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Effect of format on comprehension of adherence data in chronic disease: a cross-sectional study in HIV

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Abstract

Objective—To determine which formats communicate medication adherence effectively to patients.

Methods—HIV-infected adults on antiretrovirals viewed examples of refill data in 5 formats: (1) percentage of doses, (2) number of days late to refill (“days late”), (3) calendar of days with/without medications, (4) pie chart of days with/without medications, and (5) letter grade. Five scenarios (>95%, 90–95%, 80–90%, 70–80% and <70% adherence) were presented in each format. Participants rated scenarios on adherence improvement needed. “Good understanding” was 4 of 5 scenarios correct. We calculated odds ratios for “good understanding” using logistic regression with percentage as the referent format.

Results—124 participants were median age 48.5, 65% Black, 71% male. Understanding of all formats differed by education (all interaction p values<0.02). For 12 years education, odds ratios (OR) of understanding (95% CI) compared to percentage were: *days late* 3.3 (2.3–4.7), *calendar*

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Conflict of Interest Disclosure

Dr. Gross served on a Data and Safety Monitoring Board for tofacitinib, a Pfizer product unrelated to the treatment of HIV.

Author Contributions

Conceptualization and design: RG, AL

Implementation and data collection: AL, JH

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3.1 (2.2–4.3) *pie chart* 2.0 (1.4–2.7), and *letter grade* 1.8 (1.3–2.5) For >12 years education, ORs were: *days late* 1.3 (0.9–2.0), *calendar* 2.4 (1.5–3.8), *pie chart* 2.9 (1.8–4.6), and *letter grade* 1.7 (1.1–2.6). Calendar plot was most preferred.

Conclusions—Adherence percentage was the least understood format regardless of education.

Practice Implications—Calendars should be used to convey adherence information.

Keywords

Medication adherence; Health communication; Health numeracy; Patient preferences; HIV/AIDS

1. Introduction

Failure to adhere to prescribed medications is a major cause of morbidity among patients with any chronic disease. Medication adherence is especially important in HIV disease, where poor adherence can lead to viral mutations and the need for ever more complex, burdensome medication regimens[1–3]. Forgetting to take doses is the most commonly cited reason for non-adherence[4]. Thus, it stands to reason that an individual forgetting doses might not be aware of their own non-adherence.

Recent studies have suggested that a simple way to improve adherence may be to inform patients of how well they are taking their medications. A randomized controlled trial of Managed Problem Solving in HIV patients used feedback of electronically monitored adherence data along with counseling when adherence was suboptimal[5]. Participants in the experimental arm had significantly better adherence and virologic outcomes than usual care controls. Similarly, children with asthma whose adherence to daily inhalers was measured through an electronic monitoring device and told to them had better subsequent adherence[6].

Both these studies employed electronic drug monitoring, a highly accurate form of adherence measurement, but one which is impractical on a large scale[7]. Fortunately, a simpler form of adherence measurement exists: pharmacy refill data. Pharmacy refill data has been well validated to correlate both with actual medication adherence and disease outcomes[8–10]. A commonly used method of describing adherence is the medication possession ratio, which is the calculated proportion of days a patient has been in possession of their medications, reported as a percentage[11, 12].

However, no evidence exists on how well patients understand this type of adherence data. In the US, quantitative literacy, the ability to interpret numerical data, has been shown to be basic in 33% and below basic in 22% of the population[13]. Studies have shown that even highly educated adults have relatively poor understanding of percentages with nearly 20% of educated adults unable to understand simple risk percents[14]. We therefore hypothesized that understanding of the adherence percentage would be poor. The aim of this study was to assess HIV patients' comprehension of adherence data, analyze factors affecting understanding, and identify better understood presentation formats.

2. Methods

2.1. Setting and Participants

We conducted a cross-sectional study between November 2012 and March 2013 at the MacGregor Infectious Diseases Clinic at the Hospital of the University of Pennsylvania where approximately ten different HIV providers care for patients. The study was approved by the University of Pennsylvania IRB and written informed consent was obtained from all participants.

Participants had to be 18 years of age, HIV-infected and receiving combination antiretroviral therapy for at least three months at the time of survey. Patients were excluded if they could not consent to participate or if they lived in a care facility where their medications were dispensed to them. On recruitment days, we approached all patients in the waiting area of the HIV clinic and invited them to be evaluated for eligibility to participate. If they agreed, participants chose to complete the survey on their own or have it administered by study personnel.

2.2. Comprehension of Adherence Percentage

Participants were first presented with a list of ten adherence percentages (75%, 30%, 100%, 60%, 91%, 50%, 86%, 10%, 97%, and 82%). They were asked to consider for each percentage “how much improvement in adherence would be needed to have the best chance of suppressing the HIV viral load.” The categories were based on prior HIV research [15] and classified as: (1) Excellent: minimal to no improvement needed, (2) Very Good: needs small improvement, (3) Good: needs some improvement, (4) Fair: needs much improvement, and (5) Poor: needs major improvement. The adherence range corresponding to each category is displayed in the first data column of Table 1.

2.3. Comprehension of Alternative Presentation Formats

Participants were presented with adherence data in one of four alternative formats. The formats were (1) number of days late to refill (“days late”), (2) calendar plot, (3) pie chart and (4) letter grade. These formats were chosen to represent a broad range of numerical, visual, and temporal options. Letter grade was chosen as a subjective presentation format with no numerical values, patterned on the International Association of Providers in AIDS Care (IAPAC) adherence scale [16]. Examples of the formats are displayed in Figure 1.

Five hypothetical degrees of adherence (corresponding to medication possession ratios of 50%, 75%, 86%, 91%, and 97%) were presented in each of these formats in a mixed order that did not follow a pattern and was identical for each participant. The same categories from excellent to poor were again used to categorize adherence for these alternative formats. The categories and their corresponding values for days late and letter grade are displayed in Table 1, data columns 2 and 3, respectively. Participants were also asked which format they preferred and why.

2.4. Scoring of Participant Answers

Participants' answers to the percentage and alternative format presentations were considered "correct" if they matched or exceeded the classification scheme. For example, classifying 97% adherence as only "fair" rather than "excellent" was still considered correct because it meant the participant thought adherence should be higher than the amount presented. An incorrect answer was one which overestimated the level of adherence. "Good understanding" was defined as a score of 80% correct on the percentage format.

2.5. Other Measures

Participants self-reported their age, sex, race, ethnicity, income, highest level of education completed, and all the pharmacies they had used previously. Numeracy was assessed using the Subjective Numeracy Scale (SNS), an 8-question self-report of ease with numbers and preferences for data presentation with total score ranging from 8–48[17]. CD4 count was assessed as a marker of clinical status and plasma HIV RNA (viral load) was assessed as a marker of response to treatment; both were obtained via chart review. The most recent value obtained between six months prior to and 2 weeks following the survey date was included. Viral load <75 copies/mL was considered "undetectable" as this was the upper limit of quantification of the least sensitive test included.

Participants' actual antiretroviral adherence was measured by calculating the medication possession ratio for an index antiretroviral drug for their most recent 90 days' supply prior to study. The index drug was defined as the protease inhibitor, or alternatively, the non-nucleoside analog reverse transcriptase inhibitor. All of the patient's recently used pharmacies were called to obtain the refill dates. The most recent 4 refill dates were used to calculate the medication possession ratio according to the formula: $90 \text{ doses} / (\# \text{ days between the 1}^{\text{st}} \text{ and 4}^{\text{th}} \text{ fill}) \times 100$ [11]. For patients with only 2 or 3 refills in the previous 5 months, it was still calculated as above with 30 and 60 doses, respectively, yielding maximum values of 50% and 75%. Patients with only 1 refill in past 5 months were considered to have 25% adherence and those with no refills at any of their pharmacies were assigned 0% adherence. For participants with 90 day prescriptions, pharmacies were asked for the last 2 fill dates in the previous 8 months and adherence was calculated as $90 \text{ doses} / (\# \text{ days between 1}^{\text{st}} \text{ and 2}^{\text{nd}} \text{ fill}) \times 100$. Participants' actual adherence was assessed as a continuous variable (0–100%).

2.6. Statistical Analyses

In unadjusted analyses, dichotomous risk factors for poor understanding were compared using chisquared tests. Continuous variables were compared between those with and without poor understanding using Wilcoxon rank sum tests. Education was categorized as 12 years and 13 or more years. In multivariable models using logistic regression, we assessed the relation between participant characteristics and understanding of adherence data. We included all variables in the model if they were related to understanding with a p value <0.1. In these models, participants' actual adherence was categorized as described for 'percentage' depicted in Table 1. We also tested for effect modification of the relation between format and understanding by education level by including the interaction term education*format in the logistic regression models because we considered education-level to

be directly related to ability to understand data. Effect modification was considered present if the p value for the interaction term was <0.05 .

To compare the different formats, the score for each format was calculated as outlined above for the evaluation of “understanding.” We calculated the odds ratios and 95% confidence intervals for understanding each of the formats better than understanding percentage as the referent category using logistic regression. We stratified these analyses by education level given the evident difference in the education level between those with and without good understanding. We did not control for demographics characteristics in these analyses since we did not conceptualize these variables as intrinsically related to ability to understand the different formats.

2.7. Sample Size Considerations

We targeted enrollment of approximately 200 participants with the goal of detecting a 20% difference in understanding across formats, assuming that approximately 40% of participants would have low numeracy scores and 50% would have good understanding of the adherence percentage hypothetical scenario questions.

3. Results

3.1. Description of Study Population

We stopped enrollment at 124 participants due to time constraints and prior to any data analysis. Participants were predominantly male (71%), Black (65.3%) with median age 48.5 (Table 2). These closely matched baseline clinic characteristics.

Most participants had completed high school (89%), and about half had some advanced education. Income level was relatively low, but varied. A majority had undetectable viral loads and CD4 counts were well above the range associated with most opportunistic infections. As expected, participants with plasma HIV RNA <75 copies/ml had significantly better medication adherence than those with ≥ 75 copies/ml (83.7% adherence vs. 72% adherence, $p=0.043$). Only 43% of the cohort had good understanding of adherence percentage.

3.2. Factors Associated with Understanding

Table 3 presents unadjusted and adjusted assessments of various factors associated with poor understanding on the adherence comprehension test. In the adjusted analyses, only Black race and poor adherence were significantly associated with poor understanding of adherence information. Education level ≥ 12 years approached significance, with the 95% CI barely crossing 1.0. Low numeracy initially appeared to be significant, but there was no longer an association when we controlled for education level.

3.3. Understanding Varied by Format of Data Presentation

Table 4 shows performance on each of the different presentation formats, as compared to adherence percentage and stratified by education level, but unadjusted for other characteristics. The calendar plot was the best understood format in general: 71 (56%)

participants scored 100% and 94 (75%) scored 80%. Percentage was the least well understood: only 36 (29%) scored 100% and 59 (48%) scored 80%. Across education levels, all formats were significantly better understood than percentage, with the exception of days late, which was not associated with greater odds of understanding for the more educated group only.

3.4 Patient Preferences for Presentation Format

Most patients chose calendar (40.7%) or letter grade (24.4%) as their favorite format for receiving adherence data. Less preferred options were days late (14.6%), percentage (10.6%), and pie chart (9.8%). Commonly cited reasons for preferring the calendar were (1) familiarity: “shows it more clearly, in everyday terms”, “I have a calendar in front of me every day”, and (2) visual quality: “gives you a visual snapshot of the entire month”, “harder to misinterpret because there's no reading (involved)”. A frequent complaint regarding percentage and pie chart was difficulty in comprehension: “a lot of people don't understand percentages, percent of what?”, “I don't understand percents!”, and “Percentage... does not mean much to me.” The minority who preferred percentage or pie chart generally appreciated its precision.

All but 6 (5%) participants achieved good understanding (80% correct) on at least one format. Preferred format and best understood format did not match for 52 (42.3%) of participants. Among the participants with discordant “favorite” and “best understood” formats, 42% still demonstrated good understanding on their favorite format despite performing better on another format. 31 (25.2%) participants had poor understanding of their favorite format and performed better on other formats. The number of participants who understood their favorite format (90/123, 73.2%) was similar to the number that understood the calendar (94/124, 75.8%). Combining calendar and days late increased the number who understood to 105 (84.7%).

4. Discussion and Conclusions

4.1. Discussion

Our results demonstrate that understanding of medication adherence percentage is poor, regardless of education level. Nearly every other format tested was associated with better understanding. Calendar plot stood out as well-understood by both education levels and was the most preferred format, with patients appreciating its “real life” application. In contrast, adherence percentage was the least preferred format, with patients reporting difficulty in interpreting it. Somewhat surprisingly, the letter grade, which was designed to be the easiest to interpret, requiring no mathematical knowledge, did not fare as well and was seen as arbitrary and imprecise by many participants. Although the calendar format functioned the best overall, presenting adherence data in multiple ways increased the probability of understanding one of them. Interestingly, participants did not reliably identify their best understood format as their preferred format. This indicates that patient preference cannot be used as the primary means of ensuring universal understanding of adherence data.

Studies from the literature on communicating risk information indicate that quantitative data (percentages, frequencies) is poorly interpreted and recalled by the general population. In one study, women were able to more accurately estimate their risk of breast cancer using general categories (“higher than average”) rather than risk frequencies (“1 in 1000”). The participants’ risk frequency estimate had almost no relation to their actual risk [18]. In another study, patients who were counseled by their doctor on risk of stroke associated with foregoing carotid endarterectomy exhibited very poor recall of this information. The mean recalled stroke risk was 57% compare to actual mean risk of 22% [19]. One explanation for the limited efficacy of numerical descriptions of risk may be “fuzzy trace theory” [20]. In simplified terms, this theory of cognition asserts that humans tend to form a “gist” impression when confronted with information, rather than memorize numerical data. These gists are used later to make decisions. Applying this to our study, it may be that formats that allow patients to quickly develop a “gist” for the adherence level – such as a calendar with red/green days-may convey more meaning that is then retained better than a pure number like percentage.

Another potential explanation for the calendar plot communicating the information best is the concept of cognitive load [21]. The behavior we assessed is essentially days with missed doses. Of the presentation formats, only calendar plot and days late do not convert this number into another metric. By converting the data into other metrics such as percents, pie charts, or letter grades, these formats tax the individuals’ cognitive resources. By concretely presenting days, the calendar plot reduces the number of cognitive operations required to understand the information and thus has less cognitive load. Studies looking at the role of graphs or pictures in presenting risk have been mixed. Multiple studies have found patients prefer and understand risk best when communicated pictorially or graphically[22– 25]. However, not all graphs are easily understood or preferred. For example, in a study conveying risk reduction of medications for Crohn’s disease, the visual Cates Plot was less convincing and less preferred by participants[26]. Another small study of prenatal screening data found that patients with low numeracy actually did better with a frequency rather than visual schema[27]. This may be due to the fact that numeracy and graphicacy are correlated[28], so the design of the graph or picture is just as crucial to understanding.

Our results also suggest that certain groups of patients are at particular risk for poor understanding of adherence percentage, including those with lower levels of education and Black race. These same groups were also found to have lower adherence levels, indicating that they are the patients who may benefit from adherence interventions. In addition, poor adherence itself was independently associated with lack of understanding of adherence data. In the literature, health literacy has been weakly associated with adherence[29]. Our results suggest that understanding adherence information may be a crucial component of practicing good adherence. Patients who think that 50% adherence is “good” may therefore take their medication 50% of the time. Alternatively, they may be basing their interpretation on their own experience: i.e., “I seem to be doing ok and I only take my medicine 50% of the time, so 50% must be an okay amount.” Either way, understanding of adherence information and actual adherence appear to be linked, which should be considered in designing informational components of adherence interventions.

Strengths of this study included a heterogeneous participant group of varying races, age, income, education, and adherence levels. Since HIV is a chronic generally asymptomatic disease, we believe these results are likely generalizable to other conditions such as hypertension or diabetes. An additional strength was the correlation between viral load and adherence level, indicating that our method of measuring medication adherence was likely to be valid. We did not reach goal sample size, but still found significant differences between formats which may have been amplified by a larger sample. The major limitation of the study is that the participants were presented with hypothetical data; it is unclear how their interpretation would change when presented with their own adherence data. Additionally, we did not repeat the assessment over time to determine if patients improve (or get worse) in their interpretation of the information. We also did not measure health literacy, but this may play an important role in affecting understanding. Since the patients had many different providers, we were unable to control for the provider-patient interaction, although it is unlikely that provider-delivered information regarding adherence would differ systematically by format and thus bias our results. Finally, our scoring of participant responses was based on widely accepted HIV adherence categories. This issue might limit generalizability since little information exists in other diseases regarding levels of adherence needed for optimal disease control. However, it is unlikely that the communication efficacy of the various formats would differ greatly by disease and treatment.

4.2. Conclusions

Regardless of education level, patients' understanding of adherence percentage is poor. Alternative formats, specifically calendar plot, are identified as more meaningful and preferred methods to communicate HIV medication adherence information.

4.3. Practice Implications

Clinicians, researchers, and pharmacists involved in HIV and other chronic disease care, who have access to objective adherence information such as pharmacy refill data, should strongly consider the use of calendar plots to present adherence data to their patients. While it may seem that tailored calendar plots would be cumbersome to construct, because only a finite number of potential values occur (e.g., missing 1 day, missing 2 days, etc.), a pre-prepared menu of calendar plots describing each magnitude of adherence could be created for use with all patients.

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References

1. Bangsberg DR, Acosta EP, Gupta R, Guzman D, Riley ED, Harrigan PR, et al. Adherence-resistance relationships for protease and non-nucleoside reverse transcriptase inhibitors explained by virological fitness. *AIDS*. 2006; 20:223–231. [PubMed: 16511415]
2. Gross R, Bilker WB, Friedman HM, Strom BL. Effect of adherence to newly initiated antiretroviral therapy on plasma viral load. *AIDS*. 2001; 15:2109–2117. [PubMed: 11684930]
3. Nachega JB, Hislop M, Dowdy DW, Chaisson RE, Regensberg L, Maartens G. Adherence to nonnucleoside reverse transcriptase inhibitor-based HIV therapy and virologic outcomes. *Ann Intern Med*. 2007; 146:564–573. [PubMed: 17438315]
4. Reynolds NR, Testa MA, Marc LG, Chesney MA, Neidig JL, Smith SR, et al. Factors influencing medication adherence beliefs and self-efficacy in persons naive to antiretroviral therapy: a multicenter, cross-sectional study. *AIDS Behav*. 2004; 8:141–150. [PubMed: 15187476]
5. Gross R, Bellamy SL, Chapman J, Han X, O'Duor J, Palmer SC, et al. Managed problem solving for antiretroviral therapy adherence: a randomized trial. *JAMA Intern Med*. 2013; 173:300–306. [PubMed: 23358784]
6. Burgess SW, Sly PD, Devadason SG. Providing feedback on adherence increases use of preventive medication by asthmatic children. *J Asthma*. 2010; 47:198–201. [PubMed: 20170329]
7. Wendel CS, Mohler MJ, Kroesen K, Ampel NM, Gifford AL, Coons SJ. Barriers to use of electronic adherence monitoring in an HIV clinic. *Annals of Pharmacotherapy*. 2001; 35:1010–1015. [PubMed: 11573846]
8. Gross R, Yip B, Lo Re V 3rd, Wood E, Alexander CS, Harrigan PR, et al. A simple, dynamic measure of antiretroviral therapy adherence predicts failure to maintain HIV-1 suppression. *J Infect Dis*. 2006; 194:1108–1114. [PubMed: 16991085]
9. Grossberg R, Zhang Y, Gross R. A time-to-prescription-refill measure of antiretroviral adherence predicted changes in viral load in HIV. *J Clin Epidemiol*. 2004; 57:1107–1110. [PubMed: 15528063]
10. Nachega JB, Hislop M, Dowdy DW, Lo M, Omer SB, Regensberg L, et al. Adherence to highly active antiretroviral therapy assessed by pharmacy claims predicts survival in HIV-infected South African adults. *J Acquir Immune Defic Syndr*. 2006; 43:78–84. [PubMed: 16878045]
11. Steiner JF, Prochazka AV. The assessment of refill compliance using pharmacy records: methods, validity, and applications. *J Clin Epidemiol*. 1997; 50:105–116. [PubMed: 9048695]
12. Sikka R, Xia F, Aubert RE. Estimating medication persistency using administrative claims data. *Am J Manag Care*. 2005; 11:449–457. [PubMed: 16044982]
13. Kutner, M.; Greenberg, E.; Jin, Y.; Boyle, B.; Hsu, Y.; Dunleavy, E. *Literacy in Everyday Life: Results From the 2003 National Assessment of Adult Literacy*. Education USDo. , editor. Washington, DC: National Center for Education Statistics; 2007.
14. Lipkus IM, Samsa G, Rimer BK. General performance on a numeracy scale among highly educated samples. *Med Decis Making*. 2001; 21:37–44. [PubMed: 11206945]
15. Paterson DL, Swindells S, Mohr J, Brester M, Vergis EN, Squier C, et al. Adherence to protease inhibitor therapy and outcomes in patients with HIV infection. *Ann Intern Med*. 2000; 133:21–30. [PubMed: 10877736]
16. Amico KR, Zuniga JM, Wilson IB, Gross R, Young B. Provider guidance for linking patients to antiretroviral therapy adherence interventions: recommendations from an IAPAC advisory committee on adherence monitoring and support. *J Int Assoc Provid AIDS Care*. 2013; 12:79–83. [PubMed: 23520402]
17. Fagerlin A, Zikmund-Fisher BJ, Ubel PA, Jankovic A, Derry HA, Smith DM. Measuring numeracy without a math test: development of the Subjective Numeracy Scale. *Med Decis Making*. 2007; 27:672–680. [PubMed: 17641137]
18. Woloshin S, Schwartz LM, Black WC, et al. Women's perceptions of breast cancer risk: how you ask matters. *Med Decis Making*. 1999; 19:221–229. [PubMed: 10424829]
19. Lloyd AJ, Hayes PD, Bell PRF, et al. The role of risk and benefit perception in informed consent for surgery. *Med Decis Making*. 2001; 21:141–149. [PubMed: 11310947]

20. Brainerd CJ, Reyna VF. Gist is the grist: Fuzzy-trace theory and the new intuitionism. *Developmental Review*. 1990;3–47.
21. Sweller J, van Merriënboer J, Paas F. Cognitive Architecture and Instructional Design. *Educational Psychology Review*. 1998; 10:251–296.
22. Garcia-Retamero R, Galesic M. Who profits from visual aids: overcoming challenges in people's understanding of risks [corrected]. *Soc Sci Med*. 2010; 70:1019–1025. [PubMed: 20116159]
23. Tait AR, Voepel-Lewis T, Zikmund-Fisher BJ, Fagerlin A. The effect of format on parents' understanding of the risks and benefits of clinical research: a comparison between text, tables, and graphics. *J Health Commun*. 2010; 15:487–501. [PubMed: 20677054]
24. Goodyear-Smith F, Kenealy T, Wells S, Arroll B, Horsburgh M. Patients' preferences for ways to communicate benefits of cardiovascular medication. *Ann Fam Med*. 2011; 9:121–127. [PubMed: 21403138]
25. Goodyear-Smith F, Arroll B, Chan L, Jackson R, Wells S, Kenealy T. Patients prefer pictures to numbers to express cardiovascular benefit from treatment. *Ann Fam Med*. 2008; 6:213–217. [PubMed: 18474883]
26. Selinger CP, Kinjo Y, Jones DB, Katelaris P, Chapman G, McDonald C, et al. Conveying medication benefits to ulcerative colitis patients and effects on patient attitudes regarding thresholds for adherence. *J Crohns Colitis*. 2013; 7:e312–e317. [PubMed: 23219354]
27. Miron-Shatz T, Hanoch Y, Graef D, Sagi M. Presentation format affects comprehension and risk assessment: the case of prenatal screening. *J Health Commun*. 2009; 14:439–450. [PubMed: 19657924]
28. Brown SM, Culver JO, Osann KE, MacDonald DJ, Sand S, Thornton AA, et al. Health literacy, numeracy, and interpretation of graphical breast cancer risk estimates. *Patient Educ Couns*. 2011; 83:92–98. [PubMed: 20554149]
29. Zhang NJ, Terry A, McHorney CA. Impact of health literacy on medication adherence: a systematic review and meta-analysis. *Ann Pharmacother*. 2014; 48:741–751. [PubMed: 24619949]

Highlights

- Percent of doses taken as a measure of adherence was poorly understood by patients
- Level of education was associated with understanding of adherence data feedback
- Best understood format was calendar plot of number of days in a month missing doses

Figure 1. Adherence Data Presentation Formats

In this example, 75% adherence is presented in the five different formats used in the study.

For the calendar, a patient who fills the 30-day prescription on January 1st and next on February 10th has a medication possession ratio of $30 \text{ pills} / 40 \text{ days} \times 100 = 75\%$. The letter grade scale was designed to be purely visual and based on commonly used school cut-offs (A+ 95%, A 90–94%, B 80–89%, C 70–79%, D <70%).

Table 1

Scoring scheme for adherence data classification for percentage, number of days late and letter grade formats.

Classification	Percentage	Days Late	Letter grade
Excellent-minimal to no improvement needed	95%	0–1	A+
Very good—needs small improvement	90–94%	2–3	A
Good—needs some improvement	80–89%	4–7	B
Fair—needs much improvement	70–79%	8–12	C
Poor – needs major improvement	<70%	13	D

Table 2

Participant characteristics, stratified by performance on adherence percentage comprehension test

	All participants (n=124)	Good understanding of adherence data (n= 53)	Poor understanding of adherence data (n=71)	p-value
Median Age (IQR)	48.5 (40.5–55)	47 (40–55)	50 (41–55)	>0.5
Sex				
Male	88 (71.0%)	39 (73.6%)	49 (69.0%)	>0.5
Ethnicity				
Hispanic	5 (4.0%)	3 (5.7%)	2 (2.8%)	0.43
Race				
Black	81 (65.3%)	25 (47.2%)	56 (78.9%)	0.001
White	42 (33.9%)	27 (50.9%)	15 (21.1%)	
Other	1 (0.8%)	1	0	
Years of Education				
12	60 (48.8%)	16 (30.2%)	44 (62.0%)	0.001
13+ years	63 (51.2%)	36 (67.9%)	27 (38.0%)	
Income				
<\$30,000/yr	82 (66.7%)	30 (56.6%)	52 (73.2%)	0.071
>\$30,000	41 (33.3%)	22 (34.9%)	19 (26.8%)	
Median Subjective Numeracy Scale Score (IQR)	34 (26–42)	38 (30–43)	29 (25–40)	0.0375
HIV RNA Viral Load				
< 75 copies/mL	104 (85.2%)	45 (84.9%)	59 (83.1%)	>0.5
Median CD4 Count (IQR)	575 (365–778)	540 (369–758)	585 (363–816)	>0.5
Median Actual Medication Possession Ratio (IQR)	81.85 (52.45–98.9)	93.8 (75–100)	75 (50–92.8)	0.002

Table 3

Multivariable model of association between participant characteristics and understanding of adherence percentage.

	OR of understanding adherence percentage (unadjusted) (95% CI)	OR of understanding adherence percentage (adjusted) [*] (95% CI)
African American Race	0.24 (0.11–0.52)	0.39 (0.16–0.92)
12 years	0.27 (0.13–0.58)	0.44 (0.19–1.01)
SNS score (per 10 unit increase)	1.49 (1.01–2.18)	1.06 (0.67–1.66)
Adherence Category (per single category increase)	1.42 (1.14–1.77)	1.28 (1.01–1.62)

^{*} model included income

Table 4

Relation of understanding of each format compared to understanding of adherence percentage stratified by education level.

Presentation Format	OR of good understanding (95% CI)	
	Education 12 th grade (N=60)	Education >12 th grade (N= 63)
Percentage (base case)	1.0	1.0
Days Late	3.3 (2.3–4.7)	1.3 (0.9–2.0)
Calendar Plot	3.1 (2.2–4.3)	2.4 (1.5–3.8)
Pie Chart	2.0 (1.4–2.7)	2.9 (1.8–4.6)
Letter Grade	1.8 (1.3–2.5)	1.7 (1.1–2.6)