

Routine Collection of Patient-Reported Outcomes in an HIV Clinic Setting: The First 100 Patients[§]

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Abstract: *Background:* Information from patient-reported outcomes (PROs) can enhance patient-provider communication and facilitate clinical research. However, there are barriers to collecting PROs within a clinic. Recent technological advances may help overcome these barriers. We examined the feasibility of using a web-based application on tablet PCs with touch screens to collect PROs in a busy, multi-provider, outpatient HIV clinical care setting.

Methods: Patients presenting for routine care were asked to complete a touch-screen-based assessment containing 62 to 111 items depending on patient responses. The assessment included instruments measuring body morphology abnormalities, depression, symptom burden, medication adherence, drug/alcohol/tobacco use, and health-related quality of life.

Results: Of 136 patients approached to participate in the study, 106 patients (78%) completed the assessment, 6 (4%) started but did not complete it, and 24 (18%) refused. Of those who completed the assessment, the mean age was 48 years, and 29% reported a history of injection drug use. The median time to complete the assessment was 12 minutes. The prevalence of lipatrophy was 51%, the prevalence of lipohypertrophy was 69%, and the prevalence of moderate or severe depression was 51%. We found that 25% of those receiving highly active antiretroviral therapy noted missing a dose of their antiretroviral medications in the prior 4 days.

Conclusions: Collection of PROs using touch-screen-based, internet technology was feasible in a busy HIV clinic. We found a high prevalence of body morphology abnormalities, depression, and poor adherence. Touch-screen-based collection of PROs is a promising tool to facilitate research and clinical care.

Keywords: HIV, patient-reported outcomes, depression, lipodystrophy, adherence.

INTRODUCTION

The dramatic decline in mortality among patients infected with human immunodeficiency virus (HIV) since the introduction of highly active antiretroviral therapy (HAART) has led to increased emphasis on the long-term morbidity of HIV infection and its treatment. Patient-reported outcomes (PROs) describing mental health, substance abuse, symptom burden, medication adherence, and health-related quality of life (HRQL) have therefore become more important in the care of HIV-infected patients.

Potential advantages of instituting routine collection of PROs include improving patient care [25, 52, 66], enhancing patient-provider communication [23, 66], and facilitating clinical outcomes research. Patient care may be improved by enabling clinicians to address functional problems, mental health problems, or symptomatic conditions that might otherwise have been missed [28, 51, 66]. Logistical barriers impede the routine collection of PROs particularly paper-based PRO collection in most clinical practice settings. These barriers include the added time required for patients to complete the instruments, the added time needed for staff to

data-enter patient responses, and the need for data processing to generate the results before they can be used in clinical care. Availability of space for patients to complete the assessments in the clinic, as well as budget limitations can also hinder collection of PROs. For PROs to benefit outpatient clinical care, the PRO instruments must be clinically relevant, valid, reliable, and easy to interpret; collection must be integrated with clinic work flow; and information obtained from PROs must be available at the point-of-care to assist in clinical decision-making [68].

Technological advances may help overcome several barriers to the routine collection of PROs in the clinical setting. Touch-screen technology can facilitate data collection, decrease staff burden eliminating scoring and data-entry time compared with the use of paper forms, and also allows immediate access to results. Furthermore, this technology can be used by those with limited computer literacy or with a variety of diseases and levels of symptom distress. We examined the feasibility and acceptability of using touch-screen tablet PCs for patient-based collection of information about depression and anxiety, other symptoms, medication adherence, HRQL, and body morphology abnormalities in a large HIV clinic.

METHODS

Study Setting: This study was conducted among a convenience sample of patients in the University of Washington (UW) HIV Cohort, a longitudinal observational cohort of HIV-infected patients who receive primary care in the UW

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Harborview Medical Center HIV Clinic. The UW HIV clinic is the largest single provider of medical care to HIV-infected individuals in the northwestern United States. Patients who provide informed consent are followed until death or relocation from the clinic.

Study participants: HIV-infected patients over 18 years of age who attended the clinic for a routinely scheduled appointment between September 26, 2005, and December 1, 2005 were eligible for the study. Patients were approached by a research assistant in the waiting room before their clinic appointment and invited to participate in the study. After obtaining informed consent, the research assistant gave the participants brief instruction on the use of the touch screens and asked them to complete the assessment. Patients unable to provide informed consent, such as those with dementia or patients who did not speak English, were not eligible for the study. The study protocol was approved by the University of Washington's institutional review board.

Data sources: The assessment included instruments assessing body morphology abnormalities, depression and anxiety, current symptoms, antiretroviral medication adherence, alcohol, tobacco, and drug use, HRQL, and physical activity level. The assessment consisted of 62 to 111 items depending on patient responses.

Data were also obtained from the University of Washington HIV Information System (UWHIS), which captures longitudinal data on the UW HIV Cohort. The UWHIS integrates comprehensive clinical data from all outpatient and inpatient encounters including standardized HIV-related information collected at enrollment (initial clinic visit) regarding prior antiretroviral treatment and diagnosis history. Demographic, clinical, laboratory, medication, and socioeconomic data are obtained from the UW Electronic Medical

Record and other institutional data sources. Laboratory data are downloaded from the UW Laboratory Medicine system and include results of all tests performed as part of routine clinical care. Clinical patient data such as blood pressure, height, and weight are routinely collected and integrated in the UWHIS.

System: We used a web-based survey software application, developed specifically for patient-based measures. Patients used tablet PCs with touch screens over a wireless network infrastructure. Network communications were encrypted using secure sockets layer/transport layer security (SSL/TLS) and no patient data were stored on the tablet computers. The interface was designed for ease of navigation with questions displayed with large, easy to read type, and clearly labeled radio buttons to indicate responses (Fig. 1). The interface did not require typing to answer questions or navigate, and patients did not have a keyboard available for their use. Controls for all possible actions were always visible. The program prevents double or ambiguous answers by allowing only one response per question but permits mistakes to be easily corrected. Automated skip patterns were incorporated into the programming, decreasing patient burden. For example, if a patient answered that they were not taking any anti-HIV medications, the program skipped the remainder of the medication adherence questions.

Outcomes: We were interested in the acceptability of the system including refusal rates including number of refusals due to time constraints. We were also interested in feasibility focusing on patient completion times, completion rates, missing data rates, and number of patients requiring assistance.

Instrument Selection Criteria: We considered the Medical Outcomes Trust criteria for instrument selection

The screenshot shows a touch-screen assessment interface titled "Madison Clinic Patient Survey". The main text reads: "Now we would like to know how you are doing with your activities TODAY." Below this, the section is titled "MOBILITY" and contains three radio button options: "I have no problems in walking about", "I have some problems in walking about", and "I am unable to walk". At the bottom of the screen, there are two large blue arrows: a left-pointing arrow labeled "Previous" and a right-pointing arrow labeled "Next".

Fig. (1). Example of an item from the touch-screen assessment of patient reported outcomes.

including: validity, reliability, responsiveness, interpretability, and minimal patient burden [57]. When possible, we preferred instruments with evidence of validity established among HIV-infected individuals. Easy to interpret instruments increased the likelihood that results would be clinically meaningful for patient care. We also preferred, when possible, measures that were widely used to facilitate comparisons to other patient populations.

Instruments: We selected the depression and anxiety modules from the Primary Care Evaluation of Mental Disorders (PRIME-MD) Patient Health Questionnaire (PHQ) for mental health measures [42, 60]. Patients indicate for each of nine depressive symptoms whether, during the prior 2 weeks, the symptom bothered them “not at all,” “several days,” “more than half the days,” or “nearly every day.” For the anxiety component, they are asked if they have had any feelings of sudden fear or panic in the prior 4 weeks. If yes, they are then asked four yes/no questions about the presence of panic attacks or anxiety symptoms.

Alcohol use was evaluated using the abbreviated version of the Alcohol Use Disorders Identification Test consumption questions (AUDIT-C) [8, 12]. The AUDIT-C asks three questions about alcohol use during the past year; 1) how often a patient has a drink containing alcohol, 2) the usual quantity of drinks consumed, and 3) the frequency of drinking a large number of drinks at one time. If a patient’s response to the first question is never, then the other questions are skipped. Consistent with prior studies, we modified question 3 to ask about the frequency of consuming 5 or more drinks [22]. The original AUDIT, which asked about the frequency of 6 or more drinks, was initially developed in Australia where the standard drink size is smaller than in the United States [22]. The modified version more accurately captures the level of intake assessed in the original instrument [22].

Recreational drug use was examined using the Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) [53, 67]. This brief measure has five content domains for each drug class: lifetime use, current use, preoccupied/concerned, dependence, and problems. In addition to these drug class questions, patients are also asked one risk question about injection drug use and one question regarding treatment for drug or alcohol use during the prior year.

We used the body morphology instrument from the Fat Redistribution and Metabolic Change in HIV Infection (FRAM) study that assesses body morphology changes over the preceding six months by asking the patient to rate changes in the size of specific body regions such as their cheeks or neck [4, 29, 63]. If the patient has noted a change in size, they are asked to rate its severity and direction from severely increased to severely decreased. Based on feedback from pilot testing, we modified the initial FRAM questionnaire by combining the two items about changes in breast and chest size into a single item.

We measured symptoms using the HIV Symptom Index, adherence using questions from the AIDS Clinical Trial Group studies, and HRQL using the EuroQOL 5-dimension questionnaire (EQ-5D). The HIV Symptom Index is a previously developed measure of 20 symptom groups designed to identify the symptoms associated with HIV infection and

treatment with HIV-related medications [36]. Patients were asked to indicate the degree to which they had been bothered by a symptom over the prior 4-week period on a 5-point scale. The adherence questions asked patients if they were taking HIV medications, how many doses they had missed in the last 4 days, how many they missed the prior weekend, and when was the last time they missed any medications. The EQ-5D index is a 5-item measure of HRQL encompassing 5 dimensions of current health: mobility, self-care (problems with washing/dressing), usual activities, pain/discomfort, and mood. Each question contains 3 response options: “no problems”, “moderate problems”, or “extreme problems” [34, 35, 73].

In addition to the above measures, we also collected information on each patient’s physical activity level and tobacco use. A screening tobacco question asked whether the patient had smoked 20 or more cigarettes in their lifetime. If they answered “yes”, they were also asked if they were a current smoker, years of smoking, and packs per day. These questions allowed patients to be categorized as current or active smokers, past or ex-smokers, and nonsmokers (<20 cigarettes) [38]. For current smokers, the average amount of smoking can be expressed as cigarettes per day. “Pack-years” can be calculated as the number of packs per day multiplied by the years of smoking [38].

Statistical analyses: We performed bivariate analyses comparing study participant characteristics to the overall UW HIV cohort using chi-squared tests for categorical variables and *t*-tests for continuous variables. We calculated the proportion of patients who refused and who completed the assessment out of the total number of patients approached to participate in the study.

The PHQ depression module can be scored as a diagnostic measure indicating major depression and as a depression severity measure [42]. We scored it as a severity measure with scores ranging from 0 to 27. Levels of depression were categorized as mild (scores of 5-9), moderate (scores of 10-14), moderately severe (scores of 15-19), or severe (scores of 20 or greater) [42]. For the anxiety module, patients were classified as having anxiety symptoms if they answered yes to the first question and a panic syndrome if they answered yes to all of the panic/anxiety questions [60].

The AUDIT-C scores were calculated by summing the scores for each AUDIT-C question (0-4 points each) [12]. Consistent with previous reports, we used a score of 5 or higher for men and 4 or higher for women to define at-risk alcohol consumption [30].

There are several ways of scoring the ASSIST [53, 67] including calculating specific substance involvement scores, as well as calculating a global continuum of illicit drug risk score. Because of the negative impact of drug use on adherence [27], we were specifically interested in the prevalence of patients who reported current use of each class of drugs.

Responses to the body morphology abnormalities questions were coded on a 7-point scale ranging from -3 to +3 for each region. No change was scored as 0, mild, moderate, and severe increases were scored as +1, +2, and +3, and mild, moderate, and severe decreases were scored as -1, -2, and -3. Lipohypertrophy was scored using all positive responses from the patient-reported questionnaire (indicating

increases in the size of the different body regions) totaled together. Lipoatrophy was scored using all negative responses (indicating decreases in size) totaled together. Severity of each of these conditions was defined as mild (1-12 points), moderate (13-24 points), and severe (>24 points).

Using the HIV Symptom Index, a symptom score was calculated based on the number of symptoms that bothered the patient (excluding those symptoms that bothered the patient only a little), with higher scores indicating greater symptom burden. The combination of responses to the 5 dimensions of the EQ-5D index categorizes patients into one of 243 unique possible health states. Each health state can then be assigned a preference-based index score using preferences identified by the general population [58]. We were specifically interested in the prevalence of patients who reported the most severe health state for each of the 5 HRQL domains in the EQ-5D.

We examined the mean, median, and standard deviation of each PRO score and calculated the prevalence of each outcome in our sample. We also examined the mean and median survey completion times. Chi-squared tests for categorical variables and *t*-tests for continuous variables were used to compare clinical and demographic characteristics among patients in the slowest quartile of assessment completion times to patients in the fastest quartile of completion times, and patients with CD4⁺ cell counts over 350 to those with CD4⁺ cell counts less than 350. We calculated the percentage of completed items for each measure by dividing the number of completed items by the total number of items for each PRO. If participants were not asked a question because of a skip pattern incorporated in the software program, it was not included in either the denominator or the numerator for calculating completion rates.

RESULTS

Over a 2-month period, 136 patients were approached to participate in the study. Of these, 106 patients (78%) completed the assessment, 6 (4%) started but did not complete it, and 24 (18%) refused to participate, most often due to time constraints. Most of the 24 patients who refused stated a willingness to be approached to participate on a different day. Of the 106 patients who completed the assessment, 3 required assistance (1 due to vision issues, 2 due to literacy). No differences were seen in demographic characteristics including sex or age, or in CD4⁺ cell count nadir between those who refused or delayed participating and those who participated. The mean age of patients who refused to participate was 47.8 versus 48.4 for those who participated ($p=0.4$).

Study patients ranged in age from 25 to 66 years, 85% were men, 50% were men who reported having sex with other men as their risk factor for HIV transmission, and 29% reported a history of intravenous drug use as their risk factor for HIV transmission (Table 1). Characteristics of study patients were similar to those of all patients receiving care at the HIV clinic during the study period except that study patients were slightly older (48 years versus 44 years) than the UW cohort overall (data not shown).

We found a high prevalence of mental health abnormalities and substance use among the 106 patients who com-

Table 1. Baseline Characteristics of HIV-Infected Patients Seen in a Routine Clinic Setting who Completed the Assessment (N=106)

Characteristic	N	%
Sex		
Male	90	85
Female	16	15
Race		
White	75	71
Black	24	23
Other/Unknown	7	7
Age (years)		
< 40	18	17
40-49	40	38
≥ 50	48	45
Risk factor for HIV transmission		
Male sex-with-male	53	50
Injection drug use	31	29
Heterosexual	16	15
Other/unknown	6	6
CD4⁺ cell count nadir (cells/mm³)		
0-200	58	55
201-350	36	34
351 or greater	12	11
Currently receiving HAART		
Yes	75	71
No	31	29

pleted the assessment (Table 2). Fifty-four patients (51%) had moderate or severe depression symptoms. Only 31 patients (29%) reported no mental health symptoms. Only 21 patients (20%) reported neither mental health symptoms nor current active recreational substance use.

We also found a high prevalence of poor medication adherence, body morphology abnormalities, high symptom burden, and poor HRQL among the 106 patients who completed the assessment (Table 2). Nineteen (25%) of 76 patients receiving HAART reported missing a dose of medications in the prior 4 days. Based on the HIV Symptom Index, patients reported an average of 4.4 symptoms (excluding those symptoms that bothered patients "only a little"), with depression and fatigue being the most commonly identified symptom. Twenty patients (19%) recorded the most severe response option, indicating an extreme problem with at least one of 5 EQ-5D HRQL domains. Fifty-four patients (51%) had lipoatrophy, however, this was predominantly mild with only 5 patients (5%) having moderate or severe lipoatrophy. The prevalence of lipohypertrophy was also high with 73 patients (69%) identifying this as a problem, however, only 9 patients (8%) reported moderate or severe lipohypertrophy.

Table 2. Summary of Prevalence of Selected Patient Reported Outcomes Among HIV-Infected Patients (N=106)

Domain:	N (%)
Mental health	
Depression (any)	66 (62)
Depression (moderate or severe)	54 (51)
Anxiety	42 (40)
Panic syndrome	26 (25)
Any of the above (any mental health)	75 (71)
Substance use	
Cocaine/amphetamine/opiate use in last 3 months	37 (35)
Current at-risk alcohol use	15 (14)
Current smoker	48 (45)
Symptom burden (excluding mild symptoms)	
Symptoms (any)	78 (74)
Symptoms (4 or more)	48 (45)
Body morphology abnormalities	
Lipoatrophy (any)	54 (51)
Lipoatrophy (moderate or severe)	5 (5)
Lipohypertrophy (any)	73 (69)
Lipohypertrophy (moderate or severe)	9 (8)

Patients with higher CD4⁺ cell count nadirs had lower depression scores, less symptom burden, and better HRQL. Patients with a CD4⁺ cell count over 350 had a mean depres-

sion score of 5.2 versus 9.8 for those with a CD4⁺ cell count less than 350 ($p=0.06$). Patients with a CD4⁺ cell count over 350 had a mean symptom score of 1.8 versus 4.8 for those with a CD4⁺ cell count less than 350 ($p=0.03$). No patients with a CD4⁺ cell count over 350 reported severe responses indicating an extreme problem with an EQ-5D HRQL domain.

Median completion time was 11 minutes and 40 seconds, with a mean completion time of 12 minutes and 21 seconds (Fig. 2). Most patients completed the assessment while awaiting their appointment. Although some patients did not finish before being called to see their provider, all but 6 who initiated the assessment either completed it before their appointment or returned to complete it after their appointment.

Older age was not associated with slower completion times or higher refusal rates. When compared with patients in the slowest quartile of assessment completion times, patients in the fastest quartile were older (mean age 53 years versus 44 years, $p<0.001$). There was also a trend towards a higher CD4⁺ cell count nadir (means of 194 cells/mm³ versus 134 cells/mm³, $p=0.07$) among patients in the fastest quartile. Patients in the slowest quartile did not differ from those in the fastest quartile by sex, race, or HIV transmission risk factor.

Patients were given the option of not answering an item if they wished or of not completing the assessment. Nevertheless, completion rates were high with minimal missing data. The completion rate for the depression inventory was over 97% with similar completion rates for other inventories. Missing data for each of the symptom questions was under 3% for all questions except the query regarding bloating and gas (4.7%).

The program and server hardware/software platform was both flexible and stable; no system crashes were experienced during the study period. However, there were downtime pe-

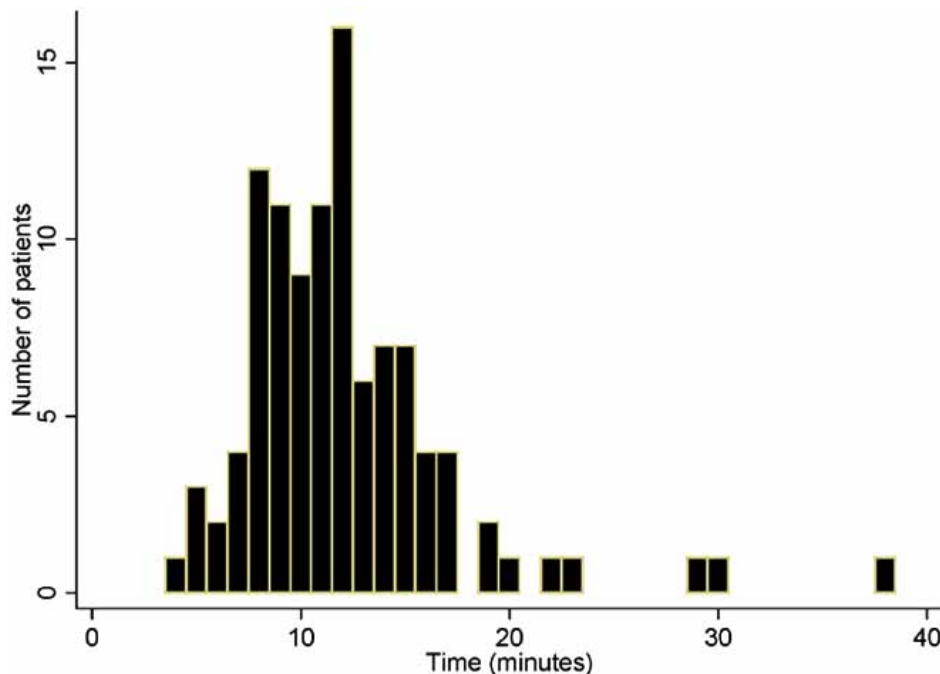


Fig. (2). Time taken to complete the assessment using touch screen computers.

riods due to wireless connectivity problems, which prevented this web-based system from being used. The initial investment in hardware including two tablet touch-screen PCs and wireless network hardware was approximately \$5000. There was an additional nominal expense to host this application on an already available server, and a small marginal cost to implement these surveys using research software which had been developed for another project. The project also included part-time salary support for a research assistant during this feasibility study.

DISCUSSION

We found that collection of PROs using tablet touch-screen PCs was feasible in a population of HIV-infected patients attending a busy HIV clinic. The touch-screen-based collection required only a modest financial investment, eliminated data entry required with paper-based collection, and imposed only minimal burden on staff and patients. This study demonstrated a high prevalence of body morphology abnormalities, HIV-related symptoms, depression, and poor antiretroviral medication adherence, suggesting that use of PROs in routine care may facilitate identification of clinical problems at the time care is provided.

As computers become more prevalent in society, many of the concerns regarding patient familiarity and comfort with computers and patient concerns regarding confidentiality [54] may no longer be salient [69]. Computer-based data collection has already been implemented in a variety of clinical settings and with different patient populations [1, 31, 70], including low-income, ethnically diverse groups who may have less exposure to computers [7]. An audio component to computer-based data collection may reduce literacy and language barriers [43]. However, the use of computer-based collection among HIV-infected patient populations has received less attention [69].

Touch-screen data entry is particularly useful since it eliminates the need for typing and avoids using mouse-based data entry systems that have not been universally successful [39, 59, 68]. Although prior studies have found that older patients may find computer entry more difficult and time consuming than younger patients [13], we did not find longer completion times among older patients in our study. Although this may be due to a younger patient population than prior studies, in fact the mean age of patients in the fastest quartile of completion times was older than that in the slowest quartile. Similarly, we did not find a difference in refusal rate based on age.

INSTRUMENTS

We included depression and anxiety measures to facilitate patient care and because they are key outcomes in clinical research. The prevalence of depressive and panic disorders has been found to be much higher among HIV-infected individuals than among the general population [6], and greatly underdiagnosed by primary care providers [46, 61]. Depression is a potential risk factor for increased morbidity, mortality, and poor medication adherence among HIV-infected individuals [3, 33]. Treatment of depression may improve antiretroviral medication adherence [74] suggesting that screening for depression may improve a variety of patient outcomes.

Studies to assess the PHQ depression and anxiety modules' validity, responsiveness, and internal consistency have been conducted in outpatient [37, 42, 47, 60], inpatient [24], and clinical trial settings [48], and in the general population [49]. Patient and physician acceptance of the PHQ depression [60] and anxiety domains [46] is high with the majority of physicians surveyed reporting that it would be beneficial to routinely incorporate the PHQ into their primary care clinic [60]. At 9 items, the depression module of the PHQ is half the length of many other depression measures, has comparable sensitivity and specificity, and encompasses the 9 criteria upon which the diagnosis of DSM-IV [2] depressive disorders are based [42]. It allowed us to detect, with minimal patient burden, a very high prevalence of patients with depression symptoms in our clinic who might benefit from further intervention.

It has been recommended that health care providers screen all HIV-infected patients for at-risk alcohol consumption [17]. At-risk alcohol use is underdiagnosed among HIV-infected patients [17] and excess alcohol consumption has been associated with considerable morbidity and mortality. Alcohol use and abuse among HIV-infected individuals has been associated with poorer outcomes including decreased adherence to antiretroviral medications [10, 20]. As with depression, identifying and treating patients with alcohol abuse will likely lead to better medication adherence and delayed HIV disease progression.

The AUDIT, upon which the AUDIT-C is based, has been used for screening in a number of patient populations [19, 65] including HIV-infected outpatients [17, 20], and found to perform better than other brief alcohol screen measures such as CRAFFT, SMAST, or CAGE [19, 26]. In particular, the AUDIT outperformed other measures when screening was not limited to identifying severe disorders such as alcohol dependence, but also included less severe drinking categories such as at-risk drinking [9, 26]. This is advantageous since many alcohol-related problems appear in non-alcohol dependent individuals [30] who may be on HAART but are also hazardous or harmful drinkers and are at high risk for poor medication adherence and other complications.

Using the PHQ, the AUDIT-C, and the ASSIST, we found a very high prevalence of mental health symptoms and active substance use. Only one in five patients had no mental health issues and no current substance use issues (not including tobacco).

The HIV Symptoms Index was developed for use with HIV-infected individuals and has been shown to have a short completion time [36]. An important benefit of the HIV Symptoms Index is that symptom burden can be quantified. The HIV Symptoms Index includes a single question about depression. Although this was the most common symptom reported, a number of cases of moderate or severe depression detected by the PHQ were missed using the HIV Symptom Index. This suggests that the HIV Symptom Index is not adequate for screening for depression, and that assessments should include longer depression instruments such as the depression domain of the PHQ.

There is no gold standard for diagnosing body morphology abnormalities although several definitions have been proposed [5, 14, 15, 50, 55]. Body morphology abnormali-

ties can be assessed using techniques other than PROs, such as dual energy X-ray absorptiometry (DEXA) and magnetic resonance imaging (MRI) scans. However, these techniques are not practical for collection in routine clinical care settings, and there are disagreements regarding their interpretation. Furthermore, single scans cannot assess changes in body morphology which are crucial given the differences in body morphology between patients, nor do they typically incorporate any measure of facial fat which is a common site of lipoatrophy. Patient-reported information will, therefore, likely be an important component of the assessment of lipodystrophy and body morphology abnormalities in routine clinical care settings.

HRQL measures are increasingly recognized as an aid to detect clinical problems, monitor disease and treatment effects, improve delivery of care, and improve patient-physician communication [23]. The EQ-5D Index is a measure of HRQL that generates health utilities, and allows for calculation of quality-adjusted life-years for cost-effectiveness analyses [73], in addition to simple descriptive summaries. This additional flexibility may come at a cost of slightly less responsiveness and greater ceiling effects compared with some longer measures [62, 73]. The EQ-5D Index has been widely used among HIV-infected individuals at all stages of HIV disease severity [62, 72, 73], in both clinical trial [73] and clinical care settings [62]. In addition, population-based standards are available [58] facilitating comparisons.

Software: The software design allows individual questions to be modified as well as additional instruments to be added or removed from the assessment via a web-based interface that requires only moderate computer skills and basic knowledge of HTML/CSS. This permits the simple incorporation of new instruments into the follow-up assessments and the deletion of poorly performing questions. Additionally, safeguards can be incorporated into the system with automatic notification of patient responses that raise concern. For example, an email warning can be sent to the primary provider or principal investigator if a patient responds that they would like to hurt themselves or others when completing the depression questions, or if the aggregate score on the PHQ-9 is above a threshold value. Skip patterns allows patient burden to be dramatically reduced. Although the assessment contains 111 questions, depending on patient responses, skip patterns allow patients to be asked as few as 62 questions. As advances continue to be made in the field of computer adaptive testing (CAT), CAT may produce precise estimates of patients' health status and other PROs and allow a further decrease in patient burden [32].

Workflow: The incorporation of this type of system in a routine clinical setting may impact workflow, although patients can usually complete the assessment during the time they are waiting to be seen by their provider. In our clinic, the nursing staff currently asks questions about tobacco use, HRQL, and medication adherence at each visit. The routine incorporation of this PRO system into our clinic would result in a reduction in nursing staff workload.

Tablet-based touch screen collection of PROs: Electronic data collection is associated with a lower rate of unanswered questions than paper forms [1, 7, 31, 70] because patients must respond to a question or press the "next" but-

ton to move on [31]. When electronic, patient-based, and interviewer-based collection have been compared in other populations, electronic collection has been preferred [1, 64, 70] due to ease of use and speed [70]. A previous study in our own clinic performed several years ago using paper forms demonstrated a much lower completion rate and a greater time to assessment completion despite the help of a staff person [21]. Additionally, patients prefer electronic data collection when the questions concern sensitive topics such as drug use and sexual behavior [44, 56]. Computer-based collection versus interview-based may allow patients to feel more at ease reporting socially undesirable behaviors reducing social desirability bias [41]. The reproducibility of electronic PRO assessments versus paper-based collection in other patient populations has been shown to be very high [16, 70].

Another advantage of tablet-based data collection is the elimination of an additional data entry step that can result in delays, costs, and errors. Direct computer entry enhances the quality of data by not allowing double or ambiguous answers [31]. With electronic data collection, patient information can be immediately scored, displayed, and printed for use in clinical care with the greatest benefit demonstrated among patients with poor health status [66]. This suggests that providing physicians with PROs results may be particularly useful among HIV-infected patients with advanced disease. Finally, in our system, the PRO data is incorporated into the University of Washington HIV information system allowing its use in outcomes research and as key covariates in other studies.

Initiation of tablet-based touch screen PRO collection in a clinical setting can be limited by the greater start-up costs of tablet-based collection versus paper forms. Despite the larger start-up costs, touch screens have been found to be less expensive per assessment in clinical settings doing 6 or more assessments per day [45]. We initially had difficulties with wireless connectivity, however these problems were resolved. In addition, a wireless system allowed us to use tablet-based collection without storing patient information on the tablets to maximize patient confidentiality. Although others have found that patients rate electronic collection as preferable to paper-based collection [64, 70], the main reason given why people did not like the electronic version was lack of computer literacy. However, in our feasibility study we found that most refusals were due to time limitations, with patients stating a willingness to complete the assessment at a different time. Only three patients required assistance and this was due to literacy or visual impairment. These patients also would have required assistance with a paper-based assessment. Although we intend to incorporate collection of the assessment with checking-in for clinic appointments, low literacy, in combination with cognitive dysfunction, visual impairments, and malaise secondary to illness guarantee that some fraction of patients will always require assistance with checking-in for appointments [11, 40, 68]. This system may reduce front desk staff check-in time on average, allowing them to focus more of their time on those patients with special needs who require additional assistance.

Study Limitations: This study is the first step to incorporating routine tablet-based collection of PROs in a busy

HIV clinical setting. However, as a feasibility study, a research assistant was present to obtain informed consent. This may have decreased the impact on the front desk staff who in the future may be called on to assist patients having difficulties. Furthermore, presenting the assessment as part of a study rather than clinical care may have influenced the refusal rate. Patients may be more willing to complete the assessment if it is part of routine clinical practice [71]. Although we kept track of the number of non-responders, we did not survey non-responders for reasons for nonparticipation other than time constraints.

Future directions: Future goals of this project include adapting the questionnaire for delivery in multiple languages, automating patient flow between check-in and notification of triage of patient arrival, and providing real-time information to providers to improve patient care. As this program becomes a more routine part of the clinic, the results of the depression, anxiety, substance use, and symptom assessments will be printed and added to the patient packet provided to clinicians at the start of clinic visits. How PRO data for individual patients should be presented to providers is still an important area of research [25, 66] although provider intervention in PROs such as depression is known to improve outcomes [18, 74]. Whether giving providers PRO data regarding other outcomes will also improve care is uncertain.

CONCLUSION

We found that collection of PROs using touch-screen technology was feasible in a busy HIV clinic. Touch-screen technology required only modest investment, was highly acceptable by patients with low refusal rates, eliminated staff data entry time compared with paper-based data collection, and did not impose a large burden on staff or patients. Collection of PROs in our clinic revealed a high prevalence of depression, substance abuse, and body morphology abnormalities, as well as poor antiretroviral medication adherence. Touch-screen-based collection of PROs is a promising tool that may facilitate both clinical research and patient care.

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REFERENCES

- [1] Aiello EJ, Taplin S, Reid R, Hobbs M, Seger D, Kamel H, Tufano J, Ballard-Barbash R. (2006). In a randomized controlled trial, patients preferred electronic data collection of breast cancer risk-factor information in a mammography setting. *Journal of Clinical Epidemiology*. 59: 77-81.
- [2] American Psychiatric Association. Task Force on DSM-IV.: Diagnostic and statistical manual of mental disorders : DSM-IV, 4th edn. Washington, DC: American Psychiatric Association; 1994.
- [3] Ammassari A, Antinori A, Aloisi MS, Trotta MP, Murri R, Bartoli L, Monforte AD, Wu AW, Starace F. (2004). Depressive symptoms, neurocognitive impairment, and adherence to highly active antiretroviral therapy among HIV-infected persons. *Psychosomatics*. 45: 394-402.
- [4] Bacchetti P, Gripshover B, Grunfeld C, Heymsfield S, McCreath H, Osmond D, Saag M, Scherzer R, Shlipak M, Tien P. (2005). Fat

- distribution in men with HIV infection. *Journal of Acquired Immune Deficiency Syndromes*. 40: 121-131.
- [5] Belloso WH, Quiros RE, Ivaldo SA, Perman MI, Galich AM, Stern LD, Barcan LA. (2003). Agreement analysis of variables involved in lipodystrophy syndrome definition in HIV-infected patients. *Journal of Acquired Immune Deficiency Syndromes*. 32: 104-111.
- [6] Bing EG, Burnam MA, Longshore D, Fleishman JA, Sherbourne CD, London AS, Turner BJ, Eggan F, Beckman R, Vitiello B, Morton SC, Orlando M, Bozzette SA, Ortiz-Barron L, Shapiro M. (2001). Psychiatric disorders and drug use among human immunodeficiency virus-infected adults in the United States. *Archives of General Psychiatry*. 58: 721-728.
- [7] Bock B, Niaura R, Fontes A, Bock F. (1999). Acceptability of computer assessments among ethnically diverse, low-income smokers. *American Journal of Health Promotion*. 13: 299-304.
- [8] Bradley KA, Bush KR, Epler AJ, Dobie DJ, Davis TM, Sporleder JL, Maynard C, Burman ML, Kivlahan DR. (2003). Two brief alcohol-screening tests From the Alcohol Use Disorders Identification Test (AUDIT): validation in a female Veterans Affairs patient population. *Archives of Internal Medicine*. 163: 821-829.
- [9] Bradley KA, Bush KR, McDonell MB, Malone T, Fihn SD. (1998). Screening for problem drinking: comparison of CAGE and AUDIT. Ambulatory Care Quality Improvement Project (ACQUIP). Alcohol Use Disorders Identification Test. *Journal of General Internal Medicine*. 13: 379-388.
- [10] Braithwaite RS, McGinnis KA, Conigliaro J, Maisto SA, Crystal S, Day N, Cook RL, Gordon A, Bridges MW, Seiler JF, Justice AC. (2005). A temporal and dose-response association between alcohol consumption and medication adherence among veterans in care. *Alcoholism: Clinical and Experimental Research*. 29: 1190-1197.
- [11] Brodie M, Flournoy RE, Altman DE, Blendon RJ, Benson JM, Rosenbaum MD. (2000). Health information, the Internet, and the digital divide. *Health Affairs (Millwood)*. 19: 255-265.
- [12] Bush K, Kivlahan DR, McDonell MB, Fihn SD, Bradley KA. (1998). The AUDIT alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. Ambulatory Care Quality Improvement Project (ACQUIP). Alcohol Use Disorders Identification Test. *Archives of Internal Medicine*. 158: 1789-1795.
- [13] Buxton J, White M, Osoba D. (1998). Patients' experiences using a computerized program with a touch-sensitive video monitor for the assessment of health-related quality of life. *Quality of Life Research*. 7: 513-519.
- [14] Carr A, Emery S, Law M, Puls R, Lundgren JD, Powderly WG. (2003). An objective case definition of lipodystrophy in HIV-infected adults: a case-control study. *Lancet*. 361: 726-735.
- [15] Carr A, Samaras K, Thorisdottir A, Kaufmann GR, Chisholm DJ, Cooper DA. (1999). Diagnosis, prediction, and natural course of HIV-1 protease-inhibitor-associated lipodystrophy, hyperlipidaemia, and diabetes mellitus: a cohort study. *Lancet*. 353: 2093-2099.
- [16] Chan-Pensley E. (1999). Alcohol-Use Disorders Identification Test: a comparison between paper and pencil and computerized versions. *Alcohol and Alcoholism*. 34: 882-885.
- [17] Conigliaro J, Gordon AJ, McGinnis KA, Rabeneck L, Justice AC. (2003). How harmful is hazardous alcohol use and abuse in HIV infection: do health care providers know who is at risk? *Journal of Acquired Immune Deficiency Syndromes*. 33: 521-525.
- [18] Cook JA, Grey D, Burke-Miller J, Cohen MH, Anastos K, Gandhi M, Richardson J, Wilson T, Young M. (2006). Effects of treated and untreated depressive symptoms on highly active antiretroviral therapy use in a US multi-site cohort of HIV-positive women. *AIDS Care*. 18: 93-100.
- [19] Cook RL, Chung T, Kelly TM, Clark DB. (2005). Alcohol screening in young persons attending a sexually transmitted disease clinic. Comparison of AUDIT, CRAFFT, and CAGE instruments. *Journal of General Internal Medicine*. 20: 1-6.
- [20] Cook RL, Sereika SM, Hunt SC, Woodward WC, Erlen JA, Conigliaro J. (2001). Problem drinking and medication adherence among persons with HIV infection. *Journal of General Internal Medicine*. 16: 83-88.
- [21] Crane HM, Rompaey SE, Dillingham PW, Herman E, Diehr P, Kitahata MM. (2006). A Single-Item Measure of Health-Related Quality-of-Life for HIV-Infected Patients in Routine Clinical Care. *AIDS Patient Care and STDS*. 20: 161-174.
- [22] Dawson DA, Grant BF, Stinson FS, Zhou Y. (2005). Effectiveness of the derived Alcohol Use Disorders Identification Test (AUDIT-

- C) in screening for alcohol use disorders and risk drinking in the US general population. *Alcoholism: Clinical and Experimental Research*. 29: 844-854.
- [23] Detmar SB, Muller MJ, Schornagel JH, Wever LD, Aaronson NK. (2002). Health-related quality-of-life assessments and patient-physician communication: a randomized controlled trial. *Journal of the American Medical Association*. 288: 3027-3034.
- [24] Diez-Quevedo C, Rangil T, Sanchez-Planell L, Kroenke K, Spitzer RL. (2001). Validation and utility of the patient health questionnaire in diagnosing mental disorders in 1003 general hospital Spanish inpatients. *Psychosomatic Medicine*. 63: 679-686.
- [25] Espallargues M, Valderas JM, Alonso J. (2000). Provision of feedback on perceived health status to health care professionals: a systematic review of its impact. *Medical Care*. 38: 175-186.
- [26] Fiellin DA, Reid MC, O'Connor PG. (2000). Screening for alcohol problems in primary care: a systematic review. *Archives of Internal Medicine*. 160: 1977-1989.
- [27] Gordillo V, del Amo J, Soriano V, Gonzalez-Lahoz J. (1999). Sociodemographic and psychological variables influencing adherence to antiretroviral therapy. *AIDS*. 13: 1763-1769.
- [28] Greenhalgh J, Meadows K. (1999). The effectiveness of the use of patient-based measures of health in routine practice in improving the process and outcomes of patient care: a literature review. *Journal of Evaluation in Clinical Practice*. 5: 401-416.
- [29] Gripshover B, Tien PC, Saag MS, Osmond D, Bacchetti P, Grunfeld C. Lipatrophy is the dominant feature of the lipodystrophy syndrome in HIV-infected men. 10th Conference on Retroviruses and Opportunistic Infections, 2003. Boston.
- [30] Gual A, Segura L, Contel M, Heather N, Colom J. (2002). AUDIT-3 and AUDIT-4: effectiveness of two short forms of the alcohol use disorders identification test. *Alcohol and Alcoholism*. 37: 591-596.
- [31] Hanscom B, Lurie JD, Homa K, Weinstein JN. (2002). Computerized questionnaires and the quality of survey data. *Spine*. 27: 1797-1801.
- [32] Hart DL, Cook KF, Mioduski JE, Teal CR, Crane PK. (2006). Simulated computerized adaptive test for patients with shoulder impairments was efficient and produced valid measures of function. *Journal of Clinical Epidemiology*. 59: 290-298.
- [33] Ickovics JR, Hamburger ME, Vlahov D, Schoenbaum EE, Schuman P, Boland RJ, Moore J. (2001). Mortality, CD4 cell count decline, and depressive symptoms among HIV- seropositive women: longitudinal analysis from the HIV Epidemiology Research Study. *Journal of the American Medical Association*. 285: 1466-1474.
- [34] Johnson JA, Coons SJ. (1998). Comparison of the EQ-5D and SF-12 in an adult US sample. *Quality of Life Research*. 7: 155-166.
- [35] Johnson JA, Coons SJ, Ergo A, Szava-Kovats G. (1998). Valuation of EuroQOL (EQ-5D) health states in an adult US sample. *Pharmacoeconomics*. 13: 421-433.
- [36] Justice AC, Holmes W, Gifford AL, Rabeneck L, Zackin R, Sinclair G, Weissman S, Neidig J, Marcus C, Chesney M, Cohn SE, Wu AW. (2001). Development and validation of a self-completed HIV symptom index. *Journal of Clinical Epidemiology*. 54(Suppl 1): S77-90.
- [37] Justice AC, McGinnis KA, Atkinson JH, Heaton RK, Young C, Sadek J, Madenwald T, Becker JT, Conigliaro J, Brown ST, Rimland D, Crystal S, Simberkoff M. (2004). Psychiatric and neurocognitive disorders among HIV-positive and negative veterans in care: Veterans Aging Cohort Five-Site Study. *AIDS*. 18(Suppl 1): S49-59.
- [38] Kiechl S, Werner P, Egger G, Oberhollenzer F, Mayr M, Xu Q, Poewe W, Willeit J. (2002). Active and passive smoking, chronic infections, and the risk of carotid atherosclerosis: prospective results from the Bruneck Study. *Stroke*. 33: 2170-2176.
- [39] Kim J, Trace D, Meyers K, Evens M. (1997). An empirical study of the Health Status Questionnaire System for use in patient-computer interaction. *Proceedings - AMIA Annual Fall Symposium*. 86-90.
- [40] Kirsch IS, Educational Testing Service., National Center for Education Statistics.: Adult literacy in America : a first look at the results of the National Adult Literacy Survey. Washington, D.C.: Office of Educational Research and Improvement [Supt. of Docs., U.S. G.P.O., distributor; 1993.
- [41] Kissinger P, Rice J, Farley T, Trim S, Jewitt K, Margavio V, Martin DH. (1999). Application of computer-assisted interviews to sexual behavior research. *American Journal of Epidemiology*. 149: 950-954.
- [42] Kroenke K, Spitzer RL, Williams JB. (2001). The PHQ-9: validity of a brief depression severity measure. *Journal of General Internal Medicine*. 16: 606-613.
- [43] Kurth AE, Martin DP, Golden MR, Weiss NS, Heagerty PJ, Spielberg F, Handsfield HH, Holmes KK. (2004). A comparison between audio computer-assisted self-interviews and clinician interviews for obtaining the sexual history. *Sexually Transmitted Diseases*. 31: 719-726.
- [44] Locke SE, Kowaloff HB, Hoff RG, Safran C, Popovsky MA, Cotton DJ, Finkelstein DM, Page PL, Slack WV. (1992). Computer-based interview for screening blood donors for risk of HIV transmission. *Journal of the American Medical Association*. 268: 1301-1305.
- [45] Lofland JH, Schaffer M, Goldfarb N. (2000). Evaluating health-related quality of life: cost comparison of computerized touch-screen technology and traditional paper systems. *Pharmacotherapy*. 20: 1390-1395.
- [46] Lowe B, Grafe K, Zipfel S, Spitzer RL, Herrmann-Lingen C, Witte S, Herzog W. (2003). Detecting panic disorder in medical and psychosomatic outpatients: comparative validation of the Hospital Anxiety and Depression Scale, the Patient Health Questionnaire, a screening question, and physicians' diagnosis. *Journal of Psychosomatic Research*. 55: 515-519.
- [47] Lowe B, Schenkel I, Carney-Doebbeling C, Gobel C. (2006). Responsiveness of the PHQ-9 to Psychopharmacological Depression Treatment. *Psychosomatics*. 47: 62-67.
- [48] Lowe B, Unutzer J, Callahan CM, Perkins AJ, Kroenke K. (2004). Monitoring depression treatment outcomes with the patient health questionnaire-9. *Medical Care*. 42: 1194-1201.
- [49] Martin A, Rief W, Klaiberg A, Braehler E. (2006). Validity of the Brief Patient Health Questionnaire Mood Scale (PHQ-9) in the general population. *General Hospital Psychiatry*. 28: 71-77.
- [50] Martinez E, Bianchi L, Garcia-Viejo MA, Bru C, Gatell JM. (2000). Sonographic assessment of regional fat in HIV-1-infected people. *Lancet*. 356: 1412-1413.
- [51] Mazonson PD, Mathias SD, Fifer SK, Buesching DP, Malek P, Patrick DL. (1996). The mental health patient profile: does it change primary care physicians' practice patterns? *Journal of the American Board of Family Practice*. 9: 336-345.
- [52] McHorney CA. (1999). Health status assessment methods for adults: past accomplishments and future challenges. *Annual Review of Public Health*. 20: 309-335.
- [53] Newcombe DA, Humeniuk RE, Ali R. (2005). Validation of the World Health Organization Alcohol, Smoking and Substance Involvement Screening Test (ASSIST): report of results from the Australian site. *Drug and Alcohol Review*. 24: 217-226.
- [54] Rosenfeld P, Booth-Kewley S, Edwards J. (1993). Computer-administered surveys in organizational settings: alternatives, advantages, and applications. *American Behavioral Scientist*. 36: 485-497.
- [55] Saint-Marc T, Partisani M, Poizot-Martin I, Rouviere O, Bruno F, Avellaneda R, Lang JM, Gastaut JA, Touraine JL. (2000). Fat distribution evaluated by computed tomography and metabolic abnormalities in patients undergoing antiretroviral therapy: preliminary results of the LIPOCO study. *AIDS*. 14: 37-49.
- [56] Sanders GD, Owens DK, Padian N, Cardinalli AB, Sullivan AN, Nease RF. (1994). A computer-based interview to identify HIV risk behaviors and to assess patient preferences for HIV-related health states. *Proceedings of the Annual Symposium on Computer Application in Med Care*. 20-24.
- [57] Scientific Advisory Committee of the Medical Outcomes Trust. (2002). Assessing health status and quality-of-life instruments: attributes and review criteria. *Quality of Life Research*. 11: 193-205.
- [58] Shaw JW, Johnson JA, Coons SJ. (2005). US valuation of the EQ-5D health states: development and testing of the D1 valuation model. *Medical Care*. 43: 203-220.
- [59] Smith MW, Sharit J, Czaja SJ. (1999). Aging, motor control, and the performance of computer mouse tasks. *Human Factors*. 41: 389-396.
- [60] Spitzer RL, Kroenke K, Williams JB. (1999). Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. *Primary Care Evaluation of Mental Disorders. Patient Health Questionnaire*. *Journal of the American Medical Association*. 282: 1737-1744.
- [61] Staab JP, Datto CJ, Weinrieb RM, Gariti P, Rynn M, Evans DL. (2001). Detection and diagnosis of psychiatric disorders in primary

- medical care settings. *Medical Clinics of North America*. 85: 579-596.
- [62] Stavem K, Froland SS, Hellum KB. (2005). Comparison of preference-based utilities of the 15D, EQ-5D and SF-6D in patients with HIV/AIDS. *Quality of Life Research*. 14: 971-980.
- [63] Tien PC, Cole SR, Williams CM, Li R, Justman JE, Cohen MH, Young M, Rubin N, Augenbraun M, Grunfeld C. (2003). Incidence of Lipoatrophy and Lipohypertrophy in the Women's Interagency HIV Study. *Journal of Acquired Immune Deficiency Syndromes*. 34: 461-466.
- [64] Velikova G, Wright EP, Smith AB, Cull A, Gould A, Forman D, Perren T, Stead M, Brown J, Selby PJ. (1999). Automated collection of quality-of-life data: a comparison of paper and computer touch-screen questionnaires. *Journal of Clinical Oncology*. 17: 998-1007.
- [65] Volk RJ, Steinbauer JR, Cantor SB, Holzer CE, 3rd. (1997). The Alcohol Use Disorders Identification Test (AUDIT) as a screen for at-risk drinking in primary care patients of different racial/ethnic backgrounds. *Addiction*. 92: 197-206.
- [66] Wagner AK, Ehrenberg BL, Tran TA, Bungay KM, Cynn DJ, Rogers WH. (1997). Patient-based health status measurement in clinical practice: a study of its impact on epilepsy patients' care. *Quality of Life Research*. 6: 329-341.
- [67] WHO ASSIST Working Group. (2002). The Alcohol, Smoking and Substance Involvement Screening Test (ASSIST): development, reliability and feasibility. *Addiction*. 97: 1183-1194.
- [68] Williams CA, Templin T, Mosley-Williams AD. (2004). Usability of a computer-assisted interview system for the unaided self-entry of patient data in an urban rheumatology clinic. *Journal of the American Medical Informatics Association*. 11: 249-259.
- [69] Williams ML, Freeman RC, Bowen AM, Zhao Z, Elwood WN, Gordon C, Young P, Rusek R, Signes CA. (2000). A comparison of the reliability of self-reported drug use and sexual behaviors using computer-assisted versus face-to-face interviewing. *AIDS Education and Prevention*. 12: 199-213.
- [70] Wilson AS, Kitas GD, Carruthers DM, Reay C, Skan J, Harris S, Treharne GJ, Young SP, Bacon PA. (2002). Computerized information-gathering in specialist rheumatology clinics: an initial evaluation of an electronic version of the Short Form 36. *Rheumatology (Oxford)*. 41: 268-273.
- [71] Wright EP, Selby PJ, Crawford M, Gillibrand A, Johnston C, Perren TJ, Rush R, Smith A, Velikova G, Watson K, Gould A, Cull A. (2003). Feasibility and compliance of automated measurement of quality of life in oncology practice. *Journal of Clinical Oncology*. 21: 374-382.
- [72] Wu AW, Jacobson DL, Berzon RA, Revicki DA, van der Horst C, Fichtenbaum CJ, Saag MS, Lynn L, Hardy D, Feinberg J. (1997). The effect of mode of administration on medical outcomes study health ratings and EuroQol scores in AIDS. *Quality of Life Research*. 6: 3-10.
- [73] Wu AW, Jacobson KL, Frick KD, Clark R, Revicki DA, Freedberg KA, Scott-Lennox J, Feinberg J. (2002). Validity and responsiveness of the euroqol as a measure of health-related quality of life in people enrolled in an AIDS clinical trial. *Quality of Life Research*. 11: 273-282.
- [74] Yun LW, Maravi M, Kobayashi JS, Barton PL, Davidson AJ. (2005). Antidepressant treatment improves adherence to antiretroviral therapy among depressed HIV-infected patients. *Journal of Acquired Immune Deficiency Syndromes*. 38: 432-438.

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