prescribed (with 11 responses from 0% to 100% in 10% intervals); and 3) how patients rated their ability to take medications as prescribed (with six responses from "very poor" to "excellent"). The mean of the rating item was not significantly different than mean from electronic monitoring, whereas the means of both the frequency and the percent items were significantly higher (indicating overreporting) than the mean from electronic monitoring. This suggests that some response tasks are better than others, but more research is needed that directly compares self-report questions with one another. There has been some evidence supporting a visual analogue type approach that asks respondents to estimate a percent adherence, often by placing an "x" on a continuum from 0% to 100%, but we believe that, to date, there are insufficient data to recommend this approach.
4. *What other techniques might improve the accuracy of recall?* Approaches to the problem of intentional deception include attempting to normalize nonadherence, use of self-administered surveys, and creating conditions that reassure respondents that their responses will be confidential [8,16,18,31]. The problem of misremembering is more difficult. Some research suggests that asking respondents to think longer before responding may produce more accurate responses, and this approach deserves further testing [12]. It is possible that cueing of various kinds might effectively "jog" respondents' memories [8,16], but we are not aware of previous work that tests cueing as an aid to adherence reports. For example, similar to the timeline followback method to measure alcohol use [32], one might ask patients to think about recent work activities, weekend activities, or other memorable events over the preceding month as a way to improve the accuracy of adherence estimates.

Methodologic suggestions

We propose the following methodologic recommendations:

1. We encourage researchers interested in self-report to assess validity using an "objective" measure of adherence rather than an indirect measure, such as viral load. Unfortunately, there is no perfect objective measure, but electronic drug monitoring, unannounced pill counts, pharmacy records, and serum drug levels are all superior to viral loads to assess the validity of self-report.

2. The methods used by psychologists interested in memory and recall can be readily applied to the research questions related to self-report of adherence, and collaborations with these skills may be fruitful. Each of the key questions noted above would benefit from methods that ask respondents to explain their cognitive processes [9]. For example, if patients are estimating adherence rates in response to our questions, how are they making the estimations? Are they "decomposing" the task somehow [8] (see especially chapter 3 in this reference), such as thinking about one week at a time? Relating it to memorable events? Relating it to what they know about recent viral load measurements? Understanding these recall processes will help us construct more effective adherence questions.
3. When comparisons are made between self-report measures, or between self-report and other adherence measures, it is probably best to use the same time frame. Differences between measures that assess different time periods may occur because actual adherence differs, not because one of the measures is less accurate.
4. We encourage investigators to present more descriptive data when comparing adherence measures. Means, medians, and ranges are generally all necessary to understand adherence data, which is often skewed, and can vary tremendously from population to population. Correlations can at times be misleading [33]. Even if a self-report achieves a correlation of 0.5 with an objective measure, which only a few do, the self-report is capturing only 25% of the variation in the objective measure. Further, correlations may not capture the upward bias consistently seen with self-reports. In many cases, important information is conveyed by a plot that is obscured by a correlation coefficient [34]. But even plots can hide important information, as Bland and Altman [33] point out. If journal editors cannot include more detailed descriptive information in published articles, links to investigators' websites may be a way to communicate this information.
5. Finally, we strongly encourage investigators to include details about all survey items, either as appendices or in links to investigator websites.

Summary

It is critical to continue to study ways to improve self-reports of ARV adherence. With forethought, much of the data needed to do so can be collected as part of studies that do not necessarily have a primary focus on measurement. In addition, we recommend that adherence researchers collaborate with psychologists with expertise in the cognitive psychology of memory and recall on projects whose primary aim is improving the validity of self-reports of ARV medication adherence.

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Disclosure

No potential conflicts of interest relevant to this article were reported.

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