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Medication Management Skill in HIV: I. Evidence for Adaptation of Medication Management Strategies in People with Cognitive Impairment. II. Evidence for a Pervasive Lay Model of Medication Efficacy

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People with HIV-related cognitive impairment may change the way they manage medication regimens, relying on a fixed medication schedule each day to avoid missed doses. Using a medication recall diary, we identified people who took medication on exactly the same schedule over 3 days and those with more variable medication schedules. Patients with low scores on executive and psychomotor tests were more likely to report fixed medication schedules; memory performance, by contrast, was not associated with reported medication regimen. Patients with low scores on executive and psychomotor tests were also less accurate in pouring medicines in the Medication Management Test. More than three fourths of these HIV+ patients assumed that medicines with higher milligram dosages were stronger than medicines with smaller milligram dosages, even across different classes of medicines. In a non-HIV sample, 28% endorsed the belief, suggesting it is a widespread way of thinking about medication strength. A performance test of medication management sheds light on the ways patients take medicines and how beliefs about medicines affect medication regimens.

KEY WORDS: Medication management; HIV; cognitive status; dementia.

INTRODUCTION

The introduction of highly active antiretroviral therapies (HAART) has led to reductions in the incidence of HIV neurocognitive disorders (De Ronchi *et al.*, 2002; Dore *et al.*, 1999; Sacktor *et al.*, 2001a) and improvements in cognitive performance for people with both mild (Deutsch *et al.*, 2001) and more severe HIV-related cognitive impairment (Ferrando *et al.*, 1998; Sacktor *et al.*, 2001b; Suarez *et al.*, 2001; Tozzi *et al.*, 1999). However, evidence also suggests that a subset of people with HIV-related cognitive impairment continue to show such impairment despite HAART. Dore and colleagues (1999) reported an increasing prevalence of AIDS-related dementia and higher CD4+ cell counts when patients first meet criteria for dementia. Recent results from the Multicenter AIDS Cohort Study also suggest an increasing proportion of new cases of HIV dementia with higher CD4+ counts (Sacktor *et al.*, 2001a), and a comparison of a pre-HAART cohort and a more recent cohort with access to HAART did not show differences in the prevalence of HIV dementia (Sacktor *et al.*, 2002). These findings suggest that HIV-related cognitive impairment continues to be an important clinical issue for patients with advanced HIV infection.

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Cognitive impairment makes medication management more difficult. For example, the most common reason reported by people with HIV for missing medication doses is "forgetting" (Chesney *et al.*, 2000). In this Adult AIDS Clinical Trials Group (AACTG) study, 20% of patients missed at least one dose of HAART over 2 days by self-report, and 66% reported that they simply forgot to take medications. Investigation of a larger clinical cohort showed that only half of the patients took all antiretroviral medicines according to time and dietary instructions, and that deviations from the antiretroviral regimen were associated with decreased drug concentrations and lower likelihood of viral suppression (Nieuwkerk *et al.*, 2001).

Despite the relevance of cognitive impairment for medication management, few studies involving people with HIV have examined the extent to which cognitive impairment may make it hard for patients to adhere to medication regimens. One way to approach this question is to use an observed performance test of medication management in which patients are scored on their ability to pour pills and make inferences on medication dosing using standardized bottles, labels, and medication inserts. We developed the Medication Management Test (MMT) for this purpose and have shown that patients with low scores in executive function and psychomotor skills were less able to follow label information and correctly pour different medicines (Albert *et al.*, 1999). People scoring one or more standard deviations below age- and education-adjusted norms correctly poured only three of the five medicines, on average, whereas respondents with better cognitive performance correctly poured four of the five medicines. Performance on the MMT was also related to self-reported adherence.

These results for cognitive impairment and medication management confirm findings for other everyday competencies. Cognitive impairment in HIV has been shown to affect driving ability (Marcotte *et al.*, 1999), employment (van Gorp *et al.*, 1999), and risk of work disability (Albert *et al.*, 1995).

An open question in prior research is the extent to which people with cognitive impairment may change the way they manage medication regimens. People with cognitive impairment may recognize their propensity for medication errors and seek ways to reduce the risk of such errors. One way to do so is to develop fixed medication regimens, with medicines taken on the same schedule every day. A host of reminder devices of varying sophistication, ranging from weekly pill organizers to electronic pagers, have been developed to meet this need. We hypothesized that people with cognitive impairment would be more likely to adopt fixed dosing regimens.

An interesting finding from the AACTG study described above was the association between adherence and particular beliefs about medications. Nonadherers were less likely to recognize the relationship between adherence and drug resistance and were often unaware of special medication management instructions (Chesney *et al.*, 2000). In pursuing research on cognitive impairment and stability of medication management regimens, we, too, were struck by the saliency of certain medication beliefs and their relevance for medication management. We describe an important set of beliefs regarding the potency of medications that appears to be widely held by respondents taking HIV medications.

METHODS

Study Participants

Respondents in this research were drawn from the Columbia University component of the Northeast AIDS Dementia Cohort (NEAD). NEAD subjects were required to be HIV+ and to have either (1) a CD4+ count below 200 or (2) a CD4+ count between 200 and 300 with evidence of cognitive impairment. Cognitive impairment was defined in two ways: (1) performance at least one standard deviation below age- and education-referenced norms on at least two of eight tests in a cognitive battery or (2) performance at least two standard deviations below age- and education-referenced norms on at least one of the eight tests. The eight tests included a computerized simple- and choice-reaction time test (CALCAP) (Miller *et al.*, 1991), the Odd Man Out (Flowers and Robertson, 1985) for assessment of executive function, Digit Symbol Modalities (Wechsler, 1981) and Grooved Pegboard Test (Kløve, 1963) for psychomotor performance, the Rey Auditory Verbal Learning Test (RAVLT; Rey, 1941) for verbal memory and visuospatial skill (Rey–Osterreich complex figure), and the FAS test (Benton, 1951) for verbal fluency. Two sets of published norms were used: norms from the ALIVE cohort (Concha *et al.*, 1995) for respondents with less than 12 years of school and norms from the MACS cohort (Selnes *et al.*, 1993) for subjects who completed high school. Respondents who did not speak English or who had severe psychiatric disorders, opportunistic infections affecting the

brain, delirium, or severe learning disabilities were excluded.

NEAD enrollment is currently underway at Columbia, Rochester, Northwestern, and Johns Hopkins Universities. At Columbia University, 100 subjects were enrolled in NEAD between 1998 and 2001; these subjects received additional tests of medication management competencies and are the subject of this report. Subjects in the Columbia cohort were recruited from the New York Presbyterian Medical Center Infectious Disease Clinic and from local programs for HIV-infected people. The Columbia University–New York Presbyterian Medical Center Institutional Review Board approved this research.

Two different samples, randomly selected from the Columbia cohort, were assessed in this research. In Study I, a random subset of respondents ($n = 60$), all of whom were taking antiretroviral medications, completed a medication recall diary. In Study II, a second random sample ($n = 58$), only partly overlapping with the first, completed measures of attitudes toward medications and beliefs about medication efficacy. Subjects participating in each substudy did not differ from the other subjects in the parent cohort.

Features of Columbia Cohort

The mean age of respondents in the full Columbia cohort was 41.7 ($SD = 8.5$). Eighty-seven percent were non-White and one third were women. Half had completed high school. Respondents were largely a low-income group and were well connected to HIV-related services. Eighty-five percent were receiving Medicaid services. Related program use included food stamps (68%) and rent subsidies (52%); an additional 18% were receiving medication prescription support through New York's AIDS Drug Assistance Program. Twenty-five percent were attending HIV or substance abuse day programs. Only 10% were working.

In this sample, 18% of men and 6% of women reported they were infected through sharing needles. Thirty-one percent of the men claimed they were infected through homosexual contact and another 24% through heterosexual contact; 60% of the women reported infection through heterosexual contact. About one fourth of both men and women reported they were unsure how they were infected. One third reported current drug use and 92% reported they had used illegal substances in the past.

Table I. Clinical Status of Parent Columbia Cohort

Indicator	Percentage
Cognitive status (% one standard deviation below age and education norm)	
Memory (RAVLT, total)	42
Choice Reaction Time (CALCAP)	25
Grooved Pegboard, dominant hand	30
Grooved Pegboard, nondominant hand	33
Odd Man Out Test	27
Symbol digit	23
Verbal fluency	18
Functional status (% with one or more disability)	
Household activities (IADL[a])	59
Self-maintenance activities (ADL[b])	4
Mental health (%)	
Major depression	11
Minor depression	4
Dysthymia	2

[a] IADL, Traveling to places out of walking distance, shopping, light housework, preparing meals, using telephone, handling money, taking medications.

[b] ADL, Dressing, grooming, bathing, eating, indoor mobility, bed and chair transfer.

Medical Status

At baseline, the median CD4+ count in the sample was 125 (range = 5–300) and the median log-transformed plasma viral load was 4.3 (range was from undetectable to 6.3). Respondents reported they had tested positive for HIV as long as 16 years prior to the study (median = 6.8 years).

The clinical status of the cohort is shown in Table I. Between one fourth and one half of the respondents had scores more than one standard deviation below age- and education-adjusted norms on each cognitive test, consistent with our inclusion criteria. More than one half reported disability in household competencies, such as preparing meals, handling money, shopping, using the telephone, or using public transportation. Less than 5% reported a problem with personal self-maintenance tasks, such as bathing or dressing. Seventeen percent met criteria for major depression, minor depression, or dysthmia, by diagnostic interview (SCID) criteria. However, only a small proportion were receiving home health care services (12% homemaker services, 13% meal services, and 12% visiting nurse services).

Medications

Seventy-four percent of respondents in the parent Columbia cohort had prescriptions for

antiretroviral therapies and in 57% the regimen included a protease inhibitor. Respondents reported a median of five medications (range = 0–23) and 13 pills (range = 0–55) daily. On the visual linear analogue scale representing accuracy of medication management ("How often do you take the right dose of medicines at the right time"), the mean was 88% (range = 0–100% of the time).

STUDY I. EVIDENCE FOR ADAPTATION OF MEDICATION MANAGEMENT STRATEGIES IN PEOPLE WITH COGNITIVE IMPAIRMENT

The aim of Study I was to examine the association between cognitive deficit and both medication accuracy and consistency in taking antiretroviral medications on a set schedule.

Measures

Accuracy in medication taking was assessed with the Medication Management Test (MMT) (Albert *et al.*, 1999). Consistency in medication schedules was assessed with a medication recall diary.

Medication Management Competencies

The MMT is a performance-based test of medication management skill in which respondents are scored according to their ability to interpret prescription label and medication insert information ("medication inference" component) and to dispense five medications from prespecified prescription medication bottles ("pill-dispensing" component). Items in the medication inference component require respondents to perform simple calculations to determine how many days a prescription will last and whether they have missed a dose of medicine based on a pill count. Other items ask respondents to identify particular dosing instructions (i.e., to determine, based on label information, which of the five medicines should be taken with food or may cause drowsiness). In the pill component, subjects are scored on their ability to transfer "pills" (actually dried peas and beans) from prescription bottles to a medication organizer, a box designed to hold 1 week's supply of pills. The test is a reliable measure of medication management skill and has been validated against cognitive status in a number of HIV patient samples (Albert *et al.*, 1999). The MMT has recently been adapted for use with schizophrenia patients (Patterson *et al.*, 2002) and performance on the test was again shown to be significantly associated with cognitive status.

Using the MMT, we calculated a measure of medication accuracy, defined as correct placement of the five medications in the pill-dispensing component of the test. Consistent with MMT guidelines, respondents were told to place pills for each of the five medications for 1 day in the daily medication organizer. Thus, for Medicine A, which involves two pills three times a day, respondents had to place six pills in the organizer. For Medicine E, respondents were told it was to be taken as the situation demands and that they should not place it in the organizer. Because many respondents did not distribute pills across the boxes of the organizer (placing all six "Medication A" pills in one box rather than two pills each in the "morning," "afternoon," and "evening" boxes), we scored as correct any placement of pills, so long as the correct number of pills was placed in the organizer. For each medicine, respondents were scored as correct or incorrect, leading to a count of correct pill dispensing (range = 0–5). We dichotomized this measure to identify respondents who correctly placed all five and those who made at least one error.

Fixity, or Consistency, of Medication Regimens

Along with the MMT, respondents completed a medication recall diary to elicit the times at which they took their antretroviral medication over the 3 days prior to the clinical assessment (Albert *et al.*, 1999). Subjects begin with "yesterday," the day before their clinic appointment, and report when they woke up, when they went to bed for the night, and when they ate meals and snacks. These provide cognitive anchors for the day. They then report the actual time at which they took each of their antiretroviral medicines. We used this measure to establish how consistent respondents were in taking antiretrovirals. Based on the 3-day recall, we coded respondents in one of two ways. They were considered "consistent" if they reported taking their medications at the same time over all 3 days. Thus, someone reporting that they took medicines at 9 a.m., 2 p.m., and 9 p.m. for all 3 days would be considered consistent. We considered someone inconsistent in medication scheduling if there was any variation in medication times from one day to the next. The intent behind this measure was to establish a group that may have developed fixed scheduling to compensate

for cognitive deficits that may make medication adherence difficult.

We examined the following as correlates of medication accuracy and consistency:

Cognitive Status

Performance on each of the eight neuropsychological tests was dichotomized; subjects were considered impaired if they scored at least one standard deviation below age- and education-referenced norms and not impaired if scores were above this score. We did not combine tests because we were interested in specific cognitive deficits relevant for medication accuracy or attempts to compensate for deficit through increased consistency of medication timing.

Sociodemographic Features and HIV Status

Age, education, and gender were entered in all models. We also included the number of medications patients reported and CD4 and viral load status.

Analyses

After calculating descriptive statistics, we developed logistic regression models to examine the association between these predictors and the medication accuracy and consistency outcomes. Odds ratios and 95% confidence intervals were calculated using SPSS. For analyses examining the relationship between neuropsychological performance and medication accuracy, we used the full Columbia NEAD cohort. For analyses involving consistency of medication regimens, we used the subsample of respondents completing the medication recall diary.

Results

Neuropsychological Performance and Medication Accuracy

Table II shows the proportion of respondents correctly placing all five medications in the MMT according to neuropsychological test performance. Respondents with test scores one or more standard deviations below the appropriate norm on psychomotor (Grooved Pegboard) and executive function (Odd Man Out, Symbol Digit) tests were significantly more likely to make errors in pill placement. Other tests showed trends in the same direction. Performance one standard deviation or more below normal was associated with about a 20% reduction in accuracy, or one additional error in pouring the five medications, confirming findings from the MMT development sample (Albert *et al.*, 1999) .

Table II. Neuropsychological Performance, Medication Accuracy, and Medication Consistency

	Correct pill placement[a] (%)	Consistent regimen[b] (%)
Choice Reaction Time		
Normal	64	74
≤1 *SD* below	52	53
Grooved Pegboard–Dominant		
Normal	69	63
≤1 *SD* below	39**	78
Grooved Pegboard–Nondominant		
Normal	69	63
≤1 *SD* below	43**	82
Odd Man Out		
Normal	70	61
≤1 *SD* below	37**	83
RAVLT–Total		
Normal	65	64
≤1 *SD* below	55	73
RAVLT–Copy Figure		
Normal	73	74
≤1 *SD* below	54	50
Symbol Digit		
Normal	66	78
≤1 *SD* below	43*	63
FAS		
Normal	67	69
≤1 *SD* below	33**	64

[a] Percentage with no errors in pouring "pills" in all five medications used in the Medication Management Test.
[b] Percentage reporting that antiretroviral medications were taken at exactly the same time over a 3-day period.
* $p < .05$, ** $p < .01$ by χ^2.

Neuropsychological Performance and Medication Consistency

Table II also shows the association between neuropsychological performance and medication consistency. Sixty-eight percent of respondents reported fixed medication schedules, taking medicines at exactly the same time across all 3 days of the medication recall diary. In unadjusted analyses, medication consistency did not significantly differ according to test

Table III. Cognitive Deficit, Medication Regimen Consistency, and Plasma Viral Load[a]

	Consistent regimen	Inconsistent regimen
Odd Man Out: normal	3.40 (±1.48) $n = 23$	3.83 (±1.26) $n = 16$
Odd Man Out: impaired (<1 *SD* below)	3.54 (±1.65) $n = 14$	4.64 (±0.21) $n = 3$

[a]Cell entries are plasma load (±*SD*). A consistent regimen is defined by report that antiretroviral medications were taken at exactly the same time over a 3-day period.

performance, though respondents with low scores on psychomotor and executive function tests were about 20% more likely to report consistency in medication regimens.

Viral Load and Medication Consistency

Respondents reporting fixed medication regimens showed greater viral suppression. Plasma viral loads (expressed in logarithms) were 3.96 (±1.2) in people with varied regimens ($n = 19$) and 3.45 (±1.2) in people with fixed regimens ($n = 38$). Notably, impaired cognitive performance and inconsistent medication regimens was each associated with poorer viral suppression. As Table III shows, viral suppression was poorest in participants with impaired cognitive performance and inconsistent medication regimens, 4.64 (±0.2), ($n = 3$), and best in people with normal cognition and consistent regimens, 3.40 (±1.5) ($n = 23$). Within each category of cognitive performance, consistent regimens were associated with greater viral suppression. These differences persisted even with adjustment for age, education, and gender in an ANOVA model, and similar results were evident for people with low scores on the grooved pegboard test. Differences did not achieve statistical significance ($p = .15$), however, because of the small sample size and relatively large variance in viral load measures.

Neuropsychological Prediction of Medication Accuracy and Consistency: Adjusted Analyses

Table IV shows results from logistic regression models for the medication accuracy and consistency outcomes. We present results from the final regression model. Sociodemographic features, disease indicators, and self-reported adherence, entered into prior models, were not significant independent predictors of either outcome except for age. Older age was associated with poorer medication accuracy. We include viral load in both models.

The table shows that low scores in certain cognitive domains were associated with the two outcomes. Low scores in executive (Odd Man Out) and psychomotor (Grooved Pegboard) performance were associated with inability to pour all five medications correctly. Scores one standard deviation or lower on the two tests were independently associated with one or more errors in the pill placement component of the MMT. The odds ratios were significant, 6.3 for the Odd Man Out and 6.2 for the Grooved Pegboard, suggesting that the two tests are strong predictors of medication accuracy, though small samples make these point estimates imprecise.

Neuropsychological performance was also associated with self-reports of consistent medication regimens over the prior 3 days. The same two tests were associated with this outcome, though because of small sample size, only performance on the Odd Man Out

Table IV. Neuropsychological Predictors of Medication Accuracy (Medication Management Test) and Consistent Medication Regimen (Diary): Final Model

Risk associated with score ≤*SD* below norm	Odds of one or more errors in pill placement: OR (95% CI) ($n = 86$)	Odds of reporting consistent regimen: OR (95% CI) ($n = 56$)
Pegboard–Dominant	6.2 (2.0, 19.1)**	5.4 (0.9, 31.2)
Choice Reaction Time	2.1 (0.6, 6.8)	0.3 (0.06, 1.1)
Odd Man Out	6.3 (2.0, 20.5)**	8.4 (1.4, 51.5)*
RAVLT–Total	1.3 (0.5, 3.5)	1.4 (0.5, 5.5)
Plasma viral load	1.0 (0.7, 1.4)	0.7 (0.5, 1.2)
Medication accuracy (≥1 error in pill placement)		0.3 (0.06, 1.5)
Model χ^2	20.9, $p = .0008$	13.9, $p = .031$

*$p < .05$, **$p < .01$.

achieved statistical significance. Still, odds ratios were similar in magnitude, 8.4 for Odd Man Out and 5.4 for Grooved Pegboard. This model controlled for medication accuracy, as elicited in the MMT, and viral load. Results suggest that low scores in executive function and psychomotor skill were each associated with greater likelihood of fixed or consistent medication regimens, as defined by self-reports of exactly the same medication schedule over 3 days.

STUDY II. EVIDENCE FOR A PERVASIVE LAY MODEL OF MEDICATION EFFICACY

In Study II, we examined beliefs about medications, including ideas about what makes medicines more or less strong, and correlates of these beliefs. For this effort, we supplemented Columbia cohort respondents ($n = 58$) with an additional 25 non-HIV+ participants, all research or administrative assistants, who were recruited from the Columbia University campus. The non-HIV sample only completed questions on medication efficacy beliefs. We wished to assess the generality of a lay or folk model of medication efficacy that became evident to us as respondents completed the Medication Management Test.

Measures

Medication Beliefs

To elicit general beliefs about medications, we used a modified version of the Beliefs about Medicines Questionnaire (BMQ; Horne *et al.*, 1999a, 1999b). The BMQ consists of a series of statements designed to elicit perceptions of the *need* for prescribed medicines (four items), the *harm* these medicines may cause (four items), potential *concerns* about taking such medicines (two items), and whether physicians *overuse* prescriptions (two items). Representative items include, "My life would be impossible without medications" (need), "I sometimes worry about the long term effects of my medication" (concern), "Most medicines are addictive" (harm), and "Doctors use too many medications" (overuse). Horne and colleagues (1999a) showed that higher perceived "need" is associated with greater self-reported medication adherence in a number of groups of chronic disease patients. For this research, we converted the BMQ measure to a dichotomous true–false format.

Perceptions of Medication Potency or Efficacy

We supplemented the medication belief inquiry with additional items designed to assess perceptions of medication efficacy. These questions emerged from a qualitative analysis of responses to one question in the MMT, which asks respondents to examine label information and identify "which of these five medications, if any, would be likely to make you drowsy." To answer the question correctly, respondents need to read labels on the bottles and find the one bottle with a red sticker. The sticker states that the medicine may cause drowsiness and that alcohol may intensify this effect. However, many respondents failed to notice the sticker. Confronted with the challenge of answering the question, these respondents systematically reread the prescription labels, noted the number of milligrams in each medicine, and chose as the correct answer the medication with the most milligrams.

This pattern was independently observed by different members of the research team and led us to record statements made by respondents as they attempted to answer this question. They justified their answers in these terms: "I would say this one, because it's 200 mg." "This one's got the most milligrams." "This one; it's the strongest [because it has 200 mg]. Probably need to take it with food, too." These wholly unanticipated remarks suggested the presence of a lay or folk model of medication efficacy, in which the medicine with the greatest number of milligrams—even across different classes of medication—was considered to be the strongest and hence most likely to produce consequences associated with potent medications, such as drowsiness, need to be taken with food, and greater likelihood of addiction.

We designed a questionnaire to investigate this lay understanding of medication efficacy in more detail. The questionnaire converted respondent statements into structured items. The questions, in simple true-or-false format, asked respondents to consider two *different* medicines, one a 2-mg medicine and the other a 100 mg medicine. They were then asked four questions: Which of the two is stronger, more likely to need to be taken with food, more likely to make someone drowsy, and more likely to be addicting? Answering "true" to each item was taken as an indication of the extent to which people accepted this lay or folk model of medication efficacy. Indeed, the four questions formed a reliable scale (Cronbach $\alpha = .78$), suggesting that respondents think about medication efficacy or potency in a consistent way. Thus, the 4-item scale described above was used as a simple sum,

ranging from 0 to 4. "Don't know" or "unsure" answers were scored as "false," a conservative approach to scoring.

Analyses

For Study II, we examined the proportion of subjects endorsing the belief that 100-mg medicines are stronger than 2-mg medicines. We also examined correlates of this belief.

Results

A majority of HIV+ patients in the sample, 72.4% (42/58), reported that a 100-mg medicine is stronger than a 2-mg medicine. Similar proportions reported that the 100-mg medicine would be more likely to cause drowsiness and be addictive and also need to be taken with food. In the non-HIV sample, 28% of respondents reported that the 100-mg medicine was the stronger of the two. The difference in proportions was highly significant ($p < .001$). In the HIV sample, endorsement of this efficacy belief, based on the 4-item composite described earlier, was not significantly associated with education (within the restricted range of education in the sample), cognitive status, or features of HIV (CD4+ count, route of infection, duration of HIV).

Table V shows correlations between medication beliefs, efficacy beliefs, and pill placement accuracy in the HIV sample. Two correlations in this sample reached statistical significance. Concern about medications (worry about becoming dependent on medications and their long-term effect) was significantly correlated with beliefs that physicians rely too heavily on prescriptions ($r = .36$, $p < .01$). Concern about medications was also associated with fewer errors in the pill placement component of the Medication Management Test ($r = .52$, $p < .001$). That is, the more concern respondents reported with regard to medicines, the more careful they were in pouring medications in the MMT.

Table V. Relationship Between Medication Beliefs, Efficacy Beliefs, and Pill Placement Accuracy

	1	2	3	4	5
Medication beliefs					
1. Concern					
2. Harm	.26				
3. Overuse	.26	.36*			
4. Necessity	.19	.02	.07		
Medication efficacy beliefs					
5. Potency	.20	.07	.03	.11	
Medication accuracy					
6. Pill accuracy	.51**	.05	.02	.16	.08

*$p < .01$, **$p < .001$.

DISCUSSION

People with cognitive deficits, particularly in executive and psychomotor skills, were less likely to be accurate in pouring medicines and, perhaps as a result, were more likely to adopt fixed regimens for medication management. Given the high prevalence of many other cognitive deficits in the sample, this may suggest that the two domains are especially important for this domain of behavior. Although the association between low scores in these cognitive domains and errors in pill placement has been reported (Albert *et al.*, 1999; Patterson *et al.*, 2002), the association between low cognitive performance and fixed medication regimens has not, to our knowledge, been reported before.

This association is plausible: People with cognitive impairment are counseled to standardize the way they take medicines, use reminding devices, and develop daily schedules that build medication taking into particular routines. The association is also reassuring, as it suggests that people with HIV-associated cognitive deficits are more likely to adopt such standardization either because they find it an effective way to ensure adherence or because others have suggested they do so.

An alternative explanation is that people with cognitive impairment are simply more likely to report a single, simple schedule for medication taking when completing the medication diary. Though we cannot rule this explanation out, it does not seem plausible for a number of reasons. First, we find an association between fixed medication schedules and only certain cognitive domains. If the association were the result of a reporting bias based on cognitive impairment, we would expect to see the association for all cognitive domains and especially for the memory measure. Second, given the social context for medication counseling and current support for patients with cognitive impairment, it seems far more likely that these patients would be encouraged to develop fixed medication regimens, as these data show.

Viral loads were lower in people who reported fixed medication regimens and this difference was most apparent in people with impaired cognitive performance. For people less than one standard deviation

below norms on the Odd Man Out, the mean viral load was 4.64 in people with varied regimens and 3.54 in people with fixed regimens, a full log lower. Thus, a fixed medication regimen appears to be an effective adaptive strategy for medication management in the presence of cognitive impairment.

A limitation of Study I is the measure of medication consistency, our proxy for fixity in medication scheduling. We defined only two states; respondents were divided into those who took their medicines on exactly the same schedule each day and those who showed any variation in scheduling over the 3 days of the medication recall diary. A more sensitive measure would identify variation in the degree of consistency. With such a measure, we might expect to see a dose–response relationship, with increasing cognitive impairment associated with increasingly fixed medication management regimens. However, it is difficult to define intermediate states for consistency of medication scheduling.

In Study II, we inadvertently elicited a widely shared lay understanding of medication strength: the more milligrams, the stronger the medicine, even across different classes of medicine. Respondents assumed that medicines with higher milligram dosages were more likely to be addictive, more likely to need to be taken with food, and more likely to produce side effects such as drowsiness. More than three fourths of the HIV sample endorsed the belief, but the belief was also common among more-educated university employees, with 28% endorsing the belief. This lay model of medication strength or presumed efficacy is not limited to people with low education, and, indeed, was not associated with education or cognitive ability in the HIV sample. Also, endorsing the model was not associated with concern about taking medications, the sense that doctors overprescribe, the extent to which people assume that medications ensure their health, or the sense that medicines may cause harm. We conclude that it is a lay or folk medical belief worthy of separate medical anthropological investigation.

Concern about medication taking, defined here as worry that one may become dependent on medications or that medicines may have long-term negative effects, was associated with medication accuracy, that is, the care with which patients poured medicines in the MMT. This is an important finding. Patients who view medicines as potentially dangerous appear to handle them with more care; they take greater pains to understand and follow medication directions.

In conclusion, this research has shown that cognitive deficit in people with HIV is associated with greater risk of error in pouring medications but also greater likelihood of medication regimens that may compensate for such error. We have also uncovered a lay understanding of medication strength that is inappropriately generalized across different classes of medicine. The relevance of this belief for medication regimens and nonadherence requires further research.

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