Assessing Self-Reported Adherence to HIV Therapy by Questionnaire: The SERAD (Self-Reported Adherence) Study

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ABSTRACT

The relationship between adherence to highly active antiretroviral therapy (HAART) and RNA-HIV viral load outcomes has been extensively shown. Although there are different procedures for assessing treatment adherence, there is no ideal method. We present the SERAD (Self-Reported Adherence) questionnaire, a qualitative and quantitative self-reported instrument designed to provide an easier adherence measurement. We also compared the questionnaire to three other methods to evaluate adherence to HAART regimens in HIV-infected patients. Two prospective, observational, longitudinal studies were developed: a single-center pilot study followed by a multicenter study. A total of 530 HIV-infected outpatients was prospectively included, 66 in the pilot study and 464 in the multicenter study. Four methods were used to study adherence to HAART regimens: the SERAD questionnaire, pill count, electronic monitoring, and plasma drug monitoring. Pearson’s correlations and Bland and Altman’s method were developed. The SERAD questionnaire showed good feasibility and significant validity. Adequate levels of agreement between methods were observed, particularly when adherence was high. Differences increased as adherence fell. Moreover, the questionnaire was completed correctly, the interviewers did not report uncovered aspects, and the information was collected easily. Our results suggest that the SERAD questionnaire is a feasible and useful instrument for assessing adherence to HAART regimens in HIV-infected patients, and makes it possible to obtain reliable qualitative and quantitative information related to treatment adherence.

INTRODUCTION

Adherence to Highly Active Antiretroviral Therapy (HAART) has been extensively related to RNA-HIV viral load outcomes and this has confirmed the strong relationship between both issues.1–5 For this reason, an optimal knowledge of adherence to antiretroviral treatment appears to be relevant for clinical decisions such as HAART simplification or intensification, or interrupting or delaying treatment.6 Moreover, reliable adherence-related information may help clinicians to ascertain the difficulties encountered in taking the medication adequately.7

Despite of the need for a rigorous assessment of HAART adherence, a “gold standard” has not yet been found.8 Hitherto, the most commonly used methods to evaluate HAART adherence have been pill count, plasma drug monitoring, electronic monitoring, and patient self-reporting. However, although some studies have used these different assessment methods, not much information is available with respect to comparisons among them.7

The most usual, feasible, and less expensive way to assess HAART adherence has been patient self-reporting. Nevertheless, this method has been criticized for methodological reasons.9 Its validity may be limited by the type of questions used,
In this study we developed a standardized self-reported questionnaire, the SERAD (Self-Reported Adherence) questionnaire, which was designed to provide significant qualitative and quantitative information related to HAART adherence. Its feasibility, validity, and usefulness were studied in a pilot and multicenter study and, in addition, the application of the SERAD was compared to three other relevant adherence methods: pill count, electronic monitoring, and plasma drug monitoring.

MATERIALS AND METHODS

Patients

A total of 11 Spanish hospitals participated in the investigation (see Acknowledgments). HIV-infected outpatients aged ≥18 years old and taking a HAART combination were invited to participate in the study. HAART combination was defined as an antiretroviral treatment including two nucleoside or nucleotide reverse transcriptase inhibitors + one nonnucleoside reverse transcriptase inhibitor, or two nucleoside or nucleotide reverse transcriptase inhibitors + one or more protease inhibitor ≥ one fusion inhibitor, or one nonnucleoside reverse transcriptase inhibitor + one protease inhibitor. Patients were informed of the purpose and procedures of the investigation, and those who agreed to participate were recruited. All participants provided written informed consent.

Study design

Two prospective, observational, comparative studies were designed, consisting of a pilot study followed by a multicenter study. The local ethics committee approved both study protocols.

Pilot study. A preliminary study was conducted to test the feasibility of the subsequent multicenter protocol. Only patients from the HIV Unit of the Germans Trias i Pujol University Hospital (Barcelona, Spain) took part in this first single-center study. Research subjects were followed up for 2 months and assessed at visits at week 0 (baseline evaluation), week 4 (month 1), and week 8 (month 2). Sociodemographic, clinical, and psychological variables were collected. Four methods were used to study individual adherence: the SERAD questionnaire, pill count, electronic monitoring, and plasma drug monitoring.

Multicenter study. Following the completion of the pilot study and the analysis of the results, a second protocol was developed. This consisted of a multicenter study that maintained the first study design. The only difference was the inclusion of a new follow-up visit at week 12 (month 3), which was established to offer the possibility of covering a longer period of time to assess adherence. The 11 aforementioned HIV units participated.

Medical and psychological assessment

The baseline evaluation included the following demographic and clinical variables: age, gender, HIV infection route, current consumption of toxic substances, time since HIV diagnosis, current CD4⁺ cell count and percentage, viral load, current HAART and usual schedule, weeks on current treatment, and antiretroviral therapy adherence assessment.

The possibility of covering three time contexts was a major advantage envisaged from the outset of the design. These times...
were chosen to provide structured and sufficiently representa-
tive information in terms of time. The measurement of 1 day
prior to the application of the questionnaire was ruled out as it
was deemed to be rather unrepresentative. On the other hand,
some studies use measurements pertaining to 3 or 4 days be-
fore the questionnaire, although we considered that it was
easier for the patient to remember 7 days, which is one week,
rather than 4. Moreover, because some studies had shown good
results with these three time settings, the decision was finally
taken to use these three measurements.

The reasons for nonadherence were also recorded whenever
noncompliant behavior was mentioned because of the evident
clinical importance. They were coded in 13 items chosen from
the most frequently reported ones in clinical practice. This
was one of the main questions addressed because of the evi-
dent clinical importance of knowing why patients fail to follow
treatment properly.

The third part of the design included the totals of the calcula-
tions and the final results. The percentages of adherence were
calculated on the basis of the following formula: (total number
do of dosage units prescribed—total number of times re-
ported)/(total number of dosage units prescribed) × 100. And
the percentages with regard to the reasons for nonadherence
were calculated as follows: (total number of reasons reported—
total number of one concrete reason reported)/(total number of
reasons reported) × 100. In the end, the SERAD made it pos-
able to calculate the following outputs:

1. Percentage of adherence with regard to the doses missed dur-
ing the last week.
2. Percentage of reasons for nonadherence during the last week.
3. Percentage of adherence with regard to the times that intake
conditions were not observed during the last week.
4. Percentage of reasons for intake conditions not observed dur-
ing the last week.
5. Percentage of adherence with regard to the doses missed dur-
ing the last month.
6. Percentage of reasons for nonadherence during the last month.
7. Percentage of adherence with regard to the times that intake
conditions were not observed during the last month.
8. Percentage of reasons for intake conditions not observed dur-
ing the last month.
9. Percentage of adherence with regard to the doses missed dur-
ing the last 3 months.

From the outset, our aim was to generate a single-sheet ques-
tionnaire in a comfortable format. Finally, the questionnaire
comprised a single sheet, and a computerized data base was cre-
ated where the results were calculated automatically.

To test its feasibility, the time to complete the questionnaire
was recorded and possible mistakes were also considered. The
latter were defined as any information recorded on the ques-
tionnaire that would render the correction process impossible.
The correction process consisted of the calculation of the ad-
herence percentages as well as the calculation of the rest of the
quantitative information provided by the SERAD. At the end
of the pilot and multicenter study the investigators were ques-
tioned concerning the difficulty of completing the question-
naire and possible relevant suggestions to improve data col-
lection. The SERAD was applied at week 4, 8 (pilot and mul-
ticenter study), and 12 (multicenter study) of the patient follow-up.

Pill count. After baseline visit, patients collected their
HAART regimen from the pharmacy hospital service, where
the number of dosage units dispensed was recorded. Patients
were instructed to return only the surplus medication collected
for the month at the next visit. This medication was recorded
again. It was assumed that patients consumed the medication
that was not returned. However, subjects reporting the use of
prior medication, or medication not returned by mistake or for-
getfulness, were not included in the evaluation. On the basis
of number of dosage units returned, an adherence percentage
was calculated with regard to the doses missed during the last month.
The following formula was applied: (total number of dosage
units collected—total number of dosage units collected)/(total
number of dosage units collected) × 100. This adherence as-
seessment method was applied at the same visits as the SERAD.

Electronic monitoring. Electronic drug exposure monitors
(eDEM, AARDEX Ltd., Zug, Switzerland; www.aardex.ch)
were used. Due to logistics and cost, only 10% of patients in
the multicenter study participated. The recruitment of patients
was conducted according to a computer-generated random-
number table. The subjects selected were offered the possi-
bility of training in the use of electronic monitoring. If they de-
clined, another patient was assigned and proposed with regard
to the randomization table. Patients who accepted were pro-
vided with an electronic drug exposure monitor cap bottle for
one of their antiretroviral drugs. Each drug assigned in the bot-
tles was selected with regard to a previously randomized list of
antiretroviral drugs, established according to the criterion of the
pharmacists of the hospital pharmacy service. The drugs were
selected particularly on the basis of dosage units that were eas-
est to store in this type of container. The software incorporated
in the cap bottles (provided by AARDEX Ltd.) reported the
number of days monitored, the number of doses taken, adher-
ence percentage, percentage of days on which the doses pre-
scribed were taken correctly, and the percentage of prescribed
doses taken on schedule (intake conditions observed percent-
age). The time range considered was 2 h before and after the
ingested dose. Patients were specifically instructed to open the
electronic monitor cap bottle only when they took the medica-
tion, and if for any reason they opened the bottle off-schedule
they were to record this and provide the information at the fol-
lowing visit. Patients were provided with a refilled bottle at
baseline, week 4, and week 8.

Plasma drug monitoring. NNRTI and PI concentrations in
plasma were assessed in the first 200 patients who were con-
secutively included in the study. Logistics and cost determined
this proportion of patients. In an attempt to avoid modifying
the usual adherence to antiretroviral therapy, subjects were not
informed that drug concentrations were going to be measured
before blood sampling. Blood samples were collected in potas-
sium and ethylenediaminetetraacetic acid (EDTA)-containing
10-mI tubes. Plasma was isolated by centrifugation (4000 rpm
for 15 min) and stored at −80°C until analysis. Drug concen-
trations were determined by high-performance liquid chro-
matography (HPLC) according to a validated method. Patients harboring drug concentrations lower than 0.01 mg/liter were considered to be nonadherent to antiretroviral therapy.

Data analysis

Analyses to establish the psychometric properties of the SERAD questionnaire were developed. Feasibility considered qualitative and quantitative aspects: time to complete the questionnaire, recorded mistakes, understanding of the interviewer’s instructions, simplicity of the data collected, aspects that could be simplified, and aspects not addressed in the questionnaire.

Validity was regarded as the agreement between the four adherence assessment methods throughout the follow-up. Pearson’s correlations were developed to study this point. However, since the Pearson correlation is known to underestimate the level of agreement, a graph analysis was used. This consisted of Bland and Altman’s method, which compared agreement between measures depending on different levels of adherence showed. This method made it possible to obtain agreement between two measures by means of a graph considering the mean of the measures and the difference between them. In the graph, points near 0 indicated a high agreement between measures, while points far from 0 indicated disagreement. Since none of the methods could be considered as a “gold standard,” all four methods were compared: SERAD questionnaire, pill count, electronic monitoring, and plasma drug monitoring. Although one of the greatest advantages of SERAD was the possibility of using different adherence measures, only four of them were used in this study. Doses missed during the last week (1) and the last month (5) and intake conditions not respected during the last week (3) and last month (7) were regarded as the most significant adherences measures. Therefore, only these were used for the data analysis. This was because SERAD made it possible to find new adherence measures, although this was not a primary endpoint of the study. And because SERAD was compared with the other three adherence methods to test its feasibility, validity, and usefulness, they did not provide the new outcomes obtained by SERAD.

FIG. 1. Comparisons of adherence measures in pilot study by Bland and Altman’s method. (A) Agreement between electronic monitoring and SERAD in last month adherence measure (n = 38). (B) Agreement between electronic monitoring and SERAD in last month intake conditions measure (n = 38). (C) Agreement between pill count and SERAD in last month adherence measure (n = 41). (D) Agreement between pill count and electronic monitoring in last month adherence measure (n = 37).
A complementary analysis was performed to convert quantitative adherence methods into qualitative binomial measures. The 95% adherence was taken as the cutoff point considering the clinical criteria established by Paterson et al. Thus, non-compliant subjects were those with levels of adherence <95%, whereas those with levels of adherence ≥95% were regarded as compliant. The qualitative transformation of these adherence measures was used to assess agreement with plasma drug levels.

Since it was thought that differences among adherence methods might appear, although not only associated with adherence outcomes, a logistic regression analysis was performed to control the possible existence of concrete profiles on patients’ responses. Moreover, to study this, patients with a >5% difference between methods were analyzed by logistic regression. The following variables were included in the analysis: participant center, age, gender, HIV infection route, current consumption of toxic substances, years since HIV diagnosis, current CD4 cell count and percentage, current HAART and usual schedule, perceived social support, perceived capacity to follow treatment (self-efficacy), depression, and the three response style indices of the 16PF-5 Inventory (IM, IN, and AQ scales).

RESULTS

Pilot study

A total of 66 patients were included in the pilot study. Forty-five (68%) of them were men. The mean (± standard deviation) age was 37 (± 9) years with 7 (± 3) years of HIV infection. The use of intravenous drugs was the infection route in 27 (41%) patients, 16 (24%) heterosexual contact, 12 (18%) men who had sex with men and 2 (3%) blood product transfusion. Nine (14%) patients provided no information about their infection route.

None of the questionnaires presented limitations for correction. They were completed adequately and the correction process of the SERAD was developed as expected. The interviewers did not report aspects not covered in the questionnaire and no investigators stated that they had encountered any difficulties collecting the information. The mean time taken to complete the information was 3.8 (±1.8) min at month 1 and 3.3 (±1.7) at month 2.

Bland and Altman’s method showed that high agreement levels were found, particularly when adherence percentages were high. This fact was observed with regard to the comparison between the SERAD and electronic monitoring, the SERAD and pill count, and electronic monitoring and pill count. Bland and Altman’s method for month 1 is shown in Fig. 1. The best levels of agreement were found between the SERAD and electronic monitoring (75%) and between the SERAD and pill count (71%). Differences between methods increased when adherence fell.

After considering the data obtained, the design of the questionnaire was maintained for its validation in the multicenter study.

Multicenter study

A total of 489 patients were informed about the purposes and procedure of the study, and 464 (95%) agreed to participate and gave their written consent. Sixty-seven percent of the patients were men, with a mean age of 38 (± 10) years. The infection route was intravenous drug use in 33% of patients, 32% heterosexual intercourse, 23% men having sex with men, and 5% blood product transfusion. No information was given by the remaining 7%. The mean years of infection were 8 (± 5). The rest of demographic, clinical, and psychological information is displayed at Table 1.

In the course of the study, 986 SERAD questionnaire forms were obtained (393, 343, and 250 at months 1, 2, and 3, respectively). The total mean time to complete the SERAD was 3.7 (±3.2) min, and mistakes were detected in 2.4% of the total.

### Table 1. Baseline Demographic and Clinical Characteristics of Study Participants

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (male)</td>
<td>305 (67%)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>38 (± 10)</td>
</tr>
<tr>
<td>Infection route</td>
<td></td>
</tr>
<tr>
<td>Injected drug user</td>
<td>33%</td>
</tr>
<tr>
<td>Heterosexual</td>
<td>32%</td>
</tr>
<tr>
<td>Homosexual</td>
<td>23%</td>
</tr>
<tr>
<td>Blood transfusion</td>
<td>5%</td>
</tr>
<tr>
<td>Unknown</td>
<td>7%</td>
</tr>
<tr>
<td>Time since HIV diagnosis (years)</td>
<td>8 (± 5)</td>
</tr>
<tr>
<td>Number of patients reporting toxic substances</td>
<td>220 (47%)</td>
</tr>
<tr>
<td>consumption</td>
<td></td>
</tr>
<tr>
<td>CD4 cell count (cells/ml)</td>
<td>497 (± 353)</td>
</tr>
<tr>
<td>% CD4 cell count (cells/ml)</td>
<td>27 (± 49)</td>
</tr>
<tr>
<td>Viral load (log10)</td>
<td>4.3 (± 5)</td>
</tr>
<tr>
<td>Time on treatment (weeks)</td>
<td>59 (± 62)</td>
</tr>
<tr>
<td>Perceived social support (VAS)</td>
<td>81 (± 31)</td>
</tr>
<tr>
<td>Perceived self-efficacy (VAS)</td>
<td>94 (± 13)</td>
</tr>
<tr>
<td>Depression (BDI)</td>
<td>11 (± 9)</td>
</tr>
</tbody>
</table>

*Data expressed as mean values (± standard deviation), except when specified. VAS, visual analogue scale; BDI, Beck depression inventory.
tal forms completed. All evaluators considered the questionnaire easy to complete and no significant suggestions to improve it were received.

As far as pill count and electronic monitoring are concerned, 633 (253, 229, 151) and 100 (38, 32, 30) forms were recorded, respectively. Table 2 shows results from the SERAD and the pill count at each visit, and Table 3 shows the same measures regarding electronic monitoring.

To study the comparison between both of the main time settings considered in the study, adherence over the last week and the last month, a subanalysis was developed with regard to the comparison between all the study participants assessed by the SERAD or pill count or electronic monitoring, and the subgroup of those participants that was electronically monitored. When last-week and last-month adherence percentages were compared, the greatest differences in agreement observed be-

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**Table 2. Percentages of Adherence and Intake Conditions Observed, According to the SERAD and Pill Count**

<table>
<thead>
<tr>
<th>Month</th>
<th>Method</th>
<th>Period</th>
<th>Measure</th>
<th>N</th>
<th>Mean (± SD)</th>
<th>Min–Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SERAD</td>
<td>Week</td>
<td>Adherence</td>
<td>373</td>
<td>97.7 (± 7.6)</td>
<td>0–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>372</td>
<td>97.7 (± 9.4)</td>
<td>0–100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Month</td>
<td>Adherence</td>
<td>373</td>
<td>94.4 (± 12.4)</td>
<td>0–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>372</td>
<td>98.3 (± 6.0)</td>
<td>13–100</td>
</tr>
<tr>
<td></td>
<td>Pill count</td>
<td>Month</td>
<td>Adherence</td>
<td>236</td>
<td>91.3 (± 17.5)</td>
<td>0–100</td>
</tr>
<tr>
<td>2</td>
<td>SERAD</td>
<td>Week</td>
<td>Adherence</td>
<td>323</td>
<td>98.2 (± 5.9)</td>
<td>28.6–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>323</td>
<td>98.3 (± 8.0)</td>
<td>0–100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Month</td>
<td>Adherence</td>
<td>323</td>
<td>94.4 (± 11.3)</td>
<td>14.3–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>323</td>
<td>98.5 (± 6.8)</td>
<td>20.4–100</td>
</tr>
<tr>
<td></td>
<td>Pill count</td>
<td>Month</td>
<td>Adherence</td>
<td>210</td>
<td>88.5 (± 19.5)</td>
<td>0.0–100</td>
</tr>
<tr>
<td>3</td>
<td>SERAD</td>
<td>Week</td>
<td>Adherence</td>
<td>232</td>
<td>98.6 (± 3.9)</td>
<td>73.4–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>232</td>
<td>98.5 (± 6.5)</td>
<td>28.6–100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Month</td>
<td>Adherence</td>
<td>232</td>
<td>96.6 (± 7.1)</td>
<td>60.7–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>232</td>
<td>99.1 (± 2.8)</td>
<td>73.4–100</td>
</tr>
<tr>
<td></td>
<td>Pill count</td>
<td>Month</td>
<td>Adherence</td>
<td>138</td>
<td>84.7 (± 22.7)</td>
<td>0.0–100</td>
</tr>
</tbody>
</table>

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**Table 3. Percentages of Adherence and Intake Conditions Observed, According to the SERAD, Electronic Monitoring, and Pill Count for Patients Monitored Electronically**

<table>
<thead>
<tr>
<th>Month</th>
<th>Method</th>
<th>Period</th>
<th>Measure</th>
<th>N</th>
<th>Mean (± SD)</th>
<th>Min–Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SERAD</td>
<td>Week</td>
<td>Adherence</td>
<td>33</td>
<td>93.7 (± 17.8)</td>
<td>0–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>32</td>
<td>94.3 (± 16.4)</td>
<td>16.6–100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Month</td>
<td>Adherence</td>
<td>33</td>
<td>89.6 (± 20.8)</td>
<td>0–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>32</td>
<td>94.1 (± 16.3)</td>
<td>20–100</td>
</tr>
<tr>
<td></td>
<td>EM</td>
<td>Week</td>
<td>Adherence</td>
<td>38</td>
<td>89.7 (± 21.8)</td>
<td>0–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>37</td>
<td>85.7 (± 16.9)</td>
<td>35.7–100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Month</td>
<td>Adherence</td>
<td>38</td>
<td>91.8 (± 16.7)</td>
<td>4.5–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>38</td>
<td>85.9 (± 15.3)</td>
<td>49.1–100</td>
</tr>
<tr>
<td></td>
<td>Pill count</td>
<td>Month</td>
<td>Adherence</td>
<td>34</td>
<td>93.9 (± 16.5)</td>
<td>3.1–100</td>
</tr>
<tr>
<td>2</td>
<td>SERAD</td>
<td>Week</td>
<td>Adherence</td>
<td>32</td>
<td>98.6 (± 3)</td>
<td>90.5–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>32</td>
<td>96.9 (± 9.1)</td>
<td>50–100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Month</td>
<td>Adherence</td>
<td>32</td>
<td>94.9 (± 8.9)</td>
<td>57.1–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>32</td>
<td>99.0 (± 2.3)</td>
<td>88.3–100</td>
</tr>
<tr>
<td></td>
<td>EM</td>
<td>Week</td>
<td>Adherence</td>
<td>32</td>
<td>94.0 (± 11.7)</td>
<td>57.1–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>32</td>
<td>85.7 (± 16.9)</td>
<td>42.9–100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Month</td>
<td>Adherence</td>
<td>32</td>
<td>93.0 (± 11.6)</td>
<td>62.2–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>32</td>
<td>85.1 (± 15.6)</td>
<td>40–100</td>
</tr>
<tr>
<td></td>
<td>Pill count</td>
<td>Month</td>
<td>Adherence</td>
<td>26</td>
<td>87.7 (± 21.9)</td>
<td>0–100</td>
</tr>
<tr>
<td>3</td>
<td>SERAD</td>
<td>Week</td>
<td>Adherence</td>
<td>27</td>
<td>97.3 (± 4.5)</td>
<td>85.7–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>27</td>
<td>96.2 (± 10.3)</td>
<td>53.9–100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Month</td>
<td>Adherence</td>
<td>27</td>
<td>93.1 (± 11.8)</td>
<td>57.1–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>27</td>
<td>98.3 (± 3.8)</td>
<td>85.2–100</td>
</tr>
<tr>
<td></td>
<td>EM</td>
<td>Week</td>
<td>Adherence</td>
<td>30</td>
<td>93.5 (± 15.1)</td>
<td>21.4–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>30</td>
<td>78.7 (± 24.9)</td>
<td>0–100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Month</td>
<td>Adherence</td>
<td>30</td>
<td>94.9 (± 10.5)</td>
<td>46.2–100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>30</td>
<td>79.8 (± 17.3)</td>
<td>48.1–100</td>
</tr>
<tr>
<td></td>
<td>Pill count</td>
<td>Month</td>
<td>Adherence</td>
<td>23</td>
<td>90.7 (± 21.1)</td>
<td>0–100</td>
</tr>
</tbody>
</table>

*EM, electronic monitoring."
Considered, an agreement was observed in 141 of 166 patients (data not shown). Differences between this assessment method and the others were very high to determine plasma drug monitoring. Rates of agreement between pill count are shown in Table 4.

Table 4. Differences among different adherence assessments

<table>
<thead>
<tr>
<th>Month</th>
<th>Method</th>
<th>Period</th>
<th>Measure</th>
<th>n</th>
<th>Mean (± SD)</th>
<th>Min–Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EM-SE</td>
<td>Week</td>
<td>Adherence</td>
<td>32</td>
<td>−3.6 (± 11.9)</td>
<td>(−50)–14.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>31</td>
<td>−9.3 (± 22.4)</td>
<td>(−60)–66.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Month Adherence</td>
<td>32</td>
<td>1.8 (± 11.5)</td>
<td>(−20.5)–54.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>31</td>
<td>−9.6 (± 16.5)</td>
<td>(−49.2)–31.7</td>
</tr>
<tr>
<td></td>
<td>PC-SE</td>
<td>Month</td>
<td>Adherence</td>
<td>24</td>
<td>4.3 (± 7.55)</td>
<td>(−7.55)–53</td>
</tr>
<tr>
<td></td>
<td>PC-EM</td>
<td>Month</td>
<td>Adherence</td>
<td>27</td>
<td>0.5 (± 2.5)</td>
<td>(−3.5)–8.2</td>
</tr>
<tr>
<td>2</td>
<td>EM-SE</td>
<td>Week</td>
<td>Adherence</td>
<td>32</td>
<td>−4.6 (± 10.5)</td>
<td>(−35.7)–7.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>32</td>
<td>−11.2 (± 19.4)</td>
<td>(−57.2)–36.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Month Adherence</td>
<td>32</td>
<td>−1.8 (± 10.6)</td>
<td>(−37.8)–12.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>32</td>
<td>−13.8 (± 16)</td>
<td>(−60)–5</td>
</tr>
<tr>
<td></td>
<td>PC-SE</td>
<td>Month</td>
<td>Adherence</td>
<td>25</td>
<td>−6.5 (± 16.3)</td>
<td>(−57.1)–14.3</td>
</tr>
<tr>
<td></td>
<td>PC-EM</td>
<td>Month</td>
<td>Adherence</td>
<td>25</td>
<td>−5.3 (± 16.6)</td>
<td>(−65.7)–29</td>
</tr>
<tr>
<td>3</td>
<td>EM-SE</td>
<td>Week</td>
<td>Adherence</td>
<td>27</td>
<td>−4.1 (± 16.4)</td>
<td>(−78.6)–14.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>27</td>
<td>−16.7 (± 25.8)</td>
<td>(−100)–7.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Month Adherence</td>
<td>27</td>
<td>2.4 (± 8.7)</td>
<td>(−11)–35.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intake cond.</td>
<td>27</td>
<td>−10.0 (± 16.7)</td>
<td>(−48)–1.7</td>
</tr>
<tr>
<td></td>
<td>PC-SE</td>
<td>Month</td>
<td>Adherence</td>
<td>22</td>
<td>−3.7 (± 14.8)</td>
<td>(−57.1)–11.1</td>
</tr>
<tr>
<td></td>
<td>PC-EM</td>
<td>Month</td>
<td>Adherence</td>
<td>23</td>
<td>−6.6 (± 20.2)</td>
<td>(−92.6)–3.9</td>
</tr>
</tbody>
</table>

*EM, electronic monitoring; SE, SERAD; PC, pill count.*

When both measures were 3.7% in all participants and 4.7% in the subgroup. When only electronic monitoring assessment was studied, the greatest difference found was 2%. These differences did not present statistical significance.

Logistic regression analysis determined that none of the variables considered showed a significant influence between patients and methods (data not shown). Bland and Altman’s analysis made it possible to obtain levels of agreement between different adherence assessment methods, and showed that high levels were observed, particularly when adherence was high. Figure 2 shows the agreement between SERAD and pill count.

When only patients electronically monitored were analyzed, differences between the SERAD and electronic cap bottles measures were less than 3% comparing adherence in the last month in all cases. Table 2 shows results from the SERAD, pill count, and electronic monitoring at each visit for electronically monitored patients. The comparison between the SERAD and pill count measures made it possible to observe differences obtained in a range between 0.5% and 6.6%.

When the intake conditions percentage was compared, differences increased in a range of 9–17%. Bland and Altman’s method provided a very similar profile of results for all participants.

Differences between the SERAD, electronic monitoring, and pill count are shown in Table 4.

One hundred and eighty-four samples (40%) were obtained to determine plasma drug monitoring. Rates of agreement between this assessment method and the others were very high (data not shown).

When the last-week adherence percentage of the SERAD was considered, an agreement was observed in 141 of 166 patients (85%). When the last-month adherence percentage was considered it was 119 out of 166 (72%). On the other hand, pill count coincided with plasma drug levels in only 59 of 100 cases (59%).

When only patients on electronic monitoring were considered, the last-week adherence percentage of the SERAD agreed with plasma drug levels in 11 of 14 cases (78.6%), and in 8 of 14 (57.1%) when the last month was evaluated. In this subgroup, pill count agreement was found in 8 of 9 cases (88.9%). Finally, rates of last-week electronic monitoring showed agreement in 11 of 14 cases (73.4%) and in 12 of 15 (80%) for the last month.

**DISCUSSION**

The results of this study reveal that the SERAD questionnaire presents an accuracy comparable to other adherence measurement methods; in addition, it is a feasible, reliable, and useful instrument for assessing HAART adherence in HIV-infected patients.

The feasibility of the SERAD was based particularly on the time taken to apply the questionnaire. This variable was controlled in each form and it was observed that the SERAD is a brief and rapid assessment instrument (particularly due to the 3.7 min obtained as the mean of the total time). This advantage should also be evaluated on the basis of the correct use of the SERAD shown by participants and evaluators. In this regard, the application of the questionnaire was also monitored in order to achieve an adequate questionnaire correction process. There was no questionnaire that could not be corrected, and

**FIG. 2.** (A) Agreement between pill count and SERAD in last month adherence measure. Month 1 (n = 236). (B) Agreement between pill count and SERAD in last month adherence measure. Month 2 (n = 210). (C) Agreement between pill count and SERAD in last month adherence measure. Month 3 (n = 138).
there were no mistakes limiting the obtainment of adherence measures. In addition, interviewers felt confident using the questionnaire and confirmed that it could be applied quickly and easily.

The study of the validity of a questionnaire is not an easy task. Moreover, patient self-reporting has usually been questioned, since the information provided may be biased. Real values may be overestimated and reliable data might be difficult to collect if the responder does not collaborate adequately. This limitation is obviously not easy to solve. Moreover, when questions cover a short time, values may not be representative, and if they cover a longer period of time, forgetfulness may produce an undesirable effect. For this reason the elaboration of SERAD took these issues into account. Questions formulated within the questionnaire were open and covered three time settings, the last week, the last month, and the last 3 months, although only the first two were considered in the study. In this sense, the measure showing the greatest stability was the last-week adherence value.

Since there is no “gold standard” for comparing methods, we seek high levels of agreement when studying the outcomes of the different assessing methods. Consequently, we observed high levels of agreement between methods, specially when high levels of adherence existed; in contrast, this agreement decreased when adherence scores were lower. Probably this is a bias in the results of the study. Nevertheless, we think that this is critical for the design study, but not a limitation of the questionnaire. One reason for finding low validity assessing low levels of adherence may probably be due to the significant number of participants who dropped out of the study within 3 months. Considering this, the association between low agreement and low adherence may be the result of the relationship between being nonadherent and being more likely to drop out of care, and thus out of the study. From this point of view, the most adherent subjects would have been who would have arrived at the end of the study follow-up. Furthermore, other explanations for this low agreement may probably be due to the significant number of participants who dropped out of the study within 3 months. Considering this, the association between low agreement and low adherence may be the result of the relationship between being nonadherent and being more likely to drop out of care, and thus out of the study. From this point of view, the most adherent subjects would have been who would have arrived at the end of the study follow-up. Furthermore, other explanations for this low agreement may be associated with the effect of overestimation in self-reporting methods. In this sense, it is expected that the patient report may differ more considerably when more missed doses are reported, as found in other studies. Therefore this limitation must be clearly taken into consideration. Finally, usefulness was assessed in terms of the advantages presented by the questionnaire. In our opinion, perhaps the main advantage of the SERAD was the possibility of obtaining different quantitative adherence percentages, providing nine measures, separated by three time settings (last week, last month, and last 3 months), and two types of adherence measures (with regard to the total number of doses prescribed and the total times that intake conditions are not observed). Similarly, an additional characteristic of the SERAD was the emphasis on associating inadequate adherence with its reasons. There is no doubt that it is important to know the reasons for presenting suboptimal adherence and, in this sense, the SERAD consequently covers each reason for each kind of inadequate behavior. The possibility of assessing intake conditions observed is another advantage of the questionnaire, and while this percentage does not appear as a resistant measure in our investigation, this aspect may be addressed more extensively in further studies.

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